NEW SOUTH WALES

ANNUAL PLANNING REPORT

2009

TransGrid

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Executive Summary

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 timely identification of emerging constraints facilitates the development and implementation of appropriate and timely network solutions to them.

Publication of the Annual Planning Report is one aspect of a comprehensive framework to deliver on reliability obligations in New South Wales.

Development of the New South Wales transmission network is driven by four main factors:

i Continuing customer electricity demand growth in NSW;

ii Replacement of ageing assets;

iii The pivotal role of the NSW network in facilitating the National Electricity Market; and

iv The effectiveness of demand management (DM) initiatives in attempting to reduce electricity demand.

Load and Energy Growth

Energy use in NSW has increased at about 1222 GWh per annum over the past ten years.

Over a similar period peak summer demand has increased by an average of about 385 MW per annum and peak winter demand by an average of about 297 MW per annum. This level of growth has continued despite concerted efforts to curb demand through DM initiatives. Although substantial policy change is proposed that may dampen future load growth options still need to continue to be developed to meet the expected residual demand growth to ensure reliability of supply to support the expected economic and population growth of New South Wales.

Demand Management and Local Generation

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.

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'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. Specific Requests for Proposals for DM and local generation alternatives have been issued for a number of areas.

In recent years TransGrid has completed a number of DM and local generation projects. The Demand Management and Planning Project was carried out with EnergyAustralia from 2003 – 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. As part of the Western 500 kV Upgrade project a portfolio of 350 MW of demand reduction was made available for supply to the Newcastle – Sydney – Wollongong load area in summer 2008/9 enabling the completion of the upgrade to be deferred to summer 2009/10.

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

Historical NSW Network Development

Consistent with the development of networks in each State of Australia the NSW network was originally planned and designed by a vertically integrated organisation that had control of both generation and transmission planning. The prime aim of network development was to provide reliable and cost effective connections between the major power stations in NSW and the major NSW load centres. This included the development of a 330 kV network to adequately transfer the "NSW and ACT allocation of Snowy power" towards Sydney, supplying the Yass/Canberra/Wagga area on the way. Additionally, the network was developed to provide reliable supplies to the more remote parts of the State.

Over the past 20 years there has been a limited number of major transmission links built in NSW. These have included the Eraring – Kemps Creek 500 kV link (commissioned in the early 1980s to match the commissioning of Eraring Power Station), and the Bayswater – Mount Piper – Marulan 500 kV link (presently operating at 330 kV and being progressively upgraded to 500 kV operation), constructed in the late 1980s and early 1990s to match the commissioning of Bayswater and Mount Piper power stations. The 330 kV and 220 kV system west of Wagga was developed to service western area loads in the late 1980s. In more recent years the NSW and Queensland networks have been connected via the QNI interconnector.

Future Development

Over the same period the NSW load has virtually doubled. Creation of the National Electricity Market has significantly changed the role of the NSW transmission network leading to generation scheduling and consequent power flows that can now be quite different from that for which the network was originally planned.

In response to these developments the network has been fine-tuned, maximising its utilisation. Little scope exists for further fine-tuning as the load continues to grow and constraints emerge. Further need for capacity increases is likely to require the construction of major new infrastructure.

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 results of the Annual Planning Review and a discussion of supply reliability in NSW;
- Section 3 contains a summary of relevant National Transmission Flow Path 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 test and some recently completed augmentations;
- Section 6 contains details of emerging constraints in NSW over 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.

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2. Introduction

2.1 Results of the Annual Planning Review for 2009

The 2009 New South Wales Annual Planning Report (APR 2009) documents process and outcomes of the New South Wales Annual Planning Review carried out since the publication of the previous APR. 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 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;
- 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 Statement of Opportunities (SOO); 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 2009 included:

- An update of TransGrid's NSW load forecast that took account of actual peak loads for winter 2008 and summer 2008/2009;
- Provision of load forecast data for inclusion in AEMO's 2009 SOO 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 2009.

It is intended that the APR 2009 will provide electricity market participants and interested parties with information that will help them contribute to the optimum development of transmission networks in New South Wales.

The timely identification of emerging constraints allows the market to identify potential DM solutions and TransGrid to develop and implement appropriate and timely network solutions to them.

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 areas of supply demand balance, transmission networks planning and distribution networks planning. They 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. They are summarised in the following table.

Summary Information for Annual Planning Documents

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

Contact information relating to TransGrid's APR 2009 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 SOO and NTS;
- 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 SOO and NTS.

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.

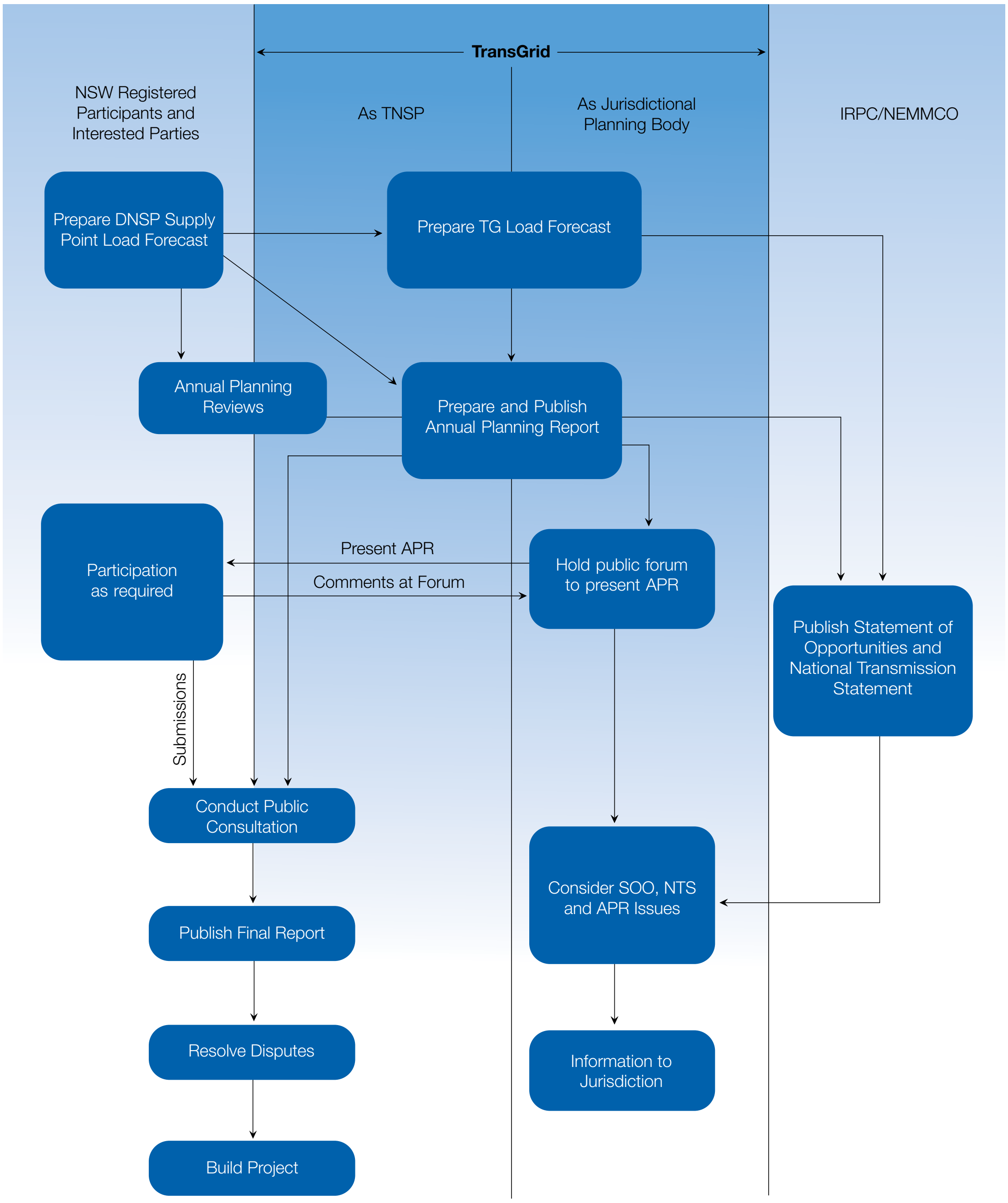
The NER require that the Annual Planning Report must include:

- Results of annual planning reviews with Distributors during the present year;
- Load forecasts submitted by Distributors;
- Planning proposals for future connection points;
- Forecast of constraints over 1, 3 and 5 years;
- Summary information for proposed augmentations;
- Summary information for prposed replacement transmission network assets;
- 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.

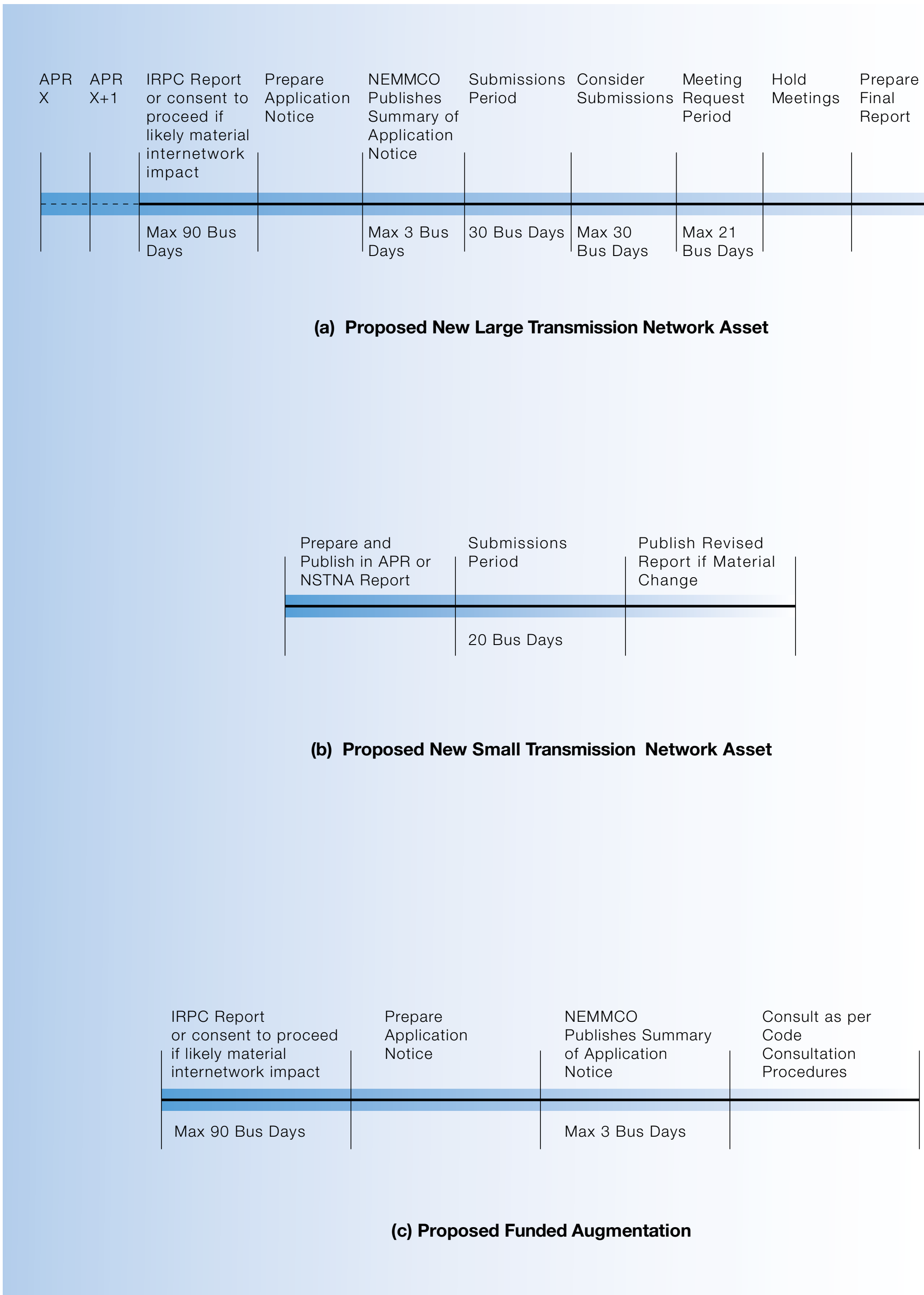
Figure 2.1 on the next page illustrates the main tasks and interrelationship of TransGrid's dual roles.

Fig 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.

Fig 2.2 NER Planning Consultation Processes



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 Distributor's network;
- Carry out joint planning to determine options for the relief of network constraints; and
- Review the load forecast provided by the Distributor.

TransGrid also conducts planning meetings and reviews with major customers.

2.3.4 Annual Planning Review for New South Wales

TransGrid as the JPB for New South Wales carries out an annual planning review of transmission networks in New South Wales. The purpose of the Review is to focus on an optimum level of transmission investment by encouraging interested parties to propose options for the relief of transmission 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 2009 commenced in October 2008 with a request by TransGrid for updated load forecasts by Distributors. These forecasts take into account electrical loads experienced during winter 2008. TransGrid has provided a revised NSW load forecast for inclusion in AEMO's 2009 SOO and NTS. 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 New 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.

3. National Transmission Flow Path Developments

2008 Annual National Transmission Statement

The Annual National Transmission Statement (ANTS) is the outcome of NEMMCO's annual national transmission review. It provides an integrated overview of the present state and potential future development of National Transmission Flow Paths (NTFPs).

The 2008 ANTS was published with NEMMCO's Statement of Opportunities on 31 October 2008. It identified the following prioritised conceptual augmentations that NEMMCO considered were worthy of more targeted investigations as indicated in the following table:

Conceptual Augmentation	Ranking	Cost	Net Market Benefit
NSW – QLD (Bidirectional Option 1)	1	$120 Million	+ $21 Million to + $94 Million
NSW – QLD (Bidirectional Option 2)	2	$35 Million	+ $25 Million to + $84 Million
VIC – NSW (Bidirectional Option 1)	3	$77.5 Million	+ $26 Million to + $79 Million
VIC Export Option 1	4	$16 Million	+ $31 Million to + $33 Million
VIC – NSW (Bidirectional Option 2)	5	$105.5 Million	+ $ 8 Million to + $55 Million
VIC Export Option 2	6	$44 Million	+ $12 Million to + $15 Million

Further details of the 2008 ANTS can be found on NEMMCO's website at www.nemmco.com.au.

The 2008 ANTS was the last ANTS to be published.

National Transmission Statement and National Transmission Network Development Plan

As part of the Federal Government's ongoing Energy Market Reforms the Australian Energy Market Operator (AEMO) is to commence operation from July 2009. AEMO will take on the functions presently carried out by NEMMCO and also become the National Transmission Planner.

AEMO will publish a National Transmission Network Development Plan (NTNDP) from 2010.

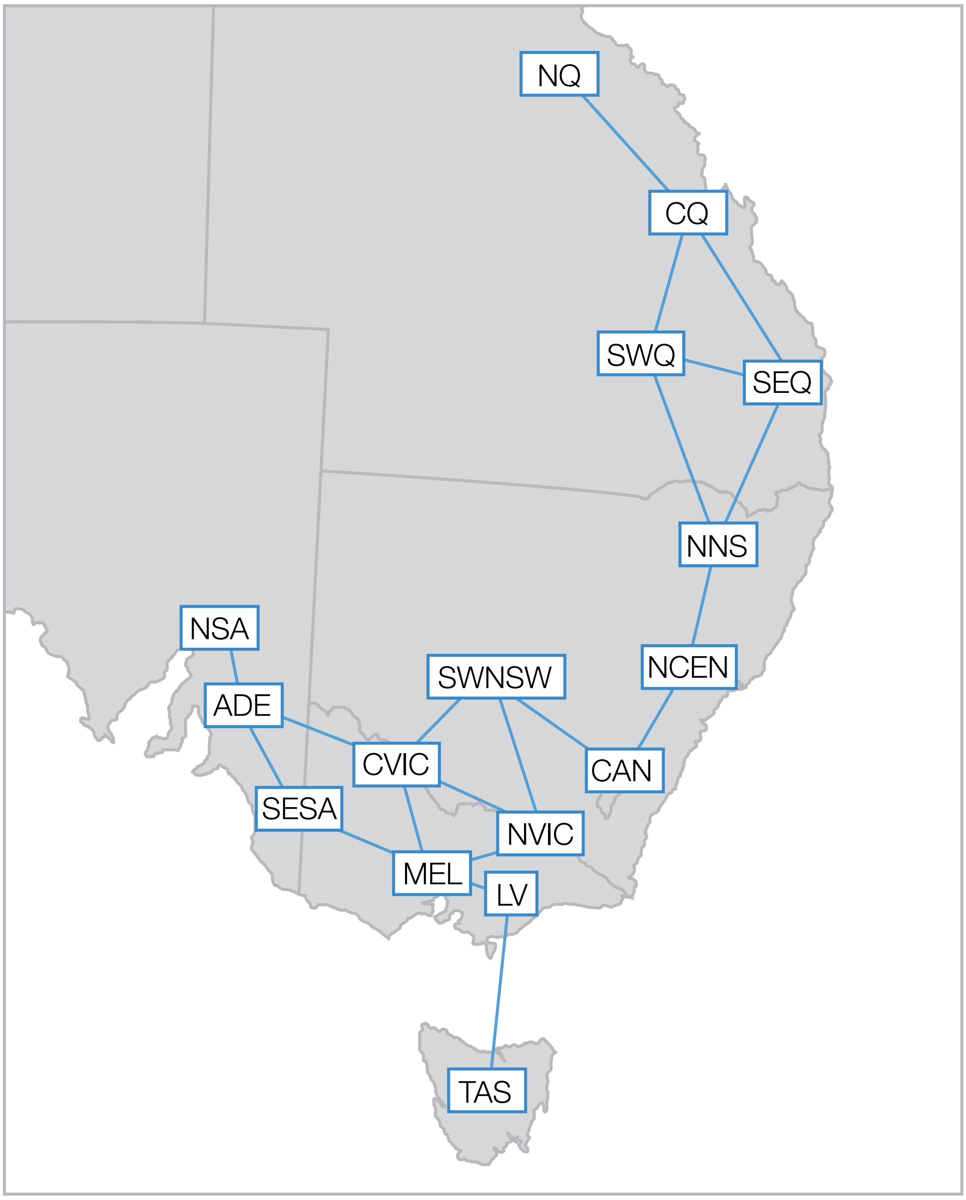
By 31 December 2009 AEMO will publish a transitional document called the National Transmission Statement (NTS) which will supersede the ANTS. The NTS will project opportunities for generation and transmission development in the National Electricity Market (NEM) for a number of scenarios for a 20 year outlook. The NTS will:

- Provide historical data and projections of network utilisation and congestion;
- Summarise emerging reliability issues and potential network solutions identified by Jurisdictional Planning Bodies (JPBs); and
- Present information on potential network augmentations and non-network alternatives and their ability to address the projected congestion.

The NTS will also describe the additional steps that will be taken to produce a NTNDP in 2010 and provide a basis for consultation on the input data and assumptions for the 2010 NTNDP.

Until 30 June 2009 NEMMCO is undertaking preparation of the NTS in consultation with ESIPC and VENCorp. NEMMCO carried out consultation on the input data and assumptions for the NTS publishing an issues paper in February 2009 and a final report in May 2009.

Current NTS Zones and National Transmission Flow Paths



Transmission Developments in NSW that may affect National Transmission Flow Paths

Within the national transmission planning framework the focus of the NSW Annual Planning Report is on intra-regional 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 are taken into account in the NTS in the development of conceptual augmentations and scenarios.

Accordingly the following table indicates where TransGrid believes that the power transfer capacity of NTFPs may be affected by committed, proposed, or possible transmission developments in NSW. These developments are detailed in subsequent sections of this APR 2009. The list of projects does not include the interconnector development options that have been developed by TransGrid and shown in the NTS.

Development	Status	Possible/Existing Commissioning Date	Possible Affected NTFP From	To	APR 2009 Section(s)
Armidale to NSW north coast 132 kV lines – system protection scheme	In service		NNS	SEQ	-
Phase Angele Regulator on Armidale – Kempsey 132 kV line 965	In service		SWQ SEQ	NNS NNS	5.1.7
Armidale SVC power oscillation damping	Installed/ testing		SWQ	NNS	5.1.8
Lismore 132 kV lines – System Protection Scheme	Country Energy works	2010	NNS	SEQ	-
Western 500 kV Upgrade	Committed	2008/9 and 2009/10	NNS NCEN CAN	NCEN CAN NCEN	5.2.1
Coffs Harbour – Kempsey second 132 kV circuit	Committed	2009	NNS	NCEN	5.2.3
Uprating Tamworth – Armidale line 86	Committed	2009	NNS SWQ	SWQ NNS	5.2.4
Dumaresq – Lismore 330 kV line	Satisfied reg test	2011/12	NNS	SEQ	5.3.1
Development of supply to the ACT	Satisfied reg test	2009	CAN	NCEN	5.3.3
Second Kempsey – Port Macquarie 132 kV line	Satisfied reg test	2010/11	NNS	NCEN	5.3.5
Manildra – Parkes 132 kV line	Satisfied reg test	2010/11	NCEN	CAN	5.3.6
Bannaby – Sydney 500 kV line	Anticipated proposal	Yet to be determined	CAN NNS	NCEN NCEN	6.2.1
Tomago – Stroud – Taree 132 kV development	Present proposal	2012/13 & 2015/16	NCEN	NNS	6.2.2
NSW – Snowy line upgrades, System Protection Scheme and associated reactive plant	Anticipated proposal	Yet to be determined	SNY	CAN	6.2.9
Second Armidale SVC	Anticipated proposal	Yet to be determined	NNS SWQ	SWQ NNS	6.2.10

4. NSW Region Energy and Demand Projections

4.1 Introduction

This chapter and Appendix 3 detail 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 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 NEMMCO's[2] Inter-Regional Planning Committee (IRPC).

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 below 30 MW capacity and are not included in the NEM dispatch process.

Information Sources

The uncertainty surrounding the evolving Global Financial Crisis has seen frequent revisions to economic forecasts. The data and information used to prepare this load forecast is that known to the end of March 2009.

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

[2] NEMMCO will become part of the Australian Energy Market Operator (AEMO) from 1 July 2009. As part of this development the IRPC will be discontinued.

As part of this process for 2009, KPMG Econtech was engaged by NEMMCO to supply Baseline (previously Medium), 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 ie 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 and other major customers. TransGrid negotiates agreed changes with DNSPs and customers to determine the connection point demand projections detailed in this Annual Planning Report. 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 may produce differing results when compared with the aggregate DNSP connection point demand projections:

- 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.
- The NSW region demand projections and aggregate DNSP connection point demand projections cannot be accurately 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 generation;
- 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 2009 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 lower whilst winter peak demand growth is marginally higher in the projection period compared with the historical period.

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

	Actual/estimated 1999/2000 to 2008/09	Projected 2009/10 to 2018/19
Energy Sent Out	1.9%	1.5%
	Actual 1999/2000 to 2008/09	**Projected 10 per cent POE 2009/10 to 2018/19**
Summer Peak Demand	3.3%	2.2%
	Actual/estimated 2000 to 2009	**Projected 10 per cent POE 2010 to 2019**
Winter Peak Demand	1.9%	2.0%

Changes since the 2008 APR

Changes in the 2009 projections compared with projections published in the 2008 APR are that:

- Energy projections are 3,989 GWh, or 4.8 per cent, on average below last year's projections;
- 10% POE (Probability of Exceedance) summer demand projections are 464 MW or 2.7 per cent, on average, below last year's projections; and
- 10% POE winter demand projections are 188 MW or 1.2 per cent, on average, lower than last year's projections.

These changes are explained 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 4.1 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 NEMMCO.

Figure 4.1 NSW Region Energy Projections

Compared with the 2008 projection the 2009 energy projection for the NSW region for the Baseline economic growth scenario is:

- 4.5 per cent lower for the 2009/10 financial year; and
- An average of 4.8 per cent lower over the 10-year forecast period.

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

- Economic growth: A significant global downturn affecting Australia's and therefore NSW's economic growth prospects including contraction of NSW's Gross State Product;
- Semi/Non Scheduled generation: A revision of NSW's Semi-Scheduled and Non-Scheduled generation projections which reflect currently available information; and
- Efficiency Allowances: Additional allowances (compared to 2008 forecasts) for the phasing out of incandescent light bulbs, accelerated uptake of solar hot water systems and small scale rooftop photovoltaics (PV).

Although the KPMG electricity price path is similar to that used for last year's load forecasts the KPMG electricity price information factors in assumptions reflecting the introduction of measures relating to the Federal Government's Carbon Pollution Reduction Scheme (CRPS).

It should be noted that there exists a degree of uncertainty in the precise shape and form of the CPRS. The latest available outline of the scheme, detailed in a December 2008 White paper, allows for two scenarios (CPRS-5 and CPRS-15) that stipulate a 5 per cent and a 15 per cent reduction in carbon emissions by 2020 respectively. The resultant effect on electricity prices depends on which CPRS scenario is implemented[3].

