TransGrid

New South Wales Annual Planning Report 2011

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Annual Planning Report 2011

TransGrid

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Foreword by the Managing Director

Our vision is "Excellence in all we do". We are committed to providing a reliable and efficient electricity transmission service to our customers. A reliable electricity supply is essential to a wide range of activities undertaken in our communities. It is relied upon every day by industries, businesses and families. The efficient delivery of this electricity supply is paramount to our economic and physical well being.

TransGrid's network forms the backbone of the National Electricity Market (NEM) facilitating interstate trade and transfer of electricity. At TransGrid, we work closely with the Australian Energy Market Operator (AEMO) to ensure our central role in the NEM supports the operation of the market and upholds the National Electricity Objective (NEO). The NEM continues to evolve through the policy and framework reviews, such as the Transmission Frameworks Review by the Australian Energy Market Commission (AEMC). TransGrid proactively participates in these developments on its own as well as with Grid Australia to seek the best outcome for its customers and market participants.

As the National Planner, AEMO developed a number of economic scenarios for its 2011 Electricity Statement of Opportunities (ESOO) and the National Transmission Network Development Plan (NTNDP). The New South Wales (NSW) Global load forecast prepared by TransGrid and included in this Annual Planning Report uses these scenarios and other economic parameters as key inputs. The forecast peak summer electricity demand displays reduced annual growth over the planning horizon compared to the baseline forecast for last year. This reduction in demand results in the deferral of timeframes for load driven augmentations, and may in some circumstances result in some lower cost solutions being pursued.

The NSW and ACT distributors have again provided their connection point forecasts for the planning horizon. These forecasts have been used to review the timing and scope of augmentation proposals as they move through from identification to project completion.

TransGrid has taken a leading role in encouraging and implementing non-network solutions and has completed a number of network support projects involving demand management (DM) and local generation. In the summer of 2008/09, TransGrid implemented the largest ever network support arrangement in the NEM involving total network support of 350 MW. This allowed deferral of the Western 500 kV Upgrade project by one year, with savings of over $14 million being returned to our customers. TransGrid continues to encourage the development of non-network alternatives through calling for expression of interest, consultations through the Regulatory Investment Test – Transmission (RIT-T) process and joint planning with distributors. We are also undertaking a number of innovation projects in Demand Management, Demand Side Response and embedded generation with our distribution network partners and universities.

With regards to electricity supply, a move towards lower carbon intensive generation such as gas and renewable generation including wind and solar is expected. These alternate sources will require connection to the network. Australia's strong financial position and proven ability to deliver commodities to growing world markets has resulted in significant interest in the development of new manufacturing and mining proposals. TransGrid's network development plans are both responsive and flexible so as to accommodate a range of potential generation and load developments. We are further streamlining our processes to ensure delivery times are more closely matched to proponent expectations.

TransGrid's APR for 2011 provides advance information to market participants, customers, stakeholders and interested parties on the nature and location of emerging constraints in TransGrid's transmission network. It also includes information on the status of network augmentation projects as they evolve from constraint identification to project completion.

Your feedback on the APR for 2011 is welcomed.

Peter McIntyre

Managing Director

June 2011


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Executive Summary

Executive Summary

TransGrid is the owner and operator of one of the largest electricity transmission networks in Australia. With 91 substations and over 12,600 kilometres of transmission lines, it forms the backbone of the National Electricity Market (NEM). The network operates at voltage levels of 500, 330, 220 and 132 kV. An overview of TransGrid and its network is provided in Chapter 2 of this Annual Planning Report (APR).

The APR 2011 provides advance information to market participants, customers, stakeholders and interested parties on the nature and location of emerging constraints in TransGrid's transmission network. It also includes information on the status of network augmentation projects as they evolve from constraint identification to project completion.

Planning and development of the network is undertaken to ensure that transmission service delivery to our customers meets the jurisdictional, contractual and National Electricity Rule (NER) obligations. This process is undertaken on a cyclical basis. The APR 2011 represents a status report to our customers and stakeholders on the needs, options and proposed augmentations as they move through the process from constraint identification to option formulation, regulatory consultation, project commitment, project commissioning and completion.

The APR is one of a number of documents that disseminate information pertinent to transmission and distribution planning in the NEM. These documents cover the broad areas of supply demand balance, transmission networks planning and distribution networks planning. The roles of AEMO, TransGrid and other parties in the planning process are set out in Figure 2.1.

AEMO is responsible for the publication of a National Transmission Network Development Plan (NTNDP) and TransGrid supports and assists AEMO in undertaking the analysis and planning which underpins the NTNDP. Chapter 3 of this APR sets out the linkages between AEMO's NTNDP and TransGrid's development plans.

Load forecasts are an important input into the planning process. As the Jurisdictional Planning Body (JPB) for NSW, TransGrid provides input to the AEMO planning process by preparing a global demand and energy forecast for NSW and the ACT.

The 2011 NSW and ACT energy and demand forecasts have been prepared using a scenario approach consistent with those to be used in AEMO's NTNDP. A map of the scenarios is shown in Figure 4.3. The key economic, price and renewable generation projections were provided to all TNSPs in the NEM by AEMO who used KPMG as its advisor. This ensures that each JPB prepares its regional load forecasts on a consistent basis. In addition to these scenarios, TransGrid engaged KPMG for further advice on additional scenarios.

The NSW and ACT demand and energy forecasts were finalised by 31 May 2011 as required by AEMO and will now be incorporated in the process used for the development of the Electricity Statement of Opportunities (ESOO) and NTNDP.

The 2011 NSW and ACT global forecast based on the current information for the central scenario shows:

- A reduction in energy growth primarily due to higher electricity price forecasts;
- Compared with the 2010 projection, the 2011 projection of the 10% POE (Probability of Exceedance) summer demand projection (i.e. the projection of demand that assumes one in ten year hot weather conditions) is 559 MW or 3.3%, on average (for the common forecast period 2011-12 to 2019-20), below last year's projections; and
- Compared with the 2010 projection, the 2011 projection of the 10% POE winter demand projection (i.e. the projection of demand that assumes one in ten year cold weather conditions) is 788 MW or 5.0%, on average (for the common forecast period 2011 to 2020) lower than last year's projections.

The energy and demand forecast scenarios are discussed in Chapter 4. Energy and demand forecasts pertaining to selected scenarios are given in Appendix 4. As with all forecasts, there is some uncertainty due to forecast risks which are discussed at the conclusion of Chapter 4.

One of the key components of the planning process is the Annual Planning Review carried out since the publication of the previous APR. This review includes:

- identification of emerging constraints;
- information on the nature, quantification and location of constraints; and
- discussion on the options that have been identified for relieving each constraint.

The timely identification of emerging constraints allows the market to identify potential non-network alternatives and TransGrid to develop and implement appropriate and timely measures. Chapters 5 and 6 of the APR cover this aspect of the planning process.

Chapter 5 sets out works completed since the publication of the last APR, which are now delivering network services to our customers. This section also details those augmentations where contracts have been executed and the works are considered committed.

In order to move to the committed stage, projects must first complete any required network development regulatory consultation as set out in the relevant version of the NER. Section 5.3 identifies a significant number of projects that have progressed to this stage.

The NER requires that the APR include constraint information and an indication as to whether TransGrid intends to issue a Request for Proposal (RfP) with respect to the proposals and this is covered in Section 5.4.

Chapter 6 sets out those constraints that are expected to emerge within a five year planning horizon, and have not advanced sufficiently to be included in Chapter 5.

Chapter 6 includes proposals for replacement of transmission network assets based on condition monitoring.

It also describes other constraints expected to emerge within a five year planning horizon where there is no firm proposal at present. One or more options for the removal of each constraint are described.

To provide a complete picture of the planning horizon Chapter 6 also summarises constraints that are expected to arise over a longer time frame than five years. One or more indicative developments to meet the constraints are given.

TransGrid takes a holistic approach to planning and considers Demand Management (DM), local/embedded generation and bundled options on an equal footing with network options when planning its network augmentations and applying the AER's regulatory test or the Regulatory Investment Test for Transmission (RIT-T).

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. The option must also have a proponent who is committed to implement the option and accept the associated risks, responsibilities and accountabilities.

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

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

Comments, views and the opinions of our stakeholders, customers, NEM participants and other interested parties on this APR are welcomed. Contact details for these are given in Appendix 7.

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Introduction

Introduction

2.1 About TransGrid

TransGrid is the owner and manager of one of the largest electricity transmission networks in Australia, connecting generators, distributors and major end users in NSW and the ACT.

TransGrid, with 91 substations and over 12,600 kilometres of transmission lines, serves the largest state in Australia's NEM, facilitates interstate energy trading and forms the backbone of the market.

2.1.1. Our Objectives

TransGrid is a State Owned Corporation (SOC) with its principal objectives stated in Section 6B of the *Energy Services Corporations Act 1995 No. 95:*

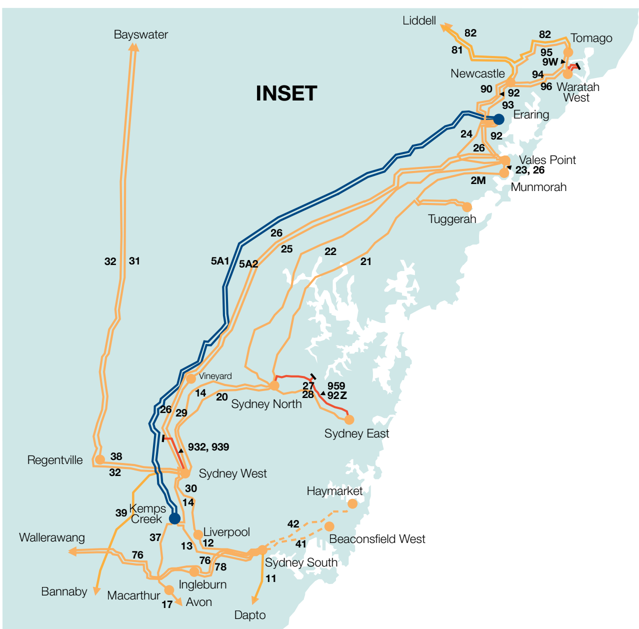
- To be a successful business, and, to this end:
  - To operate at least as efficiently as any comparable businesses
  - Maximise the net worth of the State's investment in it
  - Exhibit a sense of social responsibility by having regard to the interests of the community in which it operates.
- Protect the environment by conducting its operations in compliance with the principles of ecologically sustainable development contained in Section 6 (2) of the *Protection of the Environment Administration Act, 1991.*
- Exhibit a sense of responsibility towards regional development and decentralisation in the way in which it operates.
- Operate efficient, safe and reliable facilities for the transmission of electricity and other forms of energy.
- Promote effective access to these transmission facilities.

2.1.2. Our Network

Our network operates at voltage levels of 500, 330, 220 and 132 kV. The substations are normally located on land owned by TransGrid, with the transmission lines and underground cables generally constructed on easements acquired across private or public land.

TransGrid has staff strategically based at locations throughout NSW in order to meet day to day operation and maintenance requirements as well as being able to provide emergency response. The head office is located at the corner of Park and Elizabeth Streets in Sydney. Field staff are co-ordinated from major depots located in Western Sydney, Newcastle, Tamworth, Orange, Wagga Wagga and Yass.

TransGrid's network is shown on the electricity network maps following.



OPERATING SYSTEM VOLTAGES

- 500 kV Transmission Lines — Substations
- 330 kV Transmission Lines — Substations
- 220 kV Transmission Lines — Substations
- 132 kV Transmission Lines — Substations
- 330 kV Underground Cable
- Customer Exchange Point
- Interstate Exchange Point

2.2 Outcomes of the Annual Planning Review for 2011

The 2011 NSW Annual Planning Report (APR 2011) documents process and outcomes of the NSW 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 NSW transmission networks over appropriate planning horizons;
- Provide advance information on the nature, quantification and location of the constraints. The level of information included in this document is intended to be sufficient to encourage market participants and interested parties to formulate and propose options to relieve the constraints, including those that may include components of demand management (DM) and local generation or other options that may provide economically efficient outcomes;
- Discuss options that have been identified for relieving each constraint including network, local generation, DM and other options;
- Indicate, where possible, if and when TransGrid intends to issue an RfP for non-network alternatives to relieve a constraint;
- Comply with National Electricity Rules (NER) requirements in respect of preparation of a Transmission Network Service Provider's (TNSPs) APR and the associated consultation on proposed new small transmission network assets;
- Provide further details on the load forecast data that has been provided for input to the Electricity Statement of Opportunities (ESOO); and
- Provide a basis for annual reporting to the NSW Minister for Energy (the Minister) on the outcome of the Annual Planning Review.

The Annual Planning Review for 2011 included:

- An update of TransGrid's NSW load forecast that took account of actual peak loads for winter 2010;
- Provision of load forecast data for inclusion in AEMO's 2011 ESOO and National Transmission Network Development Plan (NTNDP);
- Ongoing planning analysis and identification of network constraints and assessment of feasible options for relieving these constraints; and
- Publication of this APR 2011.

It is intended that the APR 2011 will provide electricity market participants and interested parties with information that will help them contribute to the optimum and economically efficient development of transmission networks in NSW.

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

2.3 Context of the Annual Planning Report

The NSW APR is one of a number of documents that disseminate information pertinent to transmission and distribution planning in the 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.

Table 2.1 – Summary Information for Annual Planning Documents

Document	Published by	Covers
Electricity Statement of Opportunities for the NEM (ESOO)	AEMO	Supply demand balance and outlooks 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 this APR 2011 appears in Appendix 7.

2.4 Supply Reliability in New South Wales

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

2.4.1. TransGrid's Obligations

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

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

In this role it:

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

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

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

The NER require that the APR must include:

- Results of annual planning reviews with Distributors during the present year;
- Load forecasts submitted by Distributors;
- Planning proposals for future connection points;
- Forecast and quantification of constraints over one, three and five years;
- Plans and dates to issue an RfP for non-network alternatives for certain constraints;
- Summary information for proposed augmentations;
- Summary information for proposed replacement transmission network assets; and
- Consultation reports on proposed new small transmission network assets.

These obligations are described more fully in Chapter 5.6 of the NER and the AER's regulatory test and Regulatory Investment Test for Transmission (RIT-T).

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

For regulatory consultations initiated from 1 August 2010 the RIT-T applies for transmission network augmentation proposals of value greater than $5 million. This process is described in Figure 2.2 below and is also addressed in Section 2.7 below.

The AER's regulatory test still applies for limitations within a Distributor's network. 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 2.3.

Figure 2.1 – TransGrid's Planning Roles

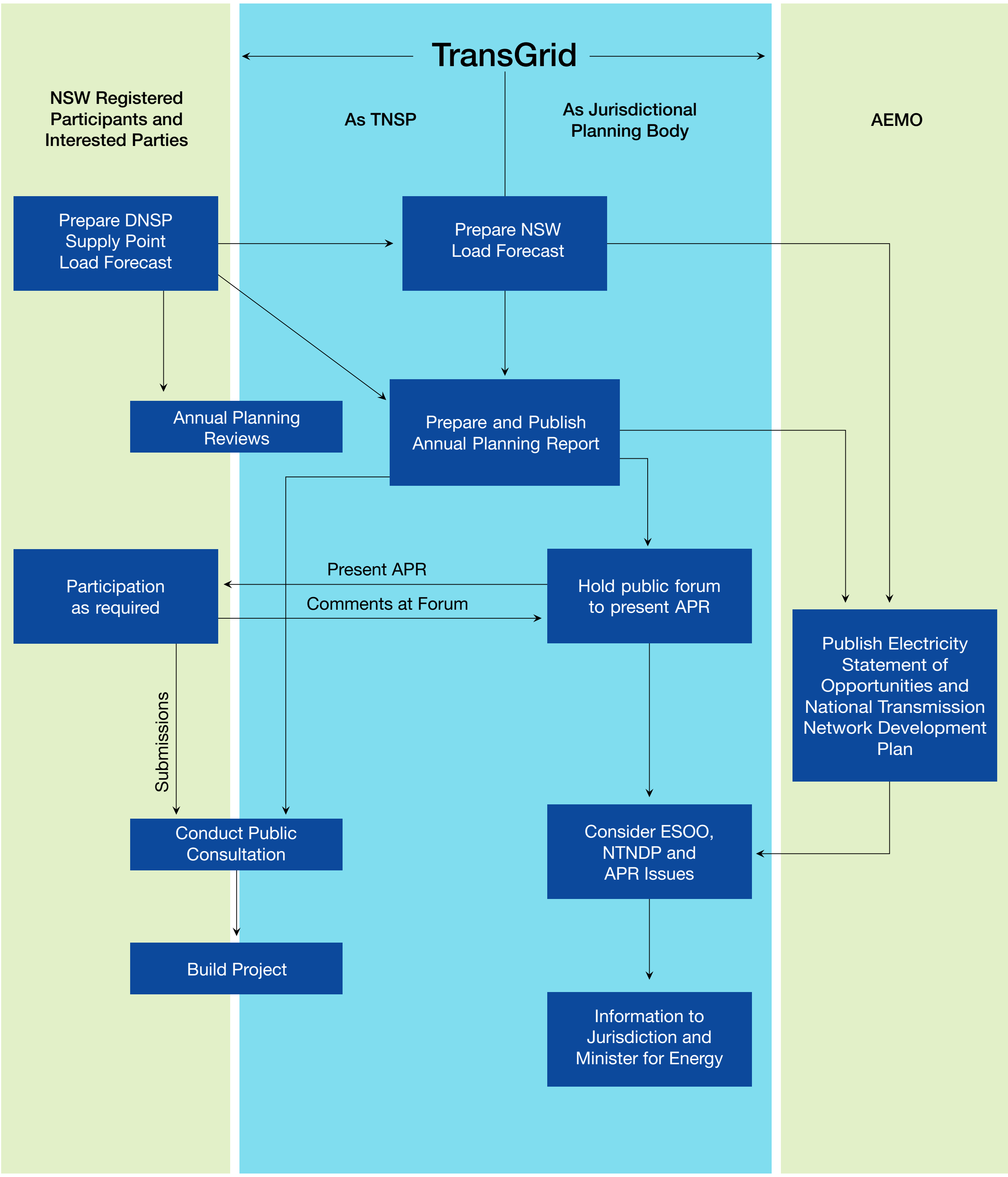
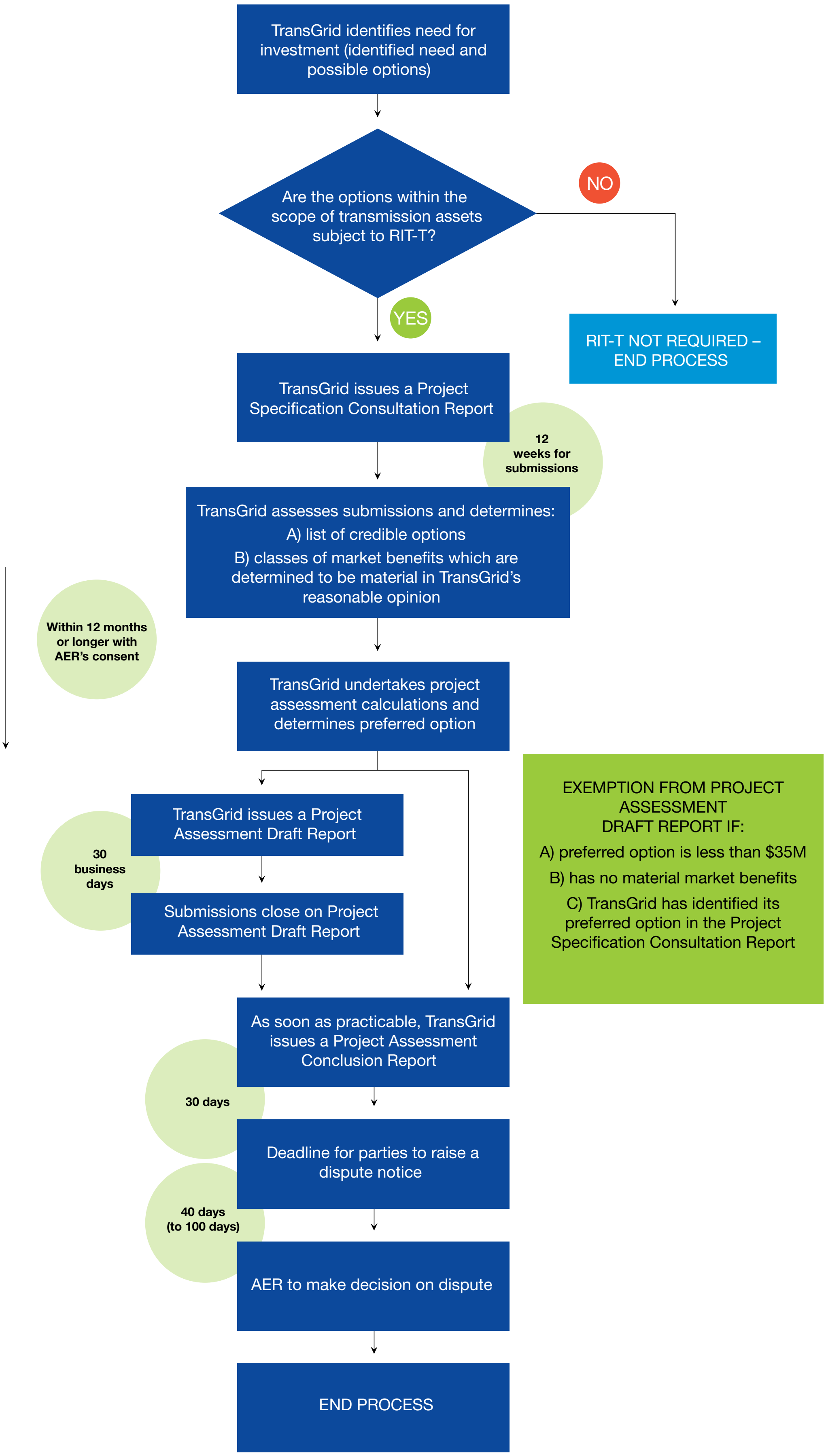
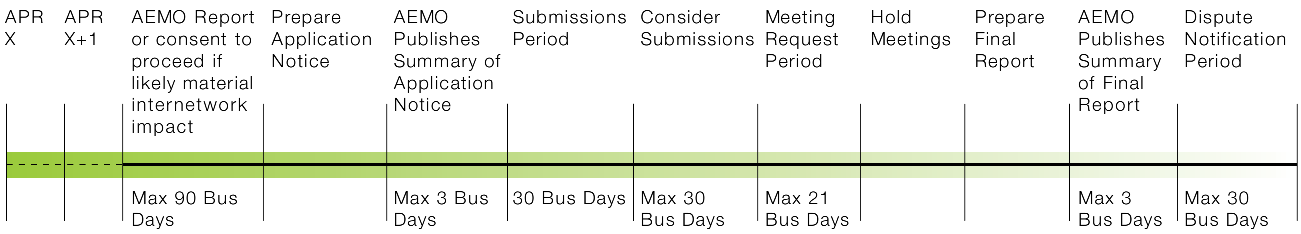


Figure 2.2 – NER Planning Consultation Processes, RIT-T

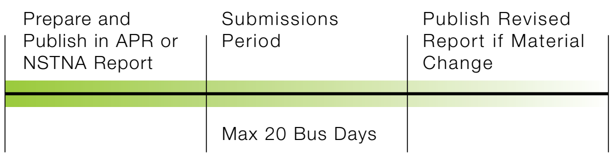


Source: Adapted from AEMC Final Rule Determination National Electricity Amendment RIT-T Rule 2009

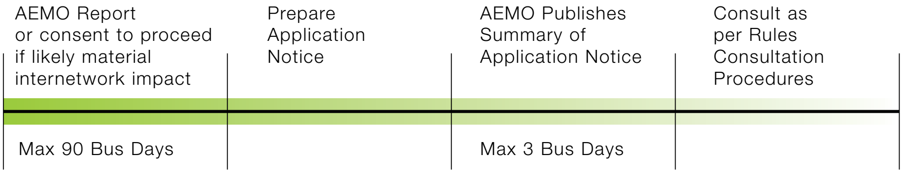
Figure 2.3 – NER Planning Consultation Processes, Regulatory Test



(a) Proposed New Large Transmission Network Asset



(b) Proposed New Small Transmission Network Asset



(c) Proposed Funded Augmentation

2.4.2. 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.

2.4.3. 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.

2.4.4. Annual Planning Review for NSW

TransGrid, as the JPB for NSW, carries out an Annual Planning Review of transmission networks across the State. 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 underpins this by requiring all TNSPs to carry out annual planning reviews with Distributors and publish the results in an APR.

The Annual Planning Review for 2011 commenced in October 2010 with a request by TransGrid for updated load forecasts by Distributors. These forecasts take into account electrical loads experienced during winter 2010. TransGrid has provided a revised NSW load forecast for inclusion in AEMO's 2011 ESOO and NTNDP. Based on these revised load forecasts, TransGrid has updated its short term (one, three and five years) and longer term (five to 20 years) analyses of present and emerging network constraints and has summarised the results in this APR.

2.4.5. 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.

The NSW Government through the former division of Industry and Investment (now the Department of Trade and Investment, Regional Infrastructure and Services) has put in place the *Transmission Network Design and Reliability Standard for NSW, December 2010* and has directed TransGrid to implement this standard in developing its plans.

2.5 Regulatory Investment Test for Transmission

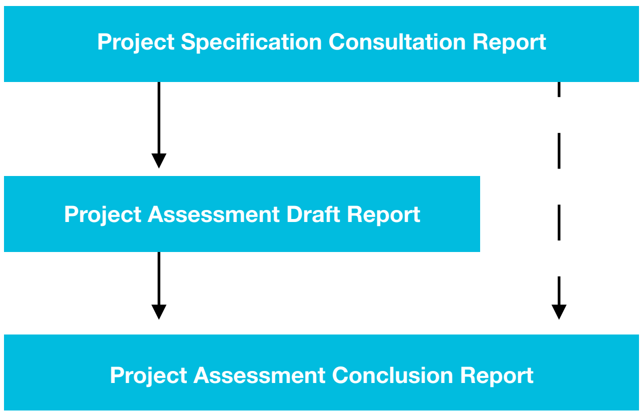
From 1 August 2010, the RIT-T applies for transmission network augmentation proposals of value greater than $5 million. This regulatory consultation process is described in Figure 2.3 above.

The RIT-T involves a three step consultation process including the issuing of the Project Specification Consultation Report (PSCR), the Project Assessment Draft Report (PADR) and the Project Assessment Conclusion Report (PACR). The PADR can be omitted in certain circumstances where the preferred option is less than $35 million and where there are no material market benefits. The consultation documents and process is shown in Figure 2.4 below. Each document has a consultation period specified and there is a requirement for the consideration of submissions received.

The preferred option under the RIT-T is the credible option that maximises the net market benefit taking into account the direct cost of the option and the market benefits arising from that option.

The process considers the available technically and commercially feasible credible options. The technical characteristics of the identified need that a non-network option would be required to deliver including the size of the load reduction or additional supply required, the location and operating profile are detailed.

Figure 2.4 – RIT-T Consultation Documents



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

2.6 RIT-T Cost Threshold and Information Disclosure on Network Replacements

The relevant cost thresholds as determined under Rule 5.6.5E are as follows:

- The RIT-T applies to a proposed transmission investment where the estimated capital cost of the most expensive credible option is more than $5 million;
- Exemption from preparing the project assessment draft report is allowed if the estimated capital cost of the proposed preferred option is less than $35 million and with no material market benefits;
- 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 is defined for the review of the thresholds every three years.

2.7 Constraint and Request for Proposal Information

In April 2009, an NER rule change was introduced taking effect from July 2009. The rule change was based on a proposal in the interest of providing DM and non-network alternative proponents more detail and allowing more time to respond.

The Rules include requirements to indicate the following:

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

This information is included in APR 2011 in Chapters 5 and 6.

2.7.1. Constraint Information Clarifying Statement

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

It should be noted that:

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

In summary, TransGrid's requirements of network support include that it:

- Must meet the size and location of support required. This can be by a single provider or in aggregate by more than one providers;
- Must meet the requirement during the time of year specified;
- Must meet reliability requirements;
- Must be able to be delivered by the needs date; and
- Proponent or proponents must be able and willing to enter into a contract to provide the support.

