TransGrid

NEW SOUTH WALES

Annual Planning Report 2012

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Foreword by the Managing Director

One of the strategic themes of our current Corporate Plan is to ‘Service the Market’. To this end, we are committed to continually reviewing and enhancing our processes to provide a reliable and efficient electricity transmission service to our customers. We provide timely and relevant information to market participants about our investment intentions in the coming years.

We have established a Portfolio Management Office to improve delivery of our capital works program.

We continue to lead the National Electricity Market (NEM) in the areas of Demand Management and network support. We are also working with the Australian Energy Market Operator (AEMO) to enhance the electricity demand forecasting for NSW and the ACT.

A reliable electricity supply is essential to our communities and for the economic prosperity of the State as well as the wider National Electricity Market. Accordingly we will continue to manage our network to ensure its safe, efficient and secure operation.

TransGrid’s Annual Planning Report 2012 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 need identification to project completion.

TransGrid continuously works to increase its effectiveness as a Transmission Network Service Provider (TNSP) in the National Electricity Market (NEM). Over the past 12 months we have established a Portfolio Management Office (PMO) to better coordinate the capital works program across the whole organisation and prioritise projects to meet the needs of our customers and other NEM participants more effectively.

In setting up the PMO, we undertook a critical examination of the steps in the capital project delivery process from needs analysis to project construction and commissioning. As a result, we have enhanced the entire investment decision making process to underpin the regulatory economic test process to ensure prudent and efficient outcomes. The new process allows us to be more responsive to changes in market conditions and customer needs.

As an example, we have deferred the Lismore – Dumaresq transmission line (part of the Far North Coast NSW Project) in response to lower electricity demand growth in northern NSW. We are also reviewing the timing and scope of network augmentation on the mid North Coast of NSW based on the recent forecasts.

We have implemented a Provision of Service model to allow the proponents of new connections to our network to meet their own commercial needs in a timely manner. TransGrid held a Generator Forum for the first time to provide details of the new commercial model for funded connections to proponents and to obtain first hand feedback regarding their connection experience and how we can enhance it.

We are now focussing on improving and enhancing the provision of relevant information to the market. In this regard, we have reviewed and updated our Network Management Plan 2011–16. The strategic framework of the Plan is based on the NSW Government’s Total Asset Management model. The Plan provides a focus for continually improving the management of the transmission system and includes all assets comprising or directly related to the network. It also covers network safety and reliability, customer and public safety awareness and bush fire risk management.

TransGrid is the recognised leader in the NEM in the areas of Demand Management and network support from non-network sources. In the last 12 months, we have published a number of Requests for Proposal asking the market for network support for various parts of the State in order to defer capital works or for operational risk management purposes. We are now on track to contract 40 MW of network support for the Sydney metropolitan area for the coming summer.

In May 2012, TransGrid hosted a first ever Demand Management Innovation Forum in the NEM. The DMI Forum was attended by all NSW distributors, universities, and consultants who are currently undertaking demand management innovation projects with TransGrid. The DMI Forum provided a venue for all participants to exchange ideas and share experience in conducting various

Foreword by the Managing Director

demand management innovation projects. The need for a broad based demand management program and its funding through prescribed revenue was recognised by all participants.

The NSW and ACT distributors' connection point forecasts for 10 years have been included in this Annual Planning Report. These forecasts have been used to review the timing and scope of augmentation proposals. It is noted that these forecasts are reviewed annually and are subject to change, particularly in the current economic times.

TransGrid has transfered the responsibility for global NSW forecasts to AEMO. We are working with AEMO on this transfer to ensure continuity and integrity of the forecast process and provide better transparency of modelling and underlying assumptions.

The 2012 global load forecasts for the NSW region have been prepared by AEMO and are included in this Annual Planning Report. The forecast peak summer and winter electricity demand display reduced annual growth over the planning horizon compared to the baseline forecast for last year. This reduction in demand may result in the deferral of timeframes for some load driven augmentations, and may in some circumstances result in some lower cost solutions being pursued.

AEMO and the TNSPs have complementary roles to play in ensuring effective development of the interconnected national transmission system. TransGrid continues to work with AEMO and other TNSPs in the NEM to support the operation of the market and planning of the national grid. Developing options for the upgrade of QNI and NEMLink are two examples of this collaborative approach and the way in which the Annual Planning Reports and the National Transmission Network Development Plan complement each other.

TransGrid is committed to contributing to the continuing evolution of energy policy and proactively participates in all current policy and framework reviews, such as the Transmission Frameworks Review by the Australian Energy Market Commission (AEMC).

Your feedback on the Annual Planning Report 2012 is welcome.

Peter McIntyre
Managing Director

June 2012

CHAPTER 1

Executive Summary

CHAPTER 1

Executive Summary

TransGrid is the owner and operator of one of the largest electricity transmission networks in Australia. With 91 substations and over 12,800 kilometres of transmission lines, its network 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 2012 (APR 2012).

The APR provides advance information to market participants, customers, stakeholders and interested parties on the nature and location of emerging constraints in TransGrid's transmission network to allow them to contribute to the optimum development of the network. In particular to develop proposals for demand management and non-network options such as embedded generation and demand side response.

Planning and development of the network is undertaken on a cyclical as well as on a needs basis to ensure that transmission service delivery to our customers is responsive to their changing requirements and meets the jurisdictional, contractual and National Electricity Rule (NER) obligations.

The APR 2012 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. Together, these documents cover the broad areas of supply demand balance, transmission networks planning and distribution networks planning.

AEMO is responsible for the preparation and publication of a National Transmission Network Development Plan (NTNDP) and TransGrid supports and assists AEMO in undertaking the analysis and planning which underpin the NTNDP.

TransGrid is the nominated Jurisdictional Planning Body (JPB) for New South Wales in the NEM and as such is responsible for the coordination of the planning and development of electricity transmission networks in New South Wales.

The roles of AEMO, TransGrid and other parties in the planning process are broadly set out in Figure 2.1 of Chapter 2. Chapter 3 sets out the linkages between AEMO's NTNDP and TransGrid's network development plans.

Load forecasts are an important input into the network development and planning process. AEMO intends to produce forecasts for each NEM region and TransGrid has agreed to transfer responsibility for global NSW forecasts to AEMO. TransGrid is working with AEMO on this transfer to ensure continuity and integrity of the forecast process and provide better transparency of modelling and underlying assumptions.

For the year 2012 AEMO has provided drafts of its forecasts for the NSW region which are included in Chapter 4. The key economic, price and demographic projections were provided by NIEIR as expert adviser to AEMO.

The draft energy forecasts show an annual energy growth of 1.2% for the forecast period 2012-13 to 2021-22. AEMO has also forecast 10% POE summer peak demand to grow annually at 1.2% for the forecast period and the winter peak demand to grow at an annual growth rate of 1.3% for the forecast period.

TransGrid also receives connection point forecast from the connected distribution network owners for the purposes of connection point planning. The connection point forecasts are included in Appendix 3. These forecasts, which in general show a reduction in the rate of peak demand growth, have been factored in network planning and as a result the required commissioning dates for a number of proposed augmentations have changed to later years. For example:

- Lismore – Dumaresq transmission line is now required by winter 2016 (if no support is available via Directlink) or winter 2022 (if one pole of Directlink is available). The previous projected need was 2015.
- Stroud – Lansdowne transmission line is now required by the early 2020s, provided that Herons Creek 132/66 kV Substation is established by that time.

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 measures. Chapters 5 and 6 of the APR 2012 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 NER. Section 5.3 lists the projects that have progressed to this stage.

In accordance with the NER requirement, Section 5.5 provides constraint information and an indication as to whether TransGrid intends to issue a Request for Proposal (RfP) with respect to the identified constraints.

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.

It also 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.

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

Chapters 5 and 6 also include proposals for replacement of transmission network assets which are necessitated based on their condition.