4.3 Demand Projections for the NSW Region

Projections of the NSW region Native demand detailed in this section are identical to projections published in the 2009 SOO.

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 90th, 50th and 10th 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)

		90% POE			50% POE			10% POE		
Year	Actual	Baseline	High	Low	Baseline	High	Low	Baseline	High	Low
1998-99	10,220									
1999-00	10,662									
2000-01	11,572									
2001-02	10,990									
2002-03	12,456									
2003-04	12,216									
2004-05	13,016									
2005-06	13,467									
2006-07	13,059									
2007-08	13,346									
2008-09	14,514									
2009-10		13,545	13,585	13,465	14,445	14,485	14,365	15,375	15,425	15,295
2010-11		13,766	13,826	13,656	14,706	14,776	14,586	15,666	15,736	15,546
2011-12		14,152	14,252	14,002	15,132	15,242	14,982	16,122	16,242	15,962
2012-13		14,408	14,548	14,218	15,428	15,568	15,228	16,448	16,608	16,248
2013-14		14,681	14,861	14,441	15,741	15,931	15,501	16,801	17,011	16,551
2014-15		14,835	15,035	14,535	15,945	16,155	15,635	17,045	17,275	16,715
2015-16		15,159	15,409	14,809	16,309	16,569	15,949	17,439	17,719	17,059
2016-17		15,490	15,790	15,100	16,680	16,990	16,270	17,860	18,190	17,420
2017-18		15,841	16,171	15,391	17,061	17,411	16,601	18,271	18,651	17,781
2018-19		16,192	16,562	15,682	17,452	17,842	16,932	18,692	19,122	18,142

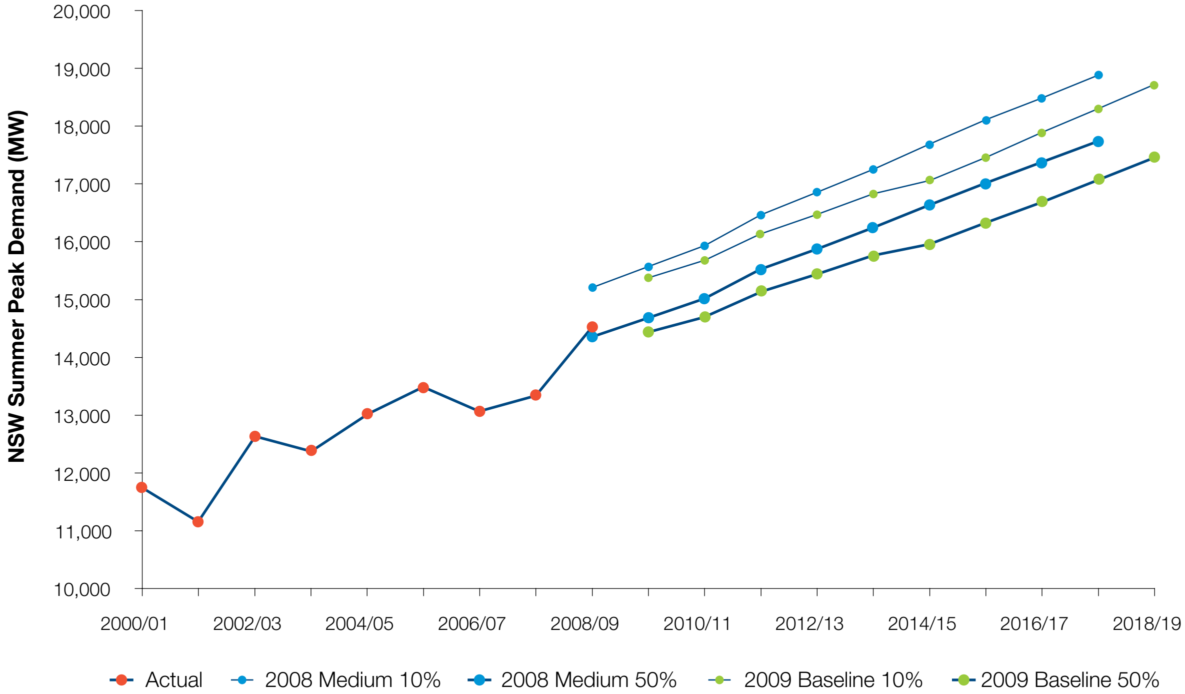
3 In May 2009 the Federal Government decided to postpone the CPRS by one year. In accordance with NEMMCO guidelines the 2009 NSW energy and demand projections do not incorporate this or any other policy changes related to CPRS after April 2009.

Table 4.3 NSW Region Winter Demand Projections (MW)

		90% POE			50% POE			10% POE		
Year	Actual	Baseline	High	Low	Baseline	High	Low	Baseline	High	Low
1999	11,324									
2000	11,900									
2001	11,760									
2002	12,156									
2003	12,476									
2004	13,199									
2005	13,302									
2006	13,251									
2007	14,054									
2008	14,695									
2009		13,963	13,993	13,933	14,313	14,343	14,283	14,703	14,733	14,673
2010		14,045	14,095	13,985	14,395	14,455	14,335	14,795	14,845	14,735
2011		14,286	14,366	14,156	14,636	14,726	14,516	15,036	15,126	14,906
2012		14,522	14,662	14,272	14,882	15,032	14,632	15,292	15,442	15,032
2013		14,678	14,888	14,348	15,048	15,258	14,708	15,458	15,678	15,098
2014		14,981	15,251	14,611	15,361	15,641	14,971	15,781	16,061	15,381
2015		15,215	15,545	14,825	15,605	15,945	15,205	16,025	16,375	15,615
2016		15,719	16,139	15,309	16,119	16,549	15,699	16,559	16,999	16,119
2017		16,110	16,590	15,660	16,530	17,020	16,060	16,980	17,480	16,500
2018		16,481	16,971	16,001	16,901	17,411	16,411	17,361	17,891	16,851
2019		16,732	17,222	16,222	17,162	17,662	16,642	17,632	18,142	17,092

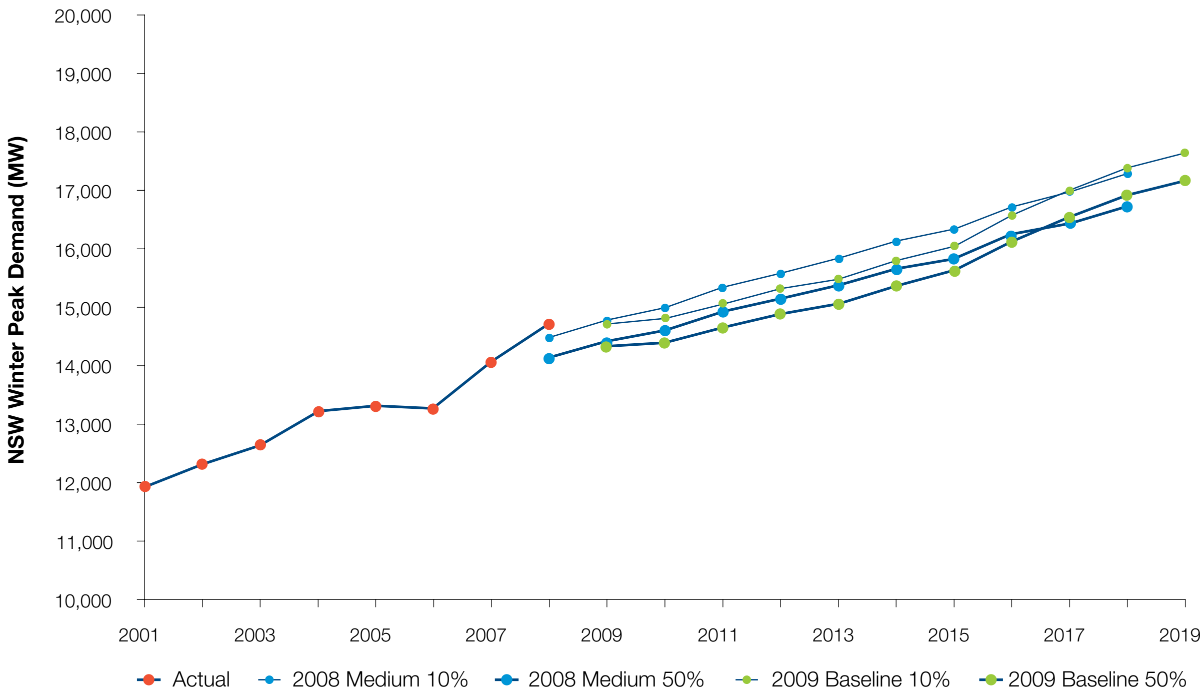
Figures 4.2 and 4.3 compare the 2009 10 per cent and 50 per cent POE demand projections with actual peak demands and the corresponding 2008 projections. Movements of actual peak demands above or below trend largely reflect weather extremes.

Figure 4.2 Comparison of NSW Region 2009 Summer Demand Projections with Corresponding 2008 Projections (Baseline Scenario) and Actual Demands



Note: The terms Medium and Baseline are used interchangeably in Figure 4.2 and 4.3

Figure 4.3 Comparison of NSW Region 2009 Winter Demand Projections with Corresponding 2008 Projections (Baseline Scenario) and Actual Demands



Note: The terms Medium and Baseline are used interchangeably in Figure 4.2 and 4.3

Compared with the 2008 projection the 2009 10 per cent POE summer demand projection is:

- 192 MW, or 1.2 per cent lower for the 2009/10 summer; and
- 613 MW, or 5.1 per cent lower for the 2017/18 summer.

Compared with the 2008 projection the 2009 10 per cent POE winter demand projection is:

- 61 MW, or 0.4 per cent lower for winter 2009; and
- 87 MW, or 0.5 per cent higher for winter 2018.

These differences between the 2009 and 2008 projections of peak demand reflect:

- Lower average demand for electricity, consistent with slowing in energy growth, due to a severe downturn in economic growth in early forecast years with growth picking up in later forecast years;
- Some moderation in air-conditioning driven peak demand growth. This has a bigger impact on summer peak demand compared with winter peak demand; and
- Enhanced efficiency measures assumed in the modelling process that affect demand (refer to Section 4.2).

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 2009 and 2008 demand projections aggregated across areas defined by the distribution networks of the following organisations:

- EnergyAustralia – 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:

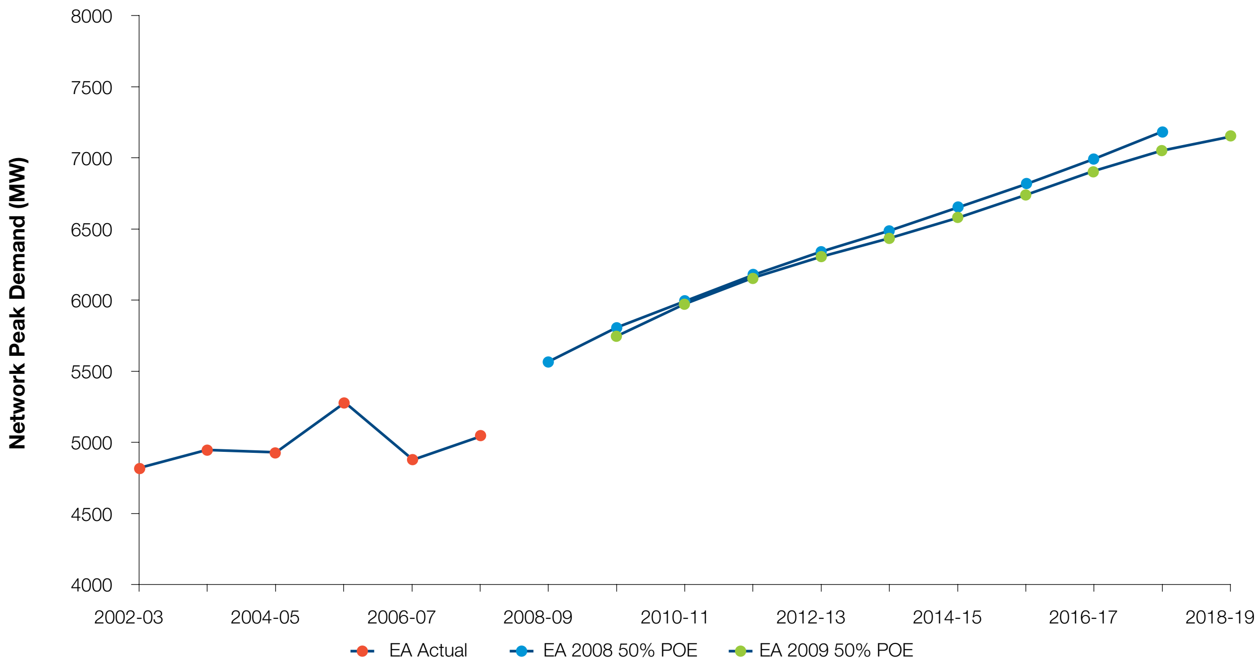
- May not be provided on the basis of a similar reported economic scenario or exact POE conditions;
- Exclude some large transmission-connected loads that are included in the NSW region projections;
- Indicate the likely peak for that network or connection point, whenever it may occur, rather than the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

4.4.1. EnergyAustralia

Figures 4.4 and 4.5 show actual and projected peak demands for EnergyAustralia's distribution network. The projections represent a 50 per cent POE demand and Baseline growth scenario.

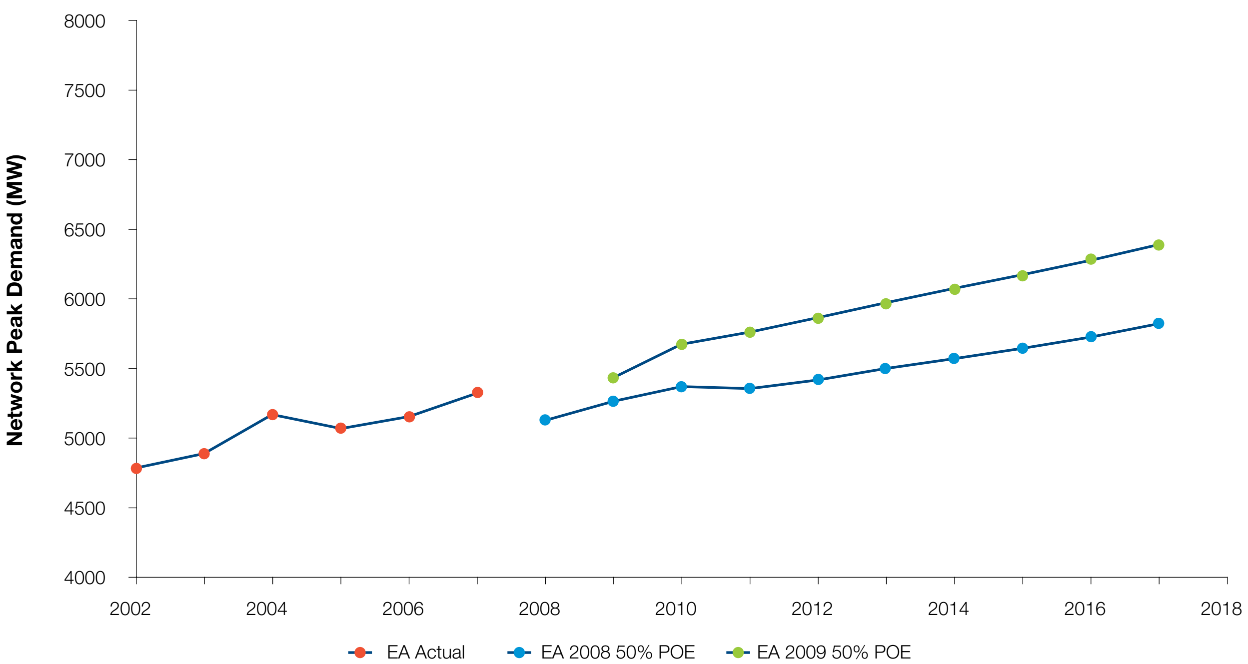
These aggregated connection point peak demands cannot be directly compared with Energy Australia's global demand forecasts published in its APR 2009. The 2009 summer demand forecasts are similar to the 2008 forecasts. However the 2009 winter demand forecasts are higher than the 2008 forecasts.

Figure 4.4 Comparison of EnergyAustralia 2009 Summer Demand Projection with the Corresponding 2008 Projection and Actual Demands



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

Figure 4.5 Comparison of EnergyAustralia 2009 Winter Demand Projection with the Corresponding 2008 Projection and Actual Demands



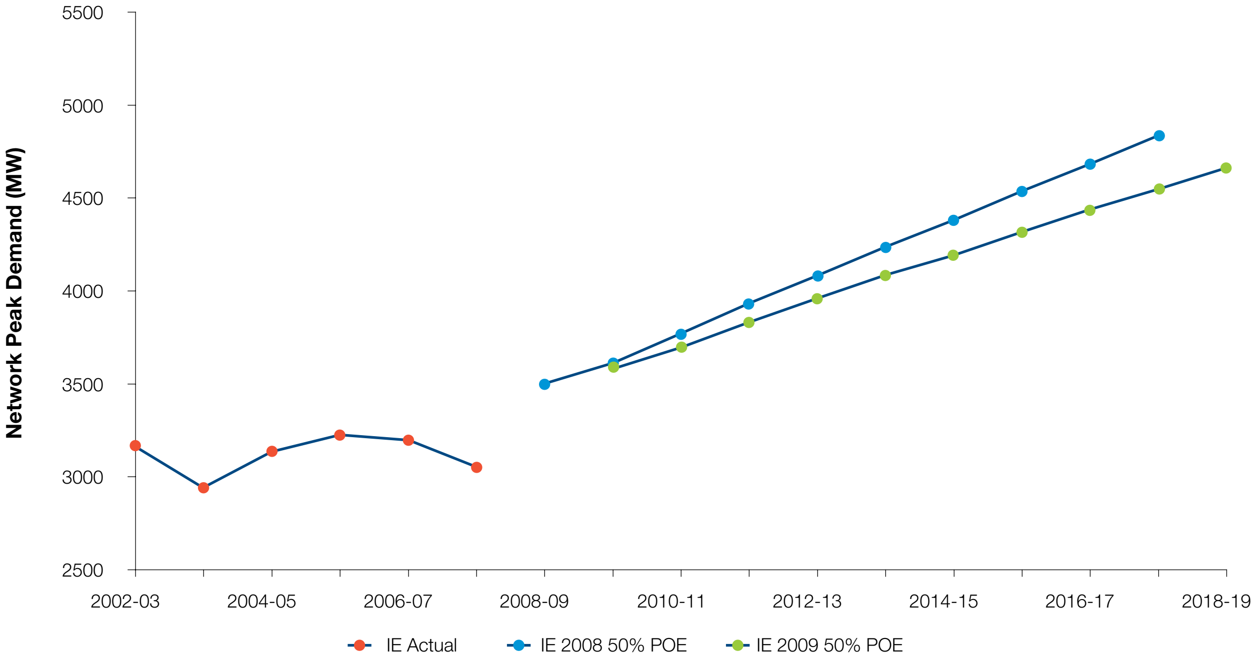
Network peak demands do not include transmission-connected loads or inter-distributor transfers

4.4.2. Integral Energy

Figures 4.6 and 4.7 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.

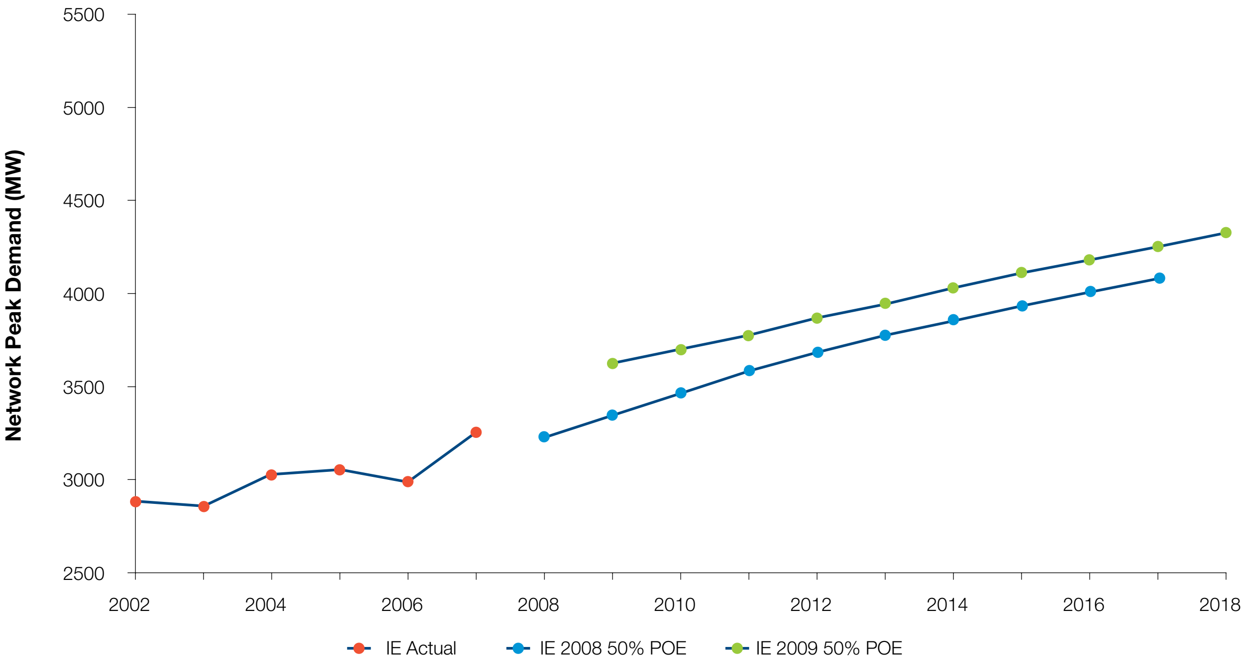
The 2009 summer demand forecasts are similar to the 2008 forecasts. However the 2009 winter demand forecasts are higher than the 2008 forecasts.

Figure 4.6 Comparison of Integral Energy 2009 Summer Demand Projection with the Corresponding 2008 Projection and Actual Demands



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

Figure 4.7 Comparison of Integral Energy 2009 Winter Demand Projection with the Corresponding 2008 Projection and Actual Demands



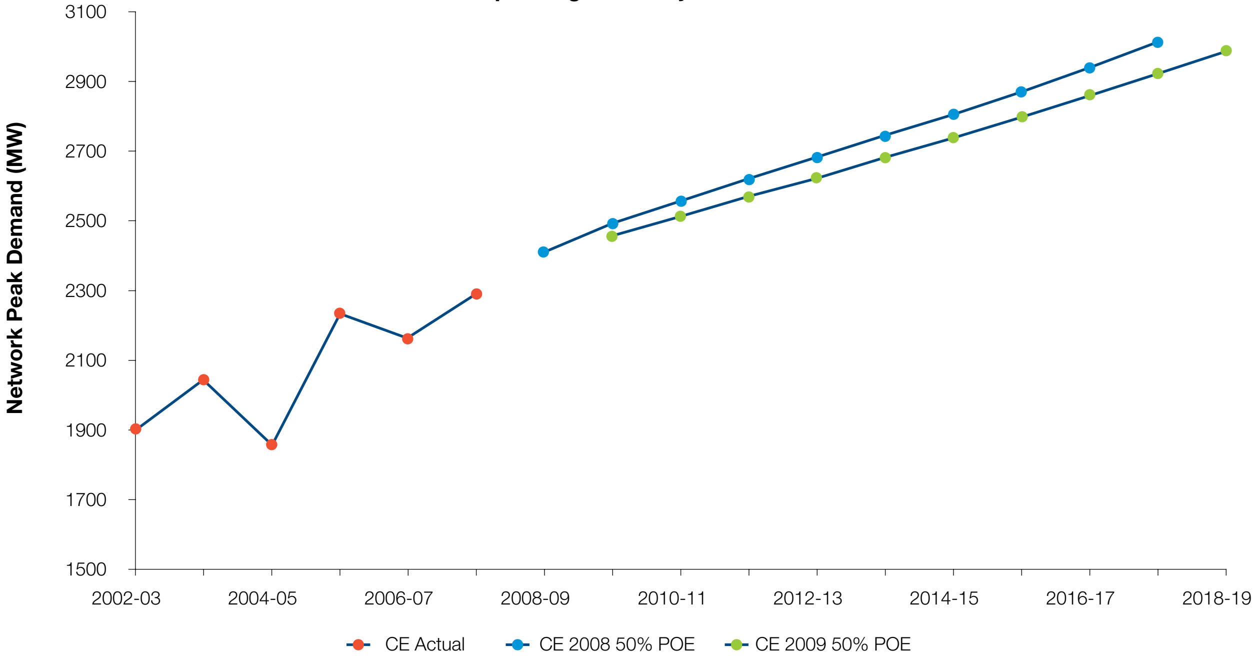
Network peak demands do not include transmission-connected loads or inter-distributor transfers

4.4.3. Country Energy

Figures 4.8 and 4.9 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.