2.7.2. Criteria to Issue RfP

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

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

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

Factors considered in developing the criteria include:

1. Outcomes of the joint planning process with DNSPs and directly connected customers on initial assessment of the potential and feasibility of non-network alternatives to meet an identified need or relieve an emerging constraint.
2. The amount of capital investment able to be deferred and its commercial value to TransGrid.
3. Length of deferral that is possible/feasible.
4. The amount of work required to issue and respond to an RfP. This is not inconsiderable in terms of defining the constraint, preparation of the RfP, assessment of offers by proponents, commercial considerations and the administration of the agreements with the network support providers.
5. Size and location of expected DM required. This also takes into account the materiality and usefulness of the information and the degree to which there are feasible DM projects likely to come forward.
6. The time horizon – that is, how long does TransGrid have to make the decision to commit to a solution? Sufficient time must be allowed from the decision as to whether to issue an RfP or not, to the time of a system support investment decision having to be made. (For example, Distributors are required by the DM Code to issue an RfP or advise that they will not issue an RfP nine months prior to the investment decision being made.)

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

- Economic efficiency as in the Regulatory Test or the RIT-T;
- Technical performance of the non-network alternative to ensure applicable reliability standards of reliability are met;
- Risks associated with non-network alternatives vis-à-vis network alternatives and some quantification of those risks in terms of impact on TransGrid's financial performance and reputation; and
- Commercial assessment including financial analysis and impact on TransGrid's financial position.

2.8 Network Support and Control Ancillary Services

On 13 April 2010, AEMO made a request to the AEMC to make a Rule Change regarding Network Support and Control Ancillary Services (NSCAS). The main purpose of the Rule Change was to transfer responsibility for planning and procurement of NSCAS from AEMO to TNSPs in view of the fact that TNSPs were already procuring some NSCAS to meet their own jurisdictional reliability requirements.

The AEMC commenced the Rule Change process on 22 July 2010 and published a draft Rule determination on 23 December 2010. After consultation with the industry, the final Rule determination was published on 7 April 2011. The new Rule provides for NSCAS to be procured by NSPs and for AEMO to have a "procurer of last resort" role if NSPs fail to procure NSCAS that AEMO has identified as being required. Part of the NSCAS may come from non-network sources.

National Transmission Network Developments

National Transmission Network Developments

3.1 2010 National Transmission Network Development Plan

AEMO published the National Transmission Network Development Plan (NTNDP) in 2010. The NTNDP examined five future market development scenarios based around factors covering economic growth, population growth, global carbon policy, a range of supply-side responses and a range of demand-side responses. Each of the five scenarios also included a trajectory for emission target reductions below year 2000 levels together with a sensitivity assessment of the carbon price trajectory. AEMO carried out modeling of the economic planting of generation and interconnector development and assessed the thermal loading on network elements to develop a view of the likely requirement for major transmission developments.

In developing the NTNDP, AEMO took into account TransGrid's long-term network development plans and the NSW APR. TransGrid provided advice on the need for network augmentation and likely network development options to overcome any shortfalls in transmission system capability. There is thus a strong linkage between the TransGrid plans for the main system development in NSW and the outcomes of the NTNDP.

AEMO also undertook a review of the benefits of a strong 500 kV link between the eastern states called NEMLink. The development of NEMLink builds apon completion of a number of 500 kV developments in NSW outlined in TransGrid's Strategic Network Development Plan.

3.2 Future Generation Development

The patterns of planting of new generation at sites in NSW dominate the extent and location of future 500 kV line development. Gas-fired or coal-fired generation would be expected to impact on the need for new 500 kV developments, but smaller-scale wind generation and other renewable generation is not expected to require large-scale line developments.

3.2.1. NTNDP Outcomes

The generation planting for the scenarios analysed in the NTNDP was based on the NTNDP generator cost data assumptions. The following table shows the approximate relative generation developments in northern, central and southern NSW, covering combined cycle gas turbine (CCGT), open cycle gas turbine (OCGT) and coal sources. The major coal-fired power station retirements are also indicated.

Table 3.1 – NTNDP Major Generation Expansion

NTNDP Scenario	Carbon Price Trajectory	Northern NSW (MW)	Central NSW (MW)	Southern NSW (MW)
Fast rate of change	High		OCGT: 3,900 Retirements: 600	CCGT: 2,800
	Medium		CCGT: 1,000 OCGT: 6,900 Retirements: 600	
Uncertain world	Low	CCGT: 6,000	OCGT: 1,500 Retirements: 600	
	Zero	CCGT: 3,000	Coal: 1,500 OCGT: 3,900 Retirements: 600	
Decentralised world	Medium	CCGT: 7,000	Retirements: 2,660	
	High	CCGT: 7,000	OCGT: 600 Retirements: 3,680	
Oil shock and adaptation	Medium		Coal: 750 OCGT: 1,500 Retirements: 600	
	Low		Coal: 750 OCGT: 1,800 Retirements: 600	
Slow rate of change	Low	CCGT: 3,500	Retirements: 2,120	
	Zero		OCGT: 3,300 Retirements: 600	Coal: 750

Hence, in the scenarios where there is a high concentration of generation development in northern NSW, there would be a need for extensive northern 500 kV line development. This includes the Hunter Valley – Eraring 500 kV line and 500 kV lines north of Bayswater.

In the scenarios where there is significant generation development in central NSW, the line development would be very dependent on the specific location of the new generation. Generation in the western area around Mt Piper or around Marulan and Bannaby tends to lead to the need for the Bannaby – Sydney 500 kV link.

Southern generation development would lead to 500 kV line development south of Bannaby and also the Bannaby – Sydney 500 kV line development.

3.2.2. NSW Connection Enquiries

In general, there is a significant contrast between the generation planting patterns in the NTNDP and the level of generation investment interest in various areas of NSW. The following table provides an indication of the interest in gas-fired generation in NSW, based on connection enquiries to TransGrid under the NER process.

Table 3.2 – Indicative NSW Generation Investment Interest for Gas-fired Generation

Northern NSW (MW)	Newcastle – Sydney – Wollongong area (MW)	Central NSW to the Yass / Canberra area (MW)
3,700	2,000	6,000

There is a greater interest in southern generation development overall compared to northern generation, leading towards a need for 500 kV line development between Bannaby and Sydney in preference to northern 500 kV developments. The generation development within the Newcastle – Sydney – Wollongong area has the potential to defer the need for increased transmission capability to the area, depending on its specific location.

3.3 Transmission Augmentation Projects in the NTNDP

AEMO has identified a need for various major transmission augmentations to overcome transmission limitations arising from the load and generation developments associated with the NTNDP scenarios. The AEMO analysis covered only plant thermal rating limitations and did not address voltage control, stability or fault level limitations. The NTNDP augmentations are set out in the table below with the number of scenarios (out of the five basic scenarios, each with two carbon trajectories) in which the augmentation is required. The status of the augmentation within TransGrid and comments are set out in the table.

Table 3.3 – NSW Transmission Augmentation Projects in the NTNDP

Transmission development	Number of scenarios – out of 10	Status within TransGrid
Northern NSW		
QNI upgrade – line series compensation	5	The first review of the QNI upgrade was completed by TransGrid and Powerlink in 2008. The impact and benefits of upgrade options are presently under active investigation by TransGrid and Powerlink. The outcomes of the present investigation will be released to the market in 2011.
Hunter Valley – northern NSW 500 kV development (three circuits or four circuits)	2	AEMO identified the need for 500 kV developments to connect major power stations in northern NSW. The route and details of any 500 kV line developments will be dependent on the location of the power stations. TransGrid is considering 500 kV line development as an option for upgrading the northern NSW 330 kV system capability.
Central NSW		
Bannaby – Sydney 500 kV line development	5	TransGrid is actively working on this development and has acquired some property to facilitate its development when required. TransGrid views the likely timing of the development as being late in this decade to manage the impact of southern generation development and load growth in the Sydney area.
Bannaby – Yass 500 kV line development	1	This development is included in TransGrid's Strategic Network Development Plan. TransGrid is presently investigating the need to upgrade the existing 330 kV lines in the area.
Hunter Valley – Eraring 500 kV line development		TransGrid is actively working on this development and has acquired some property to facilitate its development. TransGrid views the possible timing as being in the next decade to manage the impact of potential northern generation development.
Eraring second 500/330 kV transformer and uprate of the existing transformer	4	A second transformer is expected to be required soon to overcome stability constraints and TransGrid is considering rating and timing options.
Greater Newcastle / Central Coast – additional 500/330 kV transformer	1	The need for 500/330 kV transformation capability is linked to the development of the Hunter Valley – Eraring 500 kV line development.
Upgrade connections of the Wallerawang – Ingleburn line	2	This is considered relatively minor work that would be undertaken if economic in advance of any potential constraints. Voltage control limitations may otherwise limit the capability of this line. The existing line rating is adequate at present.
Mt Piper – Wallerawang 330 kV circuit development	3	TransGrid is investigating the need for this line and potential options.
Kemps Creek – Liverpool 330 kV line development	4	TransGrid is actively investigating this development and has acquired some property to facilitate its development.

Kemps Creek – Sydney West or Sydney South 330 kV line development	5	TransGrid is actively investigating this development and is considering a range of transmission options within this urban area.
Kemps Creek – replace 500/330 kV transformer and add new parallel transformer	6	TransGrid is considering the optimal transformer arrangements in conjunction with the Bannaby – Sydney 500 kV development. Transformers may be installed at Kemps Creek or a new 500 kV substation site.
500/330 kV parallel transformer at a future Sydney substation	3	TransGrid is considering the optimal transformer arrangements in conjunction with the future 500 kV system development
Rearrange Central Coast 330 kV connections and install line series reactors	3	The line rearrangement involves relatively minor works and would be undertaken if economic. Line series compensation may be pursued if economic but significant short circuit level issues would require management. The existing system has adequate capability.
Sydney North – Vales Pt circuit upgrade	1	The line rating is limited by terminal equipment ratings. Relatively minor work is required to replace the terminal equipment and this would be undertaken if economic. The existing line rating is adequate at present.
South West NSW		
220 kV phase shift transformer on the Buronga – Red Cliffs 220 kV line	10	The NSW 220 kV system has a relatively high thermal rating compared to the voltage control capability. The feasibility of a PST installation is under investigation. TransGrid and AEMO will investigate the impacts of high Murraylink power transfers on the NSW and Victorian systems in the Buronga – Red Cliffs area.
Victoria – NSW interconnection upgrade – NSW works includes a phase shifting transformer in the Jindera – Wodonga circuit	1	There are a number of options for upgrading the interconnection and joint work would be undertaken by TransGrid and AEMO.

3.4 NEMLink Transmission Works

AEMO carried out a pre-feasibility study of a high level 500 kV HVAC interconnection between the eastern Australian states. NEMLink aimed to provide a power transfer capability of 3,000 MW between the mainland regions and was modelled as proceeding from 2020/21.

The broad design of the NSW component of NEMLink is shown in Figure 3.1. The Figure shows the 500 kV double circuit lines that have already been constructed in NSW (green) and the possible additional links (blue). All of these links have been previously covered by TransGrid's Strategic Network Development Plan. AEMO has proposed line series compensation installations on some of the links as shown in the Figure.

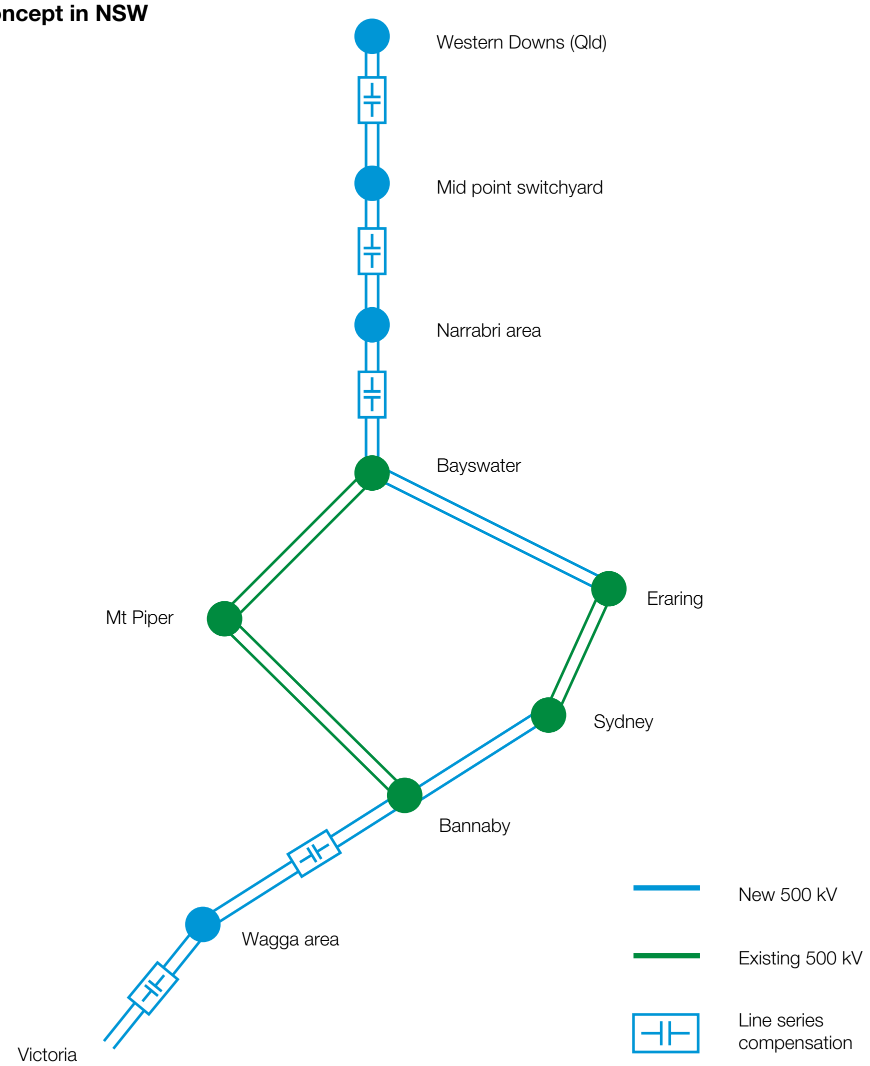
The extensive development of 500 kV lines in NSW would require a significant lead-time. Whilst it is expected that one new 500 kV link may be developed in NSW this decade, the full development of the NEMLink works will require detailed assessment for feasibility and timing.

The feasibility of 500 kV system development is also dependent on environmental and social constraints. TransGrid has been undertaking action in critical areas for some years to facilitate some of the future developments but considerable further work and expenditure would be required to secure line easement options and substation sites.

There are some issues that will need to be investigated in further developing the feasibility and detail of this concept, including:

- The transfer capability between the large state systems may be dominated by transient stability and damping considerations, rather than line thermal ratings;
- Substation switching arrangements;
- Voltage control considerations and fault level control;
- The rating of the 500/330 kV transformation – AEMO has assumed 1,000 MVA transformers compared to TransGrid's 1,500 MVA units; and
- Line development may require the use of existing 330 kV line easements which will require further investigations, including the ability to manage long-term line outages and the need for additional 500/330 kV substation sites.

Figure 3.4 – NEMLink Concept in NSW



NSW Region Energy and Demand Projections

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 as one of the inputs to identify future transmission constraints and to quantify any associated transmission development proposals.

4.1.1. Explanation of Terms

Energy and demand projections in this APR are presented as "native" quantities in accordance with AEMO's requirements.

Native energy and native demand projections include load supplied by "Scheduled" generators plus "Semi-Scheduled" and "Non-Scheduled" generators. Figure 4.1 shows the components of native energy and maximum demand.

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

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

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

A simplified schematic representation of the flow of electricity from power station to end-use customers is presented in Figure 4.2.

Figure 4.1 – Components of Native Energy and Maximum Demand

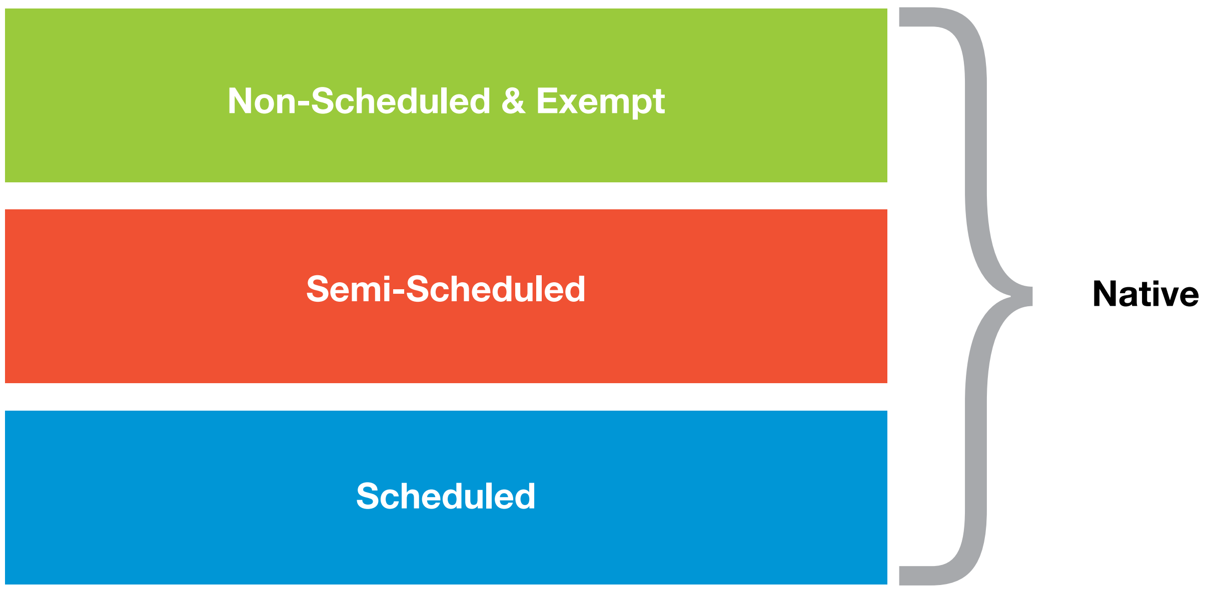
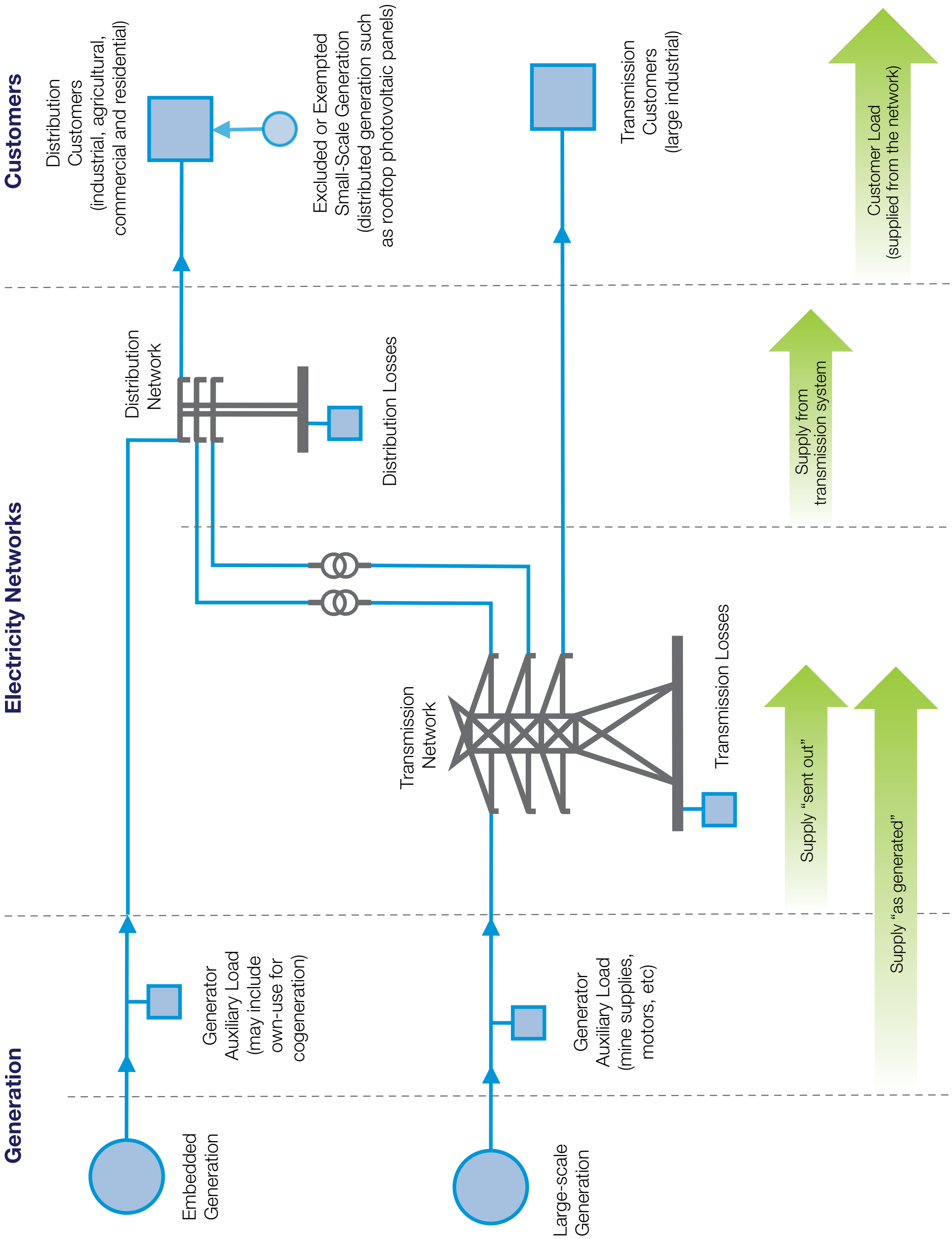


Figure 4.2 – Electricity Supply



Source: Modified version of AEMO diagram in ESOO 2010

4.1.2. Information Sources

The NSW region aggregate energy and demand projections 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 convened by AEMO.

As part of this process for 2011, KPMG Econtech was engaged by AEMO to supply economic and demographic scenarios as well as historical data and projections of Semi-Scheduled and Non-Scheduled generation and capacity on a consistent basis for each region of the NEM. The data supplied by KPMG for Non-Scheduled generation only includes "Significant" Non-Scheduled generators i.e. those above 1 MW and below 30 MW capacity.

Summer and winter peak demand projections for individual connection points in the NSW region are provided by NSW region DNSPs and other major customers. DNSPs and customers determine the connection point demand projections detailed in this APR. TransGrid also produces aggregate DNSP connection point and major customer demand projections using this data and assumptions regarding diversity and losses, permitting comparisons to be made between the top down global forecast, and the bottom up connection point forecasts.

4.1.3. Comparison with DNSP and Customer Projections

As the NSW region demand projections are derived from high level top-down econometric modelling they usually differ from the aggregate DNSP and major customer demand projections. In addition to the different methodologies used, the following factors can also contribute to these differences:

- The NSW region projections do not take into account the local demand drivers which TransGrid understands DNSPs may use for their demand projections; and
- Assumptions about diversity and losses.

However a general comparison can be used to provide a reasonability check.

4.1.4. Overview

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

- Section 4.2: Economic and Demographic Scenarios for Forecast Modelling
- Section 4.3: Energy projections for the NSW region;
- Section 4.4: Demand projections for the NSW region;
- Section 4.5: Semi-Scheduled and Non-Scheduled energy and demand projections;
- 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.
- Appendix 4: Scenarios A and E (described in Section 4.2).

4.1.5. Summary of the NSW Region 2011 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 winter peak demand growth are marginally higher whilst summer peak demand growth is lower in the projection period compared with the historical period.

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

	Actual/estimated 2001-02 to 2010-11	Projected 2011-12 to 2020-21
Energy Sent Out	1.2%	1.6%
	Actual 2001-02 to 2010-11	**Projected 10% POE 2011-12 to 2020-21**
Summer Peak Demand	3.2%	2.0%
	Actual/estimated 2002 to 2011	**Projected 10% POE 2012 to 2021**
Winter Peak Demand	1.5%	2.0%

4.1.6. Changes since the 2010 APR

Changes in the 2011 projections compared with projections published in the 2010 APR are:

- Energy projections are 4,071 GWh, or 5%, on average (for the common forecast period 2011-12 to 2019-20) lower than last year's projections;
- 10 percent POE (Probability of Exceedence) summer demand projections are 559 MW or 3.3 percent, on average (for the common forecast period 2011-12 to 2019-20), below last year's projections; and
- 10 percent POE winter demand projections are 788 MW or 5.0 percent, on average (for the common forecast period 2011 to 2020) lower than last year's projections.

These changes are examined below.

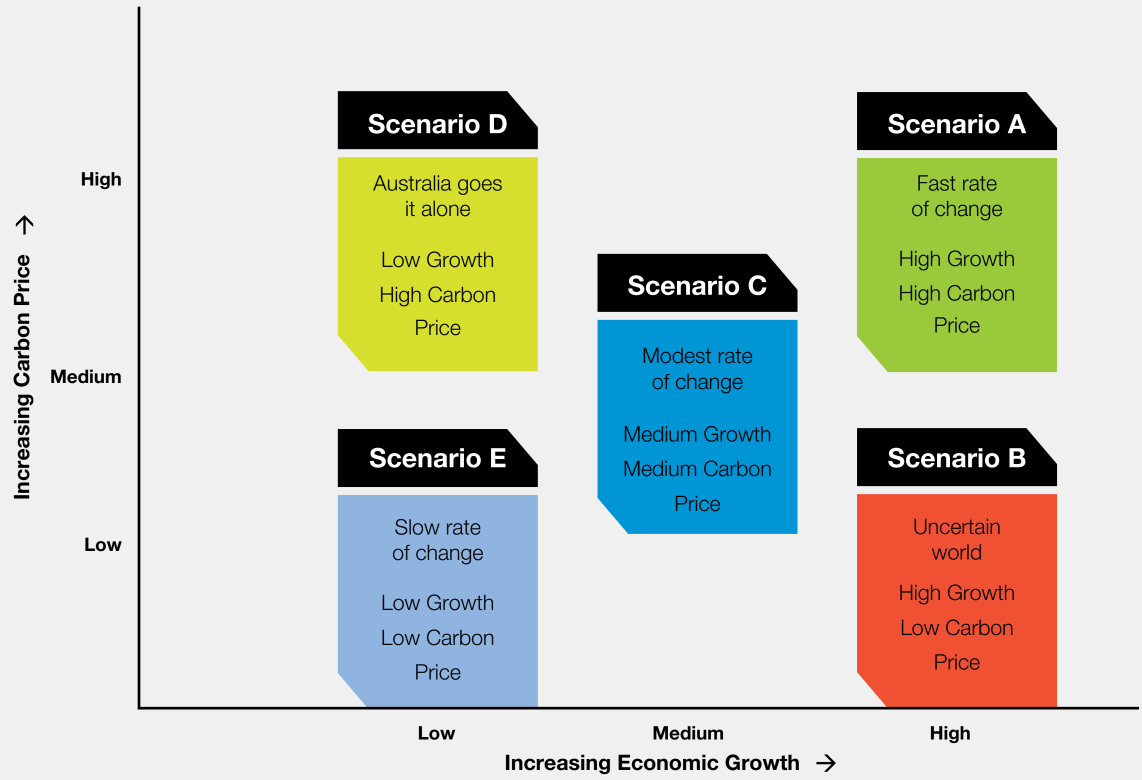
4.2 Economic and Demographic Scenarios for Forecast Modelling

4.2.1. Background

The Australian energy sector is undergoing a period of significant change. To manage the risks associated with planning in such an environment, AEMO in conjunction with the Department of Resources, Energy and Tourism has developed a range of scenarios describing alternative future outcomes for the Australian energy sector. Five scenarios were developed based on consultation with a reference group of industry experts and were subsequently published in the National Transmission Network Development Plan, 2010.

4.2.2. Scenarios

Figure 4.3 – Scenario Overview



The five scenarios as given in Figure 4.3 are distinguished in terms of the following six dimensions[2]:

- Economic growth;
- Population growth;
- Carbon policy;
- Centralised supply-side response;
- Decentralised supply response; and
- Demand-side response.

In November 2010, AEMO conducted a detailed review of the original scenarios, with the aim of identifying key areas for improvement as well as updating the assumptions to accord with the actual changes in the underlying variables. Subsequently, AEMO appointed KPMG to model three of the original five AEMO scenarios. KPMG further refined these three scenarios in quantitative terms based on the assumptions of the first three dimensions listed above. These three scenarios corresponded to the Scenarios E, C and A as presented in Figure 4.3.

[2] The scenarios were developed by Maclennan Magasanik Associates on behalf of AEMO and published in their report titled "Future Developments in the Stationary Energy Sector: Scenarios for the Stationary Energy Sector, 2030".