For NSW, the planning standards have been prescribed by the NSW jurisdiction. These standards are primarily deterministic in nature. The AEMC is undertaking a review of NSW DNSP licence conditions at the request of the NSW Government. In light of this review by the AEMC, a review of the Transmission Network Design and Reliability Standard for NSW may be appropriate. TransGrid's approach is a blend of deterministic and probabilistic assessments. A discussion of deterministic and probabilistic planning approaches is included in Appendix 2.

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 Investment Test for Transmission (RIT-T) or, where applicable the regulatory test.

For any option to be considered during the evaluation and analysis process, it must be feasible and capable of being implemented in time to relieve the emerging constraint. The option must also have a proponent 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. For contact details, please refer to Appendix 6.

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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 around 12,800 kilometres of transmission lines, serves the largest state in Australia's National Electricity Market (NEM), facilitates interstate energy trading and forms the backbone of the NEM.

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; and
  - 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 kV, 330 kV, 220 kV 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 operational and maintenance requirements, as well as being able to provide emergency response services. 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 overleaf.

2.2 Outcomes of the Annual Planning Review for 2012

The APR 2012 documents the 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 New South Wales transmission networks over appropriate planning horizons;
- Provide advance information on the nature, quantification and location of the constraints. The level of information included in this document is intended to be sufficient to encourage market participants and interested parties to formulate and propose options to relieve the constraints, including those that may include components of DM and local generation or other options that may provide economically efficient outcomes;
- Discuss options that have been identified for relieving each constraint including network, local generation, DM and other options;
- Indicate, where possible, if and when TransGrid intends to issue a Request for Proposals (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
- Provide a basis for annual reporting to the New South Wales Minister for Energy (the Minister) on the outcome of the Annual Planning Review.

The Annual Planning Review for 2012 included:

- A report of AEMO's NSW load forecast that took account of actual peak loads for the preceeding summer and winter;
- Ongoing planning analysis and identification of network constraints and assessment of feasible options for relieving these constraints; and
- Publication of this APR 2012.

It is intended that the APR 2012 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 and the ACT.

The timely identification of emerging constraints also 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 Annual Planning Report is one of a number of documents that disseminate information pertinent to transmission and distribution planning in the National Electricity Market (NEM). These documents cover the broad areas of supply demand balance, transmission networks planning and distribution networks planning. They are mandated through a variety of legislative and policy directives and therefore their scopes 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 National Electricity Market (ESOO)	AEMO	Supply demand balance and outlooks in the NEM
National Transmission Network Development Plan (NTNDP)	AEMO (from 2010)	National transmission planning
Annual Planning Reports	TNSPs	Regional transmission planning
Electricity System Development Reviews	NSW DNSPs	Distribution planning in NSW

Contact information relating to this APR 2012 is given in Appendix 6.

2.4 Supply Reliability in New South Wales

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

2.4.1. TransGrid's Obligations and Responsibilites

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

First, it has been nominated by the Minister to be the 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.

Second, it is registered as a TNSP in the NSW region of the NEM. In relation to a TNSP's obligations 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 consultation process if required;
- On the basis of the consultative process and economic analysis, determine the recommended option;
- After resolution of any disputes concerning the recommended option arrange for its implementation in a timely manner; and
- Prepare and publish an Annual Planning Report by 30 June of each year.

The NER require that the Annual Planning Report must include:

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

These obligations are described more fully in Clause 5.6 of the NER and the AER's regulatory test and RIT-T.

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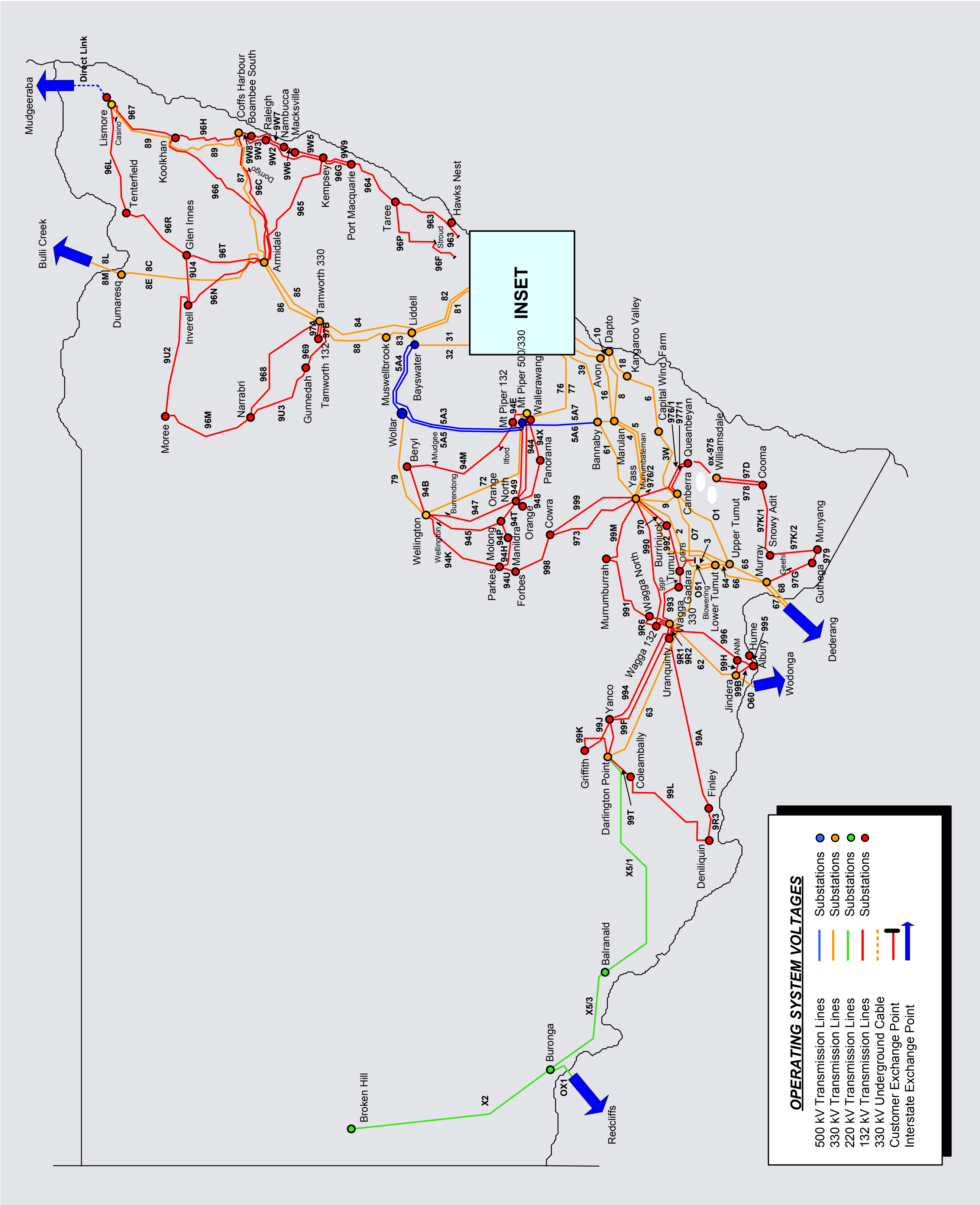
TransGrid's Electricity Network Map