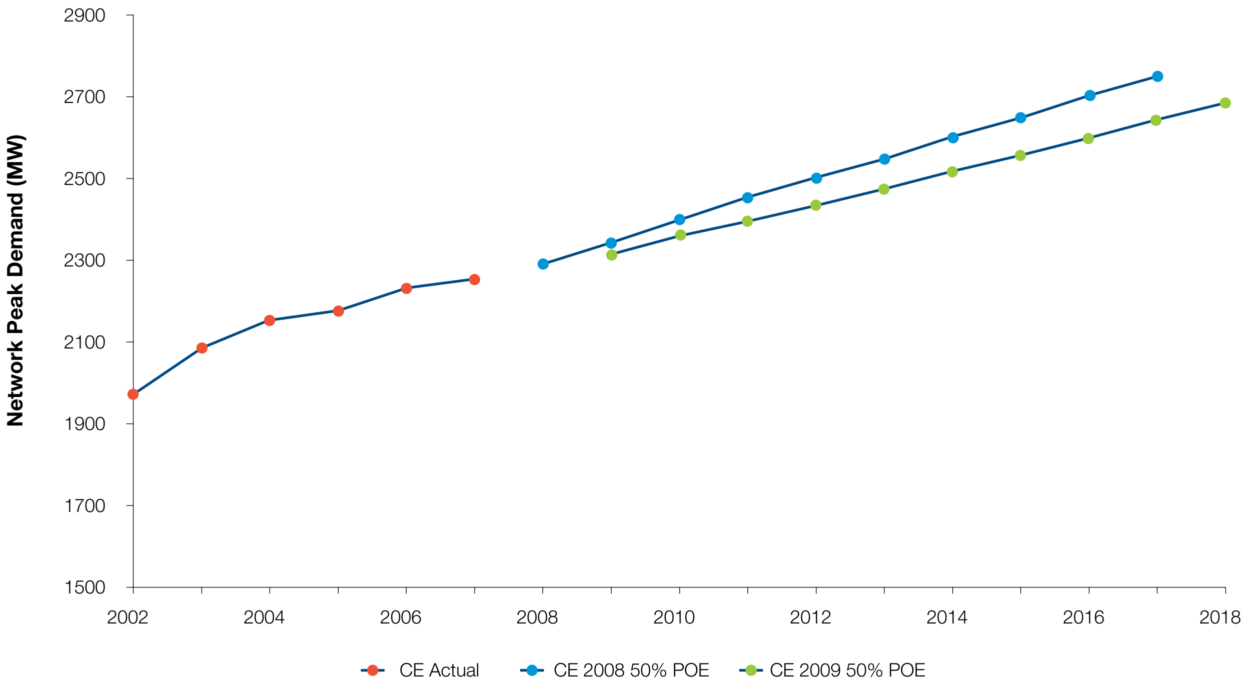
Country Energy's lower forecast demand projections for both summer and winter (compared to its 2008 forecasts) stem from a forecast reduction in energy usage that is due to an economic growth assumption that is lower than that used for its 2008 forecasts.

Figure 4.8 Comparison of Country Energy 2009 Summer Demand Projection with the Corresponding 2008 Projection and Actual Demands



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

Figure 4.9 Comparison of Country Energy 2009 Winter Demand Projection with the Corresponding 2008 Projection and Actual Demands



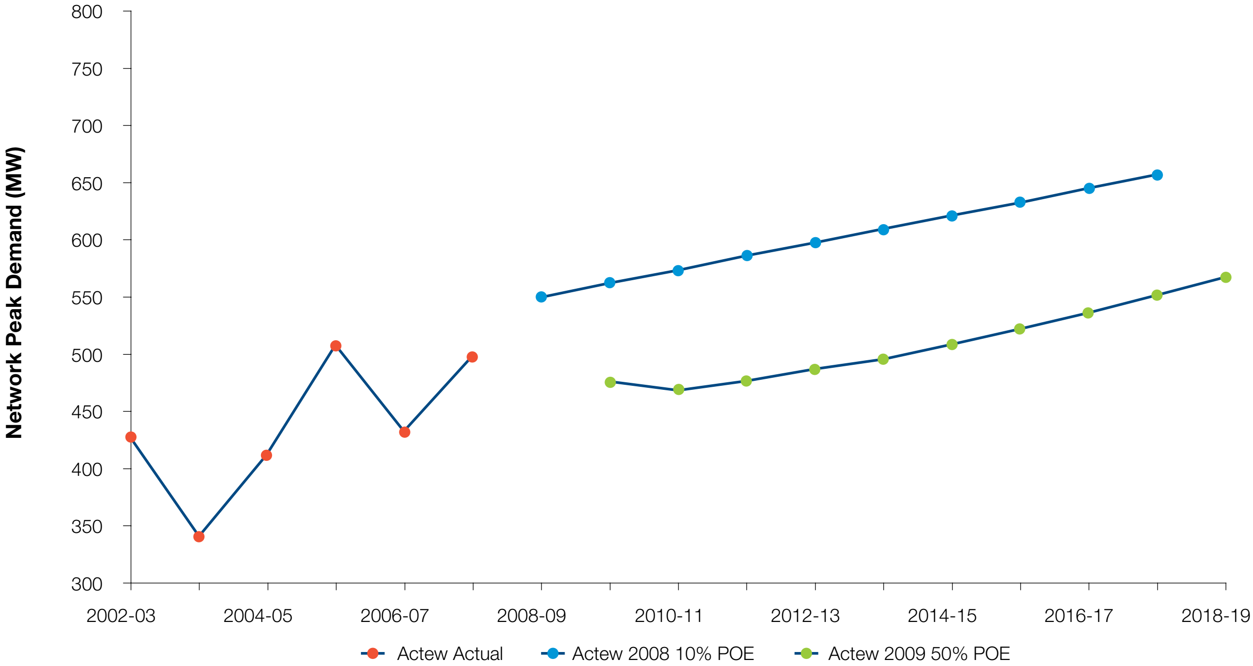
Network peak demands do not include transmission-connected loads or inter-distributor transfers

4.4.4. ActewAGL

Figures 4.10 and 4.11 below compare ActewAGL's 10 per cent POE demand projections for 2008 to this year's 50 per cent POE demand projections. The demand trajectories for both summer and winter pick up in the later years when the economy is forecast to recover from the effects of the global financial crisis.

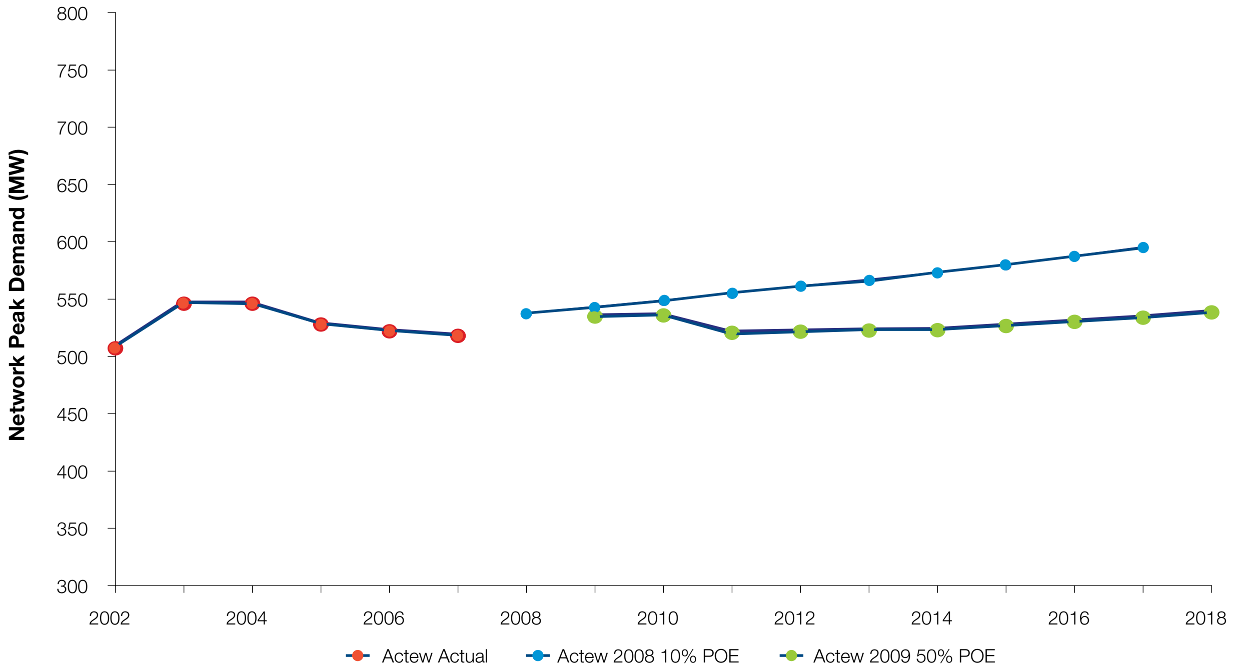
Note that 50 percent POE projections for 2008 were not available.

Figure 4.10 Comparison of ActewAGL 2009 50 Per Cent POE Summer Demand Projection with the 2008 10 Per Cent POE Projection and Actual Demands



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

Figure 4.11 Comparison of ActewAGL 2009 50 Per Cent POE Winter Demand Projection with the 2008 10 Per Cent POE Projection and Actual Demands



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

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 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 Peak and Energy

	Capacity (MW)		Demand at time of NSW region peak (MW)		Energy (GWh)	
	Wind (Semi-Scheduled)	Non-Scheduled	Wind (Semi-Scheduled)	Non-Scheduled	Wind (Semi-Scheduled)	Non-Scheduled
2005/06	0	425	0	175	0	951
2006/07	0	431	0	183	0	897
2007/08	0	655	0	406	0	1,116
2008/09	0	668	0	413	0	1,227
2009/10	168	682	8	416	428	1,249
2010/11	797	682	40	416	2,025	1,249
2011/12	994	689	50	422	2,524	1,263
2012/13	1,246	802	62	536	3,166	1,525
2013/14	1,313	802	66	536	3,337	1,525
2014/15	1,381	802	69	536	3,509	1,525
2015/16	1,448	803	72	537	3,680	1,527
2016/17	1,448	804	72	537	3,680	1,529
2017/18	1,448	805	72	538	3,680	1,531
2018/19	1,448	806	72	539	3,680	1,533

4.6. Supplementary Information

Participation in the Load Forecasting Reference Group (LFRG)

The NSW region projections were developed by TransGrid in a consistent manner 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 DSP plus Semi-Scheduled and Non-Scheduled generation survey data;
- Economic and demographic growth scenarios; and
- Semi-Scheduled and Non-Scheduled generation projections.

Participation in the LFRG encourages TransGrid to undertake 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 SOO. 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 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

5.1 Recently Completed Augmentations

This section describes augmentations that have been completed since publication of the APR 2008.

5.1.1. Works at Dapto for the Connection of Tallawarra Power Station

To provide for the connection of TRUEnergy's new 400 MW closed cycle gas turbine generator at Tallawarra and consequent rearrangements of Integral Energy's 132 kV network in the vicinity of Tallawarra, works to provide a new 132 kV switchbay and modify two other 132 kV switchbays at Dapto 330/132 kV substation were completed in September 2008.

5.1.2. Works to Connect a Gas Turbine Power Station at Uranquinty

In association with the construction of a new nominal 4 x 160 MW gas turbine power station at Uranquinty (about 17 km west of Wagga 330 kV substation) an augmentation of TransGrid's network was required as follows:

- The establishment of a new 132 kV switching station at Uranquinty adjacent to the power station;
- Reconstruction of two existing 132 kV transmission lines to a higher capacity between Wagga 330/132 kV substation and Uranquinty; and
- Review and modification of control schemes.

These works were co-ordinated with the commissioning of the power station and were completed in July 2008.

5.1.3. Tamworth Shunt Reactors Replacement

Two ageing 50 MVAr 330 kV shunt reactors at Tamworth 330/132 kV substation were replaced by new units at more suitable locations within the site. These works were completed in August 2008.

5.1.4. Turn in of Newcastle – Vales Point 330 kV Line No 24 into Eraring

To remove potential constraints on the operation of NSW Central Coast power stations and reduce system losses the Newcastle – Vales Point 330 kV line No. 24 was turned into Eraring to form separate Newcastle – Eraring and Eraring – Vales Point 330 kV circuits. These works were completed in September 2008.

5.1.5. Snowy Area: 64, 65 and 66 Lines Rehabilitation

Rehabilitation works were carried out on the Lower Tumut – Upper Tumut 330 kV line No. 64, the Murray – Upper Tumut 330 kV line No. 65 and the Murray – Lower Tumut 330 kV line No. 66 following their transfer from Snowy Hydro to TransGrid. These works were completed in May 2008.

5.1.6. Tuggerah Substation: Reliable 330 kV Supply

To meet limitations in the network supplying the NSW Central Coast the following works were carried out, with completion in December 2008:

- Completion of a 330 kV mesh busbar and Installation of a second 330/132 kV transformer at Tuggerah 330 kV substation; and
- Removal of the tee in the Munmorah – Sydney North 330 kV line to form separate Munmorah – Tuggerah and Tuggerah – Sydney North 330 kV circuits.

In addition one of two 132 kV switchbays for connection of EnergyAustralia's Berkeley Vale substation and a 132 kV bus section switchbay were provided at Tuggerah 330 kV substation in October 2008. A second 132 kV switchbay for Berkeley Vale was provided in May 2009.

5.1.7. Phase Angle Regulator on Armidale – Kempsey 132 kV Line 965

To control power flow on the Armidale – Kempsey 132 kV line 965 a 132 kV phase angle regulating transformer was installed at Armidale 330/132 kV substation with completion in February 2009.

5.1.8. Armidale SVC: Power Oscillation Damping Control

To improve damping of system oscillations a power oscillation damping control facility was installed on the Armidale SVC with completion in February 2009. Prior to actual commissioning the facility will be tested when appropriate system conditions arise.

5.1.9. 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 2008.

Location	Installation	Completion
Kempsey	Two new 60 MVA 132/33 kV transformers	October 2008
Parkes	One new 60 MVA 132/66 kV transformer	March 2009
Sydney South	Replacement of No 3 250 MVA single phase 330/132 kV transformer by a new 375 MVA three phase unit	October 2008

5.1.10. 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 2008.

Location	Installation	Completion
Cowra	Two 8 MVAr 66 kV capacitors	September 2008
Deniliquin	One 12 MVAr 132 kV capacitor	March 2009
Forbes	One 12 MVAr 132 kV capacitor	October 2008
Muswellbrook	Detune 120 MVAr 132 kV capacitor and replace circuit breaker	March 2009
Narrabri	One 8 MVAr 66 kV capacitor	August 2008
Sydney North	Two 200 MVAr 330 kV capacitors	December 2008

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 the SOO. These augmentations were previously the subject of proposals that were documented in previous APRs or regulatory consultations.

5.2.1 Western 500 kV Upgrade

The main transmission network supplying the Newcastle/Sydney/Wollongong area is facing two major emerging limitations:

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

To meet these limitations TransGrid is implementing 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 Section 7.1.2); and
- Conversion of the existing Bayswater – Mount Piper and Mount Piper – Bannaby lines which presently operate at 330 kV to operate at their design voltage of 500 kV.

  This does not entail major line works but involves significant 500 kV and some 330 kV substation works at Bayswater, Mount Piper, Wollar and the establishment of a new 500/330 kV substation at Bannaby. It also involves reconnection of two generating units at Bayswater from the 330 kV switchyard to the new 500 kV switchyard and uprating of selected 330 kV lines.

  These works are planned to be completed by 2009/10.

  Progress on these works is progressing to programme. As of June 2009 substation works at Bayswater and Mount Piper have been substantially completed enabling a Bayswater to Mount Piper circuit to be placed in service at 500 kV and the reconnection of a Bayswater unit at 500kV.

5.2.2. 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 are being 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 are being coordinated with the Western 500 kV Upgrade. The new 330 kV line is expected to be completed in 2009 and Wollar substation is expected to be completed in early 2010.

5.2.3. Coffs Harbour – Kempsey 132 kV Circuit

Within a few years low voltages and overloading of some network elements are 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 it was proposed in June 2007 that TransGrid and Country Energy carry out works to provide for the conversion of the Coffs Harbour – Kempsey 66 kV circuit (which connects to a number of intermediate substations) to its design voltage of 132 kV.

This requires 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 are planned to be completed during 2009.

5.2.4. 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 early 2010.

5.2.5. Tamworth – Gunnedah 132 kV Line 969 Realignment

A new section of double circuit 132 kV line is presently being 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 are expected to be completed in 2009.

5.2.6. 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 Southwest Sector of Sydney the following works are being carried out:

- 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.

These works are planned to be substantially completed by summer 2009/10 with Macarthur substation being completed by mid 2009.

5.2.7. 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 have 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 TransGrid works are planned to be completed by mid 2009.

5.2.8. Munmorah and Vales Point Short Circuit Rating Upgrades

Equipment replacement programs are being carried out at Munmorah and Vales Point switchyards to overcome constraints imposed by the rating of the Vales Point – Munmorah 330 kV line and fault level limitations at Munmorah.

The works are substantially completed with the remainder to be programmed.

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

Delta Electricity is developing 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 is extending the 330 kV busbar and installing new 330 kV switchbays at Munmorah switchyard.

These works are planned to be completed to co-ordinate with the commissioning of the power station which is presently expected in 2009.

5.2.10. Capital Wind Farm 330 kV Switchyard

Associated with the connection of the Capital wind farm near Canberra a new 330 kV switchyard is being constructed and connected to the Kangaroo Valley – Canberra 330 kV transmission line. The new switchyard will be owned and operated by TransGrid on completion which is expected by mid 2009.

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.

Location	Installation	Completion	Comments
Haymarket 330/132 kV substation	Four new or modified 132 kV switchbays to connect EnergyAustralia's new City North 132/11 kV zone substation and support 132 kV cable rearrangements.	Late 2009	
Sydney North 330/132 kV substation	Two 132 kV line switchbays to supply EnergyAustralia's Galston substation	Late 2009	
Vineyard 330/132 kV substation	132 kV line switchbay to supply Integral Energy's Rouse Hill substation	Late 2009	

5.2.12. Committed Substation Fault Rating Upgrades

The following table summarises committed substation fault rating upgrades.

Location	Installation	Completion	Comments
Dapto 330/132 kV substation	Equipment replacements to ensure that the 330 kV fault rating ≥ 30 kA and the 132 kV fault rating ≥ 40 kA.	Late 2009	
Sydney North 330/132 kV substation	Equipment replacements to ensure that the 132 kV fault rating ≥ 40 kA.	2010	
Sydney West 330/132 kV substation	Equipment replacements to ensure that the 330 kV fault rating ≥ 38 kA and the 132 kV fault rating ≥ 38 kA.	Mid 2010	330 kV equipment replacements are substantially complete

5.2.13. Committed Transformer Replacements and Upgrades

The following table summarises committed transformer replacements and upgrades.

Location	Installation	Completion	Comments
Coffs Harbour 132/66 kV substation	Replacement of 60 MVA 132/66 MVA transformers by two new 120 MVA units	Early 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	Mid 2010	
Finley 132/66 kV substation	Install two new 60 MVA 132/66 kV transformers	Early 2010	One installed May 2009
Gadara 132/11 kV substation	Install second 55 MVA 132/11 kV transformer	Mid 2009	
Koolkhan 132/66 kV substation	Install third 60 MVA 132/66 kV transformer	Late 2009	
Marulan	Install 200 MVA 330/132 kV transformer ex Armidale	Late 2010	Temporarily installed at Wallerawang
Orange 132/66 kV substation	Replacement of the three ageing 30 MVA transformers by two new 60 MVA 132/66 kV transformers	Late 2009	
Sydney South 330/132 kV substation	Replacement of No 1 and No 2 250 MVA single phase 330/132 kV transformers by new 375 MVA three phase units	Mid 2009	No 1 transformer has been replaced
Sydney South 330/132 kV substation	Replacement of No 3 and No 4 250 MVA single phase 330/132 kV transformers by new 375 MVA 3 phase units	Late 2009	No 3 transformer has been replaced (refer to Section 5.1.7)

5.2.14. Committed Capacitor Bank Installations

The following table summarises committed capacitor bank installations.

Location	Installation	Completion	Comments
Beryl 132/66 kV substation	One 8 MVAr 66 kV capacitor bank	Late 2009	
Sydney East 330/132 kV substation	Two 200 MVAr 330 kV capacitor banks	Mid 2009	Complete except for control systems

5.3. Planned Augmentations that have Satisfied the Regulatory Test

This section briefly describes network constraints within NSW that are being relieved by augmentations that have satisfied the regulatory test but have not progressed to the point where they can be considered committed in accordance with the criteria described in the SOO.

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 voltage limitations will increase and thermal rating limitations on 132 kV lines supplying these areas will emerge 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 (a high voltage dc link between Mullumbimby and Terranora). This support may be limited by the emergence of network limitations in the southeast Queensland network and therefore cannot be relied upon in the medium to long term.

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 temperature of 100 °C;
- 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 a 50 MVAr 330 kV line connected shunt reactor at Lismore and a 30 MVAr line connected shunt reactor at Dumaresq;
- Provide two 40 MVAr 132 kV capacitors at each of Lismore and Coffs Harbour 330/132 kV substations; and
- Provide a second 330/132 kV transformer and related 330 kV and 132 kV switchgear at Coffs Harbour 330/132 kV substation.

These works are planned to be completed by late 2011.

5.3.2. 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.

5.3.3. Development of Supply to the ACT

To meet 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.

5.3.4. 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.

5.3.5. 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 2010/11.

5.3.6. 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 2010/11.

5.3.7. Murray Switching Station and Upper Tumut Switching Station Rehabilitation

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

Remaining works at these sites are programmed for completion during 2010/11.

5.3.8. 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.

5.3.9. Proposed Transformer Replacements and Upgrades

The following table summarises proposed transformer replacements and upgrades that have satisfied the regulatory test.

Location	Installation	Completion	Comments
Beaconsfield West 330/132 substation	Installation of a third 330/132 kV transformer	Late 2011	On land adjacent to the existing site.
Sydney North 330/132 kV substation	Installation of a fifth 375 MVA 330/132 kV transformer	Late 2010	Plus modifications to existing transformer 330 kV connections
Sydney East 330/132 kV substation	Installation of a fourth 375 MVA 330/132 kV transformer	Late 2013	

5.3.10. Proposed Line Switchbays for Distributor Requirements

The following table summarises proposed projects for the provision of line switchbays to meet NSW Distributors' requirements that have satisfied the regulatory test.

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	Mid 2009	
Koolkhan 132/66 kV substation	One new 66 kV line switchbay to connect Country Energy's second Maclean 66 kV line	Mid 2009	
Newcastle 330/132 kV substation	One new 132 kV line switchbay to connect EnergyAustralia's new 132 kV line to Argenton substation	Late 2011	
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	

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 5 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 over 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 2010.

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

Section 6.3 describes other constraints expected to emerge over 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 2009 are subject to change in 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 Network Asset Summary

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

Proposal	Service Date	Cost	Details in
Wallerawang – Orange 132 kV Line 944 Replacement and Upgrade	Mid 2013	$16 Million (See Note)	Appendix 5.1
Vineyard third 330/132 kV Transformer	2010/11	$17 Million	Appendix 5.2

Note: Augmentation component only. Total cost of this proposal including replacement component is $52 Million.

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 2009 to make written submissions in respect to these proposals. The last day for submissions is 28th July 2009. Contact details appear in Appendix 7.

6.2. Other Proposals

This section describes constraints that are expected to emerge over 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 2010.

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

6.2.1. 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.