In early May 2011, TransGrid independently engaged KPMG to provide economic inputs pertaining to the remaining two scenarios, namely Scenarios D and B. The key difference between these two scenarios and Scenarios A and E are the assumptions surrounding the carbon price. Other distinguishing features relate to NSW/ACT state specific assumptions such as the pace of dwelling investments and the pace of improvement in the State's transport infrastructure.

The energy and demand forecast scenarios corresponding to the Economic Scenarios C, D and B are discussed in subsequent sections of this chapter. Energy/Demand forecasts pertaining to Economic Scenarios A and E are presented in Appendix 4.

4.3 Energy Projections for the NSW Region

The total energy that the transmission and distribution systems 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 4.4 shows native energy projections for the NSW region for the Scenarios C, D and B. These scenarios were established by KPMG on behalf of AEMO and TransGrid.

Compared with the 2010 projection the 2011 energy projection for the NSW region for the economic growth Scenario C is:

- 6% lower for the 2011-12 financial year; and
- An average of 5% lower over the common nine year forecast period.

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

- Electricity Prices: Electricity price forecasts sourced from KPMG are significantly higher compared to last year's forecasts. This difference reflects increases in distribution and to a lesser extent transmission prices as well as assumptions of a carbon price in the post 2012 period;
- Semi/Non Scheduled Generation: A revision of NSW semi-scheduled and non-scheduled generation projections which reflect currently available information; and
- Post Modelling Adjustments: Allowances have been incorporated in the forecasts to account for energy efficiencies due to phasing out of greenhouse intensive water heaters, introduction of NSW Energy Savings Scheme and phasing out of incandescent light bulbs. Additional allowances have been factored in for the operation of the NSW desalination plant.

Figure 4.4 – NSW Region Energy Projections

4.4 Demand Projections for the NSW Region

This section outlines the NSW region native summer and winter demand projections.

Demand projections based on Scenarios C, D and B were prepared by TransGrid based on the respective underlying demographic and economic growth rates provided by KPMG.

The 90%, 50% and 10% Probability of Exceedence (POE) demands presented here represent the 10th, 50th and 90th percentiles respectively of the distribution of peak demand for each season.

Tables 4.2 and 4.3 respectively show actual historical summer and winter peak demands and projections of 90%, 50% and 10% POE demands for each of the Scenarios C, D and B for the next 10 years.

Table 4.2 – NSW Region Summer Demand Projections (MW)

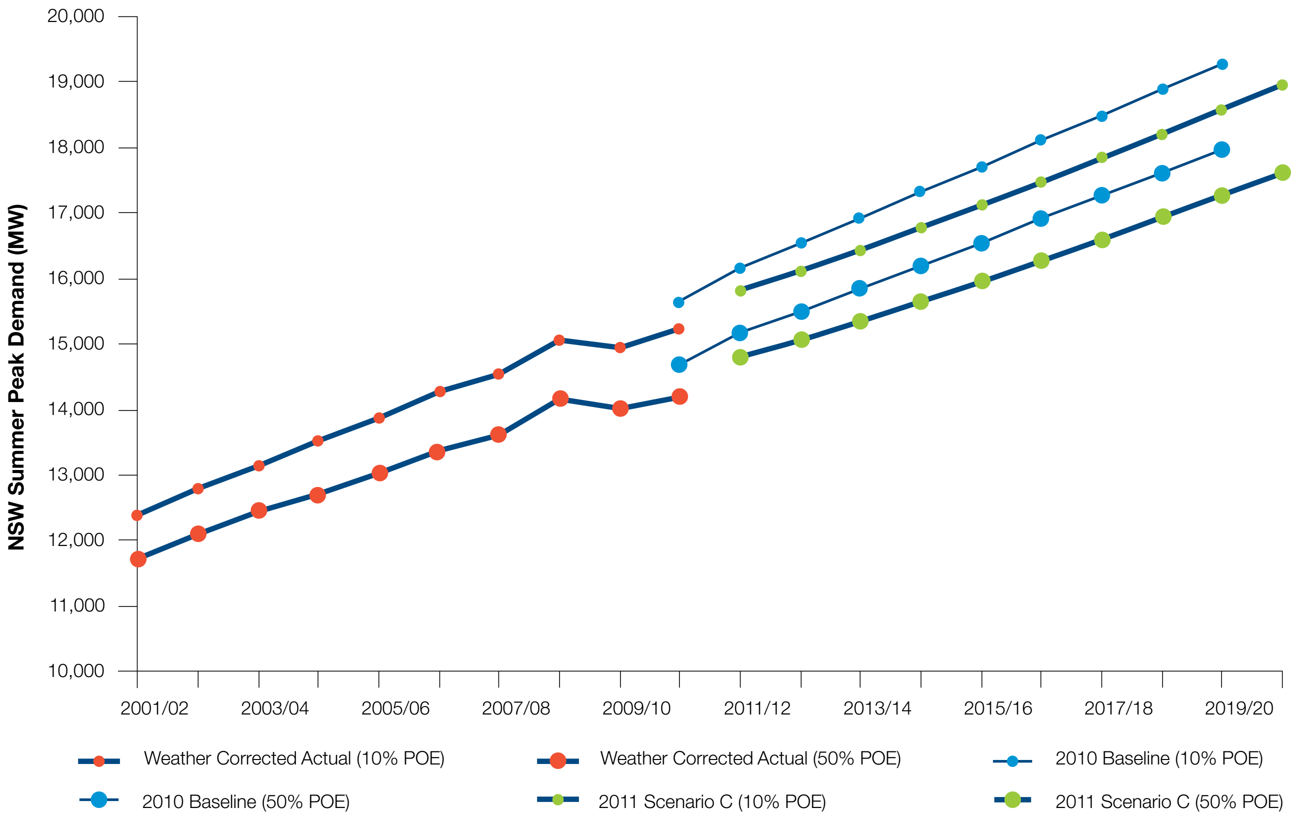
	Actual	90% POE			50% POE			10% POE		
Year		Scenario C	Scenario B	Scenario D	Scenario C	Scenario B	Scenario D	Scenario C	Scenario B	Scenario D
2000-01	11,739									
2001-02	11,155									
2002-03	12,621									
2003-04	12,311									
2004-05	12,944									
2005-06	13,461									
2006-07	12,981									
2007-08	13,071									
2008-09	14,287									
2009-10	13,957									
2010-11	14,820									
2011-12		13,827	13,906	13,775	14,807	14,886	14,745	15,827	15,916	15,765
2012-13		14,051	14,168	13,967	15,061	15,188	14,987	16,121	16,248	16,037
2013-14		14,290	14,445	14,186	15,350	15,505	15,246	16,440	16,615	16,336
2014-15		14,551	14,742	14,432	15,651	15,852	15,522	16,781	17,002	16,652
2015-16		14,821	15,054	14,677	15,951	16,204	15,807	17,121	17,384	16,967
2016-17		15,100	15,372	14,929	16,270	16,562	16,099	17,470	17,792	17,299
2017-18		15,387	15,712	15,197	16,597	16,942	16,407	17,837	18,212	17,637
2018-19		15,687	16,062	15,472	16,937	17,332	16,722	18,207	18,632	17,982
2019-20		15,997	16,420	15,752	17,277	17,720	17,032	18,587	19,070	18,332
2020-21		16,300	16,780	16,022	17,610	18,120	17,332	18,960	19,500	18,662

Table 4.3 – NSW Region Winter Demand Projections (MW)

Year	Actual	90% POE			50% POE			10% POE		
		Scenario C	Scenario B	Scenario D	Scenario C	Scenario B	Scenario D	Scenario C	Scenario B	Scenario D
2001	11,927									
2002	12,321									
2003	12,641									
2004	13,107									
2005	13,198									
2006	13,166									
2007	13,985									
2008	14,398									
2009	13,090									
2010	13,433									
2011		13,760	13,780	13,660	14,129	14,139	14,019	14,568	14,578	14,449
2012		13,999	14,048	13,847	14,369	14,417	14,207	14,818	14,866	14,646
2013		14,213	14,319	14,009	14,592	14,708	14,378	15,051	15,167	14,797
2014		14,451	14,665	14,208	14,840	15,054	14,587	15,309	15,533	15,016
2015		14,771	15,032	14,513	15,161	15,441	14,902	15,640	15,930	15,331
2016		15,200	15,493	14,987	15,610	15,912	15,387	16,109	16,411	15,826
2017		15,509	15,800	15,369	15,929	16,229	15,778	16,428	16,738	16,217
2018		15,805	16,120	15,726	16,234	16,559	16,155	16,753	17,088	16,594
2019		16,055	16,440	16,010	16,504	16,899	16,439	17,023	17,428	16,878
2020		16,425	16,916	16,320	16,874	17,385	16,759	17,413	17,934	17,198
2021		16,777	17,365	16,539	17,236	17,854	16,988	17,785	18,413	17,418

Figures 4.5 and 4.6 compare the 2011 10% and 50% POE demand projections with weather corrected actual peak demands and the corresponding 2010 projections.

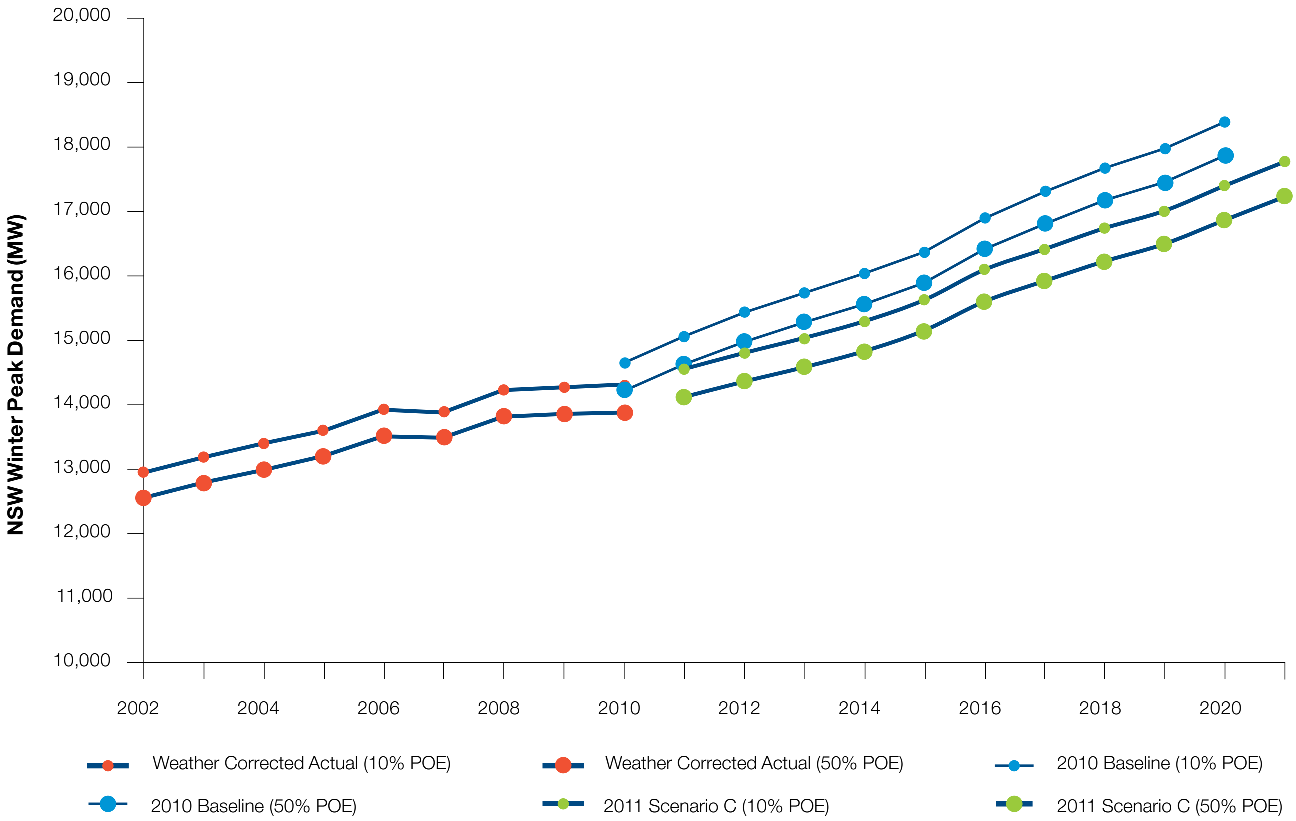
Figure 4.5 – Comparison of NSW Region 2011 Summer Demand Projections with Corresponding 2010 Projections (Scenario C 2011 & Baseline Scenario 2010) and Actual Weather Corrected Demands



Compared with the 2010 projection the 2011 10 percent POE summer demand projection is:

- 341 MW, or 2.1% lower for the 2011/12 summer; and
- 678 MW, or 3.5% lower for the 2019/20 summer.

Figure 4.6 – Comparison of NSW Region 2011 Winter Demand Projections with Corresponding 2010 Projections (Scenario C 2011 & Baseline Scenario 2010) and Actual Weather Corrected Demands



Compared with the 2010 projection the 2011 10% POE winter demand projection is:

- 509 MW, or 3.4% lower for winter 2011; and
- 996 MW, or 5.4% lower for winter 2020.

The differences between the 2011 and 2010 projections of summer and winter peak demands reflect changes in economic parameters especially upward revision in forecast electricity prices.

4.5 Semi-Scheduled and Non-Scheduled Generation

The energy and peak demand projections in Sections 4.3 and 4.4 include assumptions about the level of Scheduled, Semi-Scheduled and Non-Scheduled generation (refer to Section 4.1 for an explanation of these terms).

Table 4.4 details the Semi-Scheduled and Non-Scheduled generation that has been included in these projections. This includes generation that uses renewable fuel sources such as wind, solar, hydro, geothermal and biomass plus generation that uses non-renewable fuel sources, for example small scale thermal and gas fired generation. The projections of contribution to demand at the time of the NSW region peak have been estimated from capacity projections assuming wind and hydro availabilities at those times of 5 percent and 20 percent respectively.

4.6 Risks to Forecasts

Like any other forecasts, TransGrid's energy and maximum demand projections are subject to a number of risks and uncertainties. Three main areas of risk are discussed below:

1. Modelling/Data Limitations: The energy model forecasts electrical energy usage by regressing historical data against demographic, economic and weather variables. The peak demand models relate each season's maximum demand to average demand throughout the season (derived from the energy model) and an index of air-conditioning penetration. The forecasts of the demographic and economic input variables are supplied by AEMO/KPMG for use in TransGrid's energy and demand forecasting models. Historically, the most significant drivers of energy consumption have been NSW/ACT Gross State Product (GSP) and Electricity Prices. Generally GSP growth increases energy consumption while electricity price increases tend to reduce it. The economic

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

	Capacity (MW)		Demand at time of NSW Summer Peak (MW)		Energy (GWh)	
	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled
2007-08	0	577	0	131	0	913
2008-09	0	585	0	186	0	1,192
2009-10	0	805	0	191	0	1,681
2010-11	0	825	0	225	0	1,711
2011-12	185	737	9	358	471	1,486
2012-13	570	752	29	373	1,449	1,532
2013-14	939	752	47	373	2,386	1,532
2014-15	1,244	758	62	379	3,162	1,545
2015-16	1,609	820	80	440	4,087	1,677
2016-17	1,801	820	90	440	4,576	1,677
2017-18	1,927	820	96	440	4,896	1,677
2018-19	1,927	820	96	441	4,896	1,678
2019-20	1,927	820	96	441	4,896	1,678
2020-21	2,206	830	110	450	5,605	1,698

[3] The Scenarios A/B and D/E of this Table are presented in Appendix 3.

forecasts were finalised by KPMG in March/April 2011 based on the best available information at that time. As economic conditions are dynamic and ever changing it is possible that the actual values of key input variables may diverge from the forecasts;

2. Price Elasticity: The key downside risk[4] to the overall energy and demand forecasts relates to electricity prices. Due to absence of robust historical electricity price data in the public domain and the absence of significant energy price increases other than in the past two years, the model's historical price elasticities may not be a true reflection of the price elasticities in the future. Moreover, KPMG's price projections do not incorporate the recent recommendations of the *IPART Changes in regulated electricity retail prices from 1 July 2011* for NSW retailers. As a result it is possible that energy and peak demands may not meet the forecast levels; and

3. Economic Circumstances: There are also downside risks concerning the economy. High levels of government borrowing to support demand, and in some cases to support financial institutions, have placed the fiscal positions of many advanced economies in large deficits. Domestically, high levels of government debt and the consequent need for fiscal consolidation over the medium term may inhibit future policy responses and leave the recovery exposed to new shocks. The Reserve Bank of Australia's monetary policy statement (May 2011) says that there is uncertainty regarding the behaviour of Australian households. The household savings rate has been consistently high and spending restrained for the last few years. Continued cautious consumer behaviour could have a dampening effect on energy consumption.

When interpreting the load forecasts, consideration should be given to all of the above risks and appropriate judgement applied to reflect variations which potentially may eventuate.

4.7 Supplementary Information

4.7.1. Participation in the Load Forecasting Reference Group

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

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

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

4.7.2. Energy and Demand Definitions

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

4.7.3. 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.

4.7.4. Demand-Side Participation

Demand-side participation (DSP) occurs when consumers of electricity agree with their retailers or other parties to reduce their consumption in response to market events such as high spot prices. The regional demand projections in this APR include estimated amounts of DSP of up to 52 MW at time of summer peak and 11 MW at time of winter peak[5]. 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.

4.7.5. 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% POE projected peak demands for a given season are expected to be met or exceeded, on average, one year in 10;
- 50% POE projected peak demands for a given season are expected to be met or exceeded, on average, five years in 10; and
- 90% POE projected peak demands for a given season are expected to be met or exceeded, on average, nine years in 10.

Care should be taken when comparing actual historical and projected demands as the projected demands reflect standard conditions and the actual demands (if not corrected) reflect conditions at that time.

[4] We define "downside risk" as actual quantities being lower than forecasts

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

Completed, Committed and Planned Augmentations

Completed, Committed and Planned Augmentations

5.1 Recently Completed Augmentations

This section describes augmentations that have been completed since publication of the APR 2010.

5.1.1. Sydney South – Beaconsfield West 330 kV Cable Series Reactor Replacement

To reduce the loading on the Sydney South – Beaconsfield West 330 kV cable No. 41 the 330 kV series reactor on this cable was replaced by a unit with a higher reactance.

5.1.2. 500/330 kV Transformer – Spare Radiator

A spare 500/330 kV transformer radiator has been acquired as part of the western 500 kV conversion project. This will enable the existing spare 500/330 kV transformer units to be used at Bayswater, Mt Piper or Bannaby.

5.1.3. 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.

The Tamworth – Armidale 330 kV No. 86 line has been upgraded. This provides increased power transfer capability from Tamworth to Armidale and then to Queensland.

5.1.4. Western 500 kV Conversion Project

To meet limitations in the main transmission network supplying the Newcastle/Sydney/Wollongong load area TransGrid undertook:

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

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

5.1.5. Establishment of Tomago Supply Point

To meet present and emerging limitations in the network supplying the Newcastle area and Lower mid north coast areas TransGrid and Ausgrid carried 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 Ausgrid'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 were completed progressively in 2010/11.

5.1.6. Completed Line Switchbays for Distributor Requirements

The following table summarises projects for the provision of line switchbays to meet NSW Distributors' requirements that were included as proposals in previous APRs and completed since the publication of the APR 2010.

Table 5.1 – Completed Line Switchbays for Distributor Requirements

Location	Installation	Completion
Port Macquarie 132/33 kV Substation	Two new 33 kV line switchbays to supply Essential Energy's new Sovereign Hill 33/11 kV substation	May 2011

5.1.7. Completed Substation Fault Rating Upgrades

The following table summarises substation fault rating upgrades that were included as proposals in previous APRs and completed since publication of the APR 2010.

Table 5.2 – Substation Fault Rating Upgrades

Location	Installation	Completion
Dapto 330/132 kV Substation	Equipment replacements to ensure that the 330 kV fault rating is ≥ 30 kA and the 132 kV fault rating is ≥ 40 kA.	May 2011

5.1.8. 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 2010.

Table 5.3 – Transformer Replacements and Capacity Upgrades

Location	Installation	Completion
Sydney North 330/132 kV Substation	Installation of a fifth 375 MVA 330/132 kV transformer	Mar 2011
Sydney South 330/132 kV Substation	Replacement of No 4 250 MVA single phase 330/132 kV transformers by a new 375 MVA 3 phase unit	June 2011

5.1.9. Reactive Plant Installations

The following table summarises reactive plant installations that were included as proposals in previous APRs and completed since publication of the APR 2010.

Table 5.4 – Reactive Plant Installations

Location	Installation	Completion
Sydney South 330/132 kV Substation	Installation of Shunt Reactor on Sydney South – Beaconsfield West Cable 41	Oct 2010

5.2 Committed Augmentations

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

5.2.1. Armidale SVC: Power Oscillation Damping Control

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

5.2.2. Supply to the Sydney CBD and Inner Metropolitan Area

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

- Construction of sections of new double circuit 330 kV line and conversion of parts of an existing double circuit line to operate at 330 kV between Sydney West 330/132 kV Substation and the new Holroyd Substation;
- Construction of a new 330/132 kV substation in the Holroyd area;
- Construction of a new 330/132 kV substation in the Potts Hill area (Rookwood Road, Potts Hill); and
- Installation of two 330 kV cables between the new Holroyd substation and the new Rookwood Rd Substation (not committed).

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

5.2.3. Reinforcement of Voltage Control in Northern NSW

TransGrid plans to install two 200 MVAr switched shunt capacitor banks at Armidale to improve the power transfer capability to northern NSW loads. This consequently increases the power transfer capability between NSW and Queensland governed by voltage control limitations. The switching of the capacitor banks would be controlled by the Armidale SVC, thereby extending the overall MVAr capability of the SVC.

5.2.4. Glen Innes – Inverell 132 kV Line

To meet limitations in the network supplying the Inverell area TransGrid and Essential 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 mid 2011.

5.2.5. Redevelopment of Orange 132/66 kV Substation

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

The proposal has the following components:

- Establishment of a new 132 kV switching station to the north of the existing Orange 132/66 kV substation (to be known as Orange North switching station);
- Line rearrangements to connect Orange North 132 kV Switching Station to existing 132 kV lines and to Orange 132/66 kV Substation; and
- Refurbishment works at Orange 132/66 kV Substation (not yet committed).

The works are expected to be completed from late 2011.

5.2.6. Establishment of Williamsdale 330/132 kV Substation

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

- Construct a 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 late 2011.

5.2.7. New Kempsey – Port Macquarie 132 kV Line

To meet limitations in the network supplying the north coast of NSW TransGrid and Essential 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 late 2011.

5.2.8. Manildra – Parkes 132 kV Line

To meet limitations in the network supplying the Cowra, Forbes and Parkes area, TransGrid and Essential 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 by early 2012.

5.2.9. Wallerawang 132/66 kV Switchyard Relocation

The existing Wallerawang 132/66 kV substation is approaching the end of its serviceable life and is to be replaced.

The new substation is expected to be completed early 2014.

5.2.10. Murray Switching Station and Upper Tumut Switching Station Rehabilitation

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

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

5.2.11. Beaconsfield West 330/132 kV Substation 132 kV Equipment Replacement

It is proposed to replace ageing 132 kV equipment at Beaconsfield West 330/132 kV Substation and to provide additional 132 kV cable connections, a third 330/132 kV transformer and two 132 kV 160 MVAr capacitors.

These works are planned to be completed by late 2012.

5.2.12. 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 Ausgrid's Tomago 132/33 kV substation. A backup 33 kV supply is available from Essential 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, Essential Energy is building a new single transformer 132/33 kV substation in the Hawks Nest area supplied from the 963 Tomago – Taree 132 kV transmission line together with associated 33 kV line works to connect it to the local 33 kV network.

The proposal provides for TransGrid to construct short lengths of 132 kV line. The works are anticipated to be completed during 2011.

5.2.13. Committed Line Switchbays for Distributor Requirements

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

Table 5.5 – Committed Line Switchbays for Distributor Requirements

Location	Installation	Completion	Comments
Griffith 132/33 kV Substation	Five new or uprated 33 kV switchbays in support of Essential Energy 33 kV works in the Griffith area	July 2011	
Cooma 132/66 kV Substation	An additional 132 kV line switchbay to supply Essential Energy's Bega Substation	Late 2011	

5.2.14. Committed Substation Fault Rating Upgrades

The following table summarises committed substation fault rating upgrades.

Table 5.6 – Committed Substation Fault Rating Upgrades

Location	Installation	Completion	Comments
Sydney West 330/132 kV Substation	Equipment replacements to ensure that the 132 kV fault rating is ≥ 38 kA.	Mid 2014	
Sydney North 330/132 kV Substation	Equipment replacements to ensure that the 132 kV fault rating is ≥ 40 kA	July 2011	

5.2.15. Committed Transformer Replacements and Upgrades

The following table summarises committed transformer replacements and upgrades.

Table 5.7 – Committed Transformer Replacements and Upgrades

Location	Installation	Completion	Comments
Beaconsfield West 330/132 kV Substation	Installation of a third 330/132 kV transformer	Late 2012	In conjunction with 132 kV GIS replacement.
Narrabri 132/66 kV Substation	Replacement of three 30 MVA transformers by two 60 MVA units released from Coffs Harbour	Late 2012	
Vineyard 330/132 kV Substation	Installation of a third 375 MVA 330/132 kV transformer	Late 2011	
Wallerawang 330/132 kV Substation	Replacement of Nos. 1 and 2 330/132 kV transformers with two 375 MVA units	Mid 2011	

5.2.16. Committed Capcitor Bank Replacements and Upgrades

The following table summarises committed capacitor bank replacements and upgrades.

Table 5.8 – Capacitor Bank Installations

Location	Installation	Completion	Comments
Griffith 132/33 kV Substation	Replace existing No.1 and No.2 capacitor banks with new 8 MVAr banks	Late 2011	
Beaconsfield West 330/132 kV Substation	Install two new 132 kV 160 MVAr capacitor banks	Late 2012	In conjunction with 132 kV GIS replacement.

5.2.17. Other Committed Works

The following table summarises other committed replacements and upgrades.

Table 5.9 – Other Works

Location	Installation	Completion	Comments
Dapto 330/132 kV Substation	Dapto – Sydney South line rehabilitation	Late 2011	
Dapto 330/132 kV Substation	Install a modular control building	Mid 2012	
Liddell	Provide dual switching on 330 kV line 84	2012	Two lines connect Liddell to northern NSW. One line is equipped with dual-switching and the installation of dual-switching on the other line will improve supply reliability.
Newcastle 330 kV Substation	Provide 330 kV bus coupler circuit breaker	2012	Newcastle is a critical major substation supplying large urban loads. The works are being combined with transformer work.
Sydney South 330 kV Substation	Provide a 330 kV bus coupler circuit breaker	2012	Sydney South is a critical major substation supplying large urban loads
Sydney West 330 kV Substation	Provide a 330 kV bus coupler circuit breaker	2012	Sydney West is a critical major substation supplying large urban loads. The bus coupler work is being combined with the connection of 330 kV lines to Holroyd
Various 330 kV Substations	Install surge arrestor on 330 kV line entries	Progressive completion from 2013	To provide necessary surge protection for substation equipment

5.3 Planned Augmentations that have Completed the Regulatory Process

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

5.3.1. Supply to Far North NSW

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

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

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

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

- Uprate the 96C Armidale – Coffs Harbour 132 kV line to a conductor operating temperature of 100ºC (completed May 2011);
- Construct a new 330 kV line between Dumaresq 330 kV Switching Station and Lismore 330/132 kV Substation;
- Provide 330 kV switchgear at Dumaresq and Lismore to connect the new line;
- Provide reactive equipment at Lismore and Coffs Harbour; and
- Establish a single transformer 330/132 kV substation near Tenterfield or other alternative project to secure supply to a standard commensurate with the size of the load at Tenterfield. This requirement arose from the line route selection process.

These works are planned to be completed by 2015.

5.3.2. Supply to the Lower Mid North Coast

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

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

The works are to be carried out in a staged manner with completion dates from 2012/13.

5.3.3. Development of Southern Supply to the ACT

To meet the requirement of the ACT government, TransGrid and ActewAGL are proposing the construction of a new large transmission network asset and a new small distribution network asset. (The establishment of Williamsdale 330/132 kV substation is covered in section 5.2.6.)

The project consists of the following:

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

The works are expected to be completed in 2013.