TransGrid's Electricity Network Map – Inset

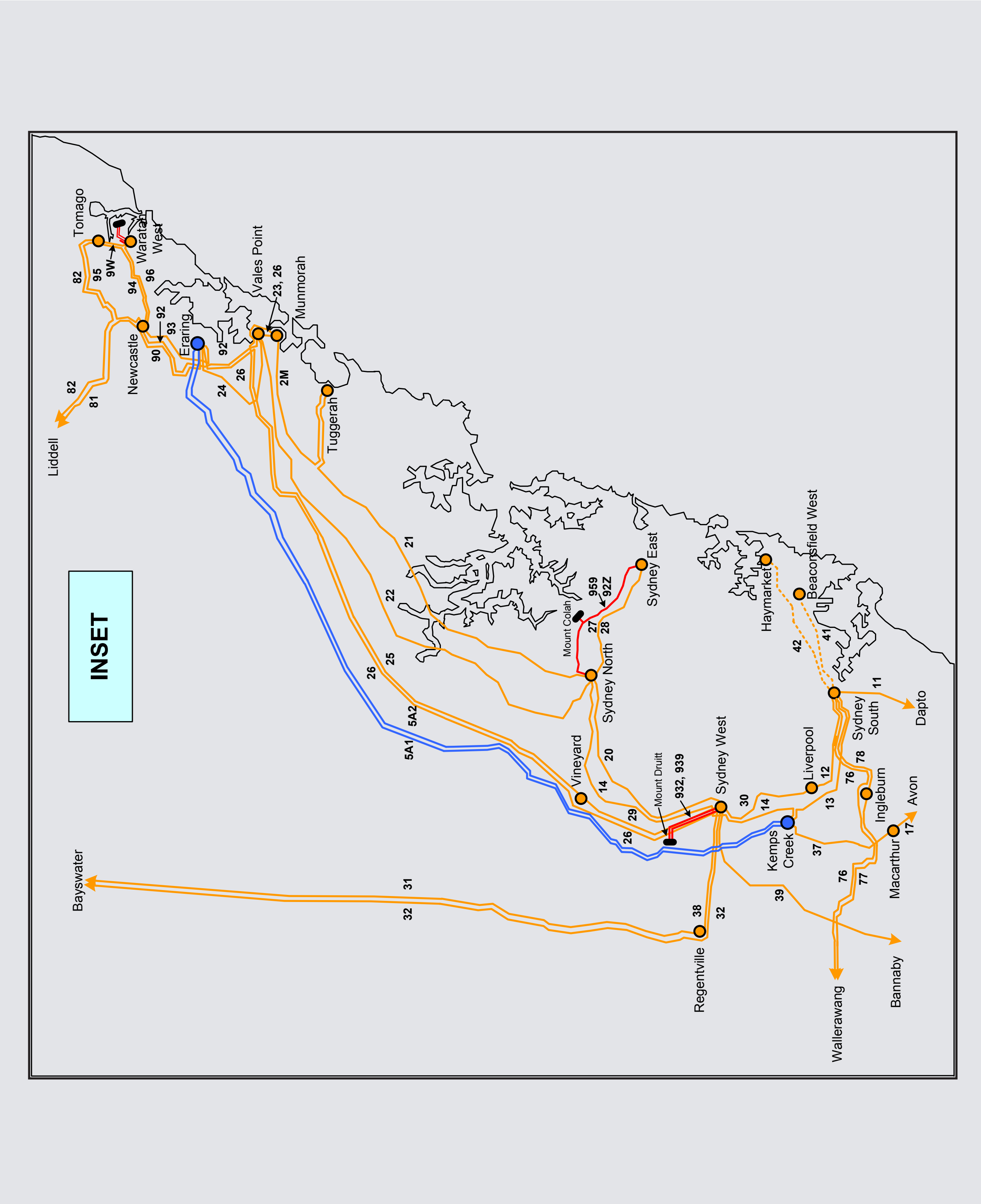


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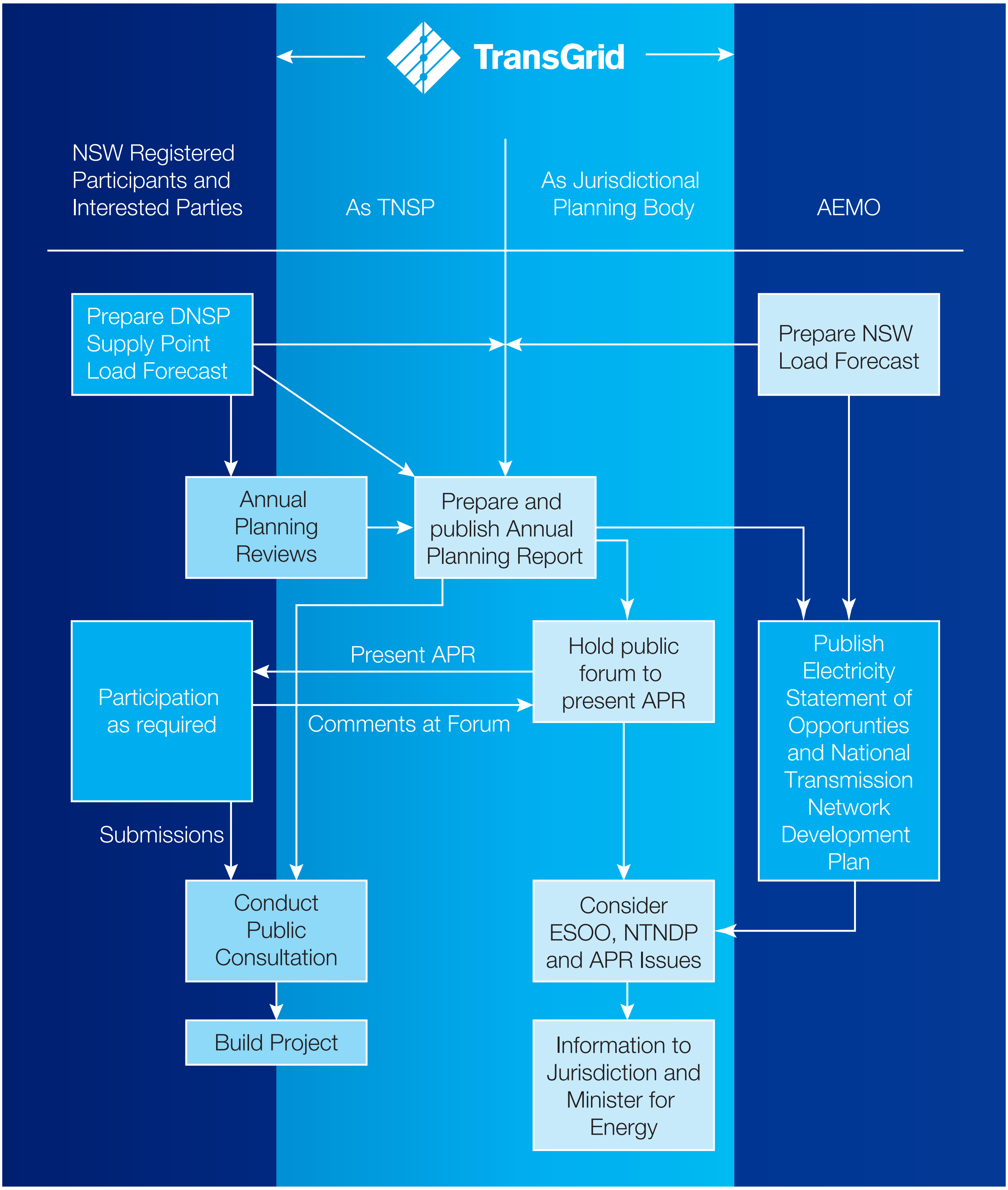
Figure 2.1 illustrates the main tasks and interrelationship of TransGrid's dual roles.

Figure 2.1 – TransGrid's Planning Roles



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

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.

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. Additionally, a discussion of deterministic and probabilistic planning criteria is included in Appendix 2.

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.