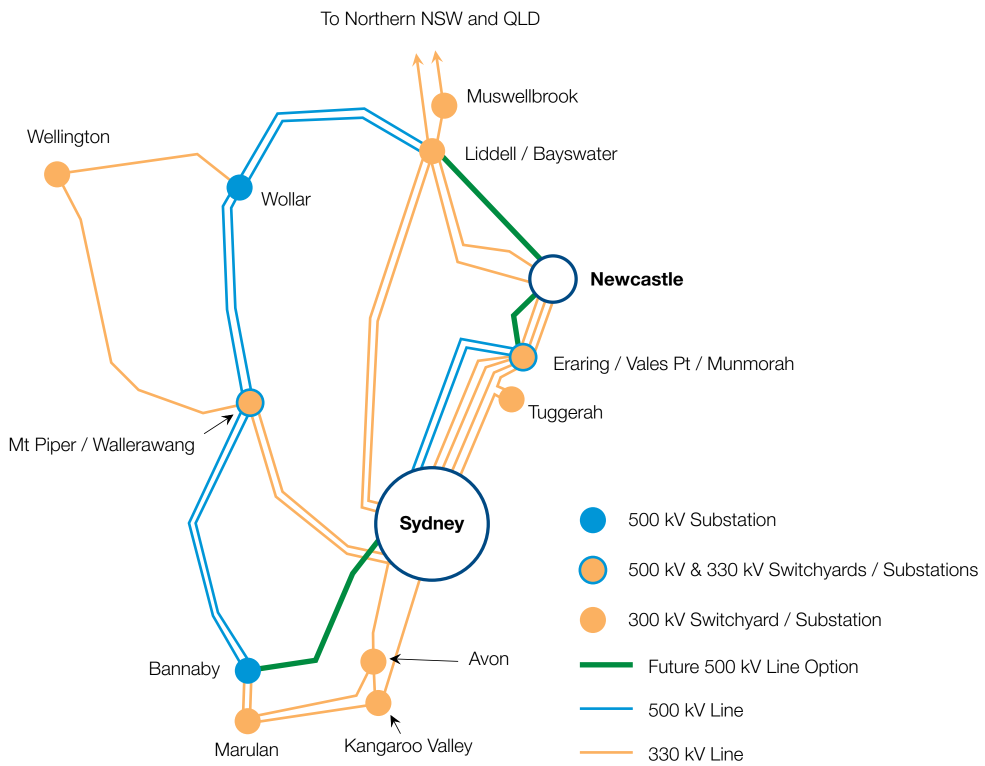
The number of locations where new generation could be connected to the NSW transmission network without the need to augment the network is now limited. The transfer of power from generators that are connected outside the Newcastle – Sydney – Wollongong area is constrained by limitations in transmission 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. Generation development is also restricted in practical terms by environmental constraints on significant quantities of new generation being sited near the coast.

The concept of developing a strong 500kV transmission ring around the Newcastle – Sydney – Wollongong area to minimise 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 are presently being converted to 500 kV operation (refer to Section 5.2.1).

Further development of a strong 500kV 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 330kV 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.

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

Options for Future 500 kV Ring Developments



- 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 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.

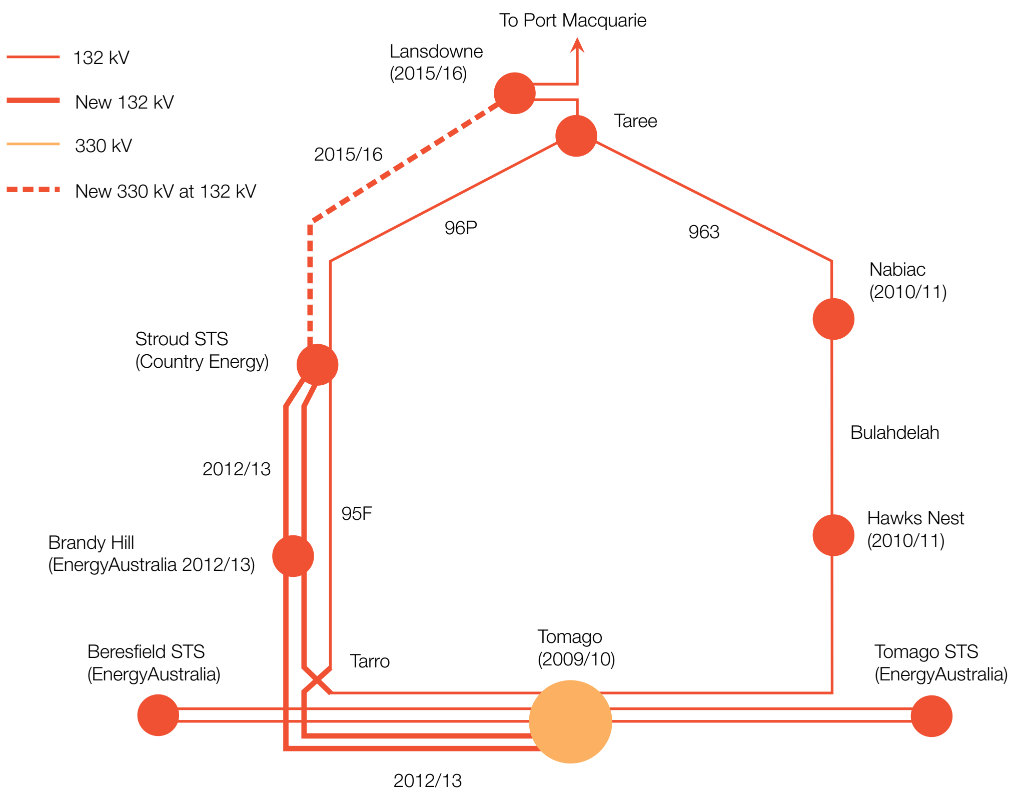
These generation development scenarios cover coal-fired and gas-fired generation developments and wind farm developments across a range of load growth scenarios.

The scenarios indicate the need to first develop the southern link in the ring. The northern link would be developed in response to major northern generation or load development.

It is anticipated that an application notice for this development will be issued in 2009/10. 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.

6.2.2. Supply to the Lower Mid North Coast

Supply System on the Lower Mid North Coast (Medium Term)



Stroud and Taree substations are supplied from 132 kV lines from the Newcastle area as depicted in the figure above. Also shown are future 132 kV works in the Newcastle area described in Section 5.3.1, possible future 132 kV substations at Hawks Nest and Nabiac (refer to Sections 6.2.12 and 6.2.13) and the preferred option described below.

On outage of either the Tomago – Stroud or Tomago – Taree 132 kV lines low voltages can occur at Stroud and Taree and the thermal rating of the remaining in service line can be exceeded.

Options being considered to meet these limitations include the construction of an additional 132 kV line between Tomago and Stroud and a line between Stroud and the Taree area which could be of 330 kV or 132 kV construction.

It is envisioned that the Tomago – Stroud works could be completed by 2012/13.

An application notice covering these options was issued in December 2008 with the preferred option including a 330 kV line between Stroud and the Taree area. It is expected that a final report of the regulatory consultation will be issued in mid 2009.

6.2.3. Supply to the Western Sydney Area

The western Sydney area is supplied from 330/132 kV or 330/66 kV substations at Sydney West, Ingleburn, Liverpool, Regentville and Vineyard. Sydney West is the largest of these substations and in the past its loading has been managed by establishing additional 330/132 kV substations at strategic locations. To this end Liverpool, Vineyard and Regentville substations were established in 1980, 1994 and 1997 respectively.

As shown in the chart below electrical demand in the area has grown markedly over the last five years. This is due in part to population growth and increasing use of air conditioners.

In recent years additional transformers have been installed at Sydney West and Liverpool. Despite this it is expected that the limitations imposed by 330/132 kV transformer capacity in the area will re-emerge within around five years.

The options to relieve this limitation include:

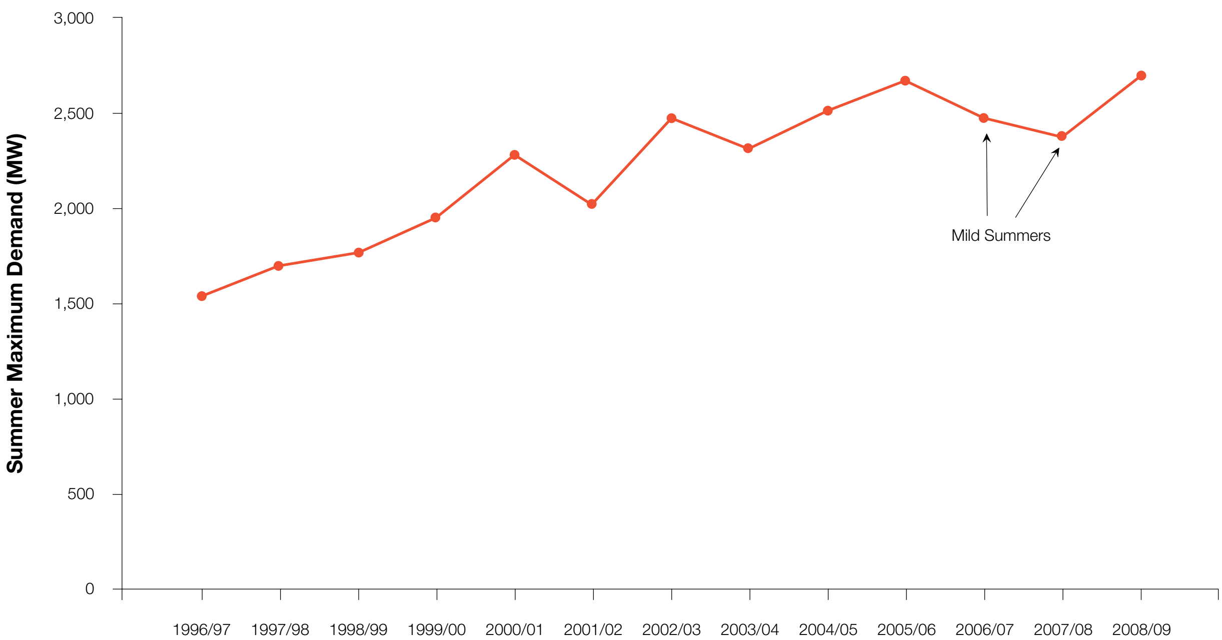
- DM and/or local generation;
- Replacement of the Sydney West transformers by larger (around 600 MVA) units;
- Installation of an additional transformer at Sydney West; and
- Establishment of an additional 330/132 kV substation at a suitable location to partially offload the transformers at Sydney West.

Should an additional substation be established it would most probably be located in the Holroyd area. There are two double circuit 132 kV lines between Sydney West and Guildford that are routed via Holroyd. Between Sydney West and Holroyd one is of 330 kV construction and the other of 132 kV construction. Due to development in the Wetherill Park/Smithfield area since the lines were constructed it would be difficult to convert them to operate at 330 kV in some locations. The construction of a double circuit 330 kV line between Sydney West and Holroyd on a combination of new and existing routes is considered feasible.

Establishment of a 330/132 kV substation near Holroyd is also a component of network development options to relieve limitations in supply to the inner metropolitan area (refer to Section 6.2.4).

Another potential location for an additional 330 kV substation that would relieve this limitation is the Mount Druitt area. A Mount Druitt area 330 kV substation could be supplied from one circuit of a double circuit line between Sydney West and Mount Druitt, which presently operates at 132 kV, or from one of the 330 kV circuits between the Central Coast and Sydney. At this stage this option is not preferred as it does not reduce the loading on Sydney West by as much as a substation in the Holroyd area.

Greater Sydney Outer Metropolitan Area



6.2.4. Supply to the Southern and Inner Metropolitan Areas of Sydney

The maximum summer demands for the southern and inner city areas (supplied from Sydney North, Sydney South, Beaconsfield West and Haymarket 330/132 kV substations) over recent years are shown in the chart below. Energy Australia's most recent load forecast is given in Appendix 3.

As the load grows the failure of either of the Sydney South – Beaconsfield West or Sydney South – Haymarket 330 kV cables and any of a number of other critical circuits or transformers may result in the rating of some remaining network elements being exceeded at or near high load periods.

It is also expected that it will become increasingly uneconomic for Energy Australia to maintain some aged and deteriorating 132 kV cables in the area in a satisfactory condition. These cables may be retired.

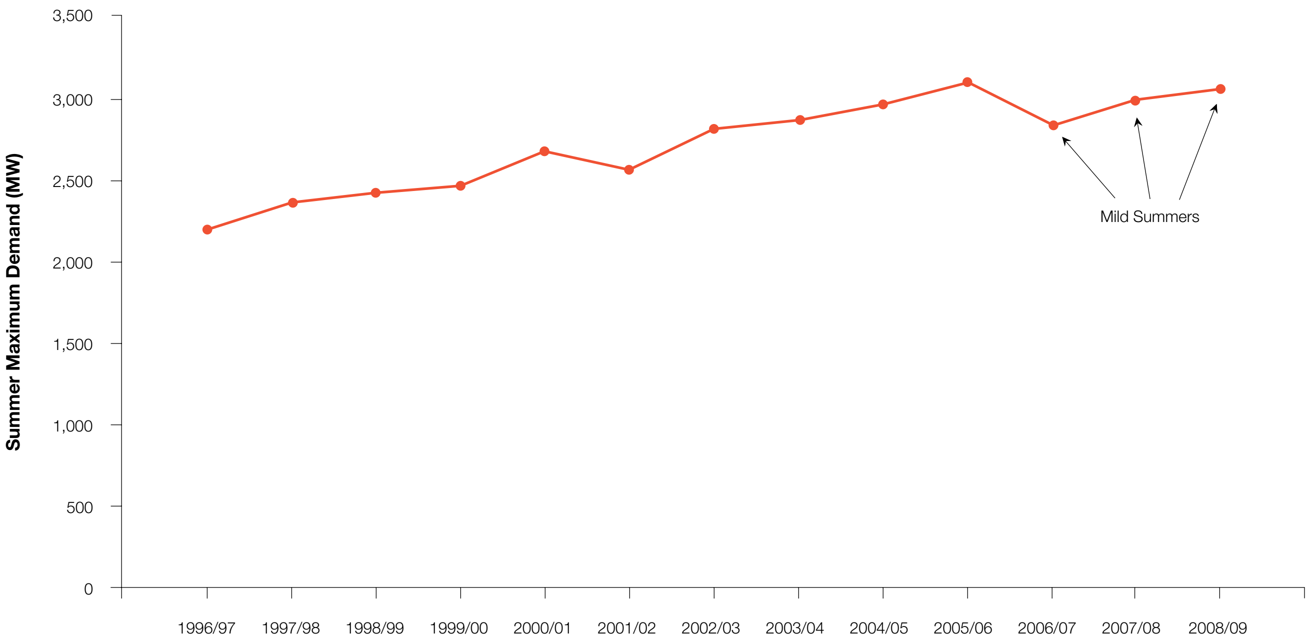
Studies to identify system limitations, when they may emerge (including consideration of possible generation patterns) and options to address them are being undertaken jointly with Energy Australia.

A number of options to address these limitations are being considered. Broadly, these are:

- Reinforcement within EnergyAustralia's 132 kV network;
- Establishment of an additional 330/132 kV substation and associated 330 kV supply; and
- DM and/or local generation.

To delay the need for a major augmentation of supply capacity a number of low to moderate cost developments have been proposed. These include the installation of additional 132 kV cables in EnergyAustralia's network as well as increased 330/132 kV transformer capacity at Sydney South (refer to Section 5.2.12), Beaconsfield West and Sydney North (refer to Section 5.3.9) and installation of capacitors at Beaconsfield West and within EnergyAustralia's network. To support these developments the series reactors connected to the Sydney South – Beaconsfield West and Sydney South – Haymarket 330 kV cables will need to be replaced to ensure better sharing of load between the 330 kV and 132 kV systems. The first replacement is expected during 2010 (refer to Section 5.3.8).

Supply to the EnergyAustralia from Sydney North, Sydney South, Haymarket and Beaconsfield West



In addition much of the equipment at Beaconsfield West substation is approaching the end of its serviceable life. It is expected that refurbishment/replacement works will be staged and undertaken as part of works to reinforce supply to the inner metropolitan area.

It is presently expected that to address the limitations described in this section an additional 330 kV line/cable and 330/132 kV substation development supporting the Sydney CBD and inner metropolitan area will be required by summer 2012/13. This development may be able to be delayed in a cost effective manner by implementation of a demand management project.

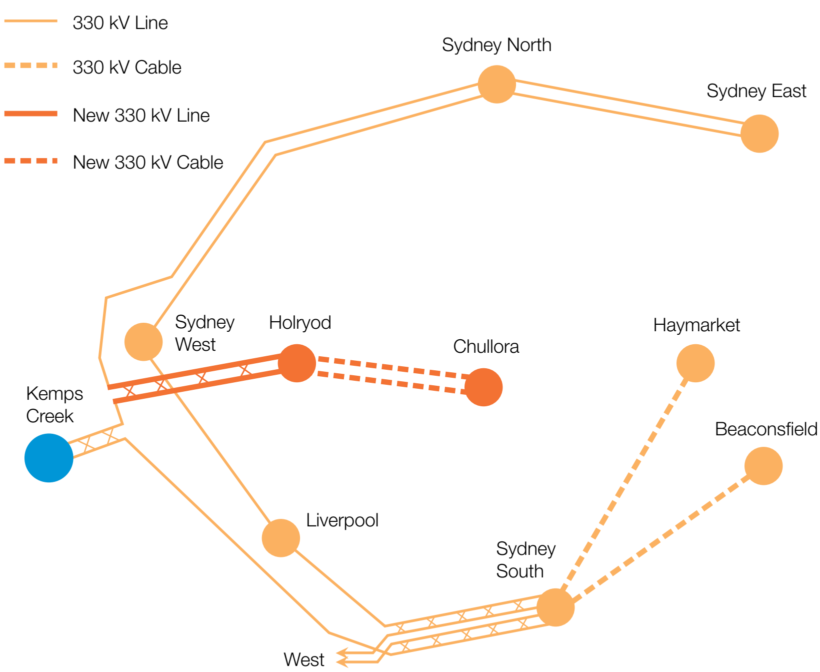
One option is the establishment of a 330/132 kV substation in the Potts Hill/Chullora area. This would increase supply capacity to the inner west of Sydney which would relieve loading on existing 330/132 kV substations, particularly Sydney South. It could initially be supplied by a 330 kV cable from Holroyd. This would require a Sydney West – Holroyd 330 kV development but would enable this option to address all of the limitations described in Sections 6.2.3 and 6.2.4. In the medium term a second cable from Holroyd to the Potts Hill/Chullora will be required and it may be cost effective to install both cables at the same time. Potts Hill/Chullora may also be a suitable location to connect a further 330 kV cable supplying a new substation in the inner metropolitan area. These developments are indicated in the figure below.

Other options to address the limitations described in this section include the development of a 330 kV supply from the north of the CBD from either Sydney North or Sydney East 330/132 kV substations. This 330 kV supply may involve overhead 330 kV line and underground 330 kV cable developments. Cabling would be required to connect to a new inner metropolitan substation.

Further development of 330 kV cables from Sydney South 330/132 kV substation is not favoured as there is a significant concentration of load at this site and it is considered prudent to diversify the major sources of supply to the CBD and inner metropolitan area of Sydney.

It is anticipated that an application notice covering a proposal to address the limitations described in Sections 6.2.3 and 6.2.4 will be issued in 2009.

Possible Sydney West – Holroyd – Potts Hill/Chullora Development



6.2.5. Redevelopment of Orange 132/66 kV Substation

Orange and its surrounding areas are supplied by a 66 kV network which emanates from Orange 132/66 kV substation. This substation was established in 1954 and is nearing the end of its serviceable life with both 132 kV and 66 kV switchgear needing complete replacement. The ageing 30 MVA transformers are presently being replaced under a committed project (refer to Section 5.2.12).

In addition the substation requires augmentation comprising of a 132 kV bus section circuit breaker and an additional 132 kV line switchbay to allow the Mount Piper – Orange – Wellington 132 kV line 947 to be looped into Orange substation. There is insufficient space to accommodate these works.

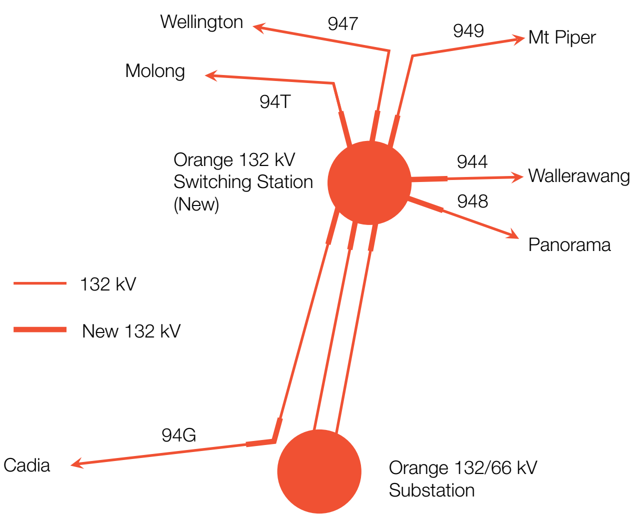
A preferred development to meet these requirements is indicated in the figure below and involves:

- Establishment of a new 132 kV switching station to the north of Orange substation which will accommodate a new and enhanced 132 kV busbar and other 132 kV switchgear;
- Relocation of 132/66 kV transformers within the existing Orange 132/66 kV substation;
- Replacement of the 66 kV busbar at the existing Orange 132/66 kV substation on space vacated by the removal of old 132 kV switchgear and relocation of the 132/66 kV transformers; and
- 132 kV line rearrangements.

It is anticipated that these works could be completed by late 2011.

An application notice covering these developments was issued in March 2009 and a final report was issued in May 2009.

Proposed Redevelopment of Orange 132/66 kV Substation



6.2.6. Development of Southern Supply to the ACT

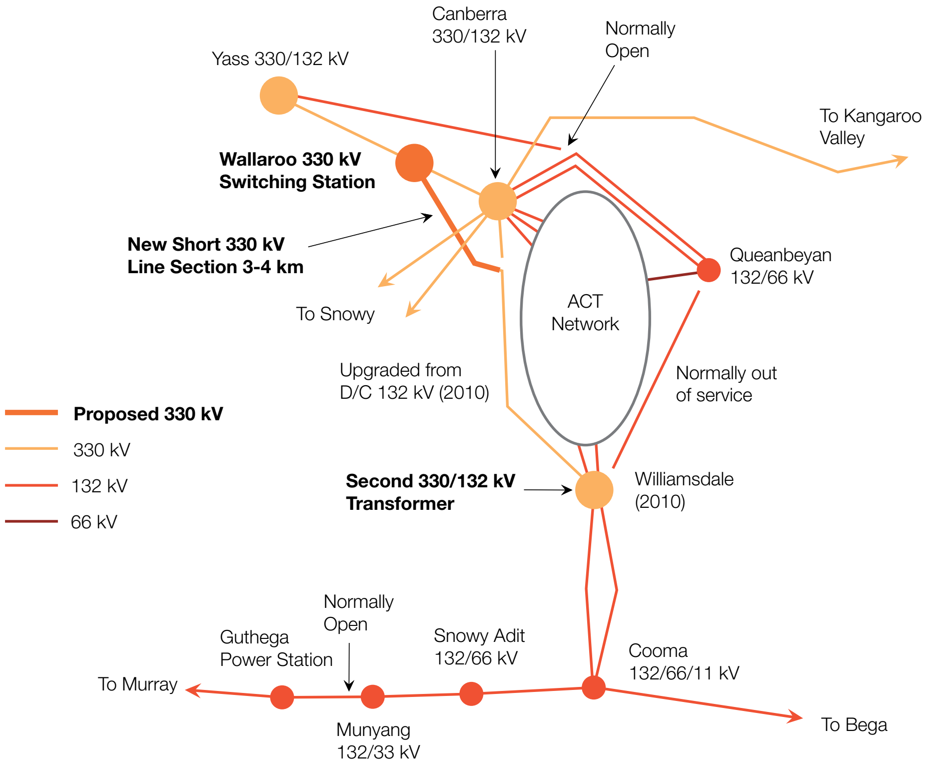
Williamsdale 330/132 kV substation is being established under a committed project for the development of supply to the ACT (refer to Section 5.3.3). To meet the requirements of the ACT government it will be necessary to provide a 330 kV supply to Williamsdale that is independent of Canberra 330/132 kV substation by mid 2012.

An option to provide this supply is illustrated in the figure on the following page and would involve the following works:

- Establishment of a new 330 kV switching substation at Wallaroo (northwest of Canberra) on the route of the Yass – Canberra 330 kV transmission line no 9;
- Formation of 330 kV circuits from Yass – Wallaroo and from Wallaroo – Canberra;
- Construction of a short section (approx 3 km) 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. A section of 330 kV line from Canberra would be disconnected at this point;
- Provision of an additional 375 MVA 330/132 kV transformer at Williamsdale; and
- Upgrading by ActewAGL of the existing Gilmore to Theodore 132 kV lines.

An application notice covering these developments was issued in April 2009 and a final report is envisaged to be issued by mid 2009.

Proposed Development of Southern Supply to the ACT



6.2.7. Supply to Lake Munmorah

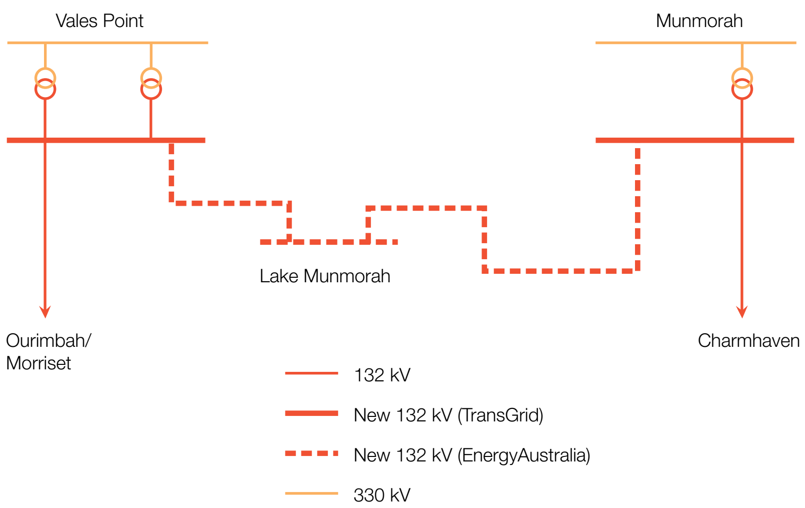
In order to address capacity and asset condition issues at its Lake Munmorah 33/11 kV zone substation EnergyAustralia is planning to redevelop it to a 132/11 kV substation with an anticipated in service date of mid 2012. The new substation will provide for anticipated load growth on the NSW Central Coast relieving the existing 33 kV network in the area.