5.3.4. Supply to the Tomerong/Nowra Area

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

The proposal has major components as follows:

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

The regulatory consultation process addressing these limitations was completed in 2010.

5.3.5. Supply to Lake Munmorah

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

The proposal has the following components:

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

The works are expected to be completed progressively from 2012.

5.3.6. Reinforcement of Supply within the Sydney Central Business District

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

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

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

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

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

The regulatory consultation for the establishment of a 132 kV cable circuit between Beaconsfield West and Haymarket was completed during 2010.

5.3.7. Capacity of the Marulan – Avon, Marulan – Dapto and Kangaroo Valley – Dapto Lines

To accommodate higher flows to the Sydney/Wollongong area from the south of the State it is necessary to uprate the Marulan – Avon, Marulan – Dapto and Kangaroo Valley – Dapto 330 kV lines. These works were included in the regulatory consultation for the western 500 kV conversion project.

5.3.8. Proposed Minor Augmentation Projects Previously Reported

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

Table 5.10 – Minor Augmentations Previously Reported

Proposal	Need	Completion	Comments
Provide a new 80 MVAr 132 kV capacitor bank at Yass	To maintain adequate power transfer capability from the southern generators towards Sydney and the NSW south coast as the load grows	2013/14	It is aimed to ensure that voltage control constraints are no more limiting than line thermal rating capability
Provide a new 120 MVAr 132 kV capacitor bank at Canberra	As above	2013/14	As above
Provide a new 200 MVAr 330 kV capacitor bank at Sydney South	To maintain adequate power transfer capability to the loads of southern Sydney	2012/13	
Transposition works on the Wallerawang – Sydney South/Ingleburn No. 76/77 double circuit 330 kV line	To meet the NER requirements for balanced voltages	Yet to be determined	The level of unbalance in the system three phase voltages has been calculated to exceed the NER requirements under certain power transfer conditions
Multiple contingency protection scheme	To minimise the possibility of a widespread disturbance to the NSW main system following multiple circuit outages for example during bushfires	2013	This will be arranged through control system facilities
Replace the existing 7.5 MVAr 66 kV capacitor bank at Coffs Harbour 132/66 kV Substation with a new 16 MVAr unit.	Replace ageing assets	Late 2011	
Albury Trip Scheme	Thermal loading of Jindera – Albury – ANM network	2013	Essential Energy plans to construct a Mulwala – Finley 132 kV circuit which will enable the Mulwala/Corowa load to be transferred to Finley.
Murray – Guthega 132 kV line rehabilitation	Restore rating for longer term requirements	Late 2013	

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

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

Table 5.11 – Proposed New Small Network Assets that have Completed the Regulatory Process

Proposal	Completion	Comments
Wallerawang – Orange 132 kV Line 944 Replacement and Upgrade	Mid 2013	
Quality of supply monitoring	Progressive installations	
Real time line rating monitoring systems	Progressive installations	

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

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

Table 5.12 – Proposed Transformer Replacements and Upgrades that have Completed the Regulatory Proces

Location	Installation	Completion	Comments
Sydney East 330/132 kV Substation	Installation of a fourth 375 MVA 330/132 kV transformer	Late 2013	
Newcastle 330/132 kV Substation	Replace the three remaining banks of single phase 330/132 kV transformers by new 375 MVA three phase units	2016	
Yanco 132/33 kV Substation	Condition-based replacement of two 45 MVA 132/33 kV transformers by two new 60 MVA units	2012/13	
Griffith 132/33 kV transformers replacement	Condition-based replacement	2014	
Munyang 132/33 kV transformers replacement	Condition-based replacement	2013	Gas insulated transformers to meet environmental requirements
Kempsey 33/66 kV transformers replacement	Condition-based replacement	2012	
Replacement of Newcastle No. 2 330/132 kV single-phase transformer bank with a three-phase unit	Condition-based replacement	2012	

5.3.11. Proposed Line Switchbays for Distributor Requirements Previously Reported

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

Table 5.13 – Proposed Line Switchbays for Distributor Requirements Previously Reported

Location	Installation	Completion	Comments
Sydney West 330/132 kV Substation	One 132 kV switchbay	2011/12	DNSP requirement
Newcastle 330/132 kV Substation	One new 132 kV line switchbay	2015	DNSP requirement
Tamworth 132/66 kV Substation	Provide a new 66 kV switchbay	2013/14	DNSP requirement
Williamsdale 330/132 kV Substation	Provide two new 132 kV switchbays	2012	DNSP requirement

5.3.12. Proposed Replacement Transmission Network Assets Previously Reported

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

Table 5.14 – Proposed Replacement Transmission Network Assets Previously Reported

Location	Installation	Completion	Comments
Broken Hill 220/22 kV Substation	Replace the control systems and some plant on both SVCs	2013/14	
Kemps Creek 500/330 kV Substation	Replace the control systems and some plant on both SVCs	2013/14	
Wagga	Rebuild 132/66 kV Substation	2015	

5.3.13. Proposed System Reactive Plant Requirements Previously Reported

The following table summarises proposed system reactive plant that have previously been reported.

Table 5.15 – System Reactive Plant Requirements

Location	Details	Indicative Date
Sydney South	Provide a new 200 MVAr 330 kV capacitor bank	Late 2012
Sydney West	Extension of one 80 MVAr 132 kV capacitor bank to 160 MVAr	About 2013/14
Regentville	One new 80 MVAr capacitor bank	About 2013/14
Canberra	One 120 MVAr 132 kV capacitor bank replacing an existing 80 MVAr bank	About 2013/14
Canberra	One new 200 MVAr 330 kV capacitor bank	About 2013/14

5.4 NER Rule 5.6.2A Reporting

The information required by NER Rule 5.6.2A requiring TransGrid to provide forecast constraint information and indicate whether it intends to issue an RfP with respect to the proposals covered in Chapter 5 is provided in the following two sections.

5.4.1. Forecast Constraint Information

The required forecast constraint information with respect to proposals in Chapter 5 is provided in Table 5.16 below.

Table 5.16 – Forecast Network Limitations

Anticipated Proposal or Limitation	Reason for Limitation	Connection Point at which MW reduction would apply	MW at Time Limitation is Reached
Supply to the NSW Far North Coast	Thermal Overload	Lismore	Summer 2014/15; 14 MW
Supply to the Lower Mid North Coast (Stage 1: Tomago-Stroud)	Thermal Overload	Taree	Summer 2011/12; 46 MW
Supply to the Lower Mid North Coast (Stage 2: Stroud-Taree)	Thermal Overload	Taree	Summer 2013/14; 7 MW
Supply to Tomerong/Nowra Area	Thermal Overload	Endeavour Energy: Mt Terry and Shoalhaven	Summer 2011/12; around 95 MW
Proposed Transformer Replacements and Upgrades that have Completed the Regulatory Process:			
• Sydney East 330/132 kV Substation	Thermal Overload	Sydney East	Summer 2013/14; 9 MW

5.4.2. Intent to Issue Request for Proposal

TransGrid's intent to issue an RfP for non-network services is provided in the following table.

Table 5.17 – Anticipated issue of an RfP for Non-Network Services

Anticipated Proposal or Limitation	Intend to Issue RfP	Date
Supply to the NSW Far North Coast	Issued	Completed 2010/11
Supply to the Lower Mid North Coast	Issued	Issued 2010
Development of Southern Supply to the ACT	No	
Supply to the Tomerong / Nowra Area	Yes	2011
Supply to Lake Munmorah	No	
Reinforcement of Supply within the Sydney CBD	No	
Capacity of the Marulan – Avon, Marulan – Dapto and Kangaroo Valley – Dapto Lines	No	
Proposed Minor Augmentation Proposals Previously Reported		
• Yass 132 kV 80 MVAr cap bank	No	
• Canberra 132 kV 120 MVAr cap bank	No	
• Sydney South 330 kV 200 MVAr cap bank	No	
• Transpose Wang – Sydney South/Ingleburn 330 kV line	No	
• Multiple Contingency Protection Scheme	No	
• Coffs Harbour 66 kV 16 MVAr cap bank	No	
• Albury Trip Scheme	No	
• Uprate Murray – Guthega 132 kV line	No	
Proposed New Small Transmission Network Assets that have Completed the Regulatory Process:		
• Wallerawang – Orange 132 kV line replacement/upgrade	No	
• Quality of Supply Metering	No	
• Real time line rating monitoring systems	No	
Proposed Transformer Replacements and Upgrades that have Completed the Regulatory Process:		
• Sydney East 330/132 kV Substation fourth 375 MVA transformer	No	
System Reactive Plant Requirements	No	
Reactive Support from Coalfields Generators	Yes	To be assessed

Chapter 6

Constraints and Proposed Network Developments within Five Years

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 describes constraints that are expected to emerge within a five year planning horizon for which there are augmentation proposals other than proposals for new small transmission network assets or where augmentation proposals are anticipated prior to publication of the APR 2012.

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

Section 6.2 describes other constraints expected to emerge within a five year planning horizon where there is at present no firm proposal. One or more options for the removal of each constraint are described. They may appear as proposals in future Annual Planning Reports.

Section 6.3 summarises constraints that are expected to arise over a longer time frame than five years. One or more indicative developments to meet the constraints are given.

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

The NER require the APR 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 5.

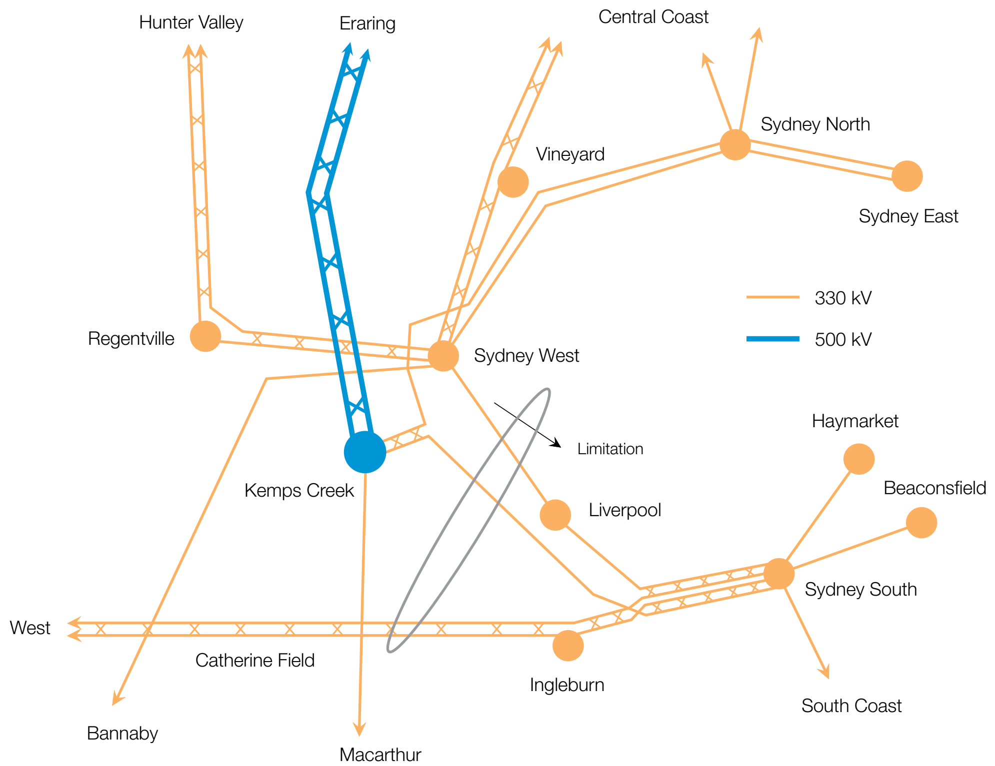
6.1 Proposed Network Developments within Five Years

This section describes constraints that are expected to emerge within a five year planning horizon, for which there are augmentation proposals other than proposals where augmentation proposals are anticipated prior to publication of the APR 2012.

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

6.1.1. Supply to Southern Sydney

Southern and Western Sydney Main System



Supply to the greater Sydney area is provided via major 500 kV and 330 kV Substations at Kemps Creek, Sydney North, Sydney East, Sydney West, Sydney South, Vineyard, Regentville, Liverpool, Ingleburn, Macarthur, Beaconsfield and Haymarket as shown in the figure above. A new Macarthur 330/132/66 kV substation connected to the Kemps Creek – Avon line has recently been commissioned.

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

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

Following the forced outage of one of the four 330 kV circuits under high system load conditions the remaining circuits will be heavily loaded. There is a need to secure this system in anticipation of the next circuit outage by the rescheduling of generation in the system. This however may only relieve the line loadings to a marginal degree and hence in accordance with the NSW planning criteria there is a need to reinforce this system to avoid the shedding of load. Reinforcement is expected to be required mid to late this 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 for the immediate system deficiencies but there is a long-term need to further support the system in this area. It is envisaged that the existing system will need to be reinforced with two additional circuits between Kemps Creek/Sydney West and Sydney South. To avoid an unnecessary proliferation of lines the more immediate network solution would need to fit within an overall strategy for the area.

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

- Because of the high cost of developments in this urban area development options will have to provide sufficient capacity for long-term needs;
- Maximum use will be made of existing easements where possible. It is preferred that any new lines would be of double circuit construction;
- Options will need to take account of significant community and environmental constraints. This may include the rationalisation of some existing connections to the same capacity where it is in the community's interest. There is potential to group multiple lines in a single corridor and remove sections of existing single circuit lines that are in the vicinity of heavily developed residential areas. Attention will also be given to assessing the potential for underground cable development, recognising the significantly higher cost and limited capability of cable developments; and
- If existing lines need to be rebuilt or conductors upgraded, the timing of construction will need to take into account their unavailability for extended periods.

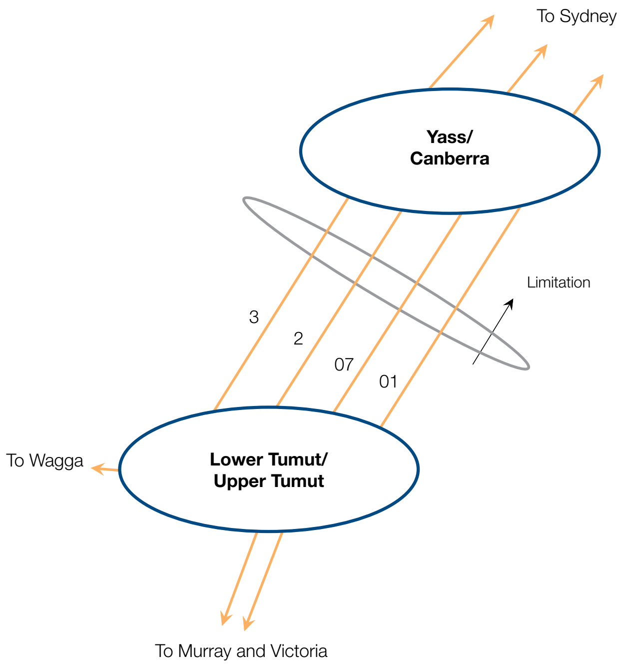
A proposal that satisfies the above principles is the initial construction of a new double circuit overhead line from Kemps Creek to near Liverpool operated as a single circuit line when commissioned. In order to minimize the number of 330 kV lines in the vicinity of Liverpool it may be feasible to use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

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

It is anticipated that a regulatory consultation process addressing these limitations will be initiated in 2011/12.

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

Snowy – Yass/Canberra 330 kV Connections



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

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

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

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

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

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

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

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

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

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

TransGrid has been undertaking a preliminary assessment of the potential market benefits from upgrading this system. Depending on the outcome of this analysis a regulatory consultation process addressing these limitations will be initiated in the near future.

6.1.3. Supply to the Forster/Tuncurry Area

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

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

The proposal provides for TransGrid to assume ownership, operation and maintenance of 132 kV assets at Nabiac substation on completion of the works, which is anticipated by late 2012.

It is anticipated that Essential Energy and TransGrid will initiate the regulatory consultation process addressing these limitations in 2011/12.

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

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

To relieve this limitation Essential Energy intends to establish a 132/66 kV substation near Herons Creek and to progressively establish a 66 kV network to supply the area. TransGrid would own the 132 kV busbar and connections within that substation on completion of the works, the first stage of which is anticipated by around 2013/14.

It is anticipated that Essential Energy and TransGrid will initiate the regulatory consultation process addressing these limitations in 2012/13.

6.1.5. Capacity of the Connections between the Central Coast Power Stations

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

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

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

Under some future generation scenarios the loading on the 330 kV outlets from the Central Coast power stations may reach the rating of the existing 330 kV lines. There is potential to rearrange the 330 kV connections to better balance the loading across the circuits. TransGrid proposed this project in the early 2000s but found the need for the line rearrangement declined with time as the power system developed. AEMO found in their 2010 NTNDP work that a constraint arose late in the study period and TransGrid would monitor the situation in future planning work to determine the need for augmentation.

A rearrangement of 330 kV connections in the Central Coast system and installation of a line series reactor is identified in the 2010 NTNDP to address line loading limitations under three of the ten NTNDP scenarios.

6.1.6. Voltage Levels in the Yass/Canberra Area

The voltage levels in the Snowy area govern the voltages in the main system in the Yass / Canberra area and the voltages in the northern Victorian 330 kV system. At times of high Victorian import from NSW or high import to NSW from the south it is necessary to maintain relatively high Snowy area voltages. In contrast to this it is sometimes necessary to maintain low voltages in the Snowy area to avoid excessive voltages in the 330 kV system from Canberra to Kangaroo Valley. Since publication of APR 2009 the voltage rating of the Canberra 330 kV bus has been upgraded to 362 kV.

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

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

6.1.7. Voltage Levels at Kangaroo Valley

The voltage levels at Kangaroo Valley must be restricted to within the 346 kV rating of the generator transformers. This imposes an overall constraint on the voltage levels in the Canberra – Kangaroo Valley system. The constraint arises at times when there are limited generators in service in the Kangaroo Valley system and during line outages for maintenance.

TransGrid is considering various options for overcoming the voltage limitation including the installation of a shunt reactor, System Protection Schemes, plant uprating and alternative supplies for the auxiliary systems at the power stations.

Both the Kangaroo Valley generation and Capital Wind Farm (including Woodlawn Wind Farm) are connected to the single circuit 330 kV line extending between Dapto and Canberra. During particular line outage conditions there is a risk of over-voltages occurring, depending on the generating units connected at the time. TransGrid is considering control system developments to manage any over-voltages.

6.1.8. Eraring Generation Capacity

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

The contingent outage of the 500/330 kV transformer under certain system conditions may lead to the outage of both units 3 and 4 which could be a significant loss of generation to the state. In order to maintain the reliability of supply to NSW loads it is proposed to install a second 500/330 kV transformer and associated works in the 500 kV switchyard to accommodate the placement of two transformers. The existing spare 500/330 kV transformer would be retained.

The need for additional transformer capacity at Eraring is identified in the 2010 NTNDP to address loading limitations under four of the ten NTNDP scenarios.

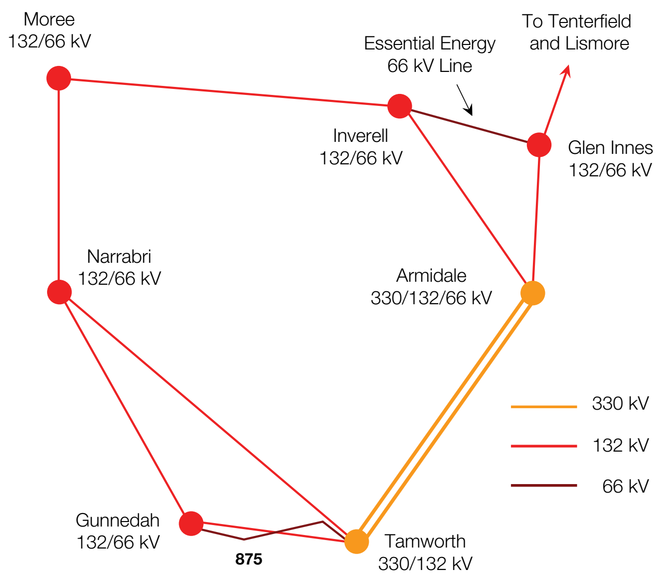
TransGrid is undertaking further investigation of the need and timing for this project.

6.1.9. 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 presently exist.

Expanded mines in the Gunnedah area have been proposed. Should those proceed, the limitations would be exacerbated.

Transmission System Supplying Gunnedah, Narrabri and Moree



Options available to address these limitations include:

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

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

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

The regulatory consultation process has commenced with the Project Scoping Consultation Report having been published on 11th March 2011.

6.1.10. Reactive Support from Coalfields Generators

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

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

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

AEMO has an obligation to ensure system security and has in the past entered into contracts for network control ancillary services (NSCAS). The AEMC has revised the Network Support and Control Ancillary Services arrangements in the NEM and TransGrid is considering the reactive power requirements to meet reliability obligations in NSW.

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

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

The following table provides a guide to the MVAr capability that will need to be contracted (based on the APR 2010 forecast).

TransGrid expects to initiate arrangements for network support contracts from 2011. Should it prove not possible to arrange the contracts for MVAr support then TransGrid would need to install 330 kV capacitor banks.

6.1.11. Murraylink Runback Control System

Murraylink is connected between Red Cliffs in Victoria and the South Australian Riverland area. The capability of Murraylink to transmit power from Victoria into South Australia is partly governed by the power transfer capacities of the NSW 220 kV system between Darlington Point and Buronga and the Victorian north west 220 kV system.

Various runback control schemes have been implemented in the Victorian 220 kV system to enable Murraylink to be operated at a relatively high level prior to a critical contingency. The power transfer over Murraylink is then run back following a contingency.

The substation controls were also installed at sites in NSW but the communication links between the sites and Murraylink have not been completed. It is proposed to complete these communication links and the owners of Murraylink have undertaken to carry out these works.

Table 6.1 – Reactive Power Capability Required to be Contracted

Area	Stations	Total MVAr contract requirement (indicative) above the performance standard		
		2011/12	2012/13	2013/14
Hunter Valley	Bayswater units 1 & 2 and Liddell units 1 to 4	198	275	317
Hunter Valley	Bayswater units 3 & 4	Nil	Nil	Nil
Central Coast	Eraring units 1 to 4	92 (at maximum)	92	92
Central Coast	Vales Pt, Munmorah and Colongra	236	377 (at maximum)	377
Western coalfields	Mt Piper and Wallerawang	489 (at maximum)	489	489
Total		**1,015**	**1,233**	**1,275**

6.1.12. Smart Grid Projects

The NSW system presently contains a range of control and protection systems, including:

- SVC voltage and oscillatory damping controls;
- Generator excitation controls and oscillatory damping controls;
- Voltage controls on individual transformers and reactive power plant, with some controls co-ordinated across areas of the system; and
- System Protection Schemes to extend the capability of the system, by automatic switching of plant and the opening of network connections.

There is also extensive application of high-speed disturbance monitoring across the system.

Smart Grid applications are being further developed through Ausgrid's Smart Grid Smart City project. TransGrid is further developing the application of wide area measurements for the improvement of load models, the control of voltage to enhance the system capability and the application of post-contingency load control to defer system augmentations.

6.1.13. Minor Augmentation Proposals

The NER requires annual planning reports to include information pertinent to all proposed augmentations to the network irrespective of their cost. Table 6.1.2 below details proposals for minor augmentations, i.e. those where the capitalised expenditure is estimated to be less than $5 million. None of these proposals will have a material inter-network impact. There are no proposals in this category this year.

Table 6.2 – Minor Augmentation Proposals

Proposal	Need	Completion	Cost ($M)	Other Options Considered	Comments
nil					

6.1.14. Proposed Replacement Transmission Network Assets

The NER requires annual planning reports to include information pertinent to all asset replacement proposals where the capitalised expenditure is estimated to be more than $5 million. These proposals are detailed in Table 6.1.3 below.

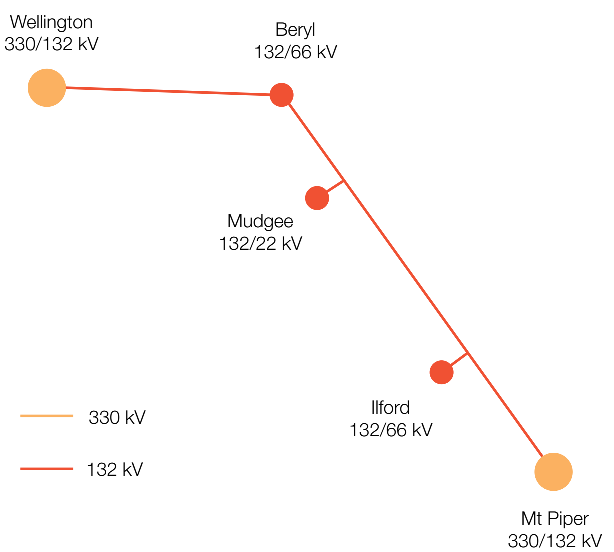
6.2 Other Constraints Emerging within Five Years

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.

6.2.1. Supply to Beryl

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

Transmission System Supplying Beryl



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

Options to relieve the limitation include:

- Installation of additional capacitors at Beryl or within Essential Energy's network supplied from Beryl;

Table 6.3 – Proposed Replacement Transmission Network Assets

Proposal	Need	Completion	Cost ($M)	Other Options Considered	Comments
Sydney West 330/132 kV Substation	Secondary Systems Replacement	2016	35		
Griffith 132/33 kV Substation	Secondary Systems Replacement	2014	15		
Tumut 132/66 kV Substation	Secondary Systems Replacement	2014	15		

- Establishment of a second Wellington – Beryl 132 kV line, possibly utilising part of the route of and existing Essential Energy 66 kV line;
- Establishment of a 330/132 kV substation near Beryl, supplied from the Wollar – Wellington 330 kV line; or
- Demand management or local generation.

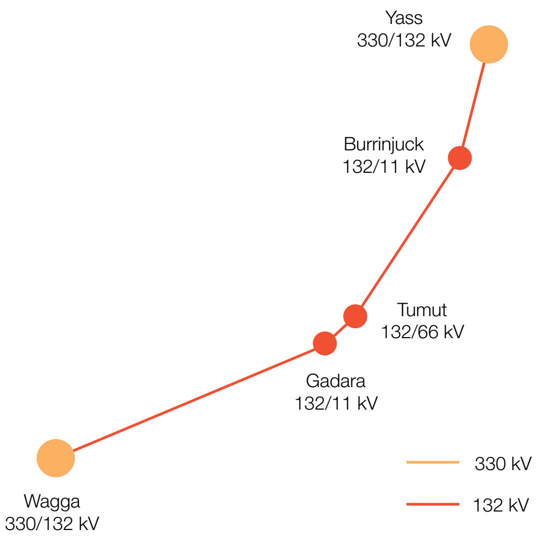
At this stage, the preferred option is the establishment of a 330/132 kV substation near Beryl.

It is presently expected that the regulatory consultation process will start in mid 2011.

6.2.2. Supply to Tumut/Gadara

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

Transmission System Supplying Tumut/Gadara



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

6.2.3. NSW to Queensland Transmission Capacity

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

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

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

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

Powerlink and TransGrid considered five augmentation options:

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

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

Since the 2008 Powerlink/TransGrid report, there have been a number of market developments that will change the previous findings and conclusions.

As a result TransGrid and Powerlink signed a MOU in 2010 to re-evaluate the market benefits, the upgrade potential of QNI and the optimal timing for the upgrade taking into account the changes to the inter-connected system that has occurred since the 2008 investigation. In general, these changes are:

- Development of the South-Eastern Queensland transmission system which has raised the voltage control limits;
- Switched capacitors to be installed at Armidale and controlled by the Armidale SVC;
- Revision of the limit equations describing the NSW to Qld transient stability power transfer capability;
- Introduction of the Regulatory Investment Test for Transmission (RIT-T) to replace the Regulatory Test; and
- Various generation developments.

Depending on the results which emerge, the organisations may decide to progress an upgrade through the formal RIT-T process. The investigation has commenced with the a report on the potential upgrade of QNI scheduled for publication in 2011.

AEMO's NTNDP 2010 also identified the potential for upgrading QNI under five of the ten scenarios of load and generation development.

6.2.4. Loading of the Wallerawang – Sydney South/Ingleburn 330 kV Lines

The double circuit 330 kV line (circuits 76 and 77) from Wallerawang across the Blue Mountains to Sydney South and Ingleburn can be heavily loaded at times of high western and northern generation.

There is potential for the loading on the line to reach the rating of the terminal equipment under future generation development scenarios. This is indicated in two of the ten scenarios in the 2010 NTNDP.