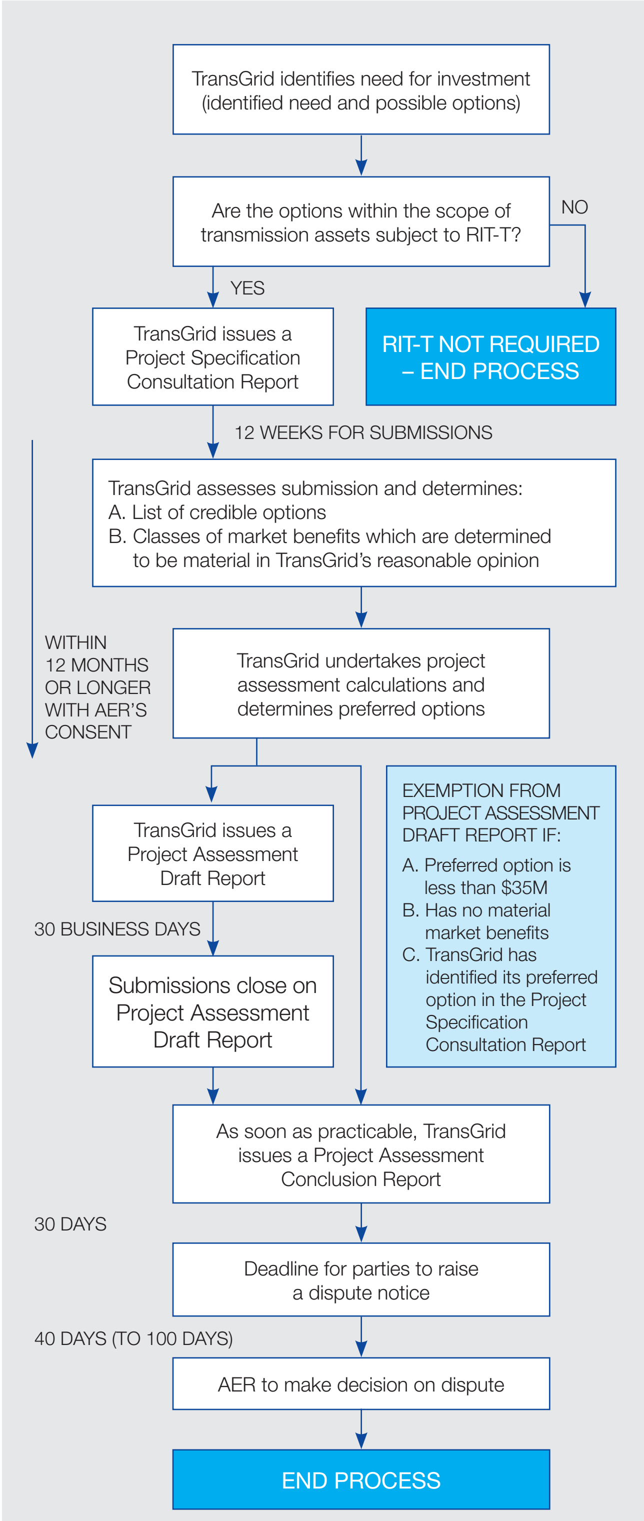
TransGrid also conducts planning meetings and reviews with major customers.

2.4.4. Annual Planning Review for NSW

As the JPB for NSW, TransGrid 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, which includes 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 2012 commenced in October 2011 with a request by TransGrid for updated load forecasts by distributors. These forecasts take into account electrical loads experienced during the preceeding summer and winter. 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.

Figure 2.2 – NER Planning Consultation Processes, RIT-T



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

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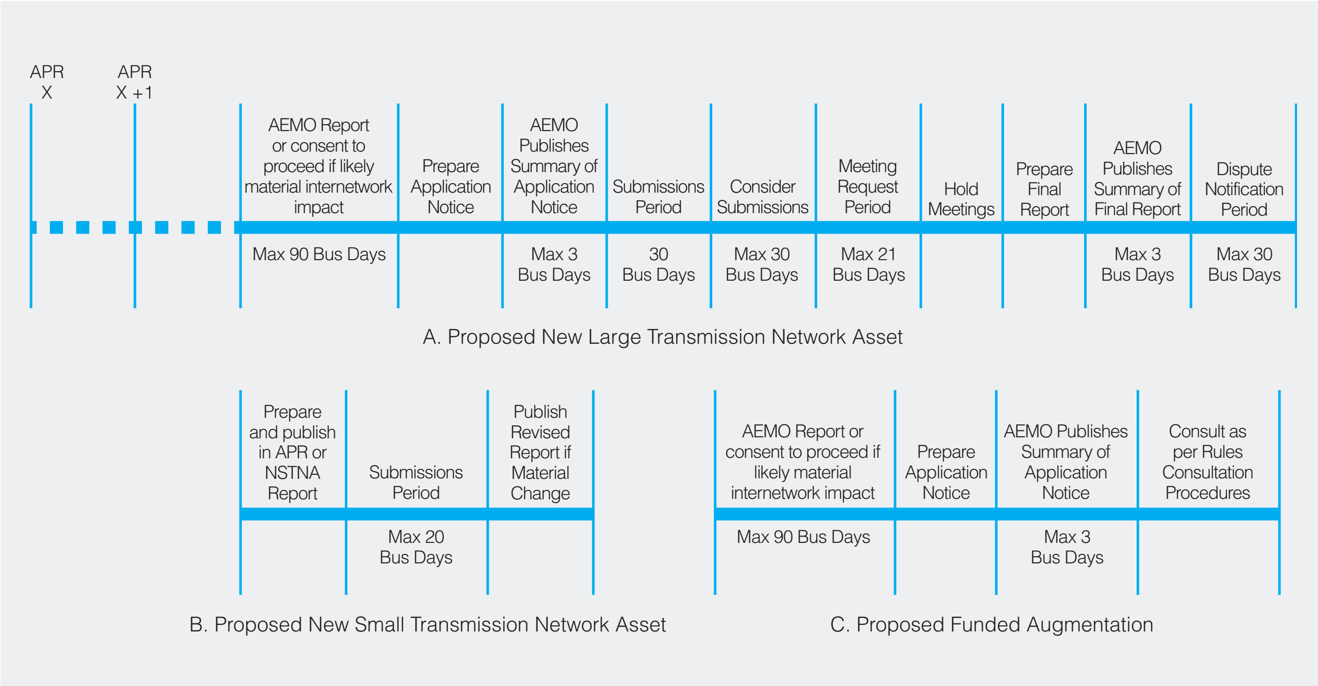
Figure 2.3 – NER Planning Consultation Process, Regulatory Test



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 Network Investment Process

TransGrid completed a review of its network investment process in 2011 to enhance its ability to deliver a large scale capital program more effectively and be more responsive to the changing needs of stakeholders. As a result of this review, a new network investment process has been implemented.

The revised process incorporates the following key elements:

- A more integrated, whole of business approach to capital program management.
- Clear ownership of the process (via the recently established Portfolio Management Office).
- Optimisation of investments, including non-network options across augmentation and asset replacement/renewal streams.
- Earlier resolution of key risk areas such as environmental approvals, property acquisition and scope definition in the project delivery process.
- More structured documentation around options evaluation and project scoping to enhance the transparency of decision making.

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 one minute to allow, for example, automatic switching to alternative supply arrangements.