The development will require 132 kV supplies from TransGrid's Munmorah and Vales Point 330/132 kV substations as illustrated in the figure above. Accordingly EnergyAustralia has requested TransGrid to provide a 132 kV switchbay at each site.

At both Munmorah and Vales Point 132 kV supplies are provided by direct connection of 132 kV feeders to 330/132 kV transformers. Provision of the new 132 kV line switchbays will therefore also require the establishment of a 132 kV busbar at each site by 2010/11.

EnergyAustralia and TransGrid have consulted on this development, publishing an application notice in December 2008 and a final report in May 2009.

Proposed Development of Supply to Lake Munmorah



6.2.8. Kemps Creek – Sydney South 330 kV Development

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 is also being progressed. 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 line carries power from Sydney South to and from the south coast.

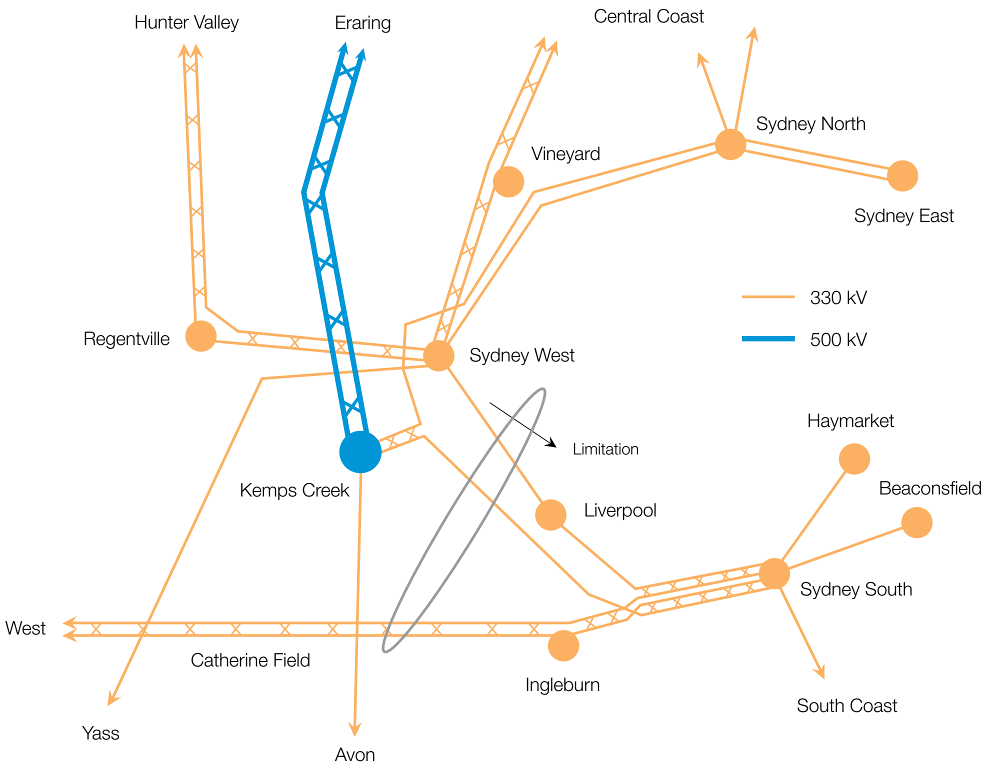
There is a need to reinforce this system in the next decade.

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 to 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.

Southern and Western Sydney Main System



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 Liverpool operated as a single circuit line when commissioned.

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 2009.

6.2.9. Upgrading of the Snowy to Yass / Canberra 330 kV System

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

The development of the Uranquinty power station, 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. The capability of this system to transfer power is limited by line rating constraints and voltage control issues. The system north of Snowy is regularly loaded to its maximum capability at times of high NSW loads.

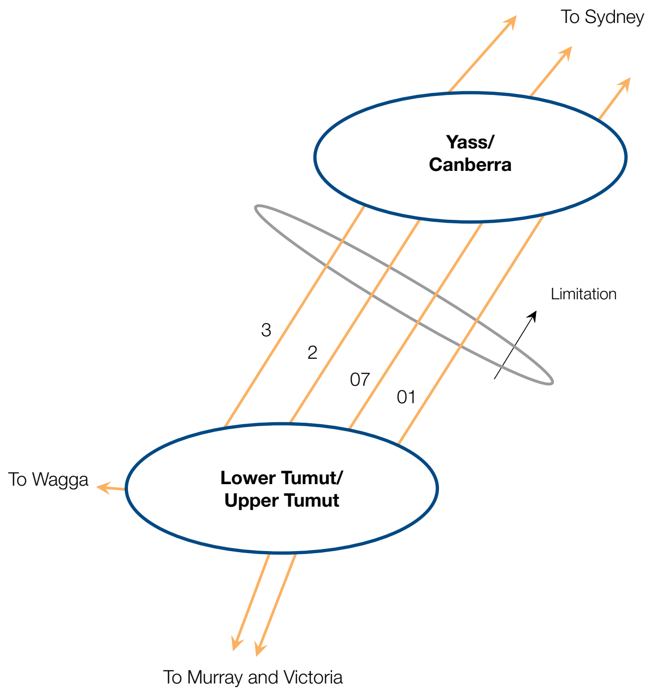
Hence there is a growing need to increase the capability of the system. Various options have been and are being investigated including:

- Reactive support plant;
- New line development;
- Upgrading of the 330 kV lines north of Snowy;
- Installation of power flow control plant;
- Real time line monitoring; and
- Implementation of a system protection scheme.

At this stage the preferred option is upgrading of the 330 kV lines north of Snowy. The resulting capability could be further augmented with a system protection scheme. 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 2009.

Snowy – Yass/Canberra 330 kV Connections



6.2.10. Reinforcement of Voltage Control in Northern NSW

There is an emerging need to reinforce voltage control facilities in northern NSW to provide reliable supply to the Tamworth, Armidale, Lismore and Coffs Harbour loads.

The critical contingencies are outage of lines in NSW and the loss of large generators in Queensland.

TransGrid is currently investigating the need for a second SVC at Armidale or the application of control systems and shunt switched reactive plant.

It is anticipated that an application notice covering these system limitations will be issued in 2009/10.

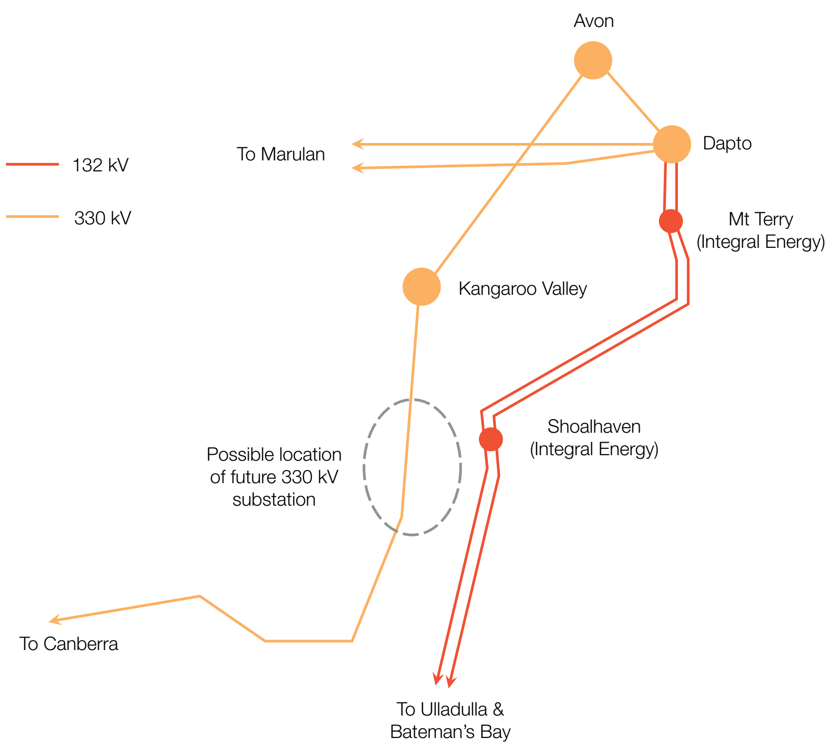
6.2.11. Supply to the Tomerong/Nowra Area

The loading on Integral Energy's 132 kV network south of the Wollongong area is approaching the capacity of that network. It is expected that additional line routes in the greater Wollongong area would be difficult to obtain.

At this stage the most likely development to provide additional capacity to the area is the establishment of a 330/132 kV substation in the Tomerong/Nowra area as indicated in the figure below. This would also relieve the loading on the 330/132 kV transformers at Dapto.

It is anticipated that an application notice addressing these limitations will be issued in 2009/10.

Possible Location of 330 kV Substation near Nowra



6.2.12. 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 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 and to assume ownership, operation and maintenance of 132 kV assets at Hawks Nest substation on completion of the works which is anticipated by about 2011.

It is anticipated that Country Energy and TransGrid will issue an application notice addressing these limitations in 2009.

6.2.13. 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 is likely to be reached within about the next five years. 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 short sections of 66 kV lines to form connections to Country Energy's 66 kV network in the area.

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 issue an application notice addressing these limitations in 2009 or early 2010.

6.2.14. 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 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, which is anticipated by about 2012.

It is anticipated that Country Energy and TransGrid will issue an application notice addressing these limitations in 2009 or early 2010.

6.2.15. Real Time Line Rating Installations

TransGrid intends to install 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 and conductor monitors at selected locations along each line, communication systems to stream the monitor data to TransGrid control centres to enable rating calculations and IT systems to interface the rating information with NEM dispatch systems.

The installations are proposed on the following 330 kV lines which presently cause constraints or may impose limitations in the near future:

- Tamworth – Armidale No. 86
- Liddell – Tamworth No.84
- Liddell – Muswellbrook No. 83
- Muswellbrook – Tamworth No. 88
- Snowy – Yass/Canberra (4 lines)
- Bannaby – Sydney West 330 kV
- Marulan – Dapto No. 8
- Marulan – Avon No. 16
- Kangaroo Valley – Dapto No. 18

Each installation is expected to cost less than about $1 Million. The installations are expected to be commissioned from 2010 to 2014.

6.2.16. Minor Augmentation Proposals

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

6.2.16 – Minor Augmentation Proposals

Proposal	Need	Completion	Cost ($M)	Other Options Considered	Comments
Provide dual switching on 330 kV line 84 at Liddell	Improve reliability of supply	Late 2010	1.7		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	Late 2010	0.9		Critical major substation supplying large urban loads
Provide 330 kV bus coupler circuit breaker at Sydney South 330 kV substation	Improve reliability of supply	Late 2010	1.1		Critical major substation supplying large urban loads
Provide 330 kV bus coupler circuit breaker at Sydney West 330 kV substation	Improve reliability of supply	Late 2010	1.1		Critical major substation supplying large urban loads
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	1.4	Like for like replacement.	Higher capacity unit has potential to delay the need for a second 330/132 kV transformer at Coffs Harbour 330/132 kV substation.
Provide a new 66 kV switchbay at Beryl 132/66 kV substation	Connection of Country Energy frequency injection equipment	Late 2009	0.3		DNSP requirement
Provide a new 132 kV switchbay at Lismore 330/132 kV substation	Connection of Country Energy 132 kV line to Casino	Late 2012	1.0		DNSP requirement
Provide a new 66 kV switchbay at Tamworth 132/66 kV substation	Connection of Country Energy 66 kV Quirindi line	Late 2012	1.1		DNSP requirement
Provide a new 132 kV switchbay at Cooma 132/66 kV substation	Connection of Country Energy 132 kV Bega line	2011	1.0		DNSP requirement
Provide 2 new 132 kV switchbays at Williamsdale 330/132 kV substation	Connection of Country Energy 132 kV lines to Tralee/Googong	2012	1.5		DNSP requirement
Albury Trip Scheme	Thermal loading of Jindera – Albury – ANM network	Late 2011	0.5	Additional 132 kV circuit Installation of capacitors	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	<5	Restore conductor clearances only	Capacity support to be carried out with works to restore conductor clearances.

6.2.17. 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 the table below.

6.2.17 – Proposed Replacement Transmission Network Assets

Proposal	Need	Completion	Cost ($M)	Other Options Considered	Comments
Replacement of 132 kV equipment at Beaconsfield West 330/132 kV substation	Replace ageing equipment	Late 2012	125.0	Use of sites adjacent to Beaconsfield West	Includes switchbays for two 132 kV capacitors and provision for four future 132 kV cable connections to EnergyAustralia.
Replace control equipment on both SVCs at Broken Hill 220/22 kV substation	Replace ageing and obsolete equipment	Mid 2011	17.0	1. Decommission one SVC and use spares for the other. 2. Replace control equipment on one SVC and use spares for the other.	
Replace ancillary equipment and control systems on both SVCs at Kemps Creek 500/330 kV substation	Replace ageing equipment	Late 2011	21.0		
Dapto – Sydney South 330 kV line rehabilitation	Line rehabilitation works	Late 2011	8.4		
Replacement of two 375 MVA 330/132 kV transformers at Wagga 330/132 kV substation by new units.	To meet EPA requirements for management of PCBs	Late 2009	19.0	Treatment of oil to remove PCBs.	As transformers are relatively old, life extension through removal of PCBs is not cost effective.
Replacement of two 215 MVA 330/132 kV transformers at Wallerawang 330/132 kV substation by new 375 MVA units.	Replacement of one failed unit.	Late 2010	21.4		The second unit cannot be tested for serviceability until replaced. If found to be serviceable it would be used elsewhere.
Establishment of a new Wallerawang 132/66 kV substation	Replace ageing equipment at existing 132 kV switchyard	Late 2011	20.4	Reconstruction adjacent to the existing switchyard	Construction on a new site
Replacement of Tenterfield – Lismore 132 kV line capacity	Possible use of line route for higher voltage line	2012		1. New 132 kV line. 2. New 330/132 kV substation.	Options currently being developed and costed.

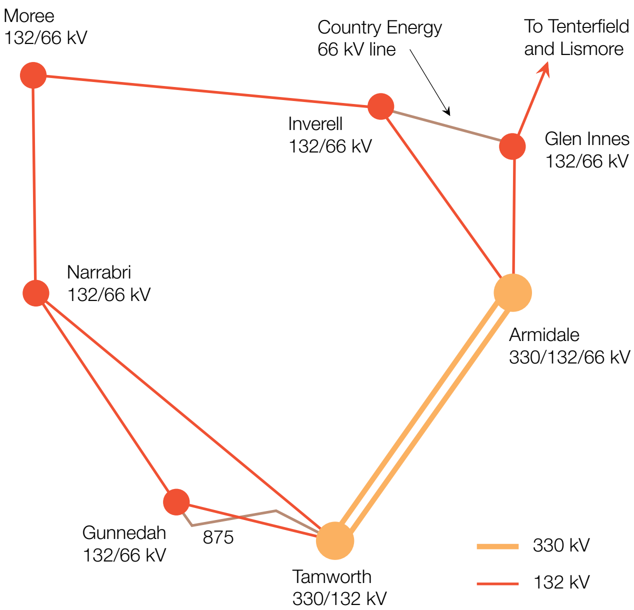
6.3. Other Constraints Emerging Within Five Years

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 within about five years.

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
- DM and/or local generation.

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

A new section of double circuit 132 kV line is presently being 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. 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 over a five year planning horizon where there is at present no firm proposal.

TransGrid Location	Details	Indicative Date	Distribution Development
Beryl	One 66 kV switchbay	2013/14	Supply to Dunedoo
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
Vineyard	Two 132 kV switchbays	2011/12	Supply to developments in the Vineyard area
Wellington	One 132 kV switchbay	2011/12	Supply to Dubbo area

6.3.3. Transformer Capacity Upgrades and Replacements

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

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
Eraring& Kemps Creek	Upgrade radiator systems on 500/330 kV transformers at these sites to achieve higher transformer rating	2012/13
Griffith	Replace three 45 MVA 132/33 kV transformers by three new 60 MVA units	2012/13
Kempsey	Replace two 15 MVA 33/66 kV transformers by two new 25 MVA units	2012/13
Munyang	Replace two 30 MVA 132/33 kV transformers by two new 60 MVA units	2014
Murray	Augment 330/132 kV transformer capacity	2014
Newcastle	Replace the three remaining banks of single phase 330/132 kV transformers by new 375 MVA three phase units	2013/14
Tamworth	Replace two of the three 60 MVA 132/66 kV transformers by new 120 MVA units	2012/13
Yanco	Replace two 45 MVA 132/33 kV transformers by two new 60 MVA units	2012/13

6.3.4. 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. They 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 over a five year planning horizon but where there is at present no firm proposal.

Location	Details	Indicative Date
Beaconsfield West	Two new 160 MVAr 132 kV capacitor banks	2012/13
Regentville	One 80 MVAr 132 kV capacitor bank	2012/13
Sydney Area	One 200 MVAr 330 kV capacitor bank	2012/13
Sydney Area	One 80 MVAr 132 kV capacitor bank	2013/14
Sydney Area	One 200 MVAr 330 kV capacitor bank	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 5 years. One or more indicative developments to meet the constraints are given.

Constraint	Indicative Development(s)	Time Frame (Years)
Voltage and thermal constraints in the 132 kV network in the ANM/Albury area.	Installation of capacitors at Albury or in Country Energy's network; Additional Jindera – Albury 132 kV circuit.	>5
Transformer capacity limitations in the network supplying the Macarthur area and the Southwest sector.	Additional transformers at Macarthur 330/132/66 kV substation; 330/132 kV transformers at Kemps Creek substation.	>5
Voltage and thermal constraints in the 132 kV network supplying Cooma/Bega area	Additional Williamsdale – Cooma line (possibly 330 kV construction).	>5
Voltage constraints in the 132 kV network supplying the Finley, Deniliquin and Coleambally areas.	New 132 kV line from Darlington Point – Coleambally; Capacitor installations.	>5
Sydney South 132 kV fault rating limitations	Uprating of 132 kV equipment and/or implementation of operating restrictions.	>5
High loading on Yass – Cowra 132 kV line 999.	Uprating or reconstruction of the line.	>5
500/330 kV transformer capacity limitation at Kemps Creek	Installation of a third 500/330 kV transformer.	>5
Power transfer and reliability limitations of Liddell – Armidale 330 kV lines	Replacement or upgrading of existing lines. (Other works are in progress or proposed – refer to Sections 5.2.4 and 6.2.16)	>5
Thermal limitations on 330 kV lines between Marulan and Yass/Canberra	Installation of power flow equipment on the lines; New Bannaby – Marulan/Yass lines (may be some 500 kV construction).	5 to 10
Deteriorating supply demand balance in Victoria/ South Australia or NSW or generation developments	NSW – Victoria/South Australia interconnection development.	5 to 10
Limitations in supply to south western NSW.	Wagga – Darlington Point/Finley 330 kV line.	10
High loadings on critical system elements in the Wagga area.	Yass – Wagga 330 kV line.	10
Limitations in supply to the North Coast of NSW	Rebuild Taree – Port Macquarie 132 kV line to double circuit 132 kV.	>10

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 DM and local generation options, to relieve the emerging network constraints. The advantages that DM and local generation 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.

TNSPs consider DM, local generation and bundled options on an equal footing with network options when 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 either 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 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

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

- Reduction in electrical energy consumption through increases, at points of end-use, of:
  - 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 through increases, at points of end-use, of:
  - 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.

Local Generation

Local generation options may include generation or cogeneration facilities located on the load side of a transmission constraint. 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 Options by TransGrid

TransGrid actively promotes DM and local generation options through:

- Identifying opportunities for DM and local generation options through joint planning with the Distributors and engaging expert external consultants;
- Informing the market of constraints via the Annual Planning Review 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 projects involving DM and energy efficiency.

7.1.2. Recent Non-Network Projects

Sydney CBD Demand Management and Planning Project

The Sydney CBD Demand Management and Planning Project (DMPP) was established in March 2003 as part of joint planning for the development of electricity supply to the Sydney CBD and inner suburbs (MetroGrid project). Funding of $5 Million each by TransGrid and Energy Australia was made available to the DMPP over a 5 year period for the identification of the potential for reduction of electricity demand in the Sydney inner metropolitan area.

The DMPP concluded in June 2008 having established a comprehensive knowledge base of DM technologies and practices. Findings of the DMPP and related reports may be found on the project website at www.planning.nsw.gov.au/dmpp/.

The main conclusion of the DMPP is that peak network demand may be moderated and energy efficiencies gained by using a portfolio of initiatives in cooperation with electricity customers. Some of the findings of the DMPP will be utilised in sourcing DM for a possible deferral of the next Sydney CBD electricity supply network augmentation (refer to Sections 6.2.3 and 6.2.4).

Western 500 kV Upgrade 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 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 upgrade project by to 2009/10 (refer to Section 5.2.1).

The AER approved 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 network support to its customers.

7.1.3. Future DM and other Non-Network Projects

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

- A DM project to enable the deferment of some elements of the network component of the preferred option for the development of electricity supply to the Sydney CBD and inner metropolitan area (refer to Sections 6.2.3 and 6.2.4);
- A project with NSW DNSPs for the encouragement of innovative demand side response solutions and responses to Requests for proposals for non-network alternatives.

Other non-network projects that are likely to be implemented 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 (refer to Section 6.2.9). This may include implementation of a special system protection scheme;
- Provision of Network Support and Control Service (NSCS). This is a new requirement for TNSPs to procure and deliver reactive power capability other than that required for main system security. Part of the NSCS may come from non-network sources.

7.1.4. Price Signals to Encourage DM and Local Generation

TransGrid is a ‘wholesale’ provider of network services and is best placed to implement ‘wholesale’ 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. It is recognised that clear and consistent price signals to these customers, reflecting actual costs, will provide incentives for DM and local generation.

TransGrid can also provide price signals via direct payments under network support contracts with wholesale suppliers of demand reductions such as larger end users or generators. 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 ‘imbedded’ 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 which is not easy to quantify.

Consistent with the NER TransGrid’s transmission charges provide strong price signals to customers linked to the cost of providing transmission services to each location. Prices include a usage charge that is different at each transmission connection point. This charge is calculated using the Cost Reflective Network Pricing methodology set out in the NER. The NSW distributors are required by their regulator (IPART until 30 June 2009) to preserve these signals, where practicable, when allocating transmission charges to end-use customers.

TransGrid's price structures for these location specific charges also include rates linked to the time at which demand for network services is greatest. Specifically TransGrid applies two rates as part of this price structure – one based on monthly maximum demand and one based on energy used in peak and shoulder periods. As a result, for customers whom transmission charges are a material component of their monthly electricity bills, there is an immediate financial benefit if they are able to reduce their maximum demand or to shift their consumption to off peak time periods.

7.1.5. Gas and Wind Generation

TransGrid is an electricity transmission network provider connecting generation to distribution networks and to large electricity consumers in NSW. It provides connections for proposed new generators to the transmission network on request to meet the requirements of the NER. In recent years the vast majority of applications to connect to TransGrid's network have been from proponents of gas or wind powered generation.

In the 2008/9 financial year TransGrid successfully connected the Uranquinty 664 MW gas fired power station. As of May 2009 arrangements to connect 668 MW of gas fired generation at Colongra and a 141MW Capital Wind Farm were well advanced. In addition TransGrid assisted Integral Energy with the connection of 400MW of gas fired generation at Tallawarra. TransGrid is also processing the connection of a number of gas and wind farm generators during the 2009/10 financial year.

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 a continuing increase in generation connection activity.

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 increasing level of interest in grid connections, particularly for gas and wind 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 requirements of intending generators whilst preserving mandated interconnected power system performance standards as well as TransGrid's performance obligations to existing generators and consumers including obligations set out in pre-existing connection agreements. There are also confidentiality requirements in the NER that limit TransGrid's ability to publicly disseminate basic information about planned generator connections. The AEMC is currently considering the adequacy of the NER more generally in the context of removing impediments to connecting new generators associated with achieving national climate change policies.

To address this challenge TransGrid is reviewing its options for developing connection arrangements, reviewing internal processes and working within the AEMC's Rule change process, in close association with other Grid Australia members, to address impediments such as unnecessarily strict confidentiality requirements.