TransGrid proposes to review the potential loading conditions and rating of the terminal equipment to determine the need for uprating of the plant.

6.2.5. Line Switchbays for Distributor Requirements

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

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

Table 6.4 – Line Switchbays for Distributor Requirements Within Five Years

TransGrid Location	Details	Indicative Date	Distribution Development
Tumut	One 66 kV switchbay	2013/14	Supply to Batlow
Wellington	One 132 kV switchbay	2013	Supply to the Dubbo area
Lismore 330	Two 132 kV switchbays	2015-17	DNSP requirement

6.2.6. Transformer Capacity Upgrades and Replacements

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

Table 6.5 – Transformer Capacity Upgrades and Replacements Within Five Years

Location	Details	Indicative Date
Canberra	Replace No 2 bank of 330/132 kV single phase transformers by a new 375 MVA three phase unit	2013/14
Wagga	Rebuild 132/66 kV Substation	2015
Tamworth	Rebuild 132/66 kV Substation; Replace two of the three 60 MVA 132/66 kV transformers by new 120 MVA units	2013/14

6.2.7. System Reactive Plant Requirements

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

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

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

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

Table 6.6 – System Reactive Plant Requirements

Location	Details	Indicative Date
Yass	One new 132 kV, 80 MVAr capacitor bank	2013/14
Sydney area	Further capacitor bank installations	from 2014/15

6.3 Longer Term Constraints and Indicative Developments

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

Table 6.7 – Longer Term Constraints and Indicative Developments

Constraint	Indicative Development(s)	Time Frame (Years)
Yass – Bannaby and Yass – Marulan 330 kV Lines	See Section 6.3.1 below	About 5
Hunter Valley – Tamworth – Armidale system	See Section 6.3.2 below	> 5
Tamworth and Armidale 330 kV switchyards	See Section 6.3.3 below	About 5
Kemps Creek 500/330 kV transformer augmentation	See Section 6.3.4 below	About 5
Spare Armidale SVC transformer	A spare transformer to provide improved SVC reliability	About 5
Limitations in supply to south western NSW	Wagga – Darlington Point/Finley 330 kV line.	> 5
Newcastle – Sydney – Wollongong load area. Further development of the 500 kV system supporting the area.	See Section 6.3.5 below	> 5
Supply to Sydney East	See Section 6.3.6 below	> 5
Deteriorating supply demand balance in Victoria/South Australia; The need for additional NSW import; or Significant renewable energy developments in South Australia and Victoria.	NSW – South Australia interconnection development – see Section 6.3.7 NSW – Victoria interconnection development – see Section 6.3.8	> 5
Bannaby – Yass and Yass – Wagga 500 kV system	See Section 6.3.1 on the Yass – Bannaby and Yass – Marulan 330 kV lines	> 5
Further development of supply to the Sydney Inner Metropolitan area	Augmentation of Rookwood Road substation to provide a 330 kV phase shifting transformer, provision of a new 330 kV cable between Rookwood Road and Beaconsfield West Substations, provision of a 330 kV busbar at Beaconsfield West, provision of a section of 330 kV cable between Beaconsfield West and Haymarket and provision of an additional 330 kV switchbay at Haymarket	> 5
Tamworth 330/132 kV Transformers	Replacement of the three existing 150 and 200 MVA transformers by two 375 MVA units	> 5
Transformer capacity required by generation development in southern NSW	Bannaby third 500/330 kV Transformer bank	> 5
Supply to the growing Vineyard and northern Sydney load areas	Vineyard 330 kV Line Reinforcement	> 5
Line rating limitations between Mt Piper and Wallerawang	Third Mt Piper – Wallerawang 330 kV Line	> 5
Voltage control in the Sydney area	Additional capacitor banks and a third SVC	About 5
Voltage control at Yass / Canberra	Additional capacitor banks and a Yass SVC	> 5

6.3.1. Yass – Bannaby and Yass – Marulan 330 kV Lines

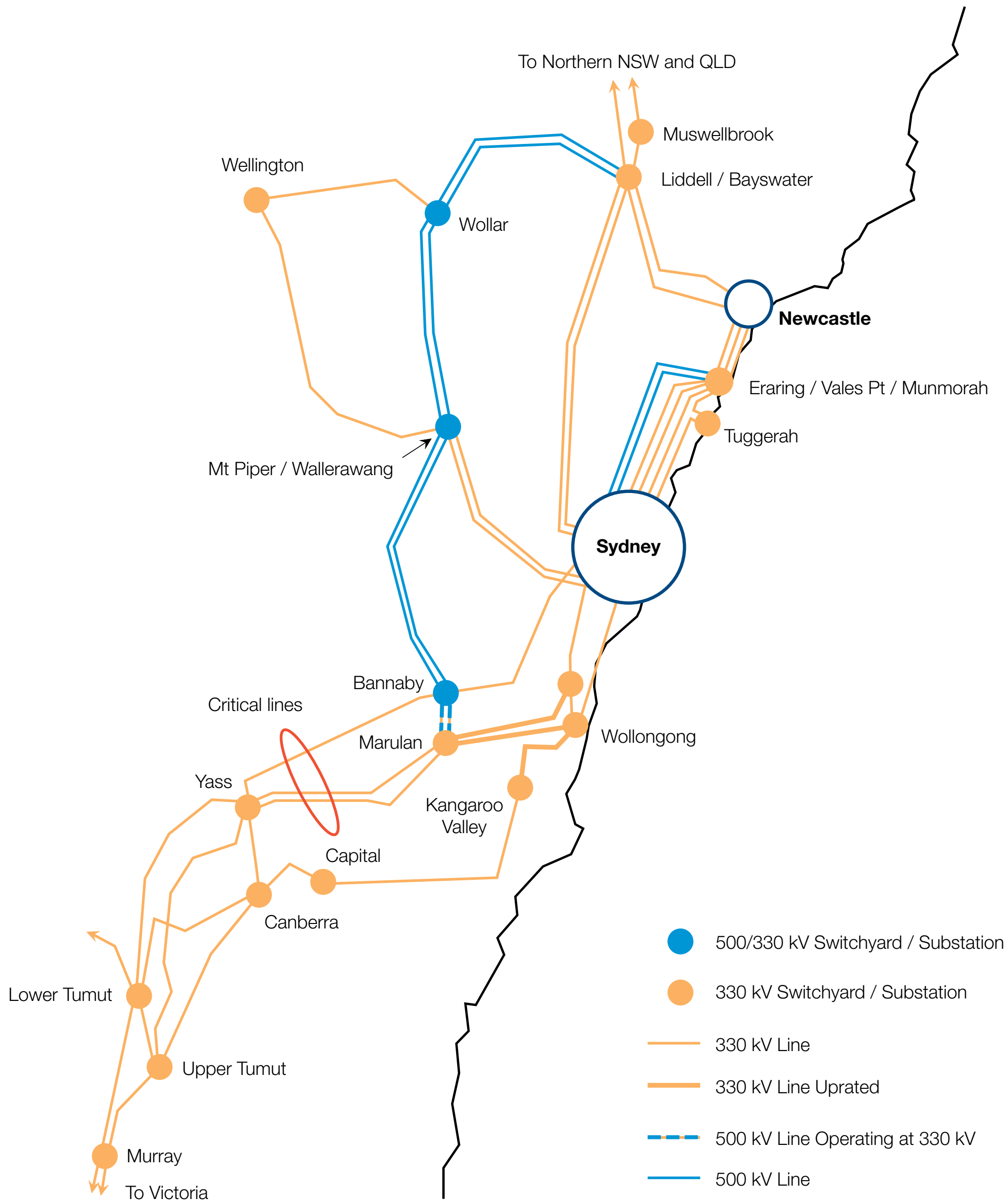
Following the development of the Bannaby 500/330 kV Substation in 2010 the transmission connections between Bannaby/Marulan and the Yass area are now as shown in the figure below. The connections consist of the Bannaby – Yass single circuit No. 61 330 kV line and the two Marulan – Yass single circuit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

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

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

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

Yass – Bannaby and Yass – Marulan Connections



NSW import from the South

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

Section 6.1.2 identifies a project for upgrading the four 330 kV lines north of Snowy. This upgrade will improve the ability of the system to absorb the power transfer as a result of the combined Snowy export to NSW, Victorian export and Uranquinty generation.

The power flow north from Yass and Canberra equals the NSW import from the south minus the total south west area load including Yass and Canberra. Alternatively the power transfer north from Yass and Canberra equals the loading on the lines immediately north of Snowy minus the load at Yass and Canberra.

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

NSW export to the south

The NSW south west loads are supplied by:

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

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

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

Future Network Development Options

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

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

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

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

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

These future developments will be influenced by AEMO's NTNDP. The need for a Bannaby – Yass 500 kV development was identified in one scenario in the 2010 NTNDP. This line would also form part of NEMLink.

6.3.2. Hunter Valley – Tamworth – Armidale 330 kV System

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

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

together with an underlying 132 kV system.

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

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

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

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

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

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

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

It is aimed to reinforce supply to the Lismore area with a 330 kV line from Dumaresq to Lismore.

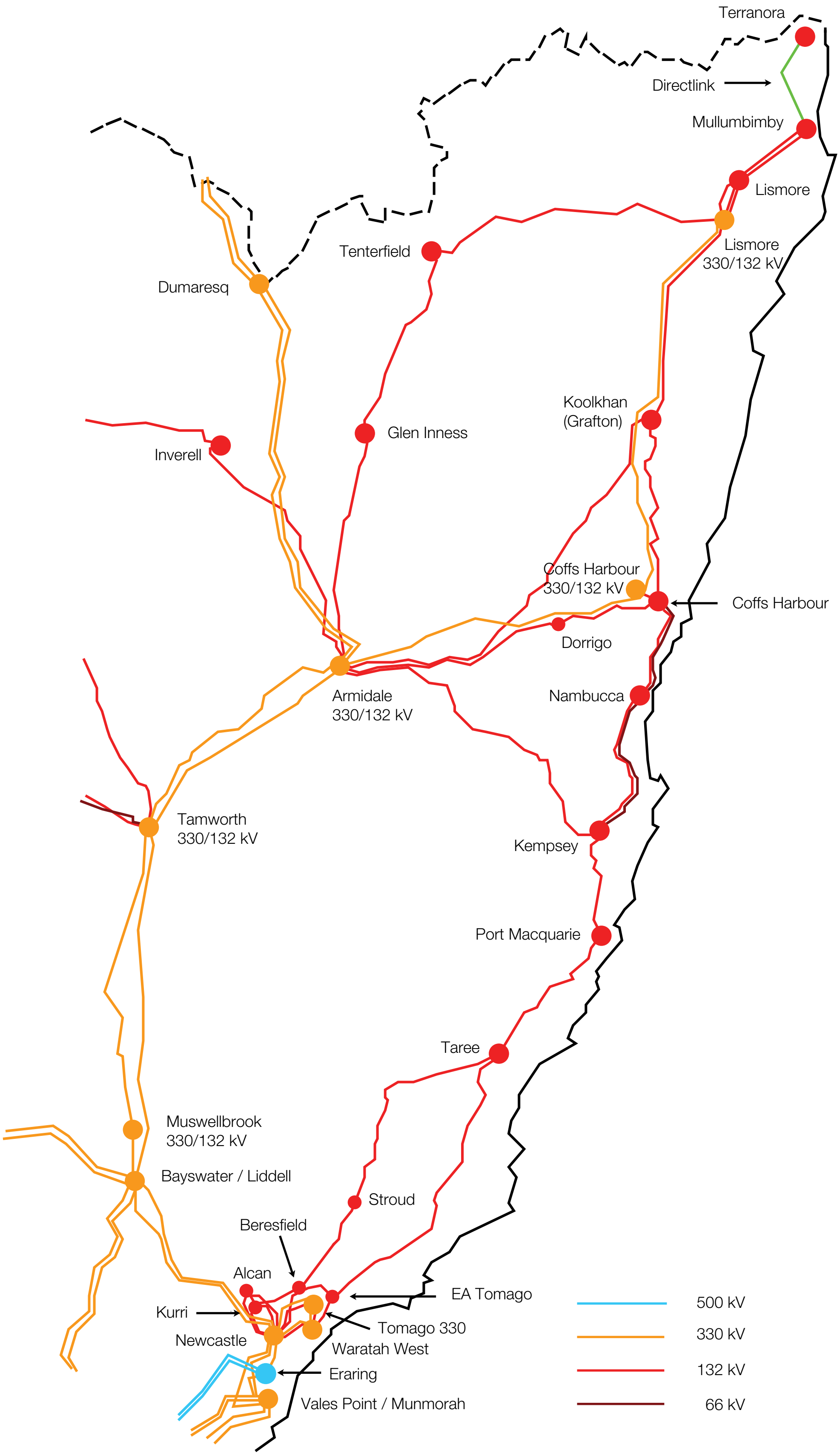
Ongoing load development in the northern area and upgrading of the power transfer levels with Queensland will require upgrading of one or both sections of the Hunter Valley – Tamworth – Armidale link.

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

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

These future developments will be influenced by AEMO's NTNDP. The development of a 500 kV system north of the Hunter Valley was identified in five of the ten scenarios in the 2010 NTNDP. Such development would also be required for NEMLink.

Northern NSW Connections



6.3.3. Tamworth and Armidale 330 kV Switchyards

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

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

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

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

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

6.3.4. Kemps Creek 500/330 kV Transformer Augmentation

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

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

There is a future need for additional 500/330 kV transformer capacity in Sydney. This may be achieved by additional transformers at Kemps Creek or at other sites. The need for additional transformers was identified in most scenarios in the 2010 NTNDP.

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

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

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

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

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

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

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

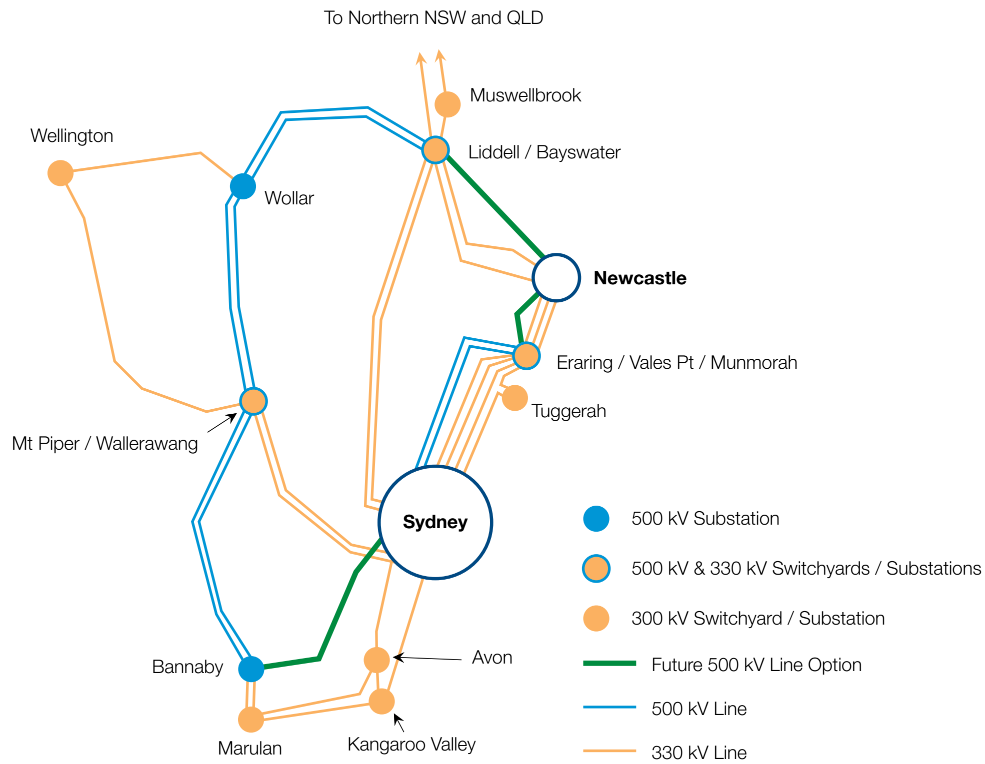
TransGrid develops the NSW electricity transmission network to ensure that there is sufficient network capability to transmit the output of generators to the major load centres in NSW at an acceptable standard of reliability. In doing so it is essential that the transmission network is developed so that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

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

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

Further development of a strong 500 kV ring around the Newcastle – Sydney – Wollongong area will address the emerging transmission network limitations. It will alter power flows to reduce the loading on the 330 kV lines between the Hunter Valley power stations and the Newcastle area, between the Hunter Valley and western power stations and the Sydney area and between the south of the state and the Sydney area. It will also support voltage control in the Newcastle – Sydney – Wollongong area. Additionally it will facilitate new generation connection over a wide range of feasible locations.

Options for Future 500 kV Ring Developments



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

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

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

TransGrid's scenarios indicate the need to first develop the southern link in the ring, particularly to supply the Sydney area and to accommodate southern gas-fired generation development. The northern link would be developed in response to major northern generation or load development.

Many of the 2010 NTNDP scenarios for future market development highlighted the investment drivers for the completion of the main 500 kV transmission ring that will support the major load centers at Sydney, Wollongong and Newcastle. The completion of the ring is also required for NEMLink. Specifically, new generation around Canberra and central NSW will result in loading issues on the 330 kV transmission lines south of Sydney with a possible solution involving development the 500 kV Bannaby-Sydney line along with a series of upgrades to the 330 kV Sydney transmission network. This outcome occurs in five out of the ten NTNDP scenarios. Northern generation development leads to the development of the Hunter Valley – Eraring 500 kV line, which also occurred in five of the ten scenarios.

It is anticipated that a regulatory consultation process addressing the limitations for which a Bannaby – Sydney 500 kV line development would be a credible option will be initiated in 2011/12. Non-network development alternatives to support the Newcastle – Sydney – Wollongong area would be expected to be brought out and, if feasible and economic, would be further developed with the proponents.

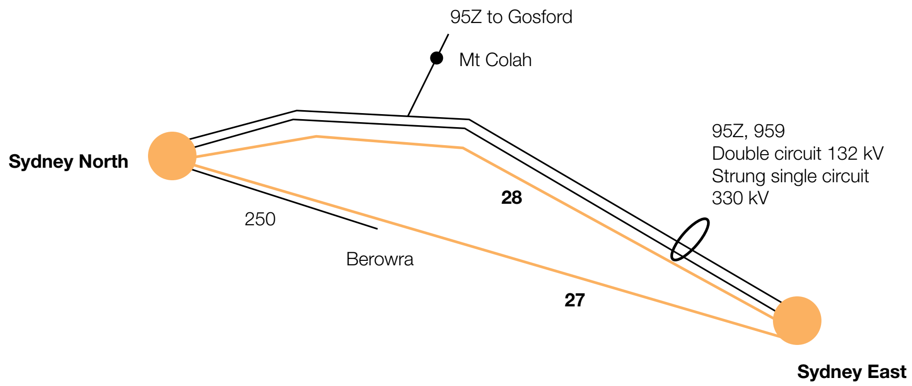
The need and timing for the Hunter Valley – coast 500 kV link is being kept under review.

Some critical properties have been purchased to maintain the viability of options and more may be required to facilitate the development of the Bannaby – Sydney and Hunter Valley – coast 500 kV lines.

6.3.6. Supply to Sydney East

The Sydney East 330/132 kV Substation is supplied via two 330 kV overhead lines from Sydney North. This is supported by a third 330 kV line that is presently operated as two 132 kV single circuits. The growing Sydney East load will require support.

Connection between Sydney North and Sydney East



One option is the conversion of the line which is operated at 132 kV to its design 330 kV operation.

It would be necessary to form a connection from the Sydney North 132 kV system to the Mt Colah line to implement this option.

6.3.7. NSW – South Australia Interconnnection

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

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

By increasing the interconnection capability with the eastern States it would enable the connection of significant levels of renewable energy sources in South Australia;

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

Electranet and AEMO have undertaken a joint feasibility study into the transmission development options between South Australia and other NEM load centres. A number of options have been considered as part of this feasibility study including incremental upgrades of the existing interconnectors.

TransGrid has been involved is providing options analysis to this process and is continuing to investigate these options and the connection into the NSW 500 kV system. Two of the options considered are for a northern interconnection between Wilmington (in South Australia) and Mt Piper (in NSW). A third option is for a 500 kV incremental upgrade and network development between Tepko (in South Australia) routed via Horsham and Shepparton (in Victoria) to Yass (in NSW).

The options proposed are:

- Northern 500 kV double circuit HVAC interconnection
- Wilmington (near Davenport in South Australia) to Mt Piper (NSW) via Broken Hill
- Northern +/- 500 kV HVDC bi-pole interconnection
- Wilmington (near Davenport in South Australia) to Mt Piper (NSW)
- Central 500 kV double circuit HVAC incremental upgrade and network development between Tepko (in South Australia) routed via Horsham and Shepparton (in Victoria) to Yass (in NSW)

6.3.8. NSW – Victoria Interconnection

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

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

These developments were documented in AEMO's NTS 2009.

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

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

These future developments will be influenced by AEMO's NTNDP and would also form part of the backbone to AEMO's NEMLink option in the 2010 NTNDP.

The 2010 NTNDP identified the development of a phase shifting transformer between Buronga and Red Cliffs. TransGrid would undertake further work with AEMO on this option.

6.4 NER Rule 5.6.2A Reporting

The information required by NER Rule 5.6.2A requiring TransGrid to provide forecast constraint information and indicate our intent to issue an RfP with respect to the proposals covered in Chapter 6 is provided in the following two sections.

6.4.1. Forecast Constraint Information

The required forecast constraint information with respect to proposals in Chapter 6 is provided in Table 6.8 below.

Table 6.8 – Forecast Network Limitations

Anticipated Proposal or Limitation	Reason for Limitation	Connection Point at which MW reduction would apply	MW at Time Limitation is Reached
Supply to Southern Sydney	Thermal Overload	Southern Sydney	See section 6.1.1
Capacity of Snowy to Yass / Canberra 330 kV System	Line thermal ratings reached	NSW Supply overall	See Section 6.1.2
Vales Point – Munmorah Line Flows	Line thermal ratings reached	Generation in the Central Coast	See Section 6.1.5
Voltage Levels in the Yass / Canberra Area	Voltage control	Yass/Canberra area	See Section 6.1.6
Eraring Generation Capacity	Transient Stability	Eraring Power Station	See Section 6.1.7
Supply to Gunnedah, Narrabri and Moree Areas	Thermal Overload	Gunnedah / Moree Area	Summer 2011/12; 11 MW
Reactive Support from Coalfields Generators	Voltage Control	NSW supply overall with the main impact on the Newcastle, Sydney Wollongong load area	Summer and Winter 2011/12; 200 MW
Supply to Beryl	Voltage Control	Beryl	Summer 13/14; 6 MW
Supply to Tumut/Gadara	See Section 6.2.2	See Section 6.2.2	See Section 6.2.2
NSW to Queensland Transmission Capacity	See Section 6.2.3	See Section 6.2.3	See Section 6.2.3

6.4.2. Intent to Issue Request for Proposal

The required indication of TransGrid's intent to issue an RfP for non-network services is indicated in the Table 6.9 below.

Table 6.9 – Anticipated issue of an RfP for Non-Network Services

Anticipated Proposal or Limitation	Intend to Issue RfP	Date
Supply to Southern Sydney	Yes	To be assessed
Capacity of the Snowy to Yass/Canberra 330 kV System	Yes	To be assessed
Supply to Forster/Tuncurry Area	No	
Supply to Kew, Laurieton and Lake Cathie Areas	No	
Vales Point – Munmorah Line Flows	No	
Voltage Levels in the Yass/Canberra Area	No	
Eraring Generation Capacity	No	
Supply to Gunnedah, Narrabri and Moree Areas	Yes	2011
Murraylink Runback	No	
Kangaroo Valley Overvoltage Controls	To be assessed	
Kangaroo Valley Auxiliary Supply	To be assessed	
Smart Grid Projects	No	
Supply to Beryl	To be assessed	
Supply to Tumut/Gadara	To be assessed	
NSW to Queensland Transmission Capacity	To be assessed	To be assessed
System Reactive Plant Requirements	To be assessed	To be assessed
Further Development of Supply to the Newcastle – Sydney – Wollongong Area	Yes	To be assessed

Chapter 7

Other Planning Issues in NSW

Other Planning Issues in NSW

7.1 Sustainability

7.1.1. Consideration of Non-Network Options by TransGrid

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

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

TransGrid considers DM, local/embedded generation and bundled options on an equal footing with network options when planning its network augmentations and applying the AER's regulatory test and the Regulatory Investment Test for Transmission (RIT-T).

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 (and now the RIT-T). It must also have a proponent who is committed to implement the option and accept the associated risks, responsibilities and accountabilities.

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

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

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

7.1.1.1. Demand Management or Demand Side Response

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

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

7.1.1.2. Embedded or Local Generation

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

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

7.1.1.3. Promotion of DM and Local Generation Alternatives by TransGrid

TransGrid actively promotes DM and local generation alternatives through:

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

7.1.2. Recent Non-Network Projects

During 2010/11, TransGrid issued requests for proposals RfP seeking network support for three regions (load areas) of NSW:

1. Network support to allow deferral by one or two years (2013/14 and 2014/15) of a major transmission project in the Sydney metropolitan area. Responses received did not provide sufficient capacity for deferral. Hence, TransGrid has contracted 20 MW of network support from non-network sources for operational risk mitigation for the Sydney Inner Metropolitan load area at times of peak demand during summer 2012/13. TransGrid is seeking further network support in the area to make the total network support up to 40 MW.
2. Network support for the Far North Coast of NSW at times of peak demand covering summers 2012/13, 2013/14 and possibly 2014/15 was issued in 2010. The process resulted in some capacity of support being offered. Discussions with potential service providers are continuing.
3. Network support for the Mid-North coast of NSW at times of peak demand was issued in late 2010 and closed in mid April 2011. Network support was sought for summers 2016/17, 2017/18 and 2018/19. Evaluation of the responses is in progress.

7.1.3. Future DM and other Non-Network Projects

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

- TransGrid has signed agreements with the NSW and ACT distributors to cooperate on demand management innovation projects. Joint projects include initiatives to reduce peak demand, to educate consumers how to use energy wisely and some research and development projects. TransGrid is also discussing with the Melbourne RMIT University a cooperation program that would examine consumer behaviour and energy usage patterns.

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

- Provision of reactive power for main system network support which may come from non-network sources;
- Provision of network support, possibly from non-network sources, to improve the power transfer capability between Snowy and Yass/Canberra. This may include implementation of a special system protection scheme; and
- Provision of Network Support and Control Ancillary Service (NSCAS). On 7 April 2011, the AEMC published a Rule Change relating to NSCAS. According to the new Rule, TNSPs are now responsible for the planning and procurement of NSCAS in their jurisdiction. Part of this NSCAS may come from non-network sources.

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

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

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

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

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

7.1.5. Gas, Wind and Solar Generation

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

Since 2008, TransGrid has successfully been involved in connecting the following new generation:

- Uranquinty Gas Fired Power Station, 664 MW;
- Colongra Gas Fired Power Station, 667 MW;
- Capital Wind Farm, 141 MW; and
- Woodlawn Wind Farm, 48 MW.

In addition to these new connections, TransGrid has also worked with the NSW Distributors to coordinate and assist with the connection of new generating systems of various technologies and scale. This includes the Tallawarra gas fired power station embedded in Endeavour Energy's 132 kV network and the Cullerin Range Wind Farm, the Gunning Wind Farm and the Jounama Hydro Power Station embedded in Essential Energy's distribution network.

During the 2011/12 financial year, an increased level of connection activity is expected to emerge once policies and funding impacts on the energy sector are finalised.

An area of particular interest will be the funding allocation as a result of the Federal Government's Solar Flagships Program. If projects within NSW proceed then additional connection activity would result.

TransGrid is neither a proponent nor a builder of generating plant but is committed to assisting and promoting the connection of new generation to its network. The expected increasing level of interest in grid connections, particularly for gas, wind and solar generation creates challenges in meeting the expectations of intending generators. The timely resolution of connection arrangements is an important component of the overall generation development process.

A key challenge for TransGrid in meeting these expectations is to reconcile the impact of intending generators technical performance with TransGrid's performance obligations to existing generators and consumers.

Under the NER, transmission services associated with connecting new generators to TransGrid's existing network are usually classified as 'Negotiated Transmission Service' and are subject to TransGrid's negotiating framework, which has been 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.

7.1.6. Industrial Loads

In parallel with the activity of new generation in NSW, in 2010/11 there has been an increase in demand for network services to supply energy to new industrial and mining operations across the state.