Figure 2.4 – Network Investment Process

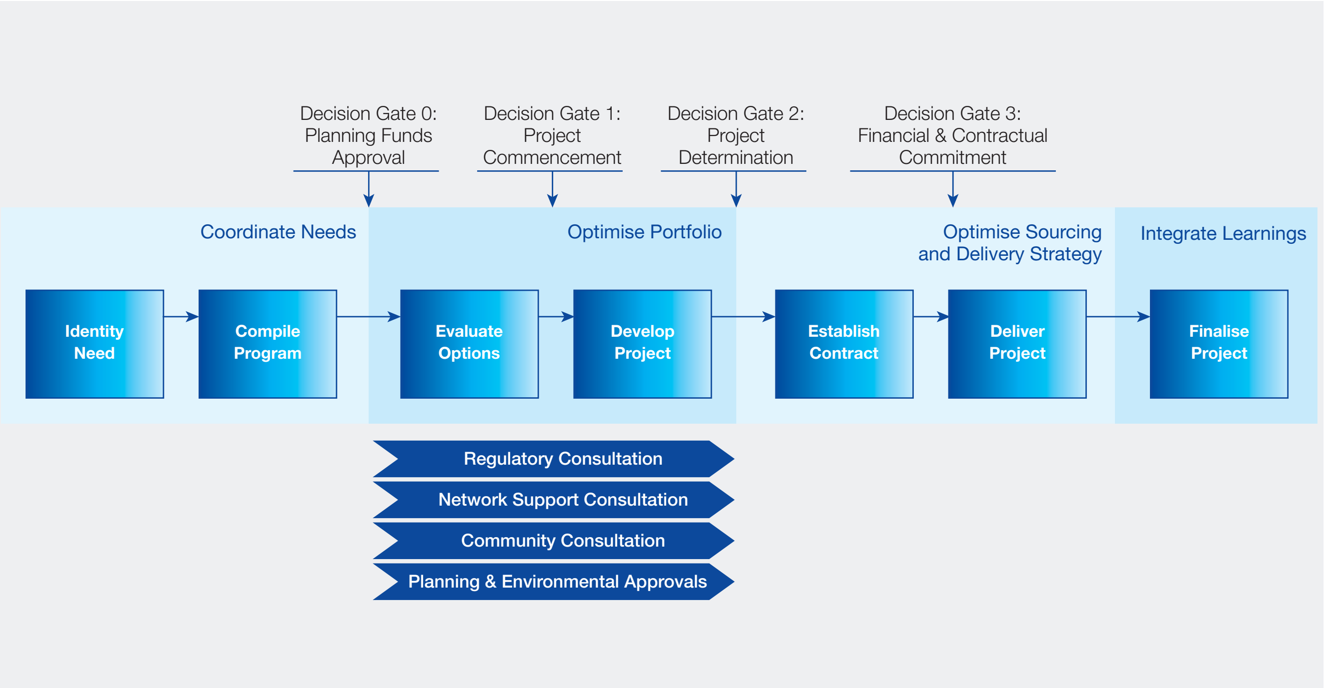


Figure 2.4 shows the new Network Investment Process and the optimisation that takes place at each stage.

Throughout the needs identification, option evaluation and project development stages, the portfolio is optimised by considering dependencies between projects and evaluating options in the context of related needs.

The governance framework for network investments has been strengthened with the implementation of four decision gates (DG):

- **Planning Funds Approval (DG0):** Approval for commencement of a range of activities, including evaluations required prior to Decision Gate 1.
- **Project Commencement (DG1):** Following desktop evaluation of network and non-network options, the most efficient and commercially acceptable feasible solution to address the need is selected. This decision gate encompasses approval for commencement of a range of activities, the most important being the appropriate regulatory investment test, preliminary design work, community consultation and environmental assessments (if applicable), and any property acquisitions required prior to Decision Gate 2.
- **Project Determination (DG2):** DG2 confirms the selection of the network or non network option which has been demonstrated to be the most efficient technically and commercially feasible solution to address the need. This decision gate will follow completion of the relevant regulatory tests and environmental approvals where possible, or progression of the environmental evaluations such that there is a high level of confidence that environmental approvals will be obtained.
- **Financial and Contractual Commitment (DG3):** This decision gate encompasses the decision which commits TransGrid to full funding for the project, which may involve non-network solutions, and is done in conjunction with and prior to the first major procurement or construction contract on the project.

2.6 TransGrid's Asset Management Process

TransGrid's asset management process has been developed and refined over a number of years to ensure its existing assets are effectively and efficiently managed.

The asset management process provides another key input to the network investment process to ensure that the delivery of condition based projects is optimised with projects driven by network augmentation needs.

More detail on TransGrid's asset management process can be found in the TransGrid Network Management Plan 2011-2016. The Network Management Plan also covers network safety and reliability, customer and public safety awareness and bush fire risk management. It includes all assets comprising or directly related to the network.

The Network Management Plan 2011-16 is available on TransGrid's website and is updated bi-annually.

2.7 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 2.2 above.

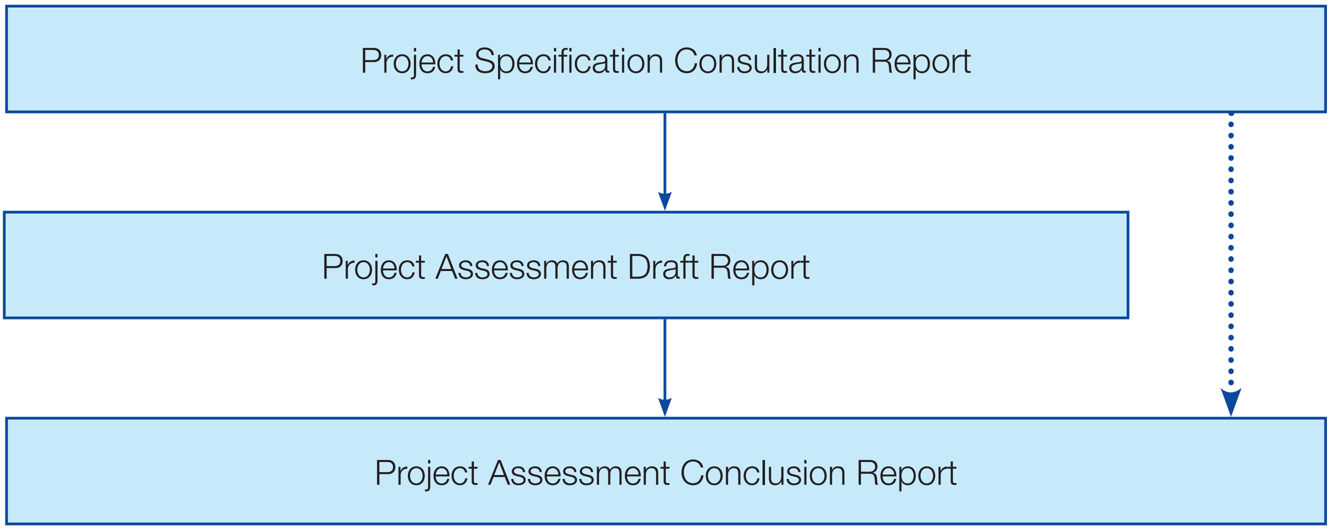
The RIT-T consultation process involves three steps including the issuing of the Project Specification Consultation Report (PSCR), the Project Assessment Draft Report (PADR) and the Project Assessment Conclusion Report (PACR). The PADR can be omitted in certain circumstances where the preferred option is less than $35 million and where there are no material market benefits.

The consultation documents and process is shown in Figure 2.5. 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 2.5 – RIT-T Consultation Documents



2.8 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 with costs 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.

2.9 Constraint and Request for Proposal Information

In April 2009, a NER rule change was approved by the AEMC, 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:

- 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 2012 in Chapters 5 and 6.

2.9.1. 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; or
  - any particular proponent's offer will be accepted.
- In some circumstances the amount of support required depends on factors beyond TransGrid's control, such as generation patterns. In these cases an indicative level of support has been provided; and
- Typically the loading on transmission networks is highest during summer and winter. Within those periods, the timing of the highest demands (at which times support may be required) depends on a number of factors including actual weather conditions. Consequently it is not possible to predict the month(s) during which support may be required. Rather, the season in which support is expected to be required is given. Summer is taken to be December to February (although in some cases it is possible that support may be required in late November or early March). Winter is taken to be June, July and August.

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 provider;
- 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 commercial contract to provide the support.

2.9.2. 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.

During 2011/12 TransGrid commenced preparation of a DM Triage Database. The project is being developed in consultation with the NSW distribution utilities who will all have access to the database as well. The intent of the project is to:

- Develop a database that will allow the NSW transmission and distribution industry to determine quickly, for any major investment (that must pass investment tests in particular) if there is the possibility of sufficient demand side resources within the area suitable to assist in deferring these investments;
- Determine if these possible sources of network support are worthy of being scoped in more detail through an Expression of Interest or Request for Proposal or related approach to the market; and
- Ensure that the decision making process is sufficiently robust over time to be able to support decisions made to not seek demand side resources as the database is showing a low probability of it being available or feasible.