Recent changes to the NER have also provided a new environment for intending generators. Services associated with assets created within, or proximate 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 associated with the significantly increased wind generation development activity in NSW. The MRET scheme is seen as a potentially major driver of wind generation in NSW over the short to medium term. The NSW Government is actively supporting these initiatives with the establishment of development zones 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. The need to develop transmission extensions to remote wind resources is not yet the priority that is emerging in other states such as South Australia.

Wind farm connection activity is occurring at both the transmission and distribution levels 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 generation develops 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.

8. Appendices

Appendix 1 – TransGrid's Network Planning Approach

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. Joint planning with DNSPs, directly supplied industrial customers, generators and interstate TNSPs is carried out to ensure that the most economic 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 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 NEMMCO's[5] 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).
- The main transmission network, which is operated by NEMMCO, should have sufficient capacity to accommodate NEMMCO's operating practices without inadvertent loss of load (other than load which is interruptible or dispatchable) or uneconomic constraints

[5] NEMMCO will become part of the Australian Energy Market Operator (AEMO) from 1 July 2009.

on the energy market. At present NEMMCO'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 requirement 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.

The Network Planning Process

The network planning process is undertaken at three 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 Planning Committee assists in the preparation of the Statement of Opportunities and the National Transmission Statement (NTS) (NTNDP from 2010). The NTS identifies actual and potential constraints on interconnectors that may be addressed by transmission augmentations, generation developments or DM developments.

TransGrid's approach to the development of the network since the advent of the NEM is in accordance with 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. 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.

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.

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 13,000 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. NEMMCO 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, NEMMCO 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.

NEMMCO 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 NEMMCO'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 (NEMMCO 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 (NEMMCO action), without the need for pre-emptive load shedding, so as to withstand the impact of a second contingency.

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 NEMMCO'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 requires the application of probabilistic-based security analysis, taking 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 NEMMCO 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 NEMMCO 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:

1. Under system normal conditions all elements must be loaded within their "recurrent cyclic" rating;

2. 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";

3. Cyclic load shedding (in areas other than the Sydney CBD) may be required in the sort 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;

4. 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;

5. The load forecast to be considered is based on "50 percent probability of exceedence";

6. 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

7. 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.

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.

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.

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.

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.

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.

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 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. Allowance is also made for the outage of two circuits in succession or both circuits of a double circuit line under reasonably probable patterns of power transfer across the main network.

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

The NER specifies reference power factors for generators and Distributors at points of connection.

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.

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.

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.

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.

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.

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.

13. Scenario Planning

Scenario planning assesses network capacity, based on the factors described above, for a number of NEM load/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 NEMMCO 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;
   - Impacts of energy related developments such as gas pipeline projects.
3. Modelling of the NEM for load/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/generation scenarios utilising the data from the market modelling.

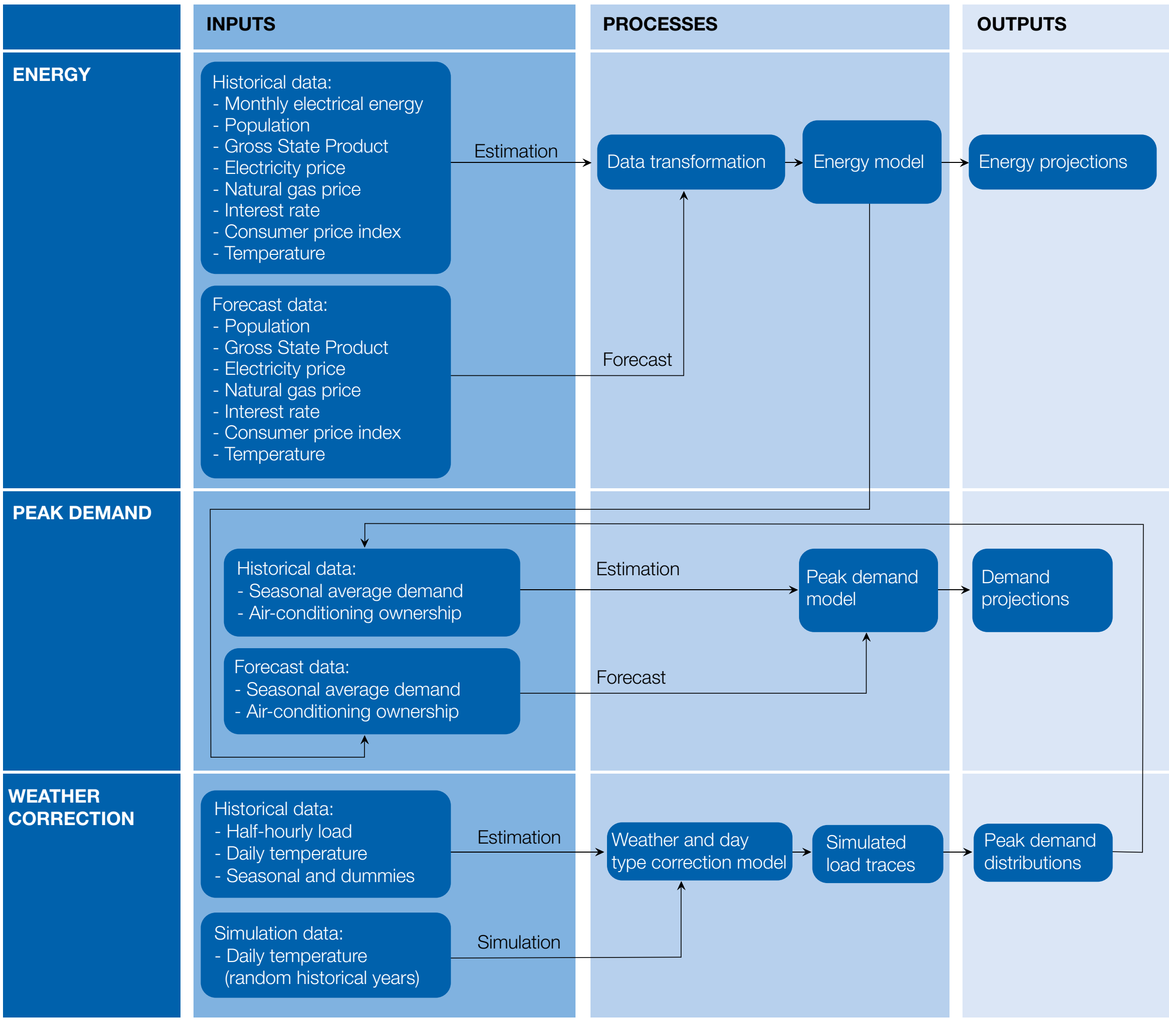
The resulting set of scenarios is then assessed over the planning horizon to establish the adequacy of the system and to assess network and non-network augmentation options.

Appendix 2 – TransGrid's Load Forecasting Process

A2.1 Overview

The production of 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) ensures that the regional energy and maximum demand projections throughout the NEM are developed by JPBs for inclusion in the Statement of Opportunities (SOO) on a consistent basis, by developing consistent definitions and input assumptions.

Inputs to the overall process include the historical data that is used for estimating and testing the various models that are used and future scenarios for the independent variables in these models. Assumptions about the future, including the economic scenarios, are 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 10th, 50th and 90th percentile summer and winter demands. These series are then used to create future projections using peak demand models.

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 EnergyAustralia, Integral Energy, Country Energy and Actew-AGL for their respective distribution network areas across the NSW region of the NEM. These projections, which are assumed to 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 modelled demands for the NSW region produced by TransGrid. An iterative process of re-examining the basis of both the TransGrid modelled projections and the connection point forecasts is undertaken to check for broad compatibility.

A2.2 Input Assumptions

Information available up to the end of March 2009 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 SOO.

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

Historical information regarding embedded and renewable generation and demand side participation (DSP) is collected via surveys undertaken by the LFRG.

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 2009 Energy and Demand Projections

	NSW Population (number)	NSW Gross State Product (2006-07 $m)	Consumer price index (index)	Nominal electricity prices (c/kwh) Residential	Business	Total	Nominal gas price (c/MJ)	Standard variable home loan rate (per cent)
Historical data								
2005/06	7,151,407	350,576	152.1	13.4	7.3	9.3	1.9	5.56
2006/07	7,228,937	357,845	156.2	13.2	7.5	9.4	1.9	5.48
2007/08	7,308,667	367,160	160.9	13.0	7.6	9.4	2.0	5.39
Baseline scenario								
2008/09	7,397,137	366,485	166.3	15.7	8.7	11.0	1.9	5.08
2009/10	7,482,619	364,335	166.8	15.4	7.8	10.3	1.8	4.39
2010/11	7,568,728	373,838	168.8	15.9	8.6	11.1	1.9	3.99
2011/12	7,656,259	381,237	175.4	16.5	9.3	11.6	1.9	3.88
2012/13	7,743,362	389,646	183.2	17.1	10.1	12.4	2.0	4.02
2013/14	7,830,164	401,854	190.6	17.7	10.8	13.1	2.0	4.25
2014/15	7,916,736	412,980	196.0	18.3	11.3	13.6	2.0	4.40
2015/16	8,003,167	425,433	198.6	18.7	11.6	13.9	2.1	4.42
2016/17	8,089,355	439,240	201.0	18.9	11.9	14.2	2.2	4.38
2017/18	8,175,217	450,016	205.9	19.3	12.4	14.7	2.2	4.33
2018/19	8,260,733	458,391	212.5	19.9	13.1	15.4	2.3	4.30
High scenario								
2008/09	7,400,359	367,096	166.3	15.7	8.7	11.0	1.9	5.08
2009/10	7,492,361	365,056	166.9	15.5	7.8	10.3	1.8	4.42
2010/11	7,588,365	375,062	168.6	16.0	8.7	11.1	1.9	4.07
2011/12	7,686,018	383,646	174.0	16.5	9.2	11.6	2.0	3.97
2012/13	7,783,467	393,313	179.7	17.0	9.7	12.1	2.0	4.05
2013/14	7,880,838	408,692	183.9	17.4	10.0	12.4	2.0	4.14
2014/15	7,978,198	424,454	186.9	17.7	10.2	12.7	2.1	4.12
2015/16	8,075,631	439,858	189.9	18.1	10.5	13.0	2.1	4.01
2016/17	8,173,028	453,281	195.0	18.5	11.0	13.5	2.2	3.94
2017/18	8,270,296	461,613	202.3	19.1	11.7	14.1	2.3	3.99
2018/19	8,367,405	467,437	210.0	19.8	12.3	14.8	2.4	4.13
Low scenario								
2008/09	7,393,916	365,815	166.3	15.7	8.7	11.0	1.9	5.07
2009/10	7,472,877	362,185	166.6	15.4	7.8	10.3	1.8	4.36
2010/11	7,549,092	369,381	168.2	15.8	8.9	11.2	1.9	3.93
2011/12	7,623,279	374,933	174.2	16.2	9.7	11.8	1.9	3.82
2012/13	7,693,514	383,534	182.3	16.8	10.8	12.8	1.9	4.03
2013/14	7,763,075	398,171	191.5	17.5	12.2	13.9	2.0	4.43
2014/15	7,832,034	410,121	200.2	18.3	13.3	14.9	2.0	4.78
2015/16	7,900,490	420,195	205.3	18.9	14.0	15.6	2.1	4.93
2016/17	7,968,349	433,110	207.5	19.3	14.3	16.0	2.2	4.89
2017/18	8,035,540	445,100	211.5	19.6	14.8	16.4	2.2	4.71
2018/19	8,102,054	453,360	219.0	20.1	15.6	17.1	2.3	4.46

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 Mortgage X Mortgage Information Service and KPMG.

A2.3 Energy Model

Electricity is consumed as a consequence of many separate decisions to utilise electrical appliances. Overall consumption may be related to distinct short and long run 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 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 simplifies 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. For a detailed technical discussion of the model, see "Electricity Consumption in New South Wales"[6]. The model has been re-estimated using up to date data and has undergone rigorous testing before the 2009 projections were finalised.

The model explains monthly 'Native'[7] 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 incandescent light bulbs and accelerated uptake of solar hot water systems and small scale rooftop PV.

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	0.959	Mean dependent variable	0.001
Adjusted R-squared	0.955	S.D. dependent variable	0.044
S.E. of regression	0.009	Akaike info criterion	-6.450
Sum squared residual	0.032	Schwarz criterion	-6.113
Log likelihood	1336.948	F-statistic	260.466
Durbin-Watson statistic	1.562	Prob (F-statistic)	0.00
Breuach-Godfrey Serial Correlation LM Test:		ARCH Test:	
Obs*R-squared	56.56	Obs*R-squared	20.27
Prob. Chi-Square (12)	0.00	Prob. Chi-Square (12)	0.062
White Heteroskedasticity Test:			
Obs*R-squared	44.58		
Prob. Chi-Square (91)	0.0859		

[6] www.transgrid.com.au/Annual_Planning_Reports.htm

[7] 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 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 known standard conditions. In the NEM, regional demand projections are presented on an exact 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 2009 demand projections used daily maximum demands between November 1991 and March 2009.

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	0.954	Mean dependent variable	1.177
Adjusted R-squared	0.954	S.D. dependent variable	0.181
S.E. of regression	0.038	Akaike info criterion	-3.649
Sum squared residual	9.467	Schwarz criterion	-3.599
Log likelihood	11558.22	Hannan-Quinn criterion	-3.632
F-statistic	2838.337	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 not shown 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 different weather scenarios were created using actual weather data from 1959 to 2009 and applied to the period under analysis (1991 to 2009). Using errors from the weather normalisation equation 600 alternative simulated error patterns were created and applied to each of the weather scenarios resulting in 30,000 alternative load profiles. Peak summer and winter demands are extracted from the simulations from which the required POE levels are calculated.

The 2009 weather and day type corrected peak demands are compared with actual peak demands in Figures A2.2 and A2.3 and show that actual summer 2008-09 peak demand was at a 36 per cent POE level (exceeded in 36 out every 100 simulations) and actual winter 2008 peak demand was at a 4 per cent POE level (exceeded in only 4 out every 100 simulations).

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

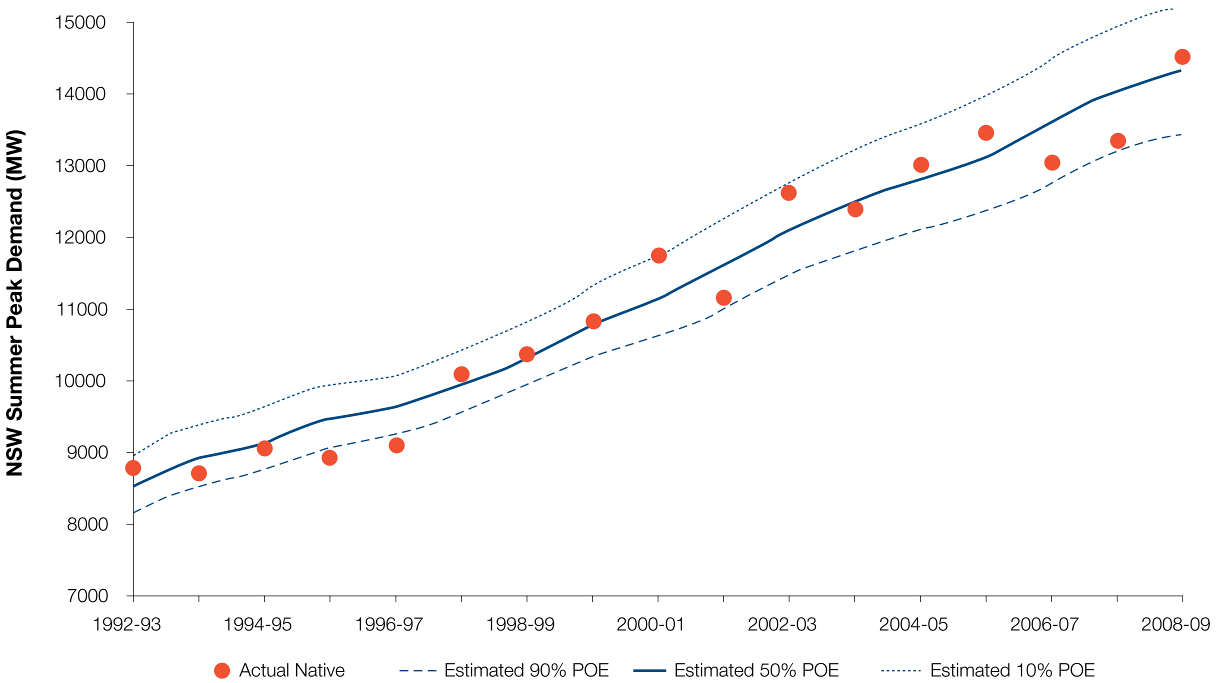
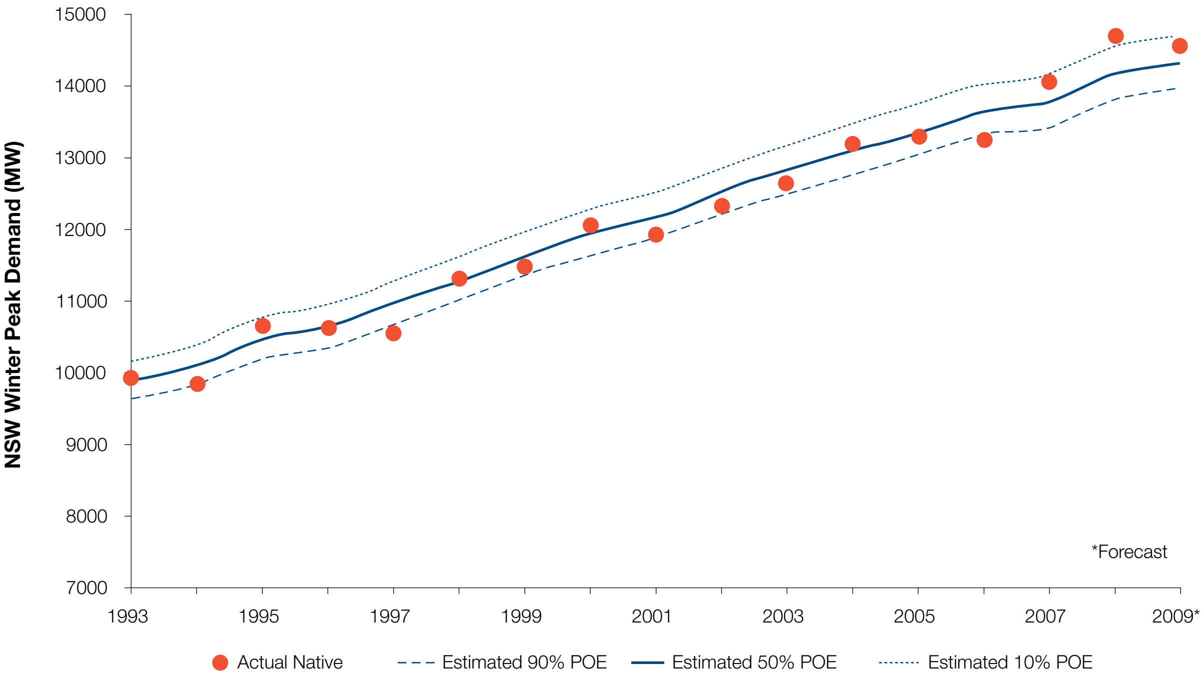


Figure A2.3: Historical Winter Peak Demand and Estimated Historical 10%, 50% and 90% POE Winter Demand



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[8]. 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 model results have been adjusted ex-post to allow for the phasing out of incandescent light bulbs and accelerated uptake of solar hot water systems and small scale rooftop PV.

The main characteristics of the 2009 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

Table A2.8: NSW Summer Demand Model Summary Statistics

Statistic	Value	Statistic	Value
R-squared	0.996	Mean dependent variable	10174
Adjusted R-squared	0.995	S.D. dependent variable	2184.9
S.E. of regression	148	Akaike info criterion	12.97
Sum squared residual	372301	Schwarz criterion	13.12
Log likelihood	-127	Hannan-Quinn criterion	13.00
F-statistic	2062	Durbin-Watson statistic	1.03
Prob (F-statistic)	0.00		

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

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 6 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 2002.

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

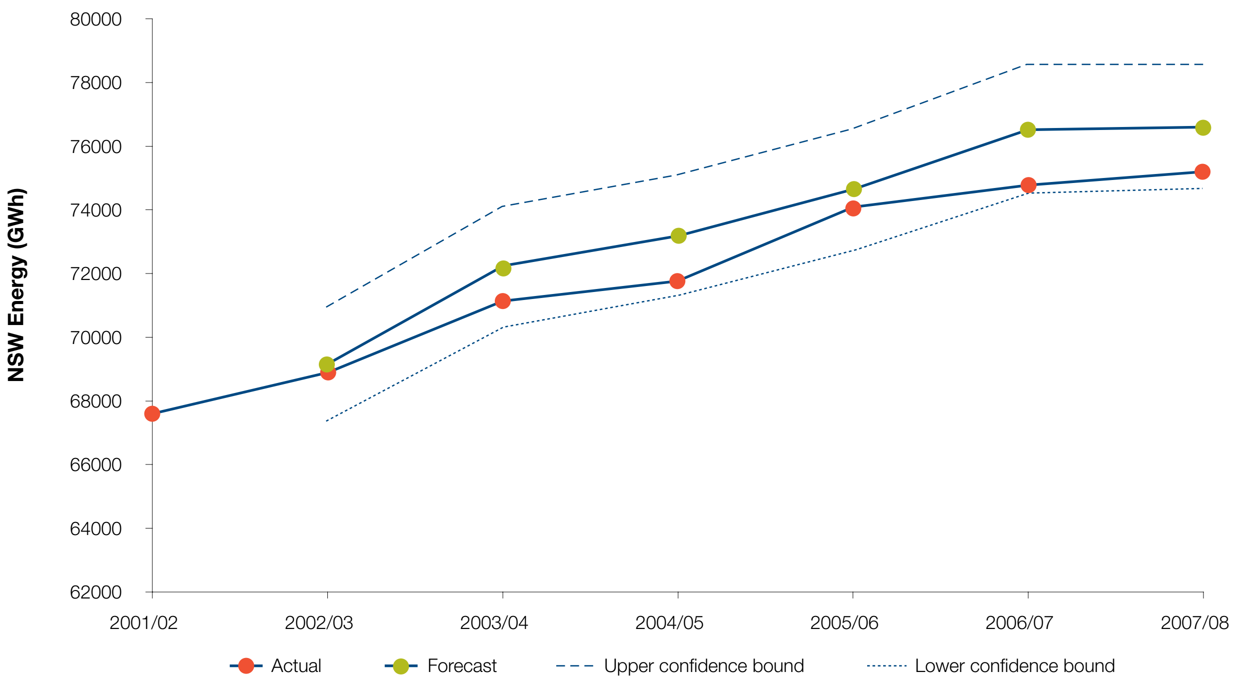


Table A2.9 NSW Energy Model Out-of-sample Forecast Performance Statistics

Performance Indicator	Value
Forecast Identifier	ESO
Forecast sample	2002/03 to 2007/08
Included observations	6
Root Mean Squared Error	1,189
Root Mean Squared Percentage Error	1.64
Mean Absolute Error	1,071
Mean Absolute Percentage Error	1.46
Theil Inequality Coefficient	0.008
Bias Proportion	0.812
Variance Proportion	0.086
Covariance proportion	0.102

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

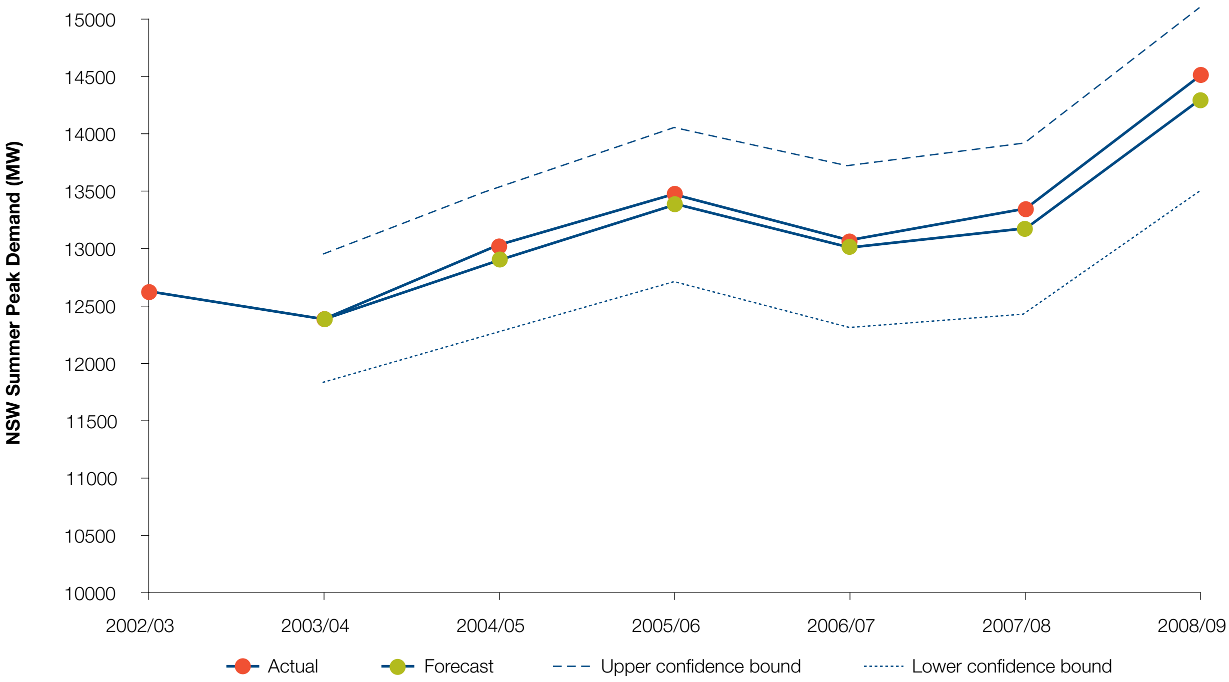


Table A2.10: NSW Summer Demand Model Out-of-sample Forecast Performance Statistics