Mining activities predominately emerge in rural parts of the state and the existing electricity transmission infrastructure is likely to require augmentation and extension to both connect and support the load increase. In some cases special protection schemes or control systems are installed to enable opportunity supply to be provided in advance of the network augmentation.

7.1.7. The Impact of Climate Change Policies on NSW Transmission

The Renewable Energy Target (RET) scheme and the Federal Government's proposed emissions control schemes currently being debated are factors which could promote increased wind and other renewable generation development activity in NSW.

There have been recent changes to the RET scheme to introduce small and large scale certificates.

There is a large amount of wind generation resource in NSW near existing transmission lines. Generation development connections that do not require the construction of new major transmission links can be developed relatively quickly.

Appendices

Appendix 1 – TransGrid's Network Planning Approach

A1.1 General

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

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

The NSW Government has specified the Transmission Network Design and Reliability Standard to be applied by TransGrid.

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 or Regulatory Investment Test – Transmission (RIT-T) as appropriate, 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 or RIT-T. It includes consideration of non-network options such as demand side response and DM and/or embedded generation, as an integral part of the planning process. Joint planning with DNSPs, directly supplied industrial customers, generators and interstate TNSPs is carried out to ensure that the most economic options, whether network options or non-network options, consistent with customer and community requirements are identified and implemented.

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

A1.1.1. Jurisdictional Planning Requirements

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

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

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

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

The NSW Government requires TransGrid to provide a commensurate level of reliability in its network supplying NSW DNSPs.

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 and social objectives 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.

A1.1.2. National Planning Requirements

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

A1.1.3. The Network Planning Process

The network planning process is undertaken at five levels:

1. Connection Planning

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

2. Network Planning within the NSW Region

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

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

3. Inter-regional Planning

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

4. Consideration of Non-Network Alternatives

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

5. Compliance with NER Requirements

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

A1.1.4. Planning Horizons and Reporting

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

In this APR 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.

A1.1.5. Identifying Network Constraints and Assessing Possible Solutions

An emerging constraint is 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 or RIT-T. In applying the applicable 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;
- More efficient generation and fuel type alternatives;
- 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 or RIT-T, 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.

A1.1.6. Application of Power System Controls and Technology

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

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

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

A1.2 Planning Criteria

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

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

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

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

A1.2.1. Main Transmission Network

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

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

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

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

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

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

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

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

The main 500 kV, 330 kV and 220 kV transmission system is augmented in response to the overall load growth and generation requirements and may be influenced by interstate interconnection power transfers. Any developments include negotiation with affected NSW and interstate parties including AEMO to maintain power flows within the capability of the NSW and other regional networks.

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

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

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

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

The system will be able to withstand a single contingency under all reasonably probable patterns of generation dispatch or interconnection power flow. In this context a single contingency is defined as the forced outage of a single transmission circuit, a single generating unit, a single transformer, a single item of reactive plant or a single busbar section.

Provision will be made for a prior outage (following failure) of a single item of reactive plant.

Further the system will be able to be secured by re-dispatching generation (AEMO action), without the need for pre-emptive load shedding, so as to withstand the impact of a second contingency.

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

The system will be able to withstand a single contingency under a limited set of patterns of generation dispatch or interconnection power flow.

Further the system will be able to be secured by re-dispatching generation (AEMO action), without the need for pre-emptive load shedding, so as to withstand the impact of a second contingency.

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

The probable patterns of generation applied to the 50% probability of exceedence load level cover patterns that are expected to have a relatively high probability of occurrence, based on the historical performance of the NEM and modelling of the NEM generation sources into the future. The limited set of patterns of generation applied to the 10% probability of exceedence load level cover two major power flow characteristics that occur in NSW. The first power flow characteristic involves high output from base-load generation sources throughout NSW and high import to NSW from Queensland. The second power flow characteristic involves high import to NSW from Victoria and southern NSW generation coupled with high output from the NSW base-load generators.

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

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

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

The analysis of network adequacy must take into account the probable load patterns, typical dispatch of generators and loads, the availability characteristics of generators (as influenced by maintenance and forced outages), energy limitations and other factors relevant to each case.

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

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

A1.2.2. 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 RIT-T.

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

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

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

The development of interconnectors between regions will be undertaken where the augmentation satisfies the RIT-T. 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 RIT-T.

A1.2.3. Networks Supplied from the Main Transmission Network

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

A1.2.4. 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.

A1.2.5. 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 Ausgrid'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 Ausgrid 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 short term following a simultaneous outage of a single 330 kV cable and any 132 kV transmission feeder or 330/132 kV transformer in the inner metropolitan area until corrective switching is carried out on the 330 kV or 132 kV systems;
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.

A1.2.6. 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 Essential Energy provides fully duplicated supply ('n-1' reliability) to a load area of 15 MW or more 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.

A1.2.7. 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.

A1.2.8. Consideration of Low Probability Events

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

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

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

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

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

A1.3 Protection Requirements

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

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

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

A1.4 Transient Stability

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

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

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

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

A1.5 Steady State Stability

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

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

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

A1.6 Line and Equipment Thermal Ratings

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

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

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

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

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

A1.7 Reactive Support and Voltage Stability

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

A1.9 Short-circuit Rating Requirements

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

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

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

Short circuit duty calculations are based on the following assumptions:

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

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

A1.10 Substation Switching Arrangements

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

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

TransGrid has applied the following arrangements in the past:

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

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

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

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

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

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

A1.11 Autoreclosure

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

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

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

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

A1.12 Power System Control and Communication

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

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

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

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

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

A1.13 Scenario Planning

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

1. Identification of possible future load growth scenarios. These are developed based on a subset of the economic growth scenarios proposed by AEMO for informing the analysis of the next NTNDP. TransGrid uses the key data for each scenario to prepare load forecasts for NSW. These are published in the APR and by AEMO in the forthcoming Electricity Statement of Opportunities. The forecast 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 and generation scenarios to quantify factors which affect network performance, including:
   - Generation from individual power stations; and
   - Interconnector flows.
4. Modelling of network performance for the load and generation scenarios utilising the data from the market modelling.

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

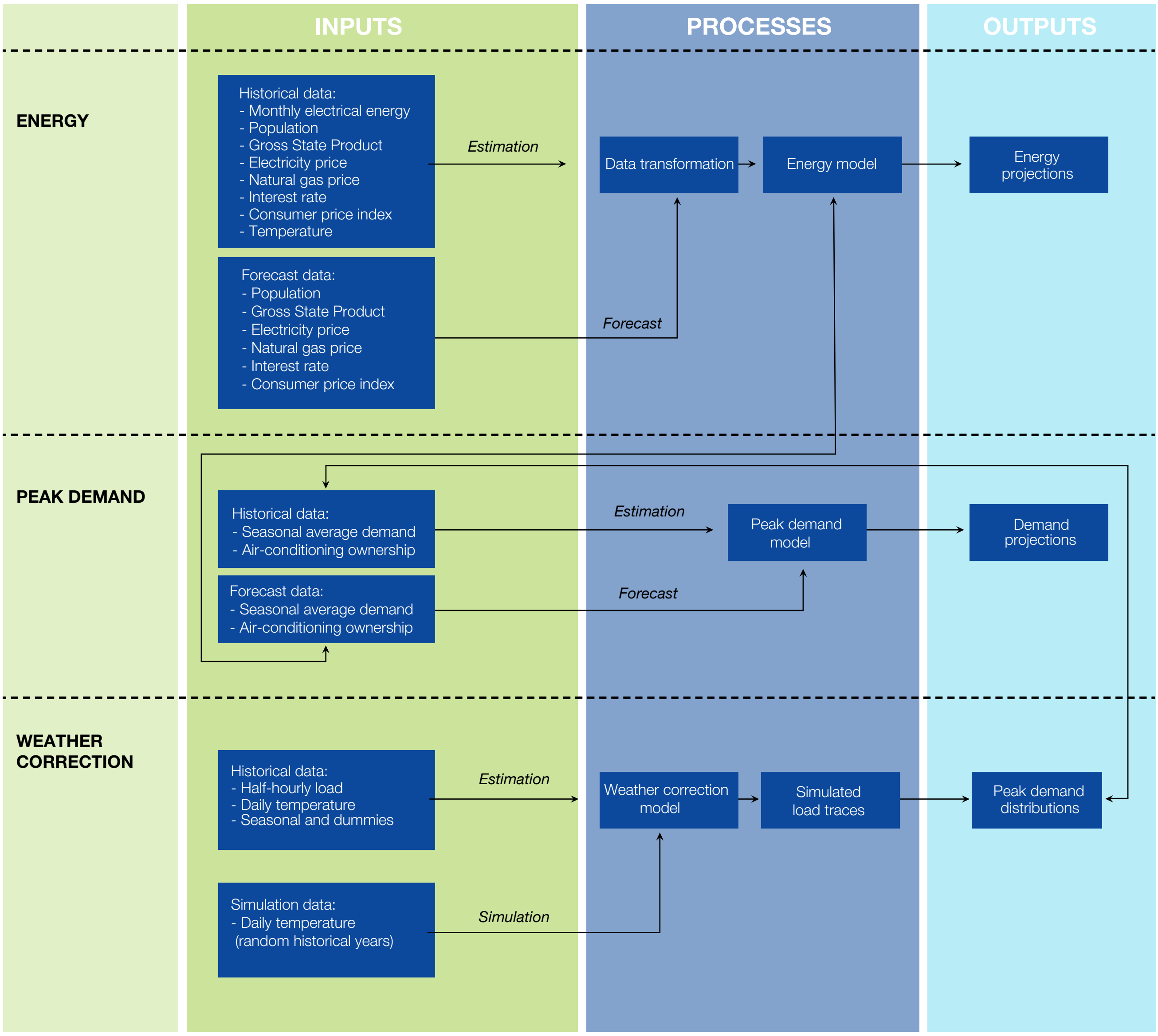
The future planning scenarios developed by TransGrid will take into account AEMO's future scenarios from the NTNDP.

Appendix 2 – TransGrid's Load Forecasting Process

A2.1 Overview

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

Figure A2.1 – TransGrid's Load Forecasting Models



The Load Forecasting Reference Group (LFRG) ensures that the regional energy and maximum demand projections throughout the NEM are developed by JPBs for inclusion in the Electricity Statement of Opportunities (ESOO) on a consistent basis, 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 forecasting models. Future economic scenarios in these models are based on the information provided by the LFRG as well as those provided by KPMG (independently engaged by TransGrid). Apart from these, assumptions on the future with regard to other independent variables are then applied to the models to produce the NSW energy and demand projections.

Several statistical models have been developed by TransGrid:

- The energy model relates electrical energy to demographic, economic, weather and day type variables.
- The weather and day type correction model conducts analysis on historical demands, day types and weather conditions to determine probability distributions of summer and winter demands for each year. The 10th, 50th and 90th percentiles of each distribution are selected to create historical series of 90%, 50% and 10% Probability of Exceedence (POE) 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 Ausgrid, Endeavour Energy, Essential Energy[1] and ActewAGL for their respective distribution network areas across the NSW region of the NEM. These projections, which represent approximate 50th percentile POE demands, are aggregated by TransGrid incorporating appropriate allowances for network losses and the time diversity of peak demands throughout the NSW region. These aggregates are then compared to the top-down modelled demands for the NSW region produced by TransGrid.

A2.2 Input Assumptions

Information available up to the end of March 2011 was used to prepare the energy and demand projections published in this APR.

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

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

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

KPMG Econtech, commissioned by AEMO, supplied projections of Semi-Scheduled and Significant Non-Scheduled generation as well as economic and demographic assumptions for Scenarios C, A and E (as outlined in Section 4.2 in Chapter 4) for each region of the NEM. TransGrid independently commissioned KPMG to provide economic scenarios pertaining to Scenarios B and D. All the five scenarios for NSW Region are shown in Table A2.1 on the next page.

Historical information regarding 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.

[1] Ausgrid was previously called Energy Australia, Endeavour Energy was Integral Energy and Essential Energy was Country Energy respectively.

Table A2.1 – Economic Scenarios Underlying the 2011 Energy and Demand Projections

	Population (in '000 persons)	Gross State Product (2008-09 $m)	Consumer price index (index)	Nominal electricity prices (c/kwh)			Nominal gas price (index)	Standard variable home loan rate (%)
				Residential	Business	Total		
Historical Data								
2007-08	7,332	416,075	160.9	16.9	7.8	10.4	219.7	8.1
2008-09	7,451	420,729	166.0	18.4	7.4	10.2	233.2	9.5
2009-10	7,545	428,579	169.8	22.2	8.4	12.7	250.3	5.8
Scenario C								
2010-11	7,639	438,142	173.7	23.9	8.4	13.9	258.6	7.4
2011-12	7,720	450,442	177.2	25.1	8.4	14.3	276.6	7.2
2012-13	7,800	461,170	180.4	26.0	8.4	14.6	286.2	6.6
2013-14	7,878	473,568	184.3	27.2	8.6	15.1	294.4	6.2
2014-15	7,956	486,616	188.7	28.9	9.2	16.1	306.1	6.2
2015-16	8,032	496,882	193.2	29.3	9.4	16.4	316.5	6.4
2016-17	8,107	506,802	197.0	29.6	9.6	16.6	326.3	6.5
2017-18	8,181	517,555	201.0	29.9	9.9	16.9	336.7	6.7
2018-19	8,253	529,155	205.1	30.3	10.1	17.2	348.0	6.8
2019-20	8,325	541,993	209.1	30.7	10.4	17.5	359.1	7.0
2020-21	8,396	556,228	212.9	31.1	10.7	17.9	369.7	7.1
Scenario B								
2010-11	7,648	441,425	173.6	24.0	8.4	13.9	258.3	7.4
2011-12	7,739	457,959	177.0	25.4	8.4	14.4	276.8	7.3
2012-13	7,832	473,160	180.8	26.4	8.4	14.7	288.7	6.9
2013-14	7,926	487,630	185.1	27.6	8.6	15.3	299.5	6.6
2014-15	8,021	501,145	188.9	29.1	8.9	16.0	309.6	6.5
2015-16	8,117	513,020	191.9	29.5	9.0	16.2	315.3	6.4
2016-17	8,212	525,910	193.6	29.9	9.0	16.3	317.2	6.3
2017-18	8,308	541,452	195.5	30.2	9.0	16.5	318.9	6.3
2018-19	8,404	558,801	198.0	30.5	9.2	16.7	323.1	6.4
2019-20	8,500	577,562	201.1	30.7	9.4	16.9	330.5	6.5
2020-21	8,596	596,789	204.3	30.9	9.6	17.1	339.7	6.5
Scenario D								
2010-11	7,629	434,234	173.5	24.0	8.4	13.9	258.2	7.4
2011-12	7,699	442,175	176.7	25.5	8.4	14.4	275.9	7.1
2012-13	7,765	451,976	179.5	26.6	8.4	14.8	284.8	6.5
2013-14	7,824	462,062	183.4	27.9	8.6	15.4	293.8	6.1
2014-15	7,882	473,945	189.4	30.5	9.3	16.8	313.0	6.1
2015-16	7,938	483,037	196.5	30.9	9.6	17.0	334.4	6.3
2016-17	7,991	490,140	204.5	31.2	9.9	17.4	360.1	6.7
2017-18	8,042	495,146	213.7	31.5	10.3	17.8	389.9	7.1
2018-19	8,091	498,123	222.8	32.0	10.8	18.2	419.8	7.4
2019-20	8,139	500,680	230.3	32.6	11.2	18.7	442.4	7.4
2020-21	8,187	504,642	234.9	33.3	11.5	19.2	452.6	7.3

Table A2.1 (Cont'd) – Economic Scenarios Underlying the 2011 Energy and Demand Projections

	Population (in '000 persons)	Gross State Product (2008-09 $m)	Consumer price index (index)	Nominal electricity prices (c/kwh)			Nominal gas price (index)	Standard variable home loan rate (%)
				Residential	Business	Total		
Scenario A								
2010-11	7,648	438,388	173.6	23.9	8.4	13.9	258.2	7.4
2011-12	7,739	453,021	177.0	25.1	8.4	14.3	275.6	7.3
2012-13	7,832	464,030	180.8	26.0	8.4	14.6	287.2	7.0
2013-14	7,926	476,258	185.0	27.2	8.6	15.1	298.0	6.6
2014-15	8,021	488,986	188.9	29.7	9.3	16.4	310.7	6.3
2015-16	8,117	500,608	191.9	30.2	9.3	16.7	316.7	6.0
2016-17	8,212	513,206	193.6	30.6	9.4	16.8	318.8	5.7
2017-18	8,308	528,398	195.6	30.9	9.4	17.0	320.7	5.5
2018-19	8,404	545,310	198.1	31.3	9.6	17.2	325.2	5.6
2019-20	8,500	563,557	201.2	31.5	9.8	17.4	332.9	5.8
2020-21	8,596	582,241	204.5	31.8	10.1	17.7	342.6	6.0
Scenario E								
2010-11	7,629	437,261	173.5	23.9	8.4	13.9	258.1	7.4
2011-12	7,699	447,066	176.7	25.1	8.4	14.3	274.8	7.1
2012-13	7,765	457,985	179.5	26.0	8.4	14.6	282.4	6.6
2013-14	7,824	471,393	183.4	27.1	8.7	15.1	289.9	6.3
2014-15	7,882	484,767	189.4	28.3	9.3	15.9	304.7	6.6
2015-16	7,938	494,320	196.5	28.5	9.7	16.3	324.2	7.2
2016-17	7,991	501,707	204.3	28.7	10.2	16.7	348.9	7.8
2017-18	8,042	506,986	213.3	29.1	10.7	17.2	379.0	8.4
2018-19	8,091	510,319	222.2	29.7	11.2	17.7	410.5	8.6
2019-20	8,139	513,338	229.3	30.4	11.6	18.2	435.7	8.5
2020-21	8,187	517,845	233.7	31.3	11.7	18.6	448.6	8.1

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 and sourced from KPMG.
4. Nominal electricity and gas prices are from ESAA, "Electricity prices in Australia", ABS, KPMG and AER.
5. Standard variable home loan interest rate is sourced from the RBA website and KPMG forecasts

A2.3 Energy Model

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

TransGrid's empirical energy model 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. The model has been re-estimated using up to date data and has undergone rigorous testing before the 2011 projections were finalised.

The model explains monthly 'Native'[7] energy per capita in NSW, net of major industrial loads, in terms of the real electricity price, the real price of natural gas from when it became available, real income per capita, the real interest rate and cooling and heating degree days. The projections are therefore dependent on assumptions about future values of these explanatory variables or their components, including resident population, real gross State product, nominal price and interest rate trajectories, air-conditioning ownership and inflation. The model results have been adjusted ex-post to allow for the phasing out of greenhouse intensive water heaters, introduction of NSW Energy Savings Scheme and phasing out of incandescent light bulbs. Additional allowances have been incorporated for the operation of NSW desalination plant.

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

Table A2.2 – NSW Energy Model Variables

Variable	Type
Per Capita Native Energy Consumption minus directly connected industrial load	Dependent
Estimated resident population of NSW and the ACT	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	0.949	Mean dependent variable	0.0005
Adjusted R-squared	0.945	S.D. dependent variable	0.044
S.E. of regression	0.010	Akaike info criterion	-6.245
Sum squared residual	0.041	Schwarz criterion	-5.922
Log likelihood	1370.452	F-statistic	221.963
Durbin-Watson statistic	1.44	Prob (F-statistic)	0.00

[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 standard weather and day type conditions as the historical data upon which they are based. Given the impossibility of forecasting daily weather conditions several years into the future, projected future demands are more useful to planners when they are referenced to standard conditions. In the NEM, regional demand projections are presented on a probabilistic basis. That is, the standard conditions underlying the weather and day type correction process are defined on the basis of specific probabilities of the demands occurring under such conditions. This allows regional demand projections to be provided on the basis of 10 percent, 50 percent and 90 percent 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 2011 demand projections used daily maximum demands between November 1991 and March 2011.

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 NSW and the ACT	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	0.949	Mean dependent variable	1.191
Adjusted R-squared	0.948	S.D. dependent variable	0.177
S.E. of regression	0.040	Akaike info criterion	-3.590
Sum squared residual	10.63	Schwarz criterion	-3.542
Log likelihood	12023.94	Hannan-Quinn criterion	-3.573
F-statistic	2688.806	Durbin-Watson statistic	2.01
Prob (F-statistic)	0.00		

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

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

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

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

A2.5 Determination of Historical POE Levels

After applying the weather and day type correction model a probabilistic determination of historical POE levels was made. Fifty two different weather scenarios were created using actual weather data from 1959 to 2011 and applied to the period under analysis (1991 to 2011). Using errors from the weather normalisation equation, multiple alternative simulated error patterns were created and applied to each of the weather scenarios resulting in a series of alternative load profiles. Peak summer and winter demands were extracted from the simulations from which the required POE levels were calculated.

The 2011 weather and day type corrected peak demands are compared with actual peak demands in Figures A2.2 and A2.3. After a couple of mild summers, the daily actual summer peak demands were relatively high especially during the first week of February 2011. The actual seasonal 2010-11 summer peak demand was at a 20% POE level (exceeded in 20 out every 100 simulations). The actual winter 2010 peak demand was marginally higher than last year. It was around the 95% POE level (exceeded in 95 out of every 100 simulations).

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

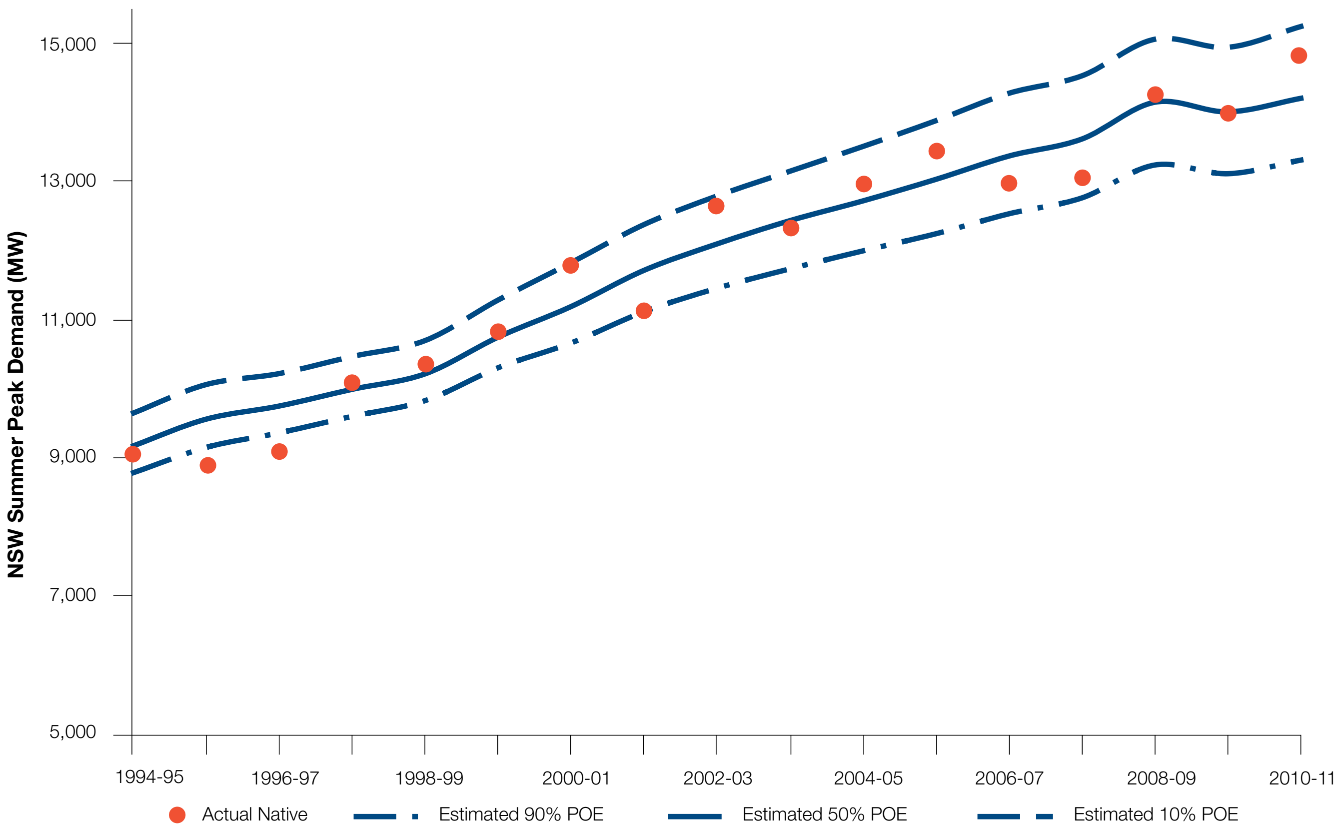
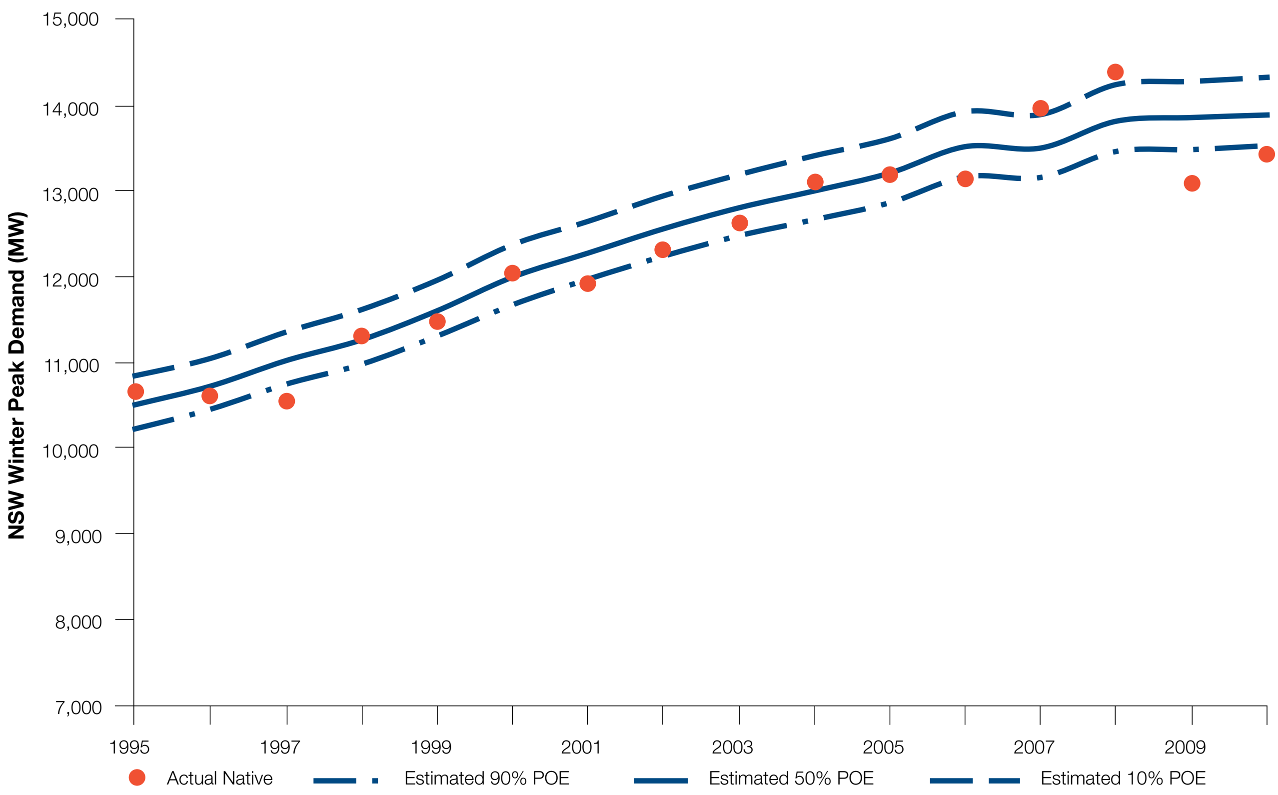


Figure A2.3 – Historical Winter Peak Demand and Estimated Historical 10%, 50% and 90% POE Winter Demand



A2.6 Demand Models

Models of peak demand for summer and winter were estimated using each respective 10%, 50% and 90% 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 results from the modelling have been adjusted ex-post to allow for the phasing out of greenhouse intensive water heaters, introduction of NSW Energy Savings Scheme and phasing out of incandescent light bulbs. Additional allowances have been incorporated for the operation of NSW desalination plant.

The main characteristics of the 2011 summer 10% POE peak demand model are shown in Table A2.7 (variables) and Table A2.8 (summary Statistics).