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 for network support providers in responding to the RfP and for TransGrid 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 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.

2.10 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.

TransGrid is addressing the NSCAS requirements in NSW as identified in AEMO's NTNDP issued in December 2011. To this extent, TransGrid is in the process of preparing relevant consultation reports for the RIT-T consultation. The RIT-T process will assess credible options, including network and non-network options in order to meet the NSCAS gap. The purpose of the RIT-T is to identify the option which maximises net economic benefits and, where applicable, meets the relevant jurisdictional or Rules based reliability standards. A call for Expressions of Interest for non-network options was issued during the 2011/12 financial year and the responses will be discussed with the proponents. A full RfP document is also underway. It is expected that the first stage of RIT-T process would be completed in the first half of 2013. Procurement of NSCAS for the year 2012-13 will be undertaken by AEMO.

CHAPTER 3

National Transmission Network Developments

CHAPTER 3

National Transmission Network Developments

3.1 2011 National Transmission Network Development Plan

AEMO published the latest National Transmission Network Development Plan (NTNDP) in 2011. The 2011 NTNDP maintained the five future market development scenarios developed for the 2010 NTNDP, which were based around factors covering economic growth, population growth, global carbon policy, a range of supply-side responses and a range of demand-side responses. AEMO noted that the Australian Government's Clean Energy Future carbon price is sufficiently similar to the 2010 NTNDP medium carbon price scenario.

Each of the five scenarios also included a trajectory for emission target reductions below 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 the NEM.

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 upon completion of a number of 500 kV developments in NSW outlined in TransGrid's Strategic Network Development Plan. Particularly important to the capability of NEMLink to transfer large levels of power will be the completion of the 500 kV ring in NSW that connects the Hunter Valley, western area, Bannaby, Sydney and the NSW central coast.

The 2011 NTNDP also addressed the potential impacts on the network of large scale investments in wind generation and other renewable generation.

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 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 are not expected to require large-scale line developments.

3.2.1. NTNDP Outcomes

The generation planting for the scenarios analysed in the 2011 NTNDP was based on the NTNDP generator cost data assumptions. Table 3.1 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

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 difference 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.

CHAPTER 3

National Transmission Network Developments

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 Table 3.3 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 also given in the table.

Table 3.3 – NSW Transmission Augmentation Projects in the NTNDP

Transmission Development	Number of Scenarios – Out of 10	Status within TransGrid	Chapter 6 Clause Reference
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 2012.	6.2.4
Hunter Valley – northern NSW 500 kV development (three circuits or four circuits)	5	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.	6.3.1
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.	6.3.3
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.	6.2.6
Hunter Valley – Eraring 500 kV line development	5	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.	6.3.3
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.	6.3.7
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.	6.3.3

Table 3.3 – NSW Transmission Augmentation Projects in the NTNDP (continued)

Transmission Development	Number of Scenarios – Out of 10	Status within TransGrid	Chapter 6 Clause Reference
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.	6.2.5
Mt Piper – Wallerawang 330 kV circuit development	3	TransGrid is investigating the need for this line and potential options.	6.3
Kemps Creek – Liverpool 330 kV line development	5	TransGrid is actively investigating this development and has acquired some property to facilitate its development.	6.1.1
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.	6.1.1
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.	6.3.2
500/330 kV transformer at a future Sydney substation	3	TransGrid is considering the optimal transformer arrangements in conjunction with the future 500 kV system development	6.3.2
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 for a number of years.	6.3.7
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.	6.3.4
South West NSW			
220 kV phase shifting 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.	6.3.6
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.	6.3.6

CHAPTER 3

National Transmission Network Developments

3.4 NEMLink Transmission Works

In 2010 AEMO commenced a pre-feasibility study of a high capacity 500 kV HVAC interconnection called NEMLink with a power transfer capability of 3,000 MW between the eastern Australian states.

In the 2011 NTNDP, these studies were continued to determine whether net market benefits can be improved by deferring individual NEMLink components. AEMO reported that with or without the Victoria to Tasmania component, NEMLink may approach economic viability by 2020-21 under high demand growth and high carbon price conditions. No change to the timing of the NSW component was proposed.

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 Figure 3.1.

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.

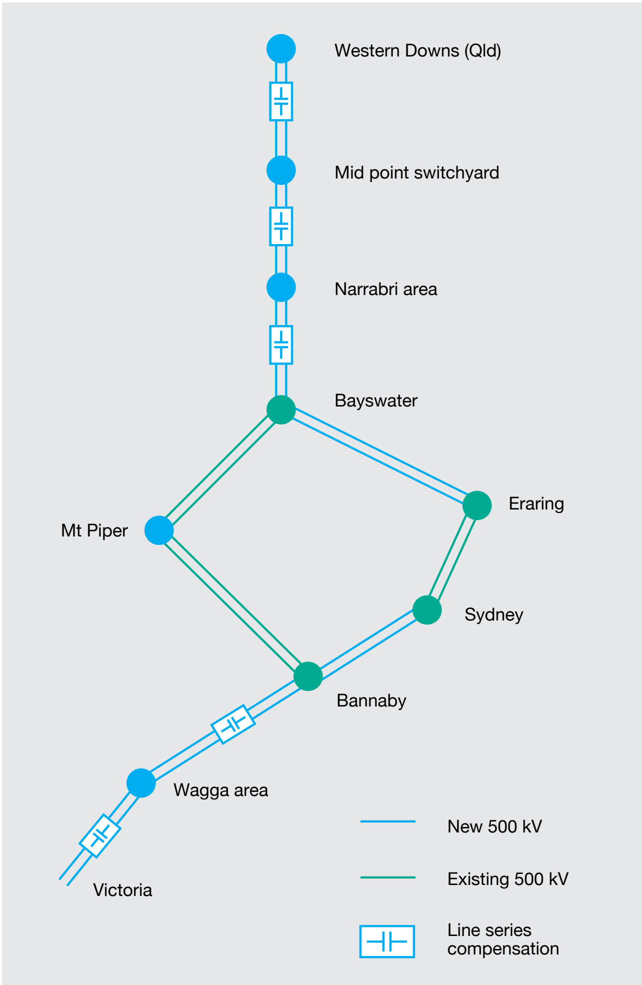
The feasibility of 500 kV system development is also dependent on environmental and social constraints. TransGrid has been undertaking action in critical areas for some years to facilitate some of the future developments but considerable further work and expenditure would be required to secure line easement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

In the 2011 NTNDP AEMO asserted that "There are also likely to be some regional projects being planned by TNSPs, which could be deferred or avoided if NEMLink is built. An extension of the Sydney 500 kV ring network is an example of where benefits might accrue." To clarify, the NSW 500 kV ring connects the Hunter Valley, western coalfields, Bannaby in the south, Sydney and the NSW Central Coast. Further it will be essential to complete the sections of the NSW 500 kV ring to enable significant levels of power transfer across NEMLink.

Figure 3.1 – NEMLink Concept in NSW






CHAPTER 4

NSW Region Energy and Demand Projections

CHAPTER 4

NSW Region Energy and Demand Projections

4.1 Introduction

This chapter and Appendix 3 provide projections of energy and demand for the NSW region of the NEM (which includes the state of NSW 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 Annual Planning Report 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.

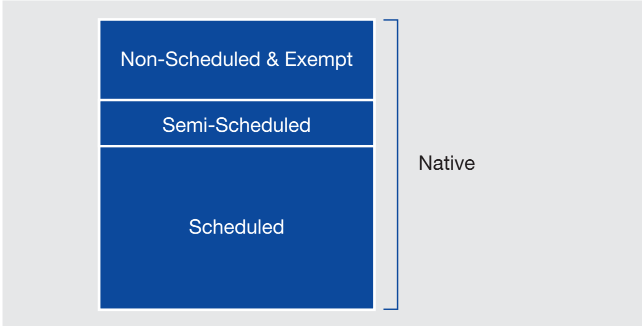
Scheduled generators are non-intermittent generators above 30 MW capacity. They are included in the NEM dispatch process.