Performance Indicator	Value
Forecast Identifier	PD(SUMMER)
Forecast sample	2003-04 to 2008-09
Included observations	6
Root Mean Squared Error	131
Root Mean Squared Percentage Error	0.99
Mean Absolute Error	109
Mean Absolute Percentage Error	0.80
Theil Inequality Coefficient	0.005
Bias Proportion	0.670
Variance Proportion	0.236
Covariance proportion	0.095

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

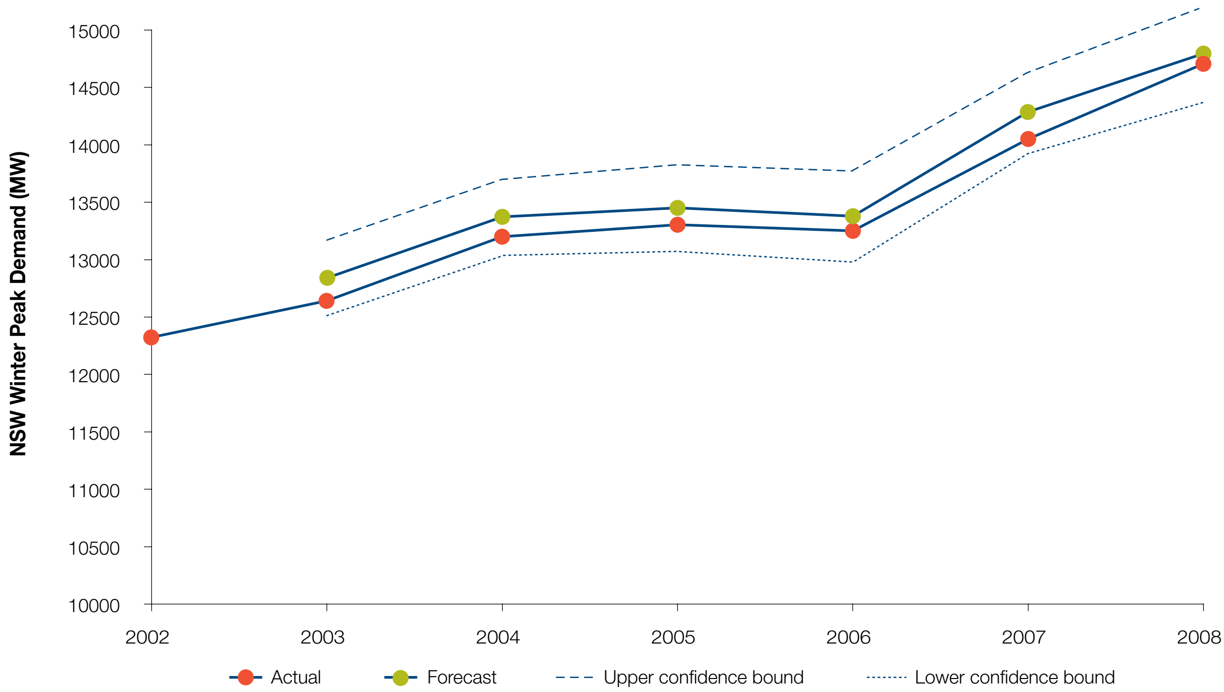


Table A2.11: NSW Winter Demand Model Out-of-sample Forecast Performance Statistics

Performance Indicator	Value
Forecast Identifier	PD(WINTER)
Forecast sample	2003 to 2008
Included observations	6
Root Mean Squared Error	168
Root Mean Squared Percentage Error	1.27
Mean Absolute Error	162
Mean Absolute Percentage Error	1.21
Theil Inequality Coefficient	0.006
Bias Proportion	0.924
Variance Proportion	0.010
Covariance proportion	0.065

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:

- 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 are derived by taking a five season weighted average (where possible) of the ratio of the aggregated individual connection point loads at the time of the NSW region peak demand against the summated seasonal peak demands at the individual connection points. 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

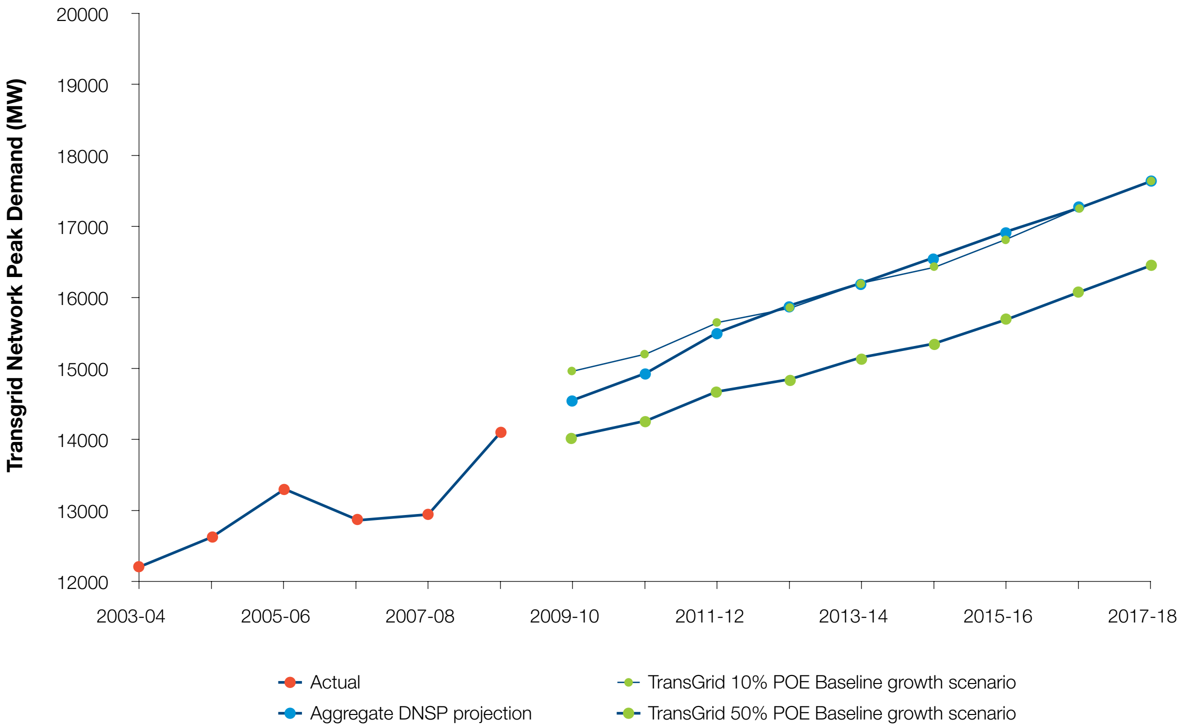


Figure A2.7 above shows the NSW Summer DNSP projection, aggregated as described above, and TransGrid's 10 per cent and 50 per cent POE projections. The chart shows the aggregate DNSP projection growing at a higher rate on average than the TransGrid projections for NSW over the forecast horizon. The DNSP projections grow at a slower rate in the initial years of the forecast period but align with TransGrid's 10 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 on the next page 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 initially growing at a higher rate compared to that of TransGrid but eventually aligning with TransGrid's 10 per cent POE projections. The average growth rate for the DNSP projections is identical to that of TransGrid's projections however the trajectory is different. While TransGrid's projections exhibit 'slowing down' in the initial years due to economic downturn (and 'catching-up' in the later years of the forecast period) the aggregate DNSP projection apparently reflects a different economic growth trajectory.

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

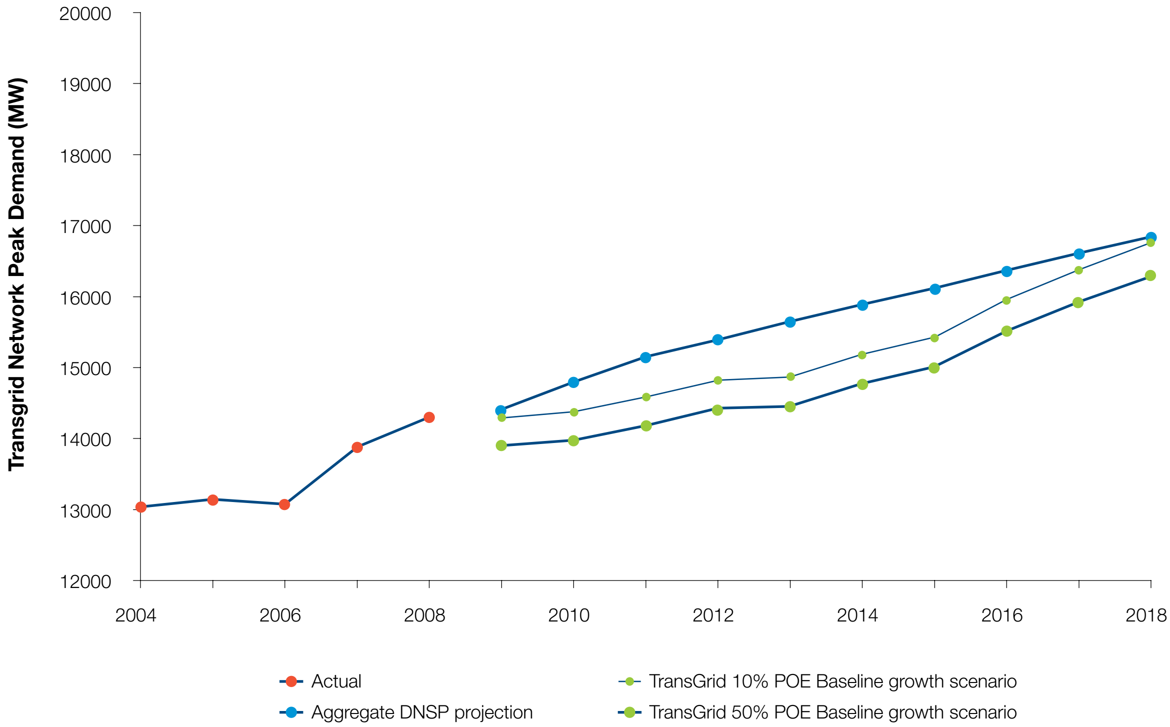


Table A2.12 presents the average annual growth rates for the summer and winter peak demand projections. The degree of similarity in growth rates displayed in this table demonstrates the extent to which TransGrid's 'top-down' approach and the aggregated DNSP 'bottom-up' approach have achieved a reasonable convergence of outcomes although the growth trajectories differ due to different economic assumptions.

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	385	2.4%	309	2.0%	343	2.1%
Winter	272	1.8%	266	1.8%	273	1.8%

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)] / 1.032

+ Embedded Scheduled and Non-Scheduled generation

Where 1.032 is a distribution loss factor.

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 A3.4 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 A3.14 and A3.15.

Note that Tables A3.4 to A3.15 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 auxiliaries (GWh)	Excluding transmission losses (GWh)	End-use sales (GWh)
1997/98	actual	64,289	60,584	57,793	58,713
1998/99	actual	65,855	62,976	59,671	59,544
1999/00	actual	68,022	64,098	61,769	60,949
2000/01	actual	69,833	66,587	63,510	61,761
2001/02	actual	70,802	67,591	63,848	62,162
2002/03	actual	72,227	68,888	65,381	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	79,123	74,783	71,738	70,540
2007/08	actual	79,650	75,200	72,150	70,950
2008/09	estimated	80,430	75,680	73,230	72,000
2009/10	projection	79,860	75,470	72,090	70,910
2010/11	projection	80,470	76,030	72,930	71,790
2011/12	projection	81,140	76,510	73,360	72,210
2012/13	projection	82,630	77,920	74,630	73,470
2013/14	projection	83,190	78,350	75,160	73,990
2014/15	projection	84,600	79,590	76,540	75,340
2015/16	projection	86,910	81,720	78,890	77,610
2016/17	projection	88,610	83,250	80,600	79,270
2017/18	projection	90,260	84,670	82,000	80,620
2018/19	projection	91,850	86,100	83,310	81,900
1999/2000 to 2008/09		1.9%	1.9%	1.9%	1.9%
2009/10 to 2018/19		1.6%	1.5%	1.6%	1.6%

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)
1998-99	10,379			
1999-00	10,826			
2000-01	11,739			
2001-02	11,155			
2002-03	12,621			
2003-04	12,383			
2004-05	13,016			
2005-06	13,467			
2006-07	13,059			
2007-08	13,346			
2008-09	14,514			
2009-10		13,545	14,445	15,375
2010-11		13,766	14,706	15,666
2011-12		14,152	15,132	16,122
2012-13		14,408	15,428	16,448
2013-14		14,681	15,741	16,801
2014-15		14,835	15,945	17,045
2015-16		15,159	16,309	17,439
2016-17		15,490	16,680	17,860
2017-18		15,841	17,061	18,271
2018-19		16,192	17,452	18,692
1999-2000 to 2008-09	3.3%			
2009-10 to 2018/19		2.0%	2.1%	2.2%

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)
1998	11,305			
1999	11,483			
2000	12,064			
2001	11,927			
2002	12,321			
2003	12,641			
2004	13,199			
2005	13,302			
2006	13,251			
2007	14,054			
2008	14,695			
2009		13,963	14,313	14,703
2010		14,045	14,395	14,795
2011		14,286	14,636	15,036
2012		14,522	14,882	15,292
2013		14,678	15,048	15,458
2014		14,981	15,361	15,781
2015		15,215	15,605	16,025
2016		15,719	16,119	16,559
2017		16,110	16,530	16,980
2018		16,481	16,901	17,361
2019		16,732	17,162	17,632
2000 to 2009	1.9%			
2010 to 2019		2.0%	2.0%	2.0%

Table A3.4: EnergyAustralia Connection Point Summer 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	486	43	498	110	521	116	429	121	446	125	460	143	459	144	463	152	477	182	484	203
Chullora	0	0	0	0	0	0	466	90	466	94	483	129	523	132	544	141	570	162	583	172
Haymarket	576	83	590	108	617	106	513	145	534	129	560	149	566	146	571	150	597	184	610	241
Liddell	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11
Munmorah	207	61	217	69	226	78	222	81	231	91	240	100	247	108	263	118	273	132	278	140
Muswellbrook	214	85	218	87	221	88	225	90	229	91	234	93	238	95	243	96	248	98	253	100
Newcastle	838	184	680	199	701	207	704	221	727	230	751	240	776	250	802	261	830	273	858	246
Sydney East	794	154	810	163	834	175	844	185	859	194	875	203	895	218	900	231	915	241	923	246
Sydney North	1132	197	1165	220	1194	234	1278	251	1247	268	1218	276	1233	295	1278	315	1261	329	1253	337
Sydney South	1418	273	1453	299	1489	308	1242	299	1297	309	1344	320	1366	335	1375	339	1407	345	1423	356
Tomago	0	0	179	30	185	31	226	25	234	25	244	28	253	29	263	31	274	33	285	34
Tuggerah	189	72	196	78	203	84	212	92	219	98	228	105	235	112	241	120	249	127	252	131
Vales Point	125	8	127	9	130	9	135	10	137	10	140	10	145	11	152	12	155	12	156	13
Waratah West	158	90	202	66	208	67	200	72	206	74	212	75	219	77	226	79	233	81	241	72

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

Table A3.5: EnergyAustralia Connection Point Winter Peak Demand[10]

	2009		2010		2011		2012		2013		2014		2015		2016		2017		2018	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beaconsfield West	518	16	487	49	482	68	497	45	405	58	413	69	416	78	424	81	426	94	431	101
Chullora	0	0	0	0	0	0	0	0	414	89	420	84	417	75	457	79	477	76	480	82
Haymarket	518	28	577	77	569	94	591	48	487	50	497	46	502	83	506	57	508	68	514	79
Liddell	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11
Munmorah	205	32	213	37	221	42	228	47	238	52	246	57	251	60	257	63	270	66	276	70
Muswellbrook	214	60	224	63	222	65	224	65	225	66	227	66	228	66	229	67	231	67	233	68
Newcastle	751	167	667	176	623	177	634	180	628	188	638	192	649	196	660	200	671	204	682	209
Sydney East	891	174	893	190	910	198	927	208	937	219	953	230	975	245	983	253	988	268	1004	281
Sydney North	986	53	1116	69	1133	84	1134	118	1227	171	1237	191	1253	202	1258	215	1283	230	1301	245
Sydney South	1391	81	1414	92	1447	148	1471	109	1229	65	1261	73	1294	98	1316	106	1332	115	1365	125
Tomago	0	0	165	21	153	27	157	28	189	23	193	24	197	25	202	26	207	28	212	29
Tuggerah	218	80	200	63	207	68	212	73	218	78	224	83	230	87	234	92	239	98	245	103
Vales Point	136	10	130	8	132	9	134	9	138	9	140	10	142	10	146	11	153	11	155	12
Waratah West	137	68	103	62	181	62	184	62	175	65	177	66	180	66	183	67	186	68	189	68

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

Table A3.6: Integral Energy Connection Point Summer Peak Demand[11]

	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	533	81	549	85	563	89	578	93	592	97	606	101	620	104	634	108	648	112	662	115
Ingleburn	183	48	188	50	193	51	198	52	203	53	207	55	211	56	215	57	220	58	224	59
Liverpool	382	120	409	129	404	127	431	136	459	145	486	154	513	163	541	172	570	180	585	185
Macarthur	329	99	337	101	323	97	335	100	348	104	359	107	372	110	384	113	396	117	406	120
Marulan	66	32	70	34	73	36	76	37	78	38	82	40	85	41	87	42	90	44	93	45
Mount Piper	40	18	40	18	40	18	40	18	40	18	40	18	40	18	40	18	40	18	40	18
Regentville	319	87	329	90	499	136	515	141	531	145	547	149	562	153	578	158	593	162	609	166
Sydney North	47	25	48	26	49	27	50	27	52	28	53	29	55	30	57	31	58	32	60	33
Sydney West	1474	579	1485	584	1434	562	1473	577	1514	593	1538	603	1571	616	1603	628	1631	641	1674	657
Vineyard	420	175	452	189	468	195	485	202	501	209	518	216	534	223	551	230	567	236	583	243
Wallerawang	53	40	53	40	53	40	54	40	54	40	54	41	54	41	54	41	54	41	54	41

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

Table A3.7: Integral Energy Connection Point Winter Peak Demand

	2009		2010		2011		2012		2013		2014		2015		2016		2017		2018	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Dapto	637	148	663	153	673	155	680	156	690	158	699	160	709	161	718	163	729	165	738	167
Ingleburn	170	42	172	43	175	44	178	44	180	45	181	45	183	45	183	46	184	46	185	46
Liverpool	299	24	292	23	309	23	308	28	323	27	336	27	348	28	357	29	365	30	372	30
Macarthur	289	16	285	16	289	15	282	17	290	16	296	17	302	17	307	17	311	17	317	18
Marulan	100	33	104	34	108	35	111	36	112	37	114	37	116	38	117	38	118	39	120	39
Mount Piper	41	16	41	16	41	16	42	16	42	16	42	16	43	16	43	16	43	16	44	17
Regentville	300	57	289	55	294	56	422	80	430	82	438	83	445	85	451	86	456	87	463	88
Sydney North	39	17	40	18	41	18	42	19	43	19	44	20	45	20	47	21	48	21	49	22
Sydney West	1544	60	1497	58	1500	58	1443	55	1466	56	1492	57	1520	58	1545	59	1567	60	1597	61
Vineyard	293	122	404	168	436	182	451	188	468	195	483	202	500	208	516	215	532	222	548	229
Wallerawang	61	33	62	33	63	34	63	34	64	34	65	35	65	35	66	35	67	36	68	36

Table A3.8: Country Energy (North) Connection Point Summer 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	34	11	34	11	35	12	36	12	36	12	37	12	38	12	39	13	39	13	40	13
Boambee South	8	0	8	2	9	2	9	2	10	2	10	3	10	3	11	3	11	3	12	3
Casino	30	9	31	10	32	10	33	10	34	10	35	11	36	11	37	12	38	12	39	12
Coffs Harbour	82	27	86	28	89	18	93	19	96	20	100	20	104	21	108	22	113	23	117	24
Dorrigo	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	5	2	5	2
Dunoon	7	2	7	2	8	2	8	2	8	2	8	2	9	2	9	2	9	3	10	3
Glen Innes	13	3	14	3	14	3	14	4	14	4	15	4	15	4	15	4	15	4	16	4
Gunnedah	25	12	26	8	26	8	27	8	27	8	27	8	28	8	28	8	29	8	29	8
Hawks Nest	10	3	11	4	11	4	12	4	12	4	13	4	14	4	14	5	15	5	15	5
Herons Ck	0	0	0	0	22	6	23	6	24	6	25	6	26	6	27	7	28	7	29	7
Inverell	30	9	30	9	31	9	31	9	32	9	32	9	33	9	33	10	34	10	34	10
Kempsey 33kV	33	12	34	12	35	13	36	13	37	14	38	14	39	14	41	15	42	15	43	16
Kempsey 66kV	2	0	2	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
Koolkhan	64	29	66	30	68	31	70	32	72	33	74	34	77	35	79	36	81	37	84	38
Lismore	131	36	136	37	141	38	146	40	152	41	157	43	163	44	169	46	175	48	182	49
Macksville	11	0	11	3	12	3	12	3	13	3	13	3	13	3	14	3	14	4	15	4
Moree	27	8	28	8	28	8	29	8	30	9	30	9	31	9	31	9	32	9	32	9
Mullumbimby	45	19	47	20	49	21	51	22	53	22	55	23	57	24	59	25	61	26	63	27
Nabiac	0	0	38	11	39	11	41	12	42	12	43	13	45	13	46	13	48	14	49	14
Nambucca	12	5	13	5	13	5	14	5	14	6	14	6	15	6	15	6	16	6	16	6
Narrabri	47	12	56	14	57	14	57	14	58	15	59	15	59	15	60	15	60	15	61	15
Port Macquarie	71	23	74	24	70	23	73	24	76	25	79	26	82	27	85	28	89	29	93	30
Raleigh	13	3	13	3	14	3	14	4	15	4	15	4	15	4	16	4	16	4	17	4
Stroud	33	5	34	5	35	5	36	5	37	5	38	5	39	6	40	6	41	6	42	6
Tamworth	112	33	115	33	117	34	120	35	123	36	126	37	130	38	133	39	136	40	139	41
Taree 33kV	33	14	34	14	34	15	35	15	36	15	37	16	37	16	38	16	39	17	40	17
Taree 66kV	73	31	39	16	27	9	28	9	29	10	30	10	31	10	33	11	34	11	35	12
Tenterfield	5	2	5	2	5	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2
Terranora	107	22	111	23	116	23	120	24	125	25	129	26	133	27	138	28	142	29	147	30