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

Table A2.7 – 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	10477
Adjusted R-squared	0.995	S.D. dependent variable	2263.9
S.E. of regression	154	Akaike info criterion	13.04
Sum squared residual	453471	Schwarz criterion	13.19
Log likelihood	-140	Hannan-Quinn criterion	13.07
F-statistic	2245	Durbin-Watson statistic	1.9
Prob (F-statistic)	0.00		

A2.7 Out-of-sample Forecasting Performance

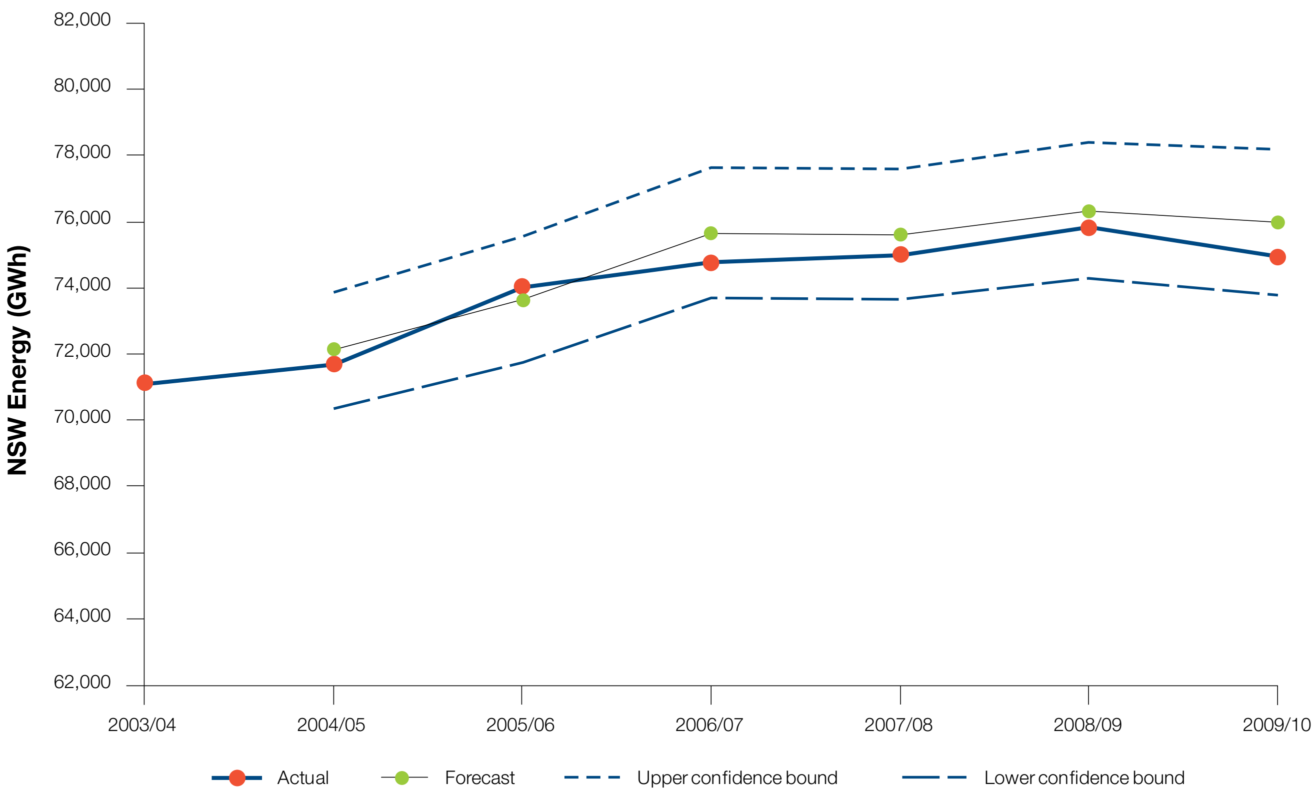
Energy Model

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

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

Performance Indicator	Value
Forecast Identifier	ESO
Forecast sample	2004-05 to 2009-10
Included observations	6
Root Mean Squared Error	695
Root Mean Squared Percentage Error	0.93
Mean Absolute Error	648
Mean Absolute Percentage Error	0.87
Theil Inequality Coefficient	0.005
Bias Proportion	0.572
Variance Proportion	0.086
Covariance proportion	0.342

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



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.

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

Performance Indicator	Value
Forecast Identifier	PD(SUMMER)
Forecast sample	2005-06 to 2010-11
Included observations	6
Root Mean Squared Error	218
Root Mean Squared Percentage Error	1.58
Mean Absolute Error	205
Mean Absolute Percentage Error	1.49
Theil Inequality Coefficient	0.008
Bias Proportion	0.649
Variance Proportion	0.000
Covariance proportion	0.351

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

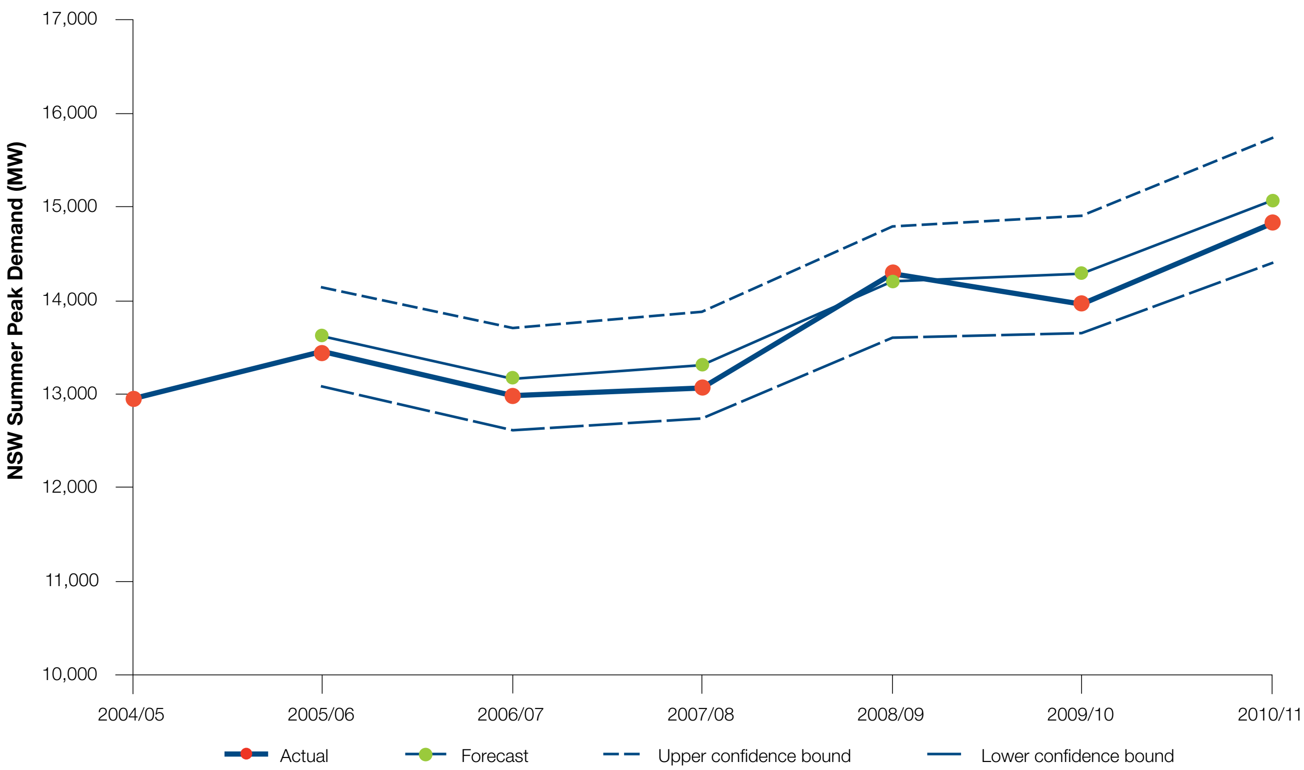


Figure A2.6 – NSW Winter Demand Model Out-of-sample Forecast Performance

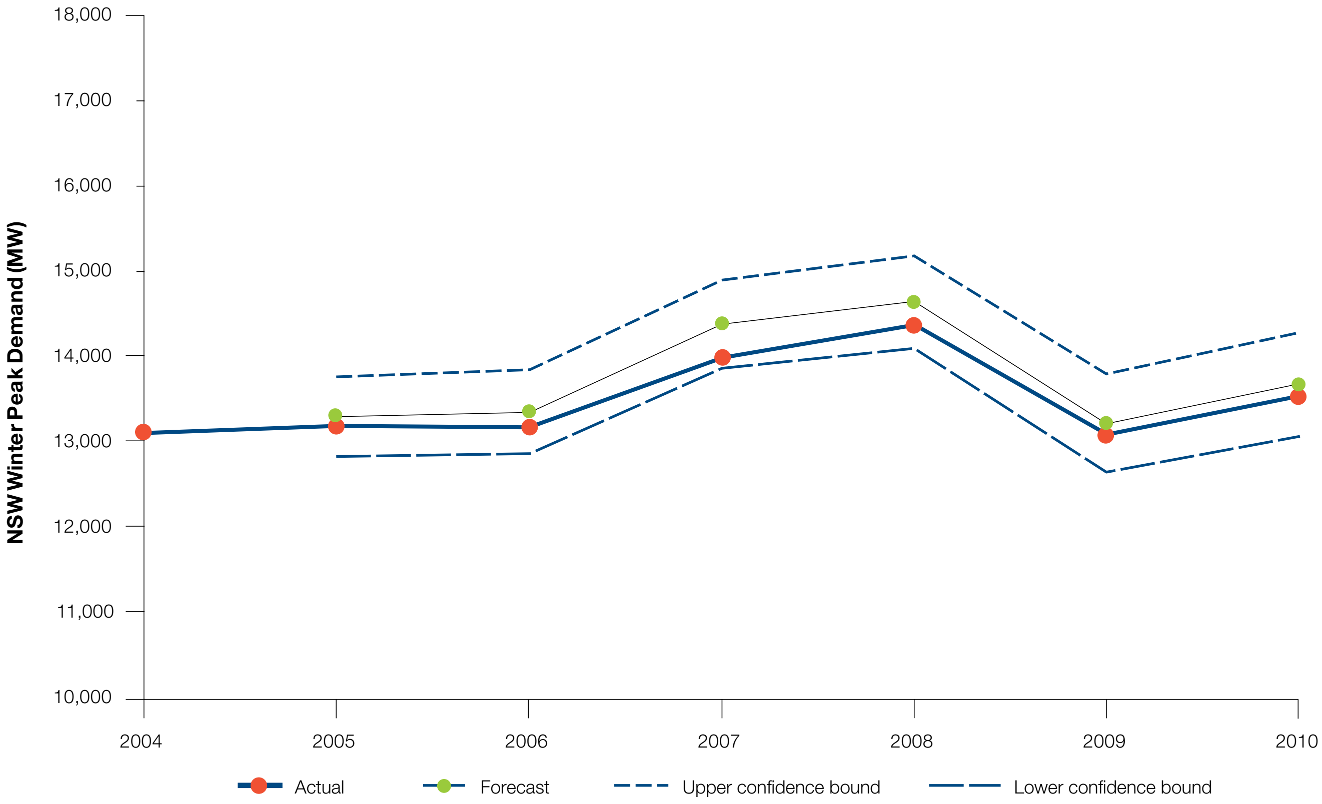


Table A2.11 – NSW Winter Demand Model Out-of-sample Forecast Performance Statistics

Performance Indicator	Value
Forecast Identifier	PD(WINTER)
Forecast sample	2005 to 2010
Included observations	6
Root Mean Squared Error	234
Root Mean Squared Percentage Error	1.72
Mean Absolute Error	211
Mean Absolute Percentage Error	1.54
Theil Inequality Coefficient	0.009
Bias Proportion	0.817
Variance Proportion	0.114
Covariance proportion	0.069

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

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

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

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

TransGrid therefore attempts to account for some of the aforementioned limitations by:

- Using 50% POE forecasts where they are available and where they are not, assuming that individual connection point projections are likely to have been based on enough historical data to converge towards an approximate 50% 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% POE and 50% POE (Scenario C) projections of summer and winter peak demand are compared to the aggregate DNSP (connection point) projections.

For the purpose of these comparisons diversity factors have been derived based on historical loads. This allows aggregated connection point peak demand projections to be adjusted to provide a comparison with the NSW region peak demand. Loss factors are estimated by comparing historical NSW regional peak demands against an aggregation of connection point loads that occurred at the same time.

Figure A2.7 shows the NSW Summer DNSP projection, aggregated as described above, and TransGrid's 10% and 50% POE projections. The chart shows the aggregate DNSP projections lie within the TransGrid's 10% and 50% POE forecast trajectories. The DNSP projections grow at a slightly higher rate in the initial years of the forecast period but align with TransGrid's 50% POE level at the end of the forecast period. 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 A2.7 – TransGrid and Aggregate DNSP Projections of NSW Summer Peak Demand

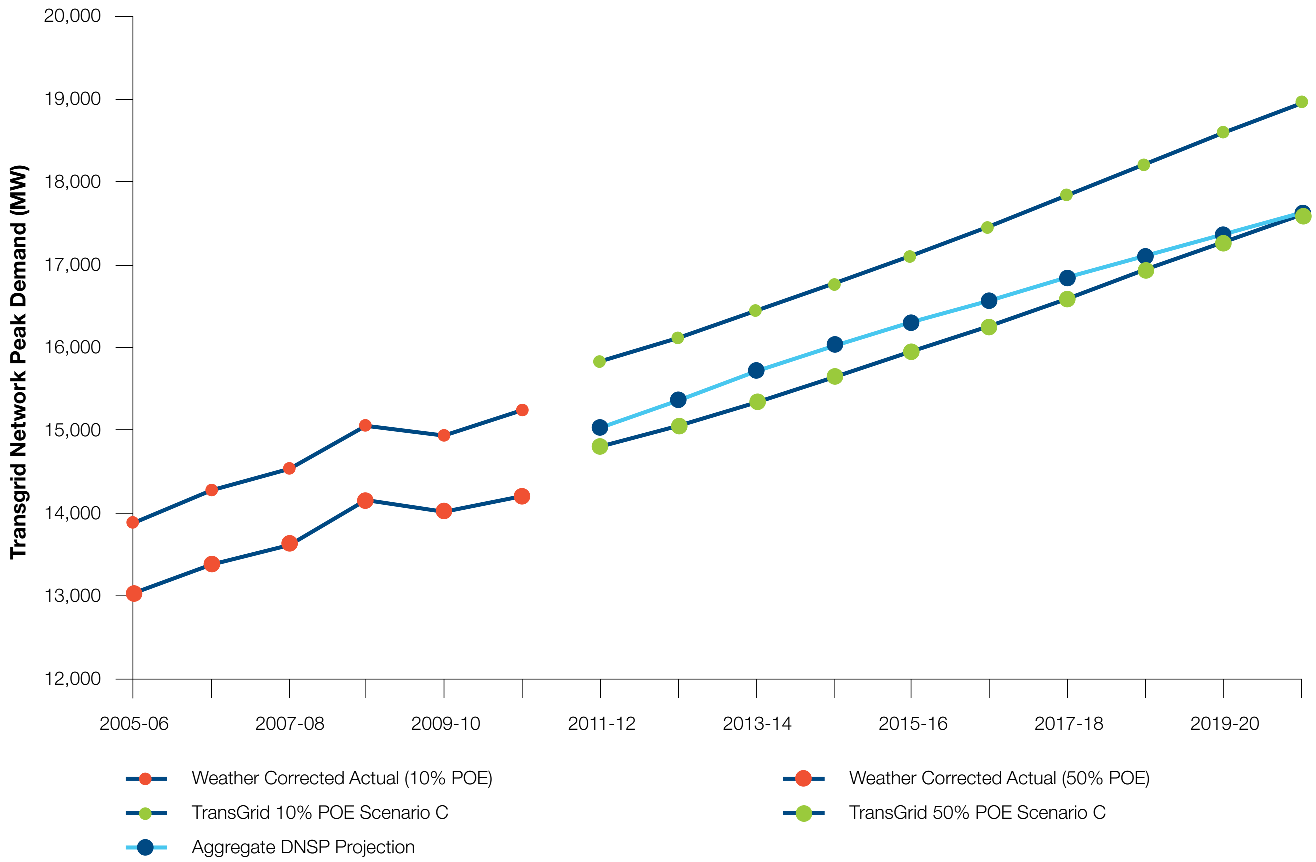


Figure A2.8 – TransGrid and Aggregate DNSP Projections of NSW Winter Peak Demand

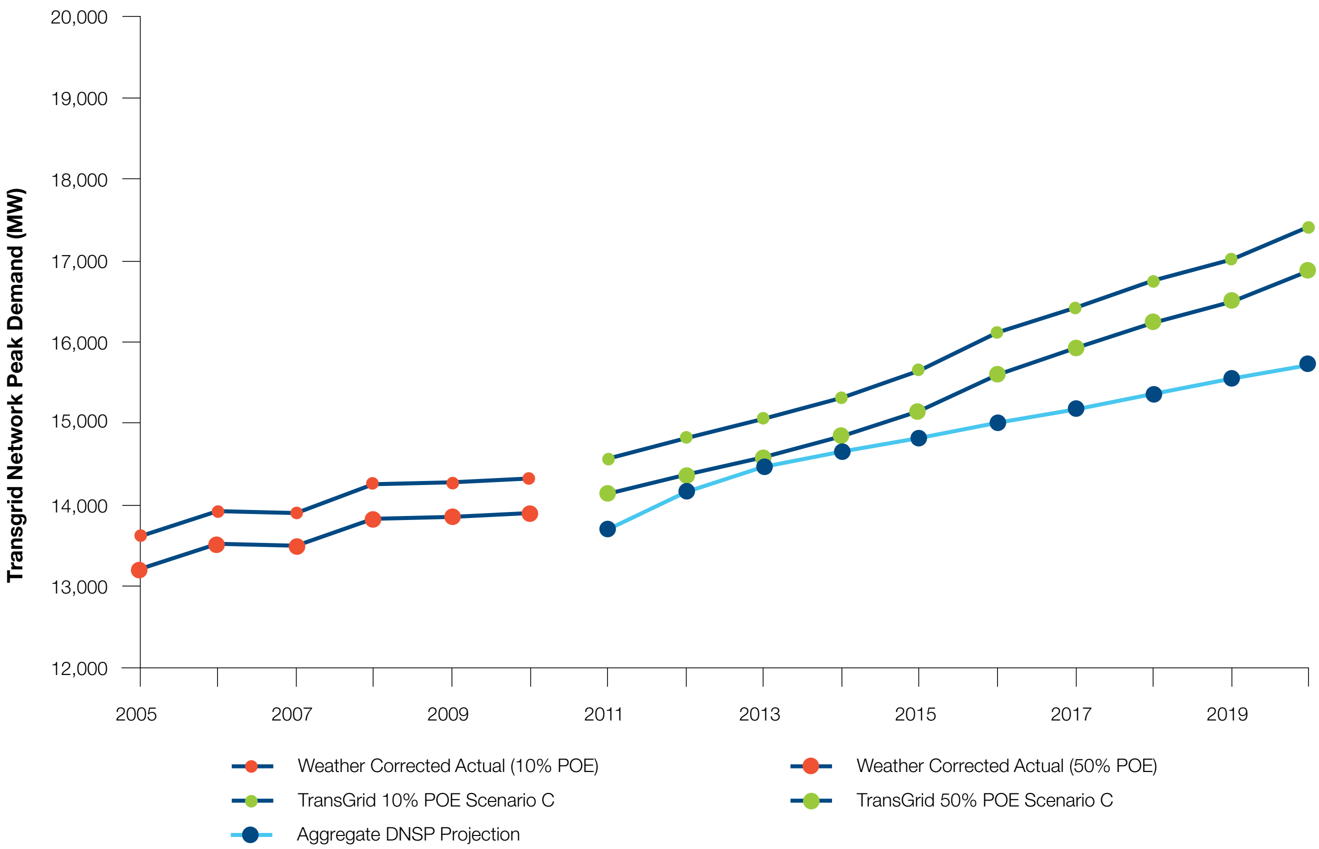


Figure A2.8 shows the NSW Winter DNSP projection, aggregated as described above, and TransGrid's 10% and 50% POE projections. The chart shows the aggregate DNSP projection lying below TransGrid's 50% POE forecast path. The differences as mentioned above stem from a divergence in approaches between TransGrid's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

Table A2.12 presents the average annual growth rates for the summer and winter peak demand projections. The growth rates for the top down 50% POE forecasts developed by TransGrid are close to that of the aggregate DNSP 50% POE for summer. However corresponding growth rates for TransGrid are higher for winter as compared to the aggregate DNSP projection. The differences are due to a variance in economic assumptions adopted by TransGrid compared to those of the individual DNSPs.

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	290	1.8%	311	1.9%	348	2.0%
Winter	225	1.5%	305	2.0%	316	2.0%

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 NSW and the ACT. These projections result from the process outlined in Appendix 2. Projections pertaining to Scenario C are detailed in Tables A3.1 to A3.3 of this appendix.

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

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

+ Embedded Scheduled and Non-Scheduled generation

Where 1.03 is a distribution loss factor.

Tables A3.2 and A3.3 provide summer and winter maximum demand projections for the Scenario C.

Tables A3.4 and A3.5 provide the scenarios of the NSW Region Semi-scheduled and Non-scheduled generation – historical and projected capacity, Demand at time of NSW Region peak and Energy corresponding to Scenarios A/B (High Growth) and Scenarios D/E (Low growth). The medium growth scenario (Scenario C) of these tables is presented in Chapter 4.

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

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

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

Table A3.1 – NSW Region Energy Projections (Scenario C)

Financial year		As generated at power stations (GWh)	Excluding power station auxilliaries (GWh)	Excluding transmission losses (GWh)	End-use sales (GWh)
2000-01	actual	69,529	66,283	63,352	61,761
2001-02	actual	70,541	67,331	63,587	62,162
2002-03	actual	72,269	68,931	65,424	63,781
2003-04	actual	74,599	71,127	67,514	65,204
2004-05	actual	75,428	71,727	68,012	67,199
2005-06	actual	77,929	74,041	70,607	68,910
2006-07	actual	79,130	74,790	71,744	70,710
2007-08	actual	79,447	74,992	71,942	70,910
2008-09	actual	80,075	75,857	73,216	72,160
2009-10	actual	79,509	74,955	72,647	71,620
2010-11	estimated	78,816	74,902	71,824	70,828
2011-12	projection	79,890	75,735	73,201	72,167
2012-13	projection	81,762	77,527	75,027	73,966
2013-14	projection	82,597	78,301	75,866	74,797
2014-15	projection	83,597	79,212	76,816	75,747
2015-16	projection	85,646	81,083	78,697	77,598
2016-17	projection	86,923	82,271	79,875	78,766
2017-18	projection	88,071	83,369	81,013	79,875
2018-19	projection	89,309	84,528	82,221	81,053
2019-20	projection	90,922	86,022	83,805	82,587
2020-21	projection	92,665	87,745	85,616	84,359
2001-02 to 2010-11		1.2%	1.2%	1.4%	1.5%
2011-12 to 2020-21		1.7%	1.6%	1.8%	1.7%

Table A3.2 – NSW Region Summer Demand Projections (Scenario C)

Year	Actual (MW)	90% POE Projection (MW)	50% POE Projection (MW)	10% POE Projection (MW)
2000-01	11,739			
2001-02	11,155			
2002-03	12,621			
2003-04	12,311			
2004-05	12,944			
2005-06	13,461			
2006-07	12,981			
2007-08	13,071			
2008-09	14,287			
2009-10	13,957			
2010-11	14,820			
2011-12		13,827	14,807	15,827
2012-13		14,051	15,061	16,121
2013-14		14,290	15,350	16,440
2014-15		14,551	15,651	16,781
2015-16		14,821	15,951	17,121
2016-17		15,100	16,270	17,470
2017-18		15,387	16,597	17,837
2018-19		15,687	16,937	18,207
2019-20		15,997	17,277	18,587
2020-21		16,300	17,610	18,960
2001-02 to 2010-11	3.2%			
2011-12 to 2020-21		1.8%	1.9%	2.0%

Table A3.3 – NSW Region Winter Demand Projections (Scenario C)

Year	Actual (MW)	90% POE Projection (MW)	50% POE Projection (MW)	10% POE Projection (MW)
2001	11,927			
2002	12,321			
2003	12,641			
2004	13,107			
2005	13,198			
2006	13,166			
2007	13,985			
2008	14,398			
2009	13,090			
2010	13,433			
2011		13,760	14,129	14,568
2012		13,999	14,369	14,818
2013		14,213	14,592	15,051
2014		14,451	14,840	15,309
2015		14,771	15,161	15,640
2016		15,200	15,610	16,109
2017		15,509	15,929	16,428
2018		15,805	16,234	16,753
2019		16,055	16,504	17,023
2020		16,425	16,874	17,413
2021		16,777	17,236	17,785
2002 to 2011	1.5%			
2012 to 2021		2.0%	2.0%	2.0%

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

	Capacity (MW)		Demand at time of NSW summer peak (MW)		Energy (GWh)	
	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled
2007-08	0	577	0	131	0	913
2008-09	0	585	0	186	0	1,192
2009-10	0	806	0	191	0	1,681
2010-11	0	827	0	225	0	1,719
2011-12	624	754	31	375	1,585	1,539
2012-13	1,054	754	53	375	2,678	1,539
2013-14	1,431	762	72	383	3,636	1,556
2014-15	1,842	840	92	460	4,678	1,722
2015-16	2,069	840	103	460	5,256	1,722
2016-17	2,231	840	112	460	5,666	1,722
2017-18	2,231	841	112	461	5,666	1,724
2018-19	2,231	841	112	461	5,666	1,724
2019-20	2,569	851	128	471	6,526	1,746
2020-21	2,569	851	128	471	6,526	1,746

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

	Capacity (MW)		Demand at time of NSW summer peak (MW)		Energy (GWh)	
	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled
2007-08	0	577	0	131	0	913
2008-09	0	585	0	186	0	1,192
2009-10	0	805	0	191	0	1,681
2010-11	0	825	0	225	0	1,711
2011-12	185	734	9	356	471	1,479
2012-13	185	736	9	358	471	1,485
2013-14	517	749	26	370	1,314	1,525
2014-15	824	749	41	370	2,094	1,525
2015-16	1,058	753	53	374	2,687	1,534
2016-17	1,376	800	69	421	3,494	1,632
2017-18	1,533	800	77	421	3,895	1,632
2018-19	1,623	800	81	421	4,124	1,632
2019-20	1,623	800	81	421	4,124	1,633
2020-21	1,623	800	81	421	4,124	1,633

Table A3.6 – Ausgrid Connection Point Summer Peak Demand[9]

	2012		2013		2014		2015		2016		2017		2018		2019		2020		2021	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beaconsfield West	453	114	475	128	455	131	464	134	473	140	484	149	492	157	501	163	509	173	517	179
Rookwood Rd	0	0	0	0	395	116	407	120	414	125	425	133	436	141	445	147	453	156	461	162
Haymarket	552	134	597	156	574	160	585	164	596	171	610	182	620	192	633	201	643	214	657	222
Liddell	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11
Munmorah	182	70	184	61	172	59	177	64	183	70	188	73	192	69	195	73	199	77	202	79
Muswellbrook	246	53	254	65	270	77	273	79	277	81	280	83	284	85	288	88	291	90	295	92
Newcastle	625	154	625	169	643	179	658	189	676	201	653	221	668	237	682	251	700	266	710	269
Sydney East	765	272	772	249	796	260	806	283	817	296	824	298	834	299	844	311	856	325	858	327
Sydney North	1,079	203	1,049	219	924	195	947	203	961	214	977	230	994	246	1,011	259	1,029	280	1,048	293
Sydney South	1,495	284	1,569	334	1,425	315	1,448	324	1,481	343	1,509	369	1,532	394	1,555	413	1,579	445	1,607	464
Tomago	174	33	217	29	223	33	230	37	236	41	264	41	269	44	275	49	284	54	296	56
Tuggerah	255	131	264	158	264	164	269	167	275	174	279	177	283	186	288	192	293	197	297	202
Vales Point	90	10	89	3	100	12	102	14	104	14	107	15	109	11	110	12	112	14	111	13
Waratah West	142	25	132	27	135	28	139	29	142	30	158	29	161	30	165	31	169	33	176	34

Table A3.7 – Ausgrid Connection Point Winter Peak Demand[10]