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



4.1.2. Information Sources

AEMO has assumed responsibility for producing aggregate energy and demand projections for each NEM region.

AEMO has provided drafts of its forecasts for the NSW region which are discussed in this chapter and Appendix 3. Interested parties should refer to AEMO's website for further details of AEMO's forecasts and forecasting methodology.

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 Annual Planning Report. TransGrid also produces aggregate DNSP connection point and major customer demand projections using this data and assumptions regarding diversity and losses. This permits comparisons to be made between the AEMO top down global forecast, and the bottom up connection point forecasts.

4.1.3. Summary of the NSW Region 2012 Energy and Demand Projections

Table 4.1 summarises historical and projected changes in the NSW region energy and summer and winter maximum demands.

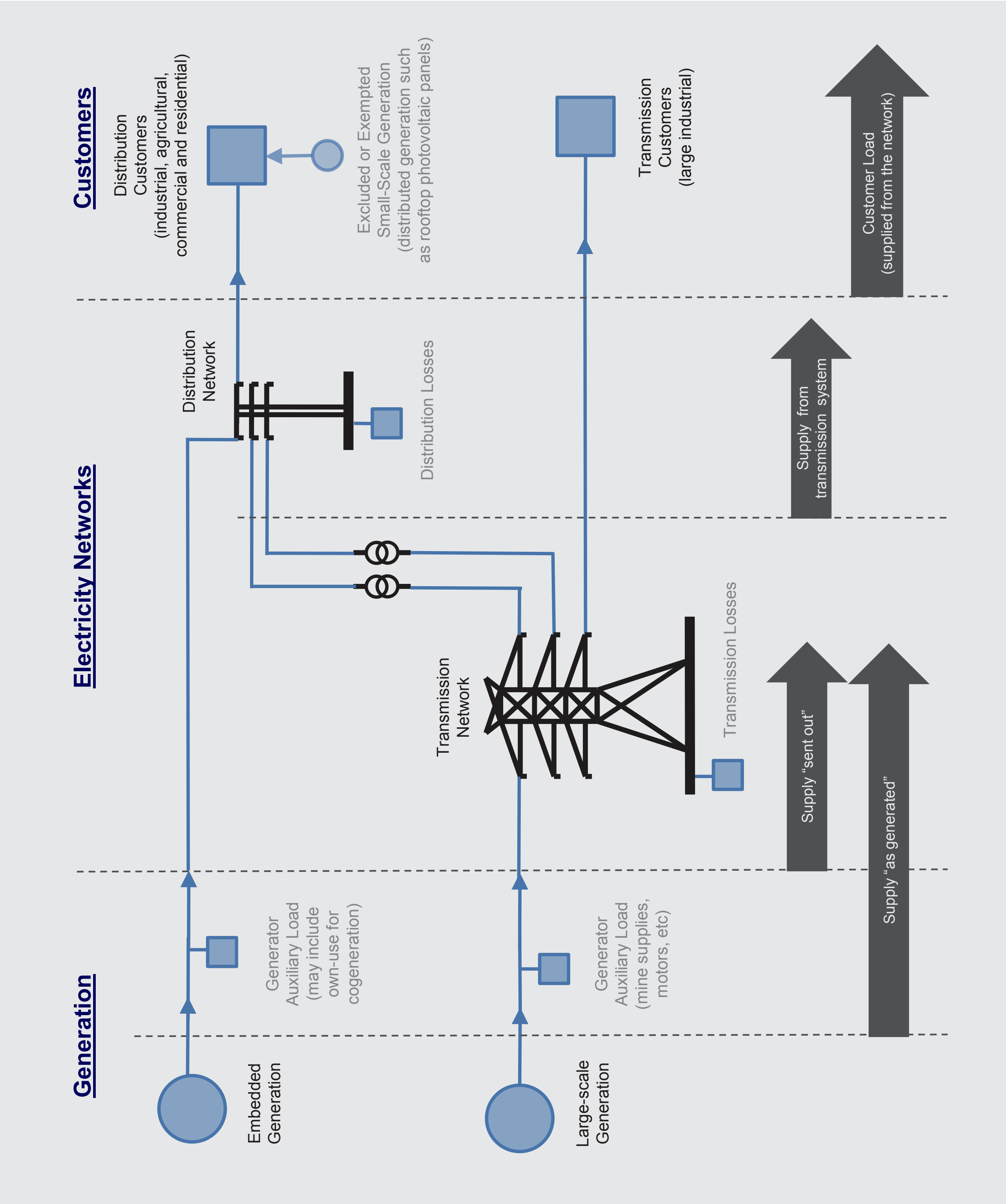
Table 4.1 – NSW Region Energy and Demand Projections (Average annual percentage changes)

	Actual/estimated 2005-06 to 2011-12	Projected 2012-13 to 2021-22
Energy Sent Out	-0.5%	1.2%

	Actual 2005-06 to 2010-11	Projected 10% POE 2012-13 to 2021-22
Summer Peak Demand	2.2%	1.2%

	Actual 2006 to 2012	Projected 10% POE 2013 to 2022
Winter Peak Demand	1.1%	1.3%

Figure 4.2 – Electricity Supply



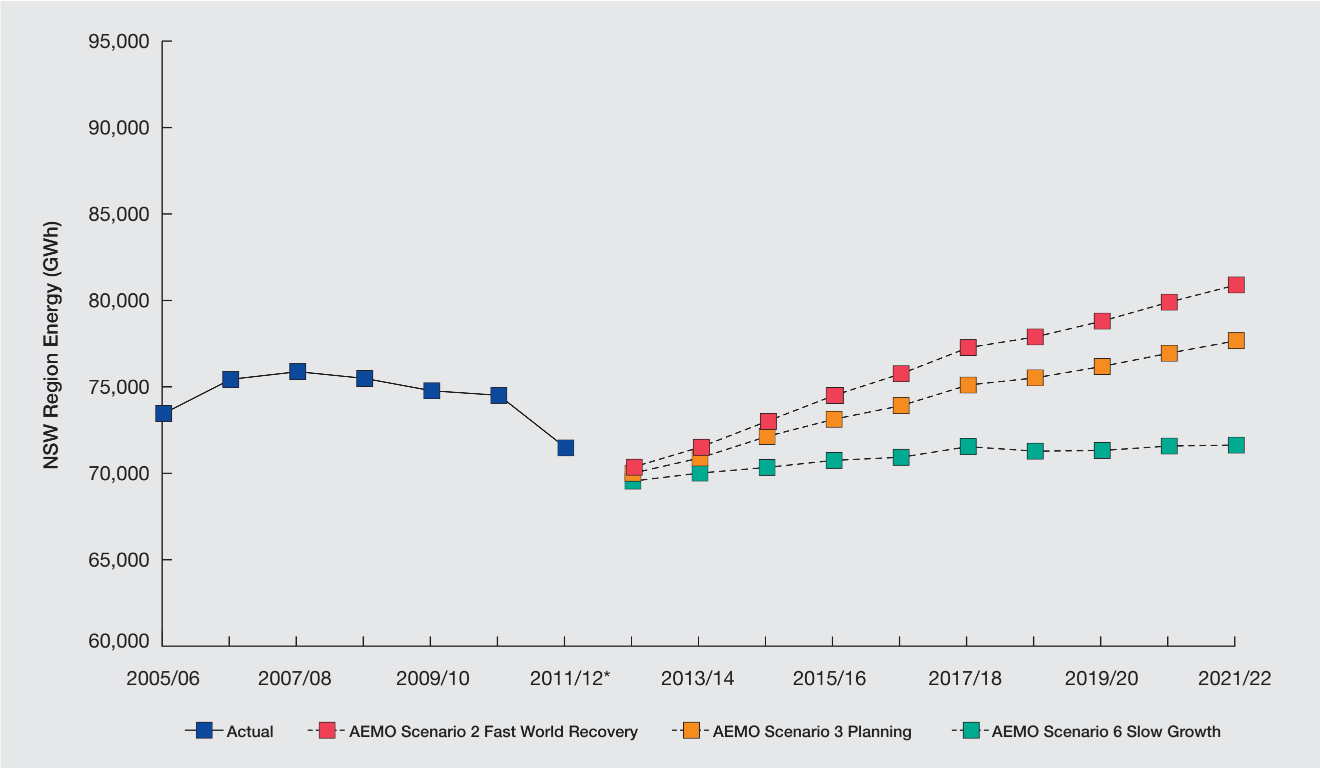
Source: Modified version of AEMO diagram in ESOO 2010

4.2 Energy Projections for the NSW Region

The total energy that the transmission and distribution systems deliver to end-use customers is described as “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 4.3 shows native energy projections on a sent-out basis for the NSW region for each of the AEMO Scenarios: Scenario 3 Planning, Scenario 2 Fast World Recovery and Scenario 6 Slow growth. These scenarios were established by NIEIR on behalf of AEMO.

Figure 4.3 – NSW Region Energy Projections



4.3 Demand Projections for the NSW Region

This section outlines the NSW region native summer and winter demand projections on an as generated basis. 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 AEMO scenarios: Scenario 3 Planning, Scenario 2 Fast World Recovery and Scenario 6 Slow growth for the next 10 years.

Table 4.2 – NSW Region Summer Demand Projections (MW)

	Actual	Scenario 2 Fast World Recovery			Scenario 3 Planning			Scenario 6 Slow Growth		
		10% POE	50% POE	90% POE	10% POE	50% POE	90% POE	10% POE	50% POE	90% POE
2005-06	13,328									
2006-07	12,896									
2007-08	12,956									
2008-09	14,176									
2009-10	13,969									
2010-11	14,863									
2011-12	12,141									
2012-13		14,145	13,474	12,764	14,065	13,399	12,697	13,937	13,277	12,586
2013-14		14,421	13,737	13,012	14,289	13,609	12,898	14,061	13,393	12,700
2014-15		14,665	13,968	13,229	14,467	13,779	13,059	14,099	13,427	12,720
2015-16		14,959	14,246	13,489	14,660	13,960	13,226	14,177	13,497	12,783
2016-17		15,236	14,504	13,731	14,865	14,151	13,398	14,279	13,590	12,867
2017-18		15,532	14,781	13,986	15,130	14,398	13,622	14,454	13,750	13,013
2018-19		15,580	14,822	14,021	15,158	14,420	13,638	14,378	13,672	12,933
2019-20		15,834	15,057	14,225	15,363	14,607	13,806	14,474	13,757	12,997
2020-21		16,019	15,232	14,400	15,497	14,732	13,921	14,531	13,806	13,047
2021-22		16,191	15,392	14,548	15,636	14,860	14,039	14,542	13,813	13,047

Table 4.3 – NSW Region Winter Demand Projections (MW)

	Actual	Scenario 2 Fast World Recovery			Scenario 3 Planning			Scenario 6 Slow Growth		
		10% POE	50% POE	90% POE	10% POE	50% POE	90% POE	10% POE	50% POE	90% POE
2006	13,088									
2007	13,890									
2008	14,316									
2009	13,028									
2010	13,424									
2011	13,030									
2012		13,940	13,422	12,988	13,961	13,441	13,007	13,875	13,360	12,926
2013		14,042	13,527	13,089	14,032	13,511	13,080	13,919	13,398	12,975
2014		14,192	13,667	13,218	14,115	13,581	13,144	13,896	13,377	12,946
2015		14,528	13,989	13,528	14,338	13,807	13,353	13,998	13,477	13,033
2016		14,793	14,237	13,776	14,539	13,994	13,543	14,066	13,531	13,100
2017		15,179	14,577	14,121	14,892	14,290	13,841	14,321	13,739	13,302
2018		15,329	14,760	14,273	15,005	14,442	13,967	14,353	13,813	13,357
2019		15,453	14,877	14,389	15,112	14,535	14,063	14,367	13,821	13,368
2020		15,719	15,132	14,633	15,328	14,743	14,261	14,505	13,951	13,494
2021		15,969	15,368	14,855	15,531	14,935	14,447	14,610	14,045	13,582
2022		16,176	15,565	15,044	15,698	15,095	14,602	14,663	14,094	13,629

Figures 4.4 and 4.5 show the AEMO 2012 10% and 50% POE demand projections and the actual summer and winter maximum demands.

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NSW Region Energy and Demand Projections

Figure 4.4 – NSW Region 2012 Summer Demand Projections and Actual Demands

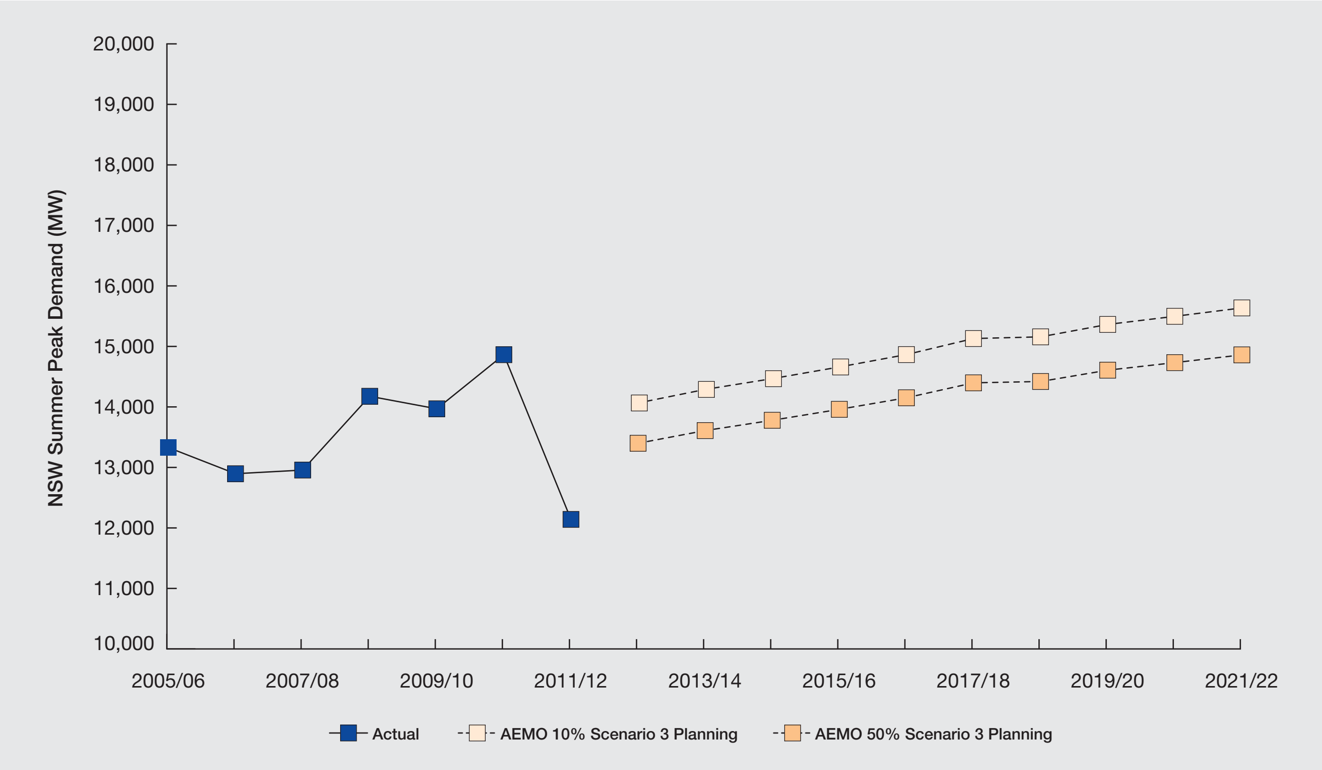