Table A3.9: Country Energy (North) Connection Point Winter Peak Demand

	2009		2010		2011		2012		2013		2014		2015		2016		2017		2018	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Armidale	44	11	46	12	47	12	48	12	49	12	50	13	51	13	52	13	53	13	54	13
Boambee South	8	0	9	2	9	2	9	2	9	2	10	2	10	3	10	3	11	3	11	3
Casino	26	7	27	8	27	8	28	8	28	8	29	8	30	8	30	9	31	9	32	9
Coffs Harbour	81	16	83	17	85	17	88	13	90	13	93	13	95	14	98	14	100	14	103	15
Dorrigo	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	5	1
Dunoon	9	2	9	2	10	2	10	2	10	2	10	2	11	2	11	2	11	2	11	2
Glen Innes	16	3	16	3	17	3	17	3	17	4	18	4	18	4	18	4	18	4	19	4
Gunnedah	26	10	27	10	27	7	28	7	28	7	28	7	29	7	29	7	30	7	30	8
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	22	6	23	6	23	6	24	6	25	6	26	6	26	7
Inverell	38	8	38	8	39	8	39	8	40	8	40	8	41	8	41	8	42	9	42	9
Kempsey 33kV	37	11	38	11	38	11	39	11	40	12	41	12	41	12	42	12	43	12	44	13
Kempsey 66kV	2	0	2	0	2	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
Koolkhan	58	15	59	15	60	15	61	15	62	16	63	16	64	16	66	16	67	17	68	17
Lismore	118	21	122	21	125	22	129	23	133	23	137	24	141	25	145	25	149	26	154	27
Macksville	11	0	11	3	12	3	12	3	12	3	12	3	13	3	13	3	13	3	14	3
Moree	36	9	36	9	36	9	37	9	37	9	38	9	38	10	39	10	39	10	40	10
Mullumbimby	42	20	43	21	45	22	46	22	48	23	49	24	50	24	52	25	53	26	55	27
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	15	3	15	3	15	3
Narrabri	47	9	55	11	55	11	55	11	56	11	56	11	56	11	57	11	57	12	57	12
Port Macquarie	85	21	87	22	89	22	84	21	86	22	89	22	91	23	94	23	96	24	99	25
Raleigh	12	0	12	3	13	3	13	3	13	3	14	3	14	3	14	4	15	4	15	4
Stroud	30	4	31	4	31	4	32	5	32	5	33	5	34	5	34	5	35	5	36	5
Tamworth	103	34	106	26	108	27	111	28	113	28	116	29	118	30	121	30	124	31	127	32
Taree 33kV	27	11	31	12	32	12	32	13	33	13	34	13	34	14	35	14	36	14	36	14
Taree 66kV	84	25	83	24	45	13	32	9	33	8	34	8	35	9	36	9	37	9	38	9
Tenterfield	6	2	6	2	6	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3
Terranora	114	16	118	17	122	17	126	18	129	18	133	19	137	20	141	20	145	21	149	21

Table A3.10: Country Energy (Central) Connection Point Summer 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	44	21	45	21	47	22	48	22	48	23	49	23	49	23	50	23	51	24	51	24
Cowra	30	10	30	10	30	10	30	10	31	10	31	10	31	10	31	10	32	10	32	10
Forbes	34	5	34	5	34	5	34	5	35	6	35	6	35	6	35	6	35	6	36	6
Manildra	10	4	10	4	10	4	10	4	10	4	11	4	11	4	11	4	11	4	11	4
Molong	5	2	5	2	5	2	5	2	5	2	6	2	6	2	6	2	6	2	6	2
Mudgee	23	9	24	9	24	9	24	9	25	9	25	10	26	10	26	10	26	10	27	10
Orange 66kV	46	28	46	28	47	28	47	28	47	28	47	28	47	28	47	28	48	29	48	29
Orange 132kV	84	41	90	44	91	44	91	44	92	45	93	45	93	45	94	46	95	46	96	46
Panorama	68	33	69	34	71	34	72	35	73	36	75	36	76	37	77	38	79	38	80	39
Parkes 66kV	24	10	24	10	24	10	25	10	25	11	25	11	25	11	25	11	25	11	25	11
Parkes 132kV	28	11	28	11	28	11	28	11	28	11	28	11	29	11	29	11	29	11	29	11
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	16	25	16	25	16	25	16	26	16	26	16	26	16	26	16
Wellington 66kV	11	5	11	5	11	5	11	5	12	5	12	5	12	6	12	6	13	6	13	6
Wellington 132kV	161	23	163	23	166	24	168	24	171	24	173	25	176	25	179	25	182	26	184	26

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

	2009		2010		2011		2012		2013		2014		2015		2016		2017		2018	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beryl	43	20	45	20	46	21	48	22	48	22	49	22	50	23	50	23	51	23	51	23
Cowra	28	4	28	4	29	4	29	4	29	4	30	4	30	4	30	4	31	4	31	4
Forbes	28	1	28	1	28	1	28	1	28	1	28	1	28	1	28	1	28	1	28	1
Manildra	10	4	10	4	10	4	10	4	10	4	11	4	11	4	11	4	11	4	11	4
Molong	6	1	6	1	6	1	6	1	6	1	6	1	6	1	6	1	6	1	6	1
Mudgee	23	6	23	6	24	6	24	6	24	6	25	6	25	6	26	6	26	7	26	7
Orange 66kV	69	23	70	23	71	23	71	23	72	24	73	24	73	24	74	24	75	25	75	25
Orange 132kV	90	32	90	33	95	35	96	35	96	35	96	35	97	35	97	35	97	35	98	35
Panorama	76	26	77	26	78	26	79	26	80	27	80	27	81	27	82	28	83	28	84	28
Parkes 66kV	21	5	21	5	21	5	21	5	21	5	21	5	21	5	21	5	21	5	22	5
Parkes 132kV	28	11	28	11	28	11	29	11	29	11	29	11	29	11	29	11	29	11	29	12
Wallerawang 66kV	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2
Wallerawang 132kV	25	14	25	14	25	14	25	14	25	14	26	14	26	15	26	15	26	15	26	15
Wellington 66kV	10	3	11	3	11	3	11	3	11	3	12	3	12	3	12	3	12	3	13	3
Wellington 132kV	146	21	147	21	148	21	148	21	149	21	150	21	151	21	152	22	152	22	153	22

Table A3.12: Country Energy (South and Far West) and ActewAGL Connection Point Summer 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
Albury	131	63	133	64	135	66	138	67	141	68	143	69	146	71	148	72	151	73	154	75
Balranald	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1
Broken Hill	33	14	34	14	35	15	35	15	36	15	36	15	37	16	38	16	38	16	39	17
Canberra	505	306	498	309	507	311	516	307	526	313	540	319	554	325	569	333	585	342	602	351
Coleambally	12	8	12	8	12	9	13	9	13	9	13	9	13	9	14	10	14	10	14	10
Cooma 11kV	11	3	11	3	11	3	11	3	11	3	11	3	11	3	11	3	11	3	11	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	41	10	41	10	41	10	42	10	42	11	42	11	42	11	43	11	43	11	43	11
Darlington Pt	14	4	14	4	14	4	15	4	15	4	15	4	15	4	15	4	15	4	15	4
Deniliquin	43	15	43	16	43	16	43	16	43	16	44	16	44	16	44	16	44	16	44	16
Finley	18	7	18	7	19	7	19	7	19	8	19	8	19	8	20	8	20	8	20	8
Griffith	76	41	78	42	80	43	82	44	84	45	86	47	88	48	91	49	93	50	95	51
Marulan	39	18	40	18	40	18	41	19	42	19	43	20	44	20	45	20	46	21	47	21
Munyang	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3
Murrumbateman	4	1	4	1	4	1	4	1	4	1	5	1	5	1	5	1	5	1	5	1
Murrumburrah	41	22	42	23	43	23	44	24	45	24	46	25	47	25	48	26	49	26	50	27
Queanbeyan	75	38	75	36	76	36	78	36	79	37	81	37	83	38	85	39	86	40	88	41
Snowy Adit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tumut	36	15	36	15	37	16	37	16	38	16	38	16	39	17	39	17	40	17	40	17
Wagga 66kV	110	62	99	56	101	57	103	58	104	59	106	60	108	61	109	62	111	63	113	64
Wagga 132kV	52	5	52	5	53	5	54	5	54	5	55	5	56	5	56	5	57	5	58	5
Wagga North	26	13	26	13	26	13	27	14	27	14	27	14	27	14	28	14	28	14	28	14
Yanco	40	23	41	23	42	24	43	24	44	25	45	26	46	26	47	27	48	27	49	28
Yass	11	4	12	5	12	5	12	5	12	5	13	5	13	5	13	5	13	5	14	5

Table A3.13: Country Energy (South and Far West) and ActewAGL Connection Point Winter Peak Demand

	2009		2010		2011		2012		2013		2014		2015		2016		2017		2018	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Albury	98	32	99	33	100	33	102	33	103	34	104	34	105	35	106	35	107	35	108	36
Balranald	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0
Broken Hill	31	6	32	6	32	7	33	7	33	7	34	7	34	7	35	7	36	7	36	7
Canberra	600	268	601	268	584	261	585	261	586	262	587	262	591	264	595	266	599	267	604	270
Coleambally	8	4	8	4	8	4	8	4	8	4	9	4	9	4	9	4	9	4	9	5
Cooma 11kV	18	6	18	6	18	6	18	6	18	6	18	6	18	6	18	6	18	6	18	6
Cooma 66kV	26	7	26	7	27	7	27	7	28	7	28	7	29	7	29	7	30	7	30	7
Cooma 132kV	48	12	48	13	49	13	49	13	50	13	50	14	51	14	51	14	52	14	52	15
Darlington Pt	15	2	15	2	15	2	15	2	16	2	16	2	16	2	16	2	17	2	17	2
Deniliquin	33	5	33	5	33	5	33	5	33	6	34	6	34	6	34	6	34	6	34	6
Finley	16	3	16	3	16	3	16	3	16	3	16	3	16	3	16	3	16	3	16	3
Griffith	49	16	50	16	50	16	51	16	52	16	52	16	53	17	54	17	55	17	55	17
Marulan	46	19	47	19	48	19	48	20	49	20	50	20	51	21	52	21	53	21	53	22
Munyang	31	21	31	21	32	22	32	22	33	23	33	23	33	23	34	24	34	24	35	25
Murrumbateman	6	1	6	1	6	1	6	1	6	1	7	1	7	1	7	1	7	1	8	1
Murrumburrah	38	11	39	12	40	12	40	12	41	13	42	13	43	13	43	14	44	14	45	14
Queanbeyan	82	31	83	32	84	32	85	32	87	33	89	33	90	34	92	34	94	35	96	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	11	36	11	37	11	37	11	37	11	37	11	38	12	38	12	38	12	39	12
Wagga 66kV	105	33	90	34	81	34	82	35	83	35	84	36	85	36	86	37	87	37	88	38
Wagga 132kV	59	5	60	5	61	5	61	5	62	5	63	5	64	5	65	5	66	6	67	6
Wagga North	15	5	24	5	24	5	24	5	24	5	24	5	24	5	24	5	24	5	24	5
Yanco	36	20	36	21	37	21	37	22	37	22	38	23	38	23	39	24	39	25	39	25
Yass	13	3	13	3	13	3	13	3	13	3	14	4	14	4	14	4	14	4	14	4

Table A3.14: Major Industrial Customers – Sum of Individual Summer 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	1623	1663	1663	1663	1663	1663	1663	1663	1663	1663

[12] Includes loads originally identified in EnergyAustralia and Integral Energy projections.

Table A3.15: Major Industrial Customers – Sum of Individual Winter Peak Demands[13]

	2009 MW	2010 MW	2011 MW	2012 MW	2013 MW	2014 MW	2015 MW	2016 MW	2017 MW	2018 MW
Industrial Loads	1615	1658	1658	1658	1658	1658	1658	1658	1658	1658

[13] 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.

Proposal	Purpose	Proposed Service Date	APR 2009 Section
Vineyard 3rd 330/132 kV transformer	Increase transformer capacity	2010/11	6.1
Holroyd and Chullora 330/132 kV substations	New 330 kV connection points	Late 2012	6.2.3 – 6.2.4
Southern Supply to the ACT	Increase reliability and capacity of connections to Williamsdale	Mid 2012	6.2.6
Supply to Lake Munmorah	Connection to Lake Munmorah zone substation	2010/11	6.2.7
Supply to Tomerong/Nowra	New 330 kV connection point	2014	6.2.11
Hawks Nest 132 kV substation	New 132 kV connection point	2011	6.2.12
Nabiac 132 kV substation	New 132 kV connection point	2011	6.2.13
Herons Creek 132 kV substation	New 132 kV connection point	2012	6.2.14
Lismore 132 kV switchbay	132 kV connection to Casino	Late 2012	6.2.16
Tamworth 66 kV switchbay	66 kV connection to Quirindi	Late 2012	6.2.16

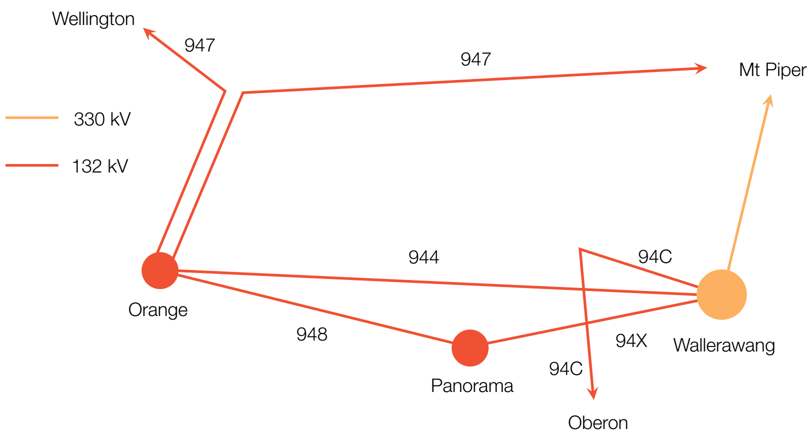
Appendix 5 – New Small Transmission Network Asset Proposals

This appendix details proposals for new small transmission network assets including need, options considered and regulatory test calculations.

A5.1 Orange – Wallerawang 132 kV Line 944 Replacement and Upgrade

The Wallerawang – Orange 132 kV transmission line is shown in the figure below. It is nearing the end of its serviceable life and needs to be replaced. It was constructed in 1956/57 and uses a small non-standard conductor.

Orange – Wallerawang 132 kV Network



In considering options for replacing the line the following specific requirements have been taken into account:

- The high likelihood that significant load increases (spot loads) may arise in the area in addition to general load increases. This is due to the high likelihood of new or increased mining loads occurring in the area in the short to medium term, currently envisaged in the period 2013 to 2015. Thus reasonable options must be able to address the possibility of spot load increases over this period; and
- As new line routes in the area will be difficult to obtain it is highly likely that any replacement line would have to be constructed on the same route as the existing line. This would require 944 line to be removed from service for an extended reconstruction period. Thus the reconstruction of 944 line cannot commence until 132 kV line works associated with the redevelopment of Orange 132/66 kV substation, which will increase the reliability of the 132 kV network in the area, have been completed (refer to Section 6.2.5). These works are anticipated to be completed around late 2011. 944 line reconstruction works would take about 18 months with a completion date of mid 2013 being envisaged for reasonable options.

Options that have been considered for the replacement of the line are as follows:

1. Do nothing.

   Removal of 944 line without replacing it is not a reasonable option. It would result in thermal and voltage limitations within a few years of the line being removed or earlier if spot loads were to arise.

2. New for old replacement.

   A new for old replacement of 944 line (no augmentation component) would involve construction of a new single circuit 132 kV line having "lemon" conductors on the route of the existing 944 line. Lemon is the nearest "standard" size conductor used by TransGrid to the conductor on 944 line. Due to the magnitude of industrial loads in the area and consequent high load factor it would be cost effective to install a larger conductor than lemon. In practice a replacement line would have "mango" conductors. The cost of such an option would be around $36 Million.

As this option would not cater adequately for spot load developments that may occur over the medium term it is not considered to be a reasonable option and is not considered further. Nevertheless its cost has been determined to facilitate the determination of the net cost of the augmentation components of other options.

3. Single circuit 132 kV line that is convertible to a double circuit 132 kV line.

   This option involves the construction of a single circuit 132 kV line on the route of the existing 944 line that is capable of being converted to a double circuit 132 kV line at relatively low cost. The line would initially be strung with a single circuit of mango conductors. If a spot load was to occur and/or general load growth was sufficient the line would be strung with a second circuit of mango conductors at that time.

   This option is regarded as reasonable from the perspectives of cost and community and environmental impacts. The cost of this option would be around $52 Million for the single circuit convertible line and $10 Million for the double circuit conversion.

4. Double circuit 132 kV line.

   This option involves the construction of a double circuit 132 kV line on the route of the existing 944 line. The line would be strung with mango conductors.

   This option is regarded as reasonable from the perspectives of cost and community and environmental impacts. The cost of this option is would be around $60 Million.

5. Staged single circuit 132 kV lines.

   This option involves the construction of a single circuit 132 kV line on the route of the existing 944 line but with phase conductors in a vertical configuration. This would allow for a second similar line to be constructed adjacent to the first line at a future time that a spot load was to occur and/or general load growth was sufficient. The cost of this option would be around $40 Million for each line.

   Given the availability of Options 3 and 4 this option is not regarded as reasonable from any of the perspectives of cost and community and environmental impacts.

6. New 330/132 kV substation in the Orange area.

   This option would involve the construction of a new 330/132 kV substation in the Orange area together with relatively minor 330 kV and 132 kV line works. Depending on the location of the new substation a partial reconstruction of 944 line may be required. The cost of this option would depend on the location of the new substation but would be at least $70 Million.

   Given the availability of Options 3 and 4 this option is not regarded as reasonable from the perspective of cost.

From the above the only reasonable options are Options 3 and 4.

Economic calculations have been carried to determine the ranking of these options in accordance with the AER's regulatory test for reliability augmentations. The following tables detail the major assumptions used and summarises the results.

The second table shows the results of the regulatory test calculations for the base value of parameters in the first table. For other values of these parameters the relative ranking of Options 3 and 4 is unchanged.

Parameter	Base Value	Sensitivity Variation
Planning Horizon	15 Years	-
Discount Rate	9%	±3%
Line Lifetime	45 Years	±15 Years
O&M Cost	2% p.a.	±1% p.a.
Cost Estimate Variation	-	±25%
Replacement year	2013	-
Spot Load year	2018	±3 Years

Option	Cost ($M)	PV of Costs ($M)	Rank
Option 3	$61.6	$32.0	1
Option 4	$59.7	$34.0	2

Thus Option 3 is the highest ranked option in all of the cases considered and is considered to satisfy the regulatory test.

Accordingly it is proposed to proceed with the Option 3, being the reconstruction of the Orange – Wallerawang 132 kV line 944 as new single circuit 132 kV line with mango conductors that is capable of being converted to double circuit. These works are estimated to cost around $52 Million and are envisaged to be constructed in the period from 2011/12 – mid 2013.

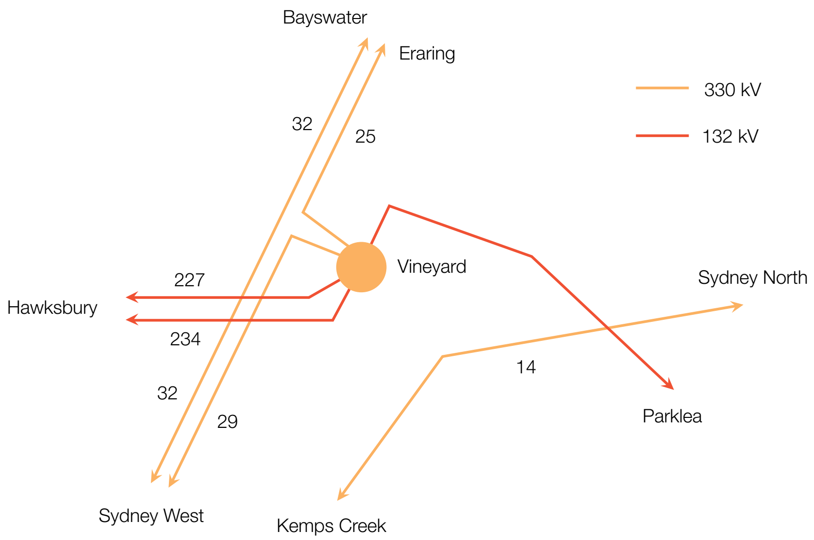
The replacement component of these works, with estimated costs of $36 Million, is a replacement network asset and the augmentation component of these works, with estimated costs of $16 Million, is a new small transmission network asset.

This proposal will not have a material internetwork impact.

A5.2 Vineyard Third 330/132 kV Transformer

Vineyard 330/132 kV substation is located to the northwest of Sydney near Windsor. It is equipped with two 375 MVA 330/132 kV transformers and supplies load to the northwest of Sydney including the Northwest Sector development area.

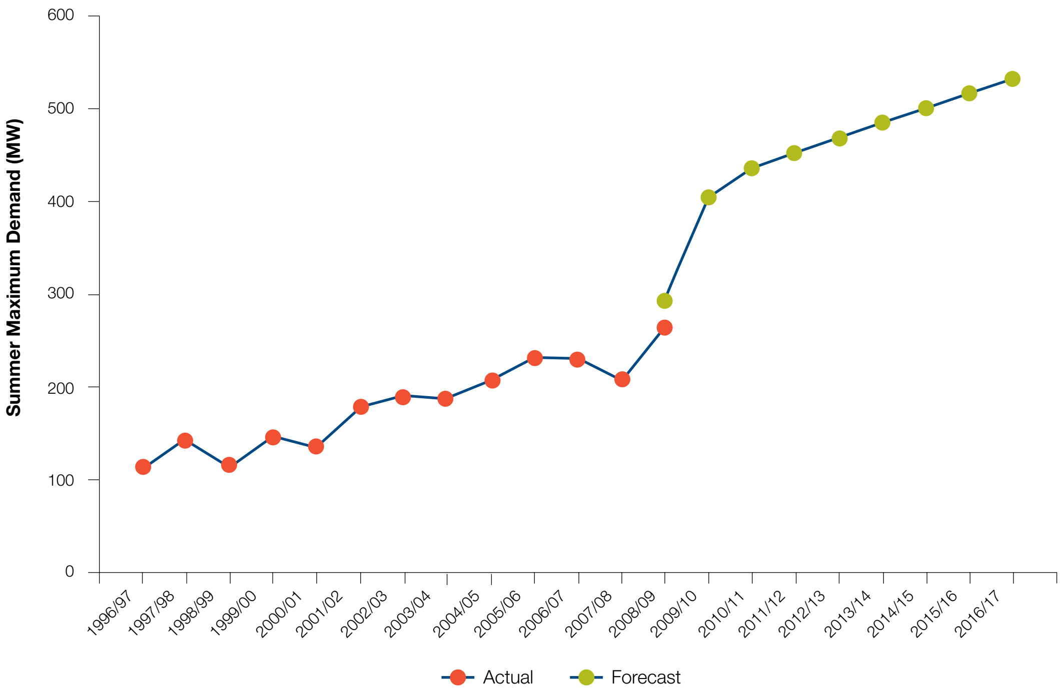
Main Connections to Vineyard 330/132 kV Substation



The main connections to Vineyard are shown in the figure above. The 132 kV line to Parklea is presently being re-constructed as a high capacity double circuit 132 kV line to supply Integral Energy's Rouse Hill substation.

The most recent load forecast for Vineyard is depicted in the chart below. This shows that there is forecast to be a significant increase in the load at Vineyard for summer 2009/10 compared with summer 2008/9 with strong ongoing load increases of about 5% pa in subsequent years. The large 2008/9 – 2009/10 load increase is due to load from housing developments in areas such as the Northwest sector coming on stream and load transfers onto Vineyard as Integral Energy develops its 132 kV network in the area.

Vineyard Summer Maximum Demand



The 400 MVA firm transformer capacity at Vineyard is expected to be exceeded in summer 2010/11.

Options that have been considered to address this transformer capacity constraint include:

1. Installation of a third 375 MVA 330/132 kV transformer and associated 330 kV and 132 kV switchgear at Vineyard.

   This can be achieved by summer 2010/11 at an estimated cost of $17 Million.

2. Establishment of a new 330/132 kV substation in the area.

   Given the availability of Option 1 this is not considered to be a reasonable option. It would be much more costly and have significantly greater community and environmental impacts than Option 1.

3. Transfer of load to other substations during the outage of a transformer.

   Joint planning with Integral Energy has determined that load transfers from Vineyard during peak load periods are likely to result in overloads in its network without a significant enhancement to that network. Therefore this option is not considered to be feasible.

4. Reduction of transformer loading via power factor correction, demand management programs or local generation.

   Given the size of the 2008/9 – 2009/10 load increase at Vineyard and strong ongoing load growth it is considered unlikely that power factor correction or demand management programs would be effective in meeting the transformer capacity constraint. Similarly there is no known generation in the area that could meet the constraint. Therefore this option is not considered to be feasible.

The only reasonable option is Option 1. Therefore, to cater for the growing load at Vineyard it is proposed to install a third 375 MVA 330/132 kV transformer and associated 330 kV and 132 kV switchgear at Vineyard by summer 2010/11 at an estimated cost of $17 Million.

This proposal will not have a material internetwork impact.

Appendix 6 – Glossary

Term	Explanation/Comments
AEMO	The Australian Energy Market Operator. AEMO commences operation on 1 July 2009. AEMO takes 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 that 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 2009.
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 that is convened by NEMMCO and has 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.
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.
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 administers and operates the National Electricity Market. From 1 July 2009 NEMMCO will become part of AEMO.
NTFP	National Transmission Flow Path.
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 NEMMCO as an NER participant.
SVC	Static VAr Compensator. A device that provides for control of reactive power.
Statement of Opportunities (SOO)	A document produced by AEMO that focuses on 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

For all general enquiries regarding the Annual Planning Report and for making written submissions in respect to the proposed new small network assets described in Section 6.1 contact:

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