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beaconsfield West	395	79	410	90	430	92	403	94	408	98	416	104	421	110	427	114	432	121	439	125
Rookwood Rd	0	0	0	0	0	81	340	84	347	88	356	93	361	99	365	103	373	109	376	113
Haymarket	478	94	494	109	531	112	498	115	504	120	516	127	522	135	530	141	537	150	541	155
Liddell	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11
Munmorah	177	49	186	60	175	56	175	52	179	59	184	63	186	64	188	66	189	66	191	66
Muswellbrook	211	34	212	35	213	41	214	43	215	43	216	44	218	45	219	45	221	46	222	47
Newcastle	535	92	553	100	547	110	559	114	567	120	579	126	555	141	563	150	571	159	581	165
Sydney East	820	191	826	175	888	182	867	198	878	207	887	209	896	209	905	218	916	228	927	229
Sydney North	921	142	962	153	916	137	830	142	836	150	842	161	851	172	860	181	869	196	878	205
Sydney South	1,306	195	1,448	230	1,495	216	1,352	223	1,368	236	1,384	254	1,404	272	1,419	285	1,433	308	1,449	321
Tomago	138	5	143	8	179	5	182	8	186	10	190	13	212	11	215	14	218	18	223	21
Tuggerah	252	105	257	108	267	111	258	113	261	114	265	116	267	115	269	117	271	116	274	122
Vales Point	106	12	110	15	126	23	125	22	127	23	130	25	132	26	134	28	136	29	138	30
Waratah West	122	25	125	25	116	26	118	27	120	27	122	27	135	26	137	26	139	27	141	27

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

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

Table A3.8 – Endeavour Energy Connection Point Summer Peak Demand[11]

	2012		2013		2014		2015		2016		2017		2018		2019		2020		2021	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Dapto	518	96	538	100	567	105	428	80	439	82	446	83	469	87	476	88	481	89	492	91
Holroyd	0	0	0	0	424	86	425	86	427	86	429	87	432	87	435	88	438	89	441	89
Ingleburn	141	35	144	35	146	36	146	36	148	36	151	37	154	38	156	38	159	39	162	40
Liverpool	388	82	407	86	439	92	451	95	461	97	472	100	483	102	494	104	505	107	517	109
Macarthur	267	71	273	71	280	73	289	75	298	77	308	80	319	82	330	85	342	89	353	92
Marulan	78	31	80	31	81	32	83	33	85	33	86	34	88	35	90	35	92	36	94	37
Mount Piper	42	20	42	20	42	20	42	20	42	20	42	20	43	20	43	20	43	20	43	20
Regentville	281	74	270	71	273	72	276	73	278	73	281	74	284	75	286	75	289	76	291	77
Sydney North	41	23	37	20	37	20	37	20	38	21	38	21	38	21	38	21	39	21	39	21
Sydney West	1,775	359	1,707	345	1,325	268	1,357	275	1,390	281	1,425	288	1,459	295	1,491	302	1,520	308	1,549	313
Tomerong	0	0	0	0	0	0	165	31	165	31	165	31	167	31	167	31	170	32	171	32
Vineyard	305	110	428	155	452	164	460	166	468	169	477	173	487	176	498	180	508	184	519	184
Wallerawang	63	23	63	23	63	24	64	24	64	24	64	24	65	24	65	24	65	24	66	24

Table A3.9 – Endeavour Energy Connection Point Winter Peak Demand

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Dapto	554	80	557	80	588	85	452	65	454	66	465	67	470	68	482	70	486	70	491	71
Holroyd	0	0	0	0	0	0	352	95	353	95	354	96	355	96	355	96	356	96	357	96
Ingleburn	123	17	124	17	125	17	124	17	124	17	125	17	125	17	125	17	125	17	126	17
Liverpool	344	27	283	22	305	24	342	26	350	27	358	28	367	28	376	29	384	30	391	30
Macarthur	129	42	245	80	241	79	245	80	249	82	254	84	263	86	276	91	293	96	312	103
Marulan	82	30	84	31	85	32	86	32	87	32	88	33	89	33	90	34	92	34	93	34
Mount Piper	44	21	44	21	49	24	49	24	49	24	49	24	49	24	49	24	49	24	49	24
Regentville	221	58	218	58	223	59	226	60	228	60	229	60	230	61	231	61	232	61	233	61
Sydney North	32	16	27	14	27	14	27	14	28	14	28	14	28	14	28	14	28	14	28	14
Sydney West	1,462	54	1,421	53	1,435	53	1,101	41	1,126	42	1,151	43	1,178	44	1,201	45	1,222	45	1,238	46
Tomerong	0	0	0	0	0	0	170	170	173	173	174	174	174	174	174	174	175	175	175	175
Vineyard	192	34	285	51	299	53	304	54	309	55	315	56	322	57	330	59	338	60	347	62
Wallerawang	76	22	78	23	78	23	78	23	78	23	78	23	78	23	78	23	78	23	78	23

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

Table A3.10 – Essential Energy (North) Connection Point Summer Peak Demand

	2012		2013		2014		2015		2016		2017		2018		2019		2020		2021	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Armidale	33	13	34	13	34	14	35	14	36	14	37	15	37	15	38	15	39	15	40	15
Boambee South	21	5	22	6	23	6	23	6	24	6	24	6	25	6	26	6	26	7	27	7
Casino	34	8	35	9	36	9	36	9	37	9	37	9	37	9	37	9	37	9	38	9
Coffs Harbour	70	20	72	15	74	15	77	16	79	16	81	16	84	17	86	17	89	18	91	18
Dorrigo	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2
Dunoon	7	2	7	2	8	2	8	2	8	2	8	2	8	2	8	2	8	2	8	2
Glen Innes	12	3	13	3	13	3	13	3	13	3	13	3	13	3	14	3	14	3	14	3
Gunnedah	27	13	28	8	28	8	29	8	29	8	30	9	30	9	30	9	31	9	31	9
Hawks Nest	9	3	10	3	10	3	10	3	11	4	11	4	11	4	12	4	12	4	12	4
Herons Ck	0	0	0	0	15	4	15	4	15	4	16	4	16	4	16	4	17	4	17	4
Inverell	36	9	37	9	37	9	38	9	38	10	39	10	39	10	40	10	40	10	41	10
Kempsey 33 kV	31	9	32	9	32	9	33	10	33	10	34	10	35	10	35	10	36	10	36	10
Kempsey 66 kV	2	0	2	0	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
Koolkhan	64	19	66	19	67	20	68	20	70	20	71	21	73	21	74	22	76	22	77	22
Lismore	120	30	124	31	127	32	131	33	134	34	138	35	142	36	146	37	150	38	152	38
Macksville	10	2	10	2	10	2	10	2	11	2	11	2	11	2	11	2	11	2	11	2
Moree	28	7	28	7	28	7	29	7	29	7	30	7	30	8	30	8	31	8	31	8
Mullumbimby	39	11	40	11	41	11	42	12	44	12	45	12	46	13	47	13	49	13	50	13
Nabiac	33	8	34	9	35	9	36	9	37	9	38	10	39	10	41	10	42	10	42	10
Nambucca	10	4	10	4	10	4	10	4	11	4	11	4	11	4	11	4	11	5	11	5
Narrabri	58	19	59	19	59	19	61	20	61	20	62	20	62	20	62	20	63	21	63	21
Port Macquarie	71	15	74	15	76	15	78	16	80	16	82	17	84	17	86	18	88	18	89	18
Raleigh	13	3	13	3	13	3	13	3	14	3	14	3	14	3	14	3	15	3	15	3
Stroud	35	6	35	6	36	6	37	6	38	7	38	7	39	7	40	7	41	7	41	7
Tamworth	119	37	122	38	125	39	128	40	131	41	134	42	137	43	141	44	144	45	145	45
Taree 33 kV	33	14	33	14	34	15	35	15	36	15	36	15	37	16	38	16	39	17	39	17
Taree 66 kV	37	15	38	15	24	8	25	8	26	8	26	9	27	9	28	9	28	9	28	9
Tenterfield	5	2	5	2	5	2	5	2	6	2	6	2	6	2	6	2	6	2	6	2
Terranora	104	18	108	19	112	20	115	20	119	21	122	21	126	22	130	23	133	23	134	23

Table A3.11 – Essential Energy (North) Connection Point Winter Peak Demand

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Armidale	44	17	45	18	46	18	47	18	48	19	49	19	50	20	51	20	52	20	53	21
Boambee South	21	4	21	4	22	4	22	4	22	5	23	5	23	5	24	5	24	5	24	5
Casino	27	7	28	7	28	7	29	7	29	7	30	7	30	8	31	8	32	8	32	8
Coffs Harbour	70	18	72	18	74	10	75	11	77	11	79	11	81	12	83	12	85	12	87	12
Dorrigo	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	5	1
Dunoon	7	1	7	1	7	1	7	2	8	2	8	2	8	2	8	2	8	2	8	2
Glen Innes	15	3	15	3	15	3	16	3	16	3	16	3	16	3	16	3	17	3	17	3
Gunnedah	27	10	27	10	28	7	28	7	28	7	29	7	29	7	30	7	30	8	30	8
Hawks Nest	0	0	9	3	10	3	10	3	10	3	11	3	11	4	11	4	12	4	12	4
Herons Ck	0	0	0	0	16	0	16	4	16	4	16	4	17	4	17	4	17	4	18	4
Inverell	34	7	34	7	35	7	35	7	36	7	36	7	36	7	37	7	37	8	38	8
Kempsey 33 kV	35	7	35	7	36	7	36	7	37	7	37	8	38	8	38	8	39	8	39	8
Kempsey 66 kV	2	0	2	0	2	0	2	0	2	1	3	1	3	1	3	1	3	1	3	1
Koolkhan	57	14	58	14	59	15	60	15	60	15	61	15	62	16	63	16	64	16	65	16
Lismore	111	30	113	31	115	31	118	32	120	33	123	33	125	34	128	35	130	35	133	36
Macksville	10	2	10	2	10	2	10	2	10	2	10	2	10	2	11	2	11	2	11	2
Moree	35	9	35	9	36	9	36	9	36	9	37	9	37	9	38	9	38	9	38	10
Mullumbimby	39	8	40	8	41	8	41	8	42	9	43	9	44	9	45	9	46	9	47	9
Nabiac	0	0	38	9	39	10	40	10	41	10	42	11	43	11	44	11	45	11	46	12
Nambucca	13	3	13	3	13	3	13	3	14	3	14	3	14	4	14	4	14	4	15	4
Narrabri	61	20	61	20	61	20	63	21	63	21	64	21	64	21	64	21	64	21	64	21
Port Macquarie	81	17	83	17	85	17	87	18	90	18	92	19	94	19	96	20	98	20	101	20
Raleigh	11	2	11	2	12	2	12	2	12	2	12	2	12	2	12	2	12	2	12	3
Stroud	29	5	29	5	30	5	30	5	31	5	31	5	32	6	32	6	33	6	33	6
Tamworth	103	30	105	26	106	27	108	27	110	27	111	28	113	28	115	29	116	29	118	30
Taree 33 kV	29	11	33	13	34	13	35	14	35	14	36	14	36	14	37	15	38	15	38	15
Taree 66 kV	81	24	41	12	26	7	26	8	26	8	27	8	27	8	28	8	28	8	29	8
Tenterfield	6	2	6	2	6	3	6	3	7	3	7	3	7	3	7	3	7	3	7	3
Terranora	107	15	110	16	112	16	115	16	118	17	121	17	124	18	127	18	129	18	132	19

Table A3.12 – Essential Energy (Central) Connection Point Summer Peak Demand

	2012		2013		2014		2015		2016		2017		2018		2019		2020		2021	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beryl	58	21	59	18	67	21	73	23	73	23	74	23	75	24	76	24	76	24	76	24
Cowra	33	2	34	2	34	2	35	2	36	2	36	2	37	2	38	2	38	2	39	2
Forbes	33	0	33	0	33	0	33	0	33	0	33	0	33	0	33	0	34	0	34	0
Manildra	11	4	11	4	11	4	12	4	12	4	12	4	12	5	13	5	13	5	13	5
Molong	5	1	5	1	5	1	5	1	5	1	5	1	5	1	5	1	5	1	5	1
Mudgee	24	8	25	8	25	8	26	9	26	9	27	9	28	9	28	9	29	9	29	10
Orange 66 kV	52	24	52	24	52	24	52	24	52	24	52	24	52	24	52	24	52	24	52	24
Orange 132 kV	120	37	136	37	144	38	145	36	147	37	149	37	150	37	152	38	154	38	155	39
Panorama	76	34	77	23	78	17	79	17	80	18	81	18	82	19	83	19	84	20	85	20
Parkes 66 kV	24	0	25	0	25	0	25	0	25	0	25	0	25	0	25	0	25	0	26	0
Parkes 132 kV	29	15	29	15	29	15	30	15	30	15	30	15	30	15	30	15	30	15	30	16
Wallerawang 66 kV	5	1	5	2	5	2	5	2	5	2	5	2	5	2	5	2	5	2	5	2
Wallerawang 132 kV	25	16	25	16	25	16	25	17	25	17	25	17	25	17	25	17	25	17	26	17
Wellington 66 kV	12	5	12	5	12	5	13	5	13	5	13	5	13	5	14	5	14	5	14	5
Wellington 132 kV	167	27	169	27	172	27	174	28	177	28	180	29	182	29	185	30	188	30	191	30

Table A3.13 – Essential Energy (Central) Connection Point Winter Peak Demand

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beryl	50	19	61	18	63	16	77	20	77	20	78	21	79	21	79	21	80	21	80	21
Cowra	26	1	26	1	26	1	26	1	26	1	26	1	26	1	26	1	26	1	27	1
Forbes	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0
Manildra	10	4	10	4	11	4	11	4	11	4	11	4	11	4	12	4	12	4	12	4
Molong	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0
Mudgee	24	5	24	4	25	4	26	4	26	4	27	4	27	4	28	5	28	5	29	5
Orange 66 kV	67	22	68	21	68	22	69	22	69	22	70	22	71	22	71	23	72	23	72	23
Orange 132 kV	117	35	131	38	145	39	146	39	148	39	150	40	151	40	153	41	155	41	157	42
Panorama	76	24	77	24	77	6	78	6	78	6	79	7	79	7	80	7	81	7	81	7
Parkes 66 kV	20	0	20	0	20	0	20	0	20	0	20	0	20	0	20	0	20	0	20	0
Parkes 132 kV	29	12	29	12	29	12	29	12	30	12	30	12	30	12	30	12	30	12	30	12
Wallerawang 66 kV	7	2	7	2	7	2	7	2	7	2	7	2	7	2	7	2	7	2	7	2
Wallerawang 132 kV	25	16	25	16	25	16	25	16	25	16	26	16	26	16	26	16	26	16	26	16
Wellington 66 kV	10	2	10	2	10	2	11	2	11	2	11	2	11	2	11	2	11	2	11	2
Wellington 132 kV	144	21	144	20	145	20	146	20	147	20	147	20	148	20	149	20	149	20	150	21

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

	2012		2013		2014		2015		2016		2017		2018		2019		2020		2021	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Albury	138	53	141	54	144	56	147	57	150	58	153	59	156	60	159	61	162	63	165	64
Balranald	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1
Broken Hill	35	17	35	17	36	17	36	17	37	18	37	18	38	18	38	19	39	19	40	19
Canberra	518	234	490	242	498	247	507	253	514	258	524	264	531	269	539	274	548	279	557	284
Coleambally	12	7	12	7	12	7	12	7	13	7	13	7	13	8	13	8	14	8	14	8
Cooma 11 kV	11	3	11	3	11	3	12	3	12	3	12	3	12	3	12	3	12	3	12	3
Cooma 66 kV	21	4	21	4	21	4	21	4	21	4	22	4	22	4	22	4	22	4	22	4
Cooma 132 kV	41	11	41	11	41	11	41	11	41	11	41	11	42	11	42	11	42	12	42	12
Darlington Pt	15	4	15	4	15	4	15	4	15	4	15	4	15	4	15	4	15	4	15	4
Deniliquin	45	12	45	12	45	12	45	12	46	12	46	13	46	13	46	13	46	13	46	13
Finley	20	6	20	6	20	6	21	6	21	6	21	6	21	6	21	7	21	7	22	7
Griffith	85	17	87	18	89	18	91	19	93	19	95	20	98	20	100	20	102	21	105	21
Marulan	46	14	47	14	49	15	50	15	52	16	53	16	55	17	56	17	58	18	59	18
Munyang	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3
Murrumbateman	5	1	5	1	5	1	5	1	6	1	6	1	6	1	6	1	7	1	7	1
Murrumburrah	42	23	43	23	43	24	44	24	45	25	46	25	46	25	47	26	48	26	49	27
Queanbeyan	95	42	97	43	100	44	103	45	105	46	108	47	111	49	114	50	117	51	120	52
Snowy Adit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tumut	36	16	37	16	37	16	38	16	38	16	38	17	39	17	39	17	40	17	40	17
Wagga 66 kV	112	59	113	60	115	61	117	62	119	63	120	64	122	65	124	66	126	67	128	68
Wagga 132 kV	56	5	56	5	57	5	57	5	58	5	58	5	59	5	59	5	60	5	60	5
Wagga North	24	11	24	12	24	12	24	12	24	12	24	12	25	12	25	12	25	12	25	12
Williamsdale	94	94	134	134	138	138	141	141	144	144	148	148	151	151	154	154	157	157	160	160
Yanco	42	6	43	6	44	6	45	6	45	6	46	7	47	7	48	7	49	7	50	7
Yass 66 kV	13	4	13	4	14	4	14	4	15	4	15	4	15	5	16	5	16	5	17	5

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

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Albury	95	28	96	29	96	29	96	29	97	29	97	30	98	30	98	30	98	30	99	30
Balranald	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0
Broken Hill	30	5	30	7	30	7	30	7	30	7	31	7	31	7	31	7	31	7	32	7
Canberra	599	275	544	154	506	158	510	160	515	161	519	163	523	165	528	166	532	168	537	170
Coleambally	8	4	8	4	8	4	8	4	8	4	8	4	8	4	9	4	9	4	9	5
Cooma 11 kV	16	3	16	3	16	3	16	3	17	3	17	3	17	3	17	4	17	4	17	4
Cooma 66 kV	32	6	33	5	33	5	34	5	35	6	35	6	36	6	37	6	38	6	38	6
Cooma 132 kV	49	8	49	10	50	10	50	10	51	10	52	10	52	10	53	10	53	10	54	11
Darlington Pt	12	0	12	2	12	2	12	2	12	2	12	2	12	2	12	2	12	2	12	2
Deniliquin	31	0	31	0	31	0	31	0	32	0	32	0	32	0	32	0	32	0	32	0
Finley	15	0	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	16	1
Griffith	49	8	50	7	50	7	51	7	52	8	52	8	53	8	53	8	54	8	54	8
Marulan	50	11	56	11	57	11	58	11	59	11	59	11	60	11	61	11	62	12	62	12
Munyang	32	20	32	21	33	21	33	21	33	22	34	22	34	22	35	22	35	23	36	23
Murrumbateman	6	1	6	1	6	1	6	1	7	1	7	1	7	1	7	1	8	1	8	1
Murrumburrah	36	11	36	13	37	13	37	13	37	13	37	13	38	13	38	13	38	13	38	14
Queanbeyan	95	33	97	34	99	35	101	35	103	36	105	37	108	38	110	39	113	40	115	41
Snowy Adit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tumut	35	9	36	9	36	9	36	9	36	9	36	9	36	9	36	9	36	9	37	9
Wagga 66 kV	81	23	82	21	83	21	84	21	85	22	86	22	87	22	88	22	89	23	90	23
Wagga 132 kV	61	4	61	5	62	5	62	5	63	5	63	5	64	5	64	5	65	5	65	5
Wagga North	25	11	25	10	26	10	26	10	26	10	26	10	27	11	27	11	27	11	28	11
Williamsdale	0	0	61	61	104	104	105	105	106	106	107	107	108	108	109	109	109	109	109	109
Yanco	33	7	33	6	33	6	33	6	33	6	34	6	34	6	34	7	34	7	34	7
Yass 66 kV	13	3	14	3	14	3	14	3	14	3	15	3	15	3	15	3	15	3	16	3

Table A3.16 – Major Industrial Customers – Sum of Individual Summer Peak Demands[12]

	2012 MW	2013 MW	2014 MW	2015 MW	2016 MW	2017 MW	2018 MW	2019 MW	2020 MW	2021 MW
Industrial Loads	1,726	1,761	1,762	1,763	1,764	1,765	1,765	1,766	1,767	1,769

Table A3.17 – Major Industrial Customers – Sum of Individual Winter Peak Demands[13]

	2011 MW	2012 MW	2013 MW	2014 MW	2015 MW	2016 MW	2017 MW	2018 MW	2019 MW	2020 MW
Industrial Loads	1,733	1,736	1,746	1,749	1,752	1,755	1,758	1,761	1,764	1,768

[12] Includes loads originally identified in Ausgrid and Endeavour Energy projections.

[13] Includes loads originally identified in Ausgrid and Endeavour Energy projections.

Appendix 4 – Scenarios A and E

Table A4.1: NSW Region Energy Projections (Scenarios A & E)

Financial Year		Scenario A	Scenario E
2004-05	actual	71,727	71,727
2005-06	actual	74,041	74,041
2006-07	actual	74,790	74,790
2007-08	actual	74,992	74,992
2008-09	actual	75,857	75,857
2009-10	actual	74,955	74,955
2010-11	estimated	74,862	74,922
2011-12	projection	76,431	76,212
2012-13	projection	78,122	77,319
2013-14	projection	78,915	78,153
2014-15	projection	80,251	79,162
2015-16	projection	81,637	80,796
2016-17	projection	82,785	82,627
2017-18	projection	83,587	83,993
2018-19	projection	84,805	85,517
2019-20	projection	87,369	87,032
2020-21	projection	88,844	87,755

Table A4.2: NSW Region Summer Demand Projections (Scenarios A & E)

	Actual	90% POE		50% POE		10% POE	
Year		Scenario A	Scenario E	Scenario A	Scenario E	Scenario A	Scenario E
2004-05	12,944						
2005-06	13,461						
2006-07	12,981						
2007-08	13,071						
2008-09	14,287						
2009-10	13,957						
2010-11	14,820						
2011-12		13,856	13,845	14,826	14,825	15,856	15,845
2012-13		14,088	14,067	15,108	15,087	16,168	16,147
2013-14		14,335	14,316	15,395	15,376	16,495	16,466
2014-15		14,612	14,572	15,722	15,682	16,862	16,812
2015-16		14,894	14,837	16,044	15,977	17,214	17,157
2016-17		15,202	15,119	16,382	16,289	17,602	17,499
2017-18		15,522	15,397	16,752	16,607	18,002	17,857
2018-19		15,872	15,672	17,132	16,922	18,422	18,202
2019-20		16,230	15,932	17,530	17,222	18,860	18,532
2020-21		16,600	16,182	17,930	17,502	19,300	18,842

Table A4.3: NSW Region Winter Demand Projections (Scenarios A & E)

	Actual	90% POE		50% POE		10% POE	
Year		Scenario A	Scenario E	Scenario A	Scenario E	Scenario A	Scenario E
2004	13,107						
2005	13,198						
2006	13,166						
2007	13,985						
2008	14,398						
2009	13,090						
2010	13,433						
2011		13,790	13,720	14,149	14,079	14,588	14,518
2012		14,068	13,977	14,437	14,346	14,896	14,785
2013		14,329	14,139	14,708	14,508	15,167	14,937
2014		14,595	14,358	14,985	14,737	15,454	15,166
2015		14,882	14,712	15,282	15,101	15,761	15,541
2016		15,273	15,237	15,682	15,646	16,181	16,085
2017		15,551	15,648	15,970	16,067	16,479	16,506
2018		15,861	16,035	16,290	16,454	16,809	16,903
2019		16,180	16,319	16,619	16,758	17,148	17,197
2020		16,636	16,639	17,096	17,088	17,634	17,527
2021		17,096	16,839	17,575	17,298	18,133	17,737

Appendix 5 – Connection Point Proposals

The NER requires the APR to set out planning proposals for future connection points. These can be initiated by generators or customers or arise as the result of joint planning with a Distributor.

In the following table, proposals for augmentations to the capacity of existing connection points are included with proposals for new connection points.

Table A5.1 Connection Point Proposals

Proposal	Purpose	Proposed Service Date	APR 2011 Section
Port Macquarie 132/33 kV Substation	New 33 kV connections to Sovereign Hill	Completed	5.1.6
Holroyd and Chullora 330/132 kV Substations	New 132 kV connection points	Summer 2013/14	5.2.2
Hawks Nest 132 kV Substation	New 132 kV connection point	2011	5.2.12
Cooma 132/66 kV Substation	New 132 kV switchbay connection	2011	5.2.13
Griffith 132/66 kV Substation	New 33 kV switchbay connections	2011	5.2.13
Vineyard 3rd 330/132 kV transformer	Increase transformer capacity	2011	5.2.15
Beaconsfield West 330/132 kV Substation	Increase transformer capacity	2012	5.2.15
Southern Supply to the ACT	Increase reliability and capacity of connections to Williamsdale	2013	5.3.3
Supply to the Tomerong/Nowra Area	New 132 kV connection point	2014	5.3.4
Supply to Lake Munmorah	Connection to Lake Munmorah zone substation	2012	5.3.5
Haymarket 330/132 kV Substation	Increase reliability and capacity of connections to Haymarket	2012	5.3.6
Beaconsfield West 330/132 kV Substation	Increase reliability and capacity of connections to Beaconsfield	2012	5.3.6
Sydney East 330/132 kV Substation	Increase transformer capacity	2013	5.3.10
Tamworth 66 kV switchbay	New 66 kV connection to Quirindi	2013/14	5.3.11
Newcastle 330/132 kV Substation	New 132 kV connection to Argenton	2015	5.3.11
Sydney West 330/132 kV Substation	New 132 kV switchbay connection	2011/12	5.3.11
Nabiac 132 kV Substation	New 132 kV connection point	Late 2012	6.1.3
Herons Creek 132 kV Substation	New 132 kV connection point	2013/14	6.1.4
Lismore 330/132 kV Substation	Two new 132 kV switchbay connections	2015 - 17	6.2.5
Tumut 132/66 kV Substation	New 66 kV switchbay connection	2013/14	6.2.5
Wellington 330/132 kV Substation	New 132 kV switchbay connection	2013	6.2.5

Appendix 6 – Glossary

Term	Explanation/Comments
AEMO	The Australian Energy Market Operator. Responsible for management of the NEM and has the role of Victorian JPB.
AER	The Australian Energy Regulator.
AEMC	The Australian Energy Market Commission.
Annual National Transmission Statement (ANTS)	A document produced annually by NEMMCO until 2008 which focused on the status and options for development of Major National Transmission Flow Paths.
Annual Planning Review	The annual planning process covering transmission networks in NSW.
Annual Planning Report (APR 20XX)	A document that sets out issues and provides information to the market that is relevant to transmission planning in NSW. This document is the APR 2011.
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.
Electricity Statement of Opportunities (ESOO) or Statement of Opportunities (SOO)	A document produced by AEMO that focuses on electricity supply demand balance in the NEM.
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
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.
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 NEM that have been approved by participating State governments under the National Electricity Law. The NER supersedes the National Electricity Code (NEC or "the Code") and is administered by the AEMC.
National Transmission Statement (NTS)	A one-off document produced by AEMO in 2009 and based on past ANTS's. The 2009 NTS was a transitional document to the present NTNDP.
Native energy (demand)	Energy (demand) that is inclusive of Scheduled, Semi-Scheduled and Non-Scheduled generation.
NEM	The NEM.
NTFP	National Transmission Flow Path.
NTNDP	National Transmission Network Development Plan replaces NTS from 2010
new small transmission network asset	An augmentation of the transmission network that is expected to cost between $5 million and $20 million.
new large transmission network asset	An augmentation of the transmission network that is expected to cost more than $20 million.
Regulatory Test	A test promulgated by the AER that is required by the NER to be applied when determining the relative economic merits of options for the relief of transmission constraints.
Registered Participant	A person registered with AEMO as an NER participant.
RET	Renewable Energy Target.
RIT-T	Regulatory Investment Test – Transmission, introduced from 1 August 2010.
SVC	Static VAr Compensator. A device that provides for control of reactive power.
the Minister	The NSW Minister for Energy.
TNSP	Transmission Network Service Provider. A body that owns controls and operates a transmission system in the NEM.

Appendix 7 – Contact Details

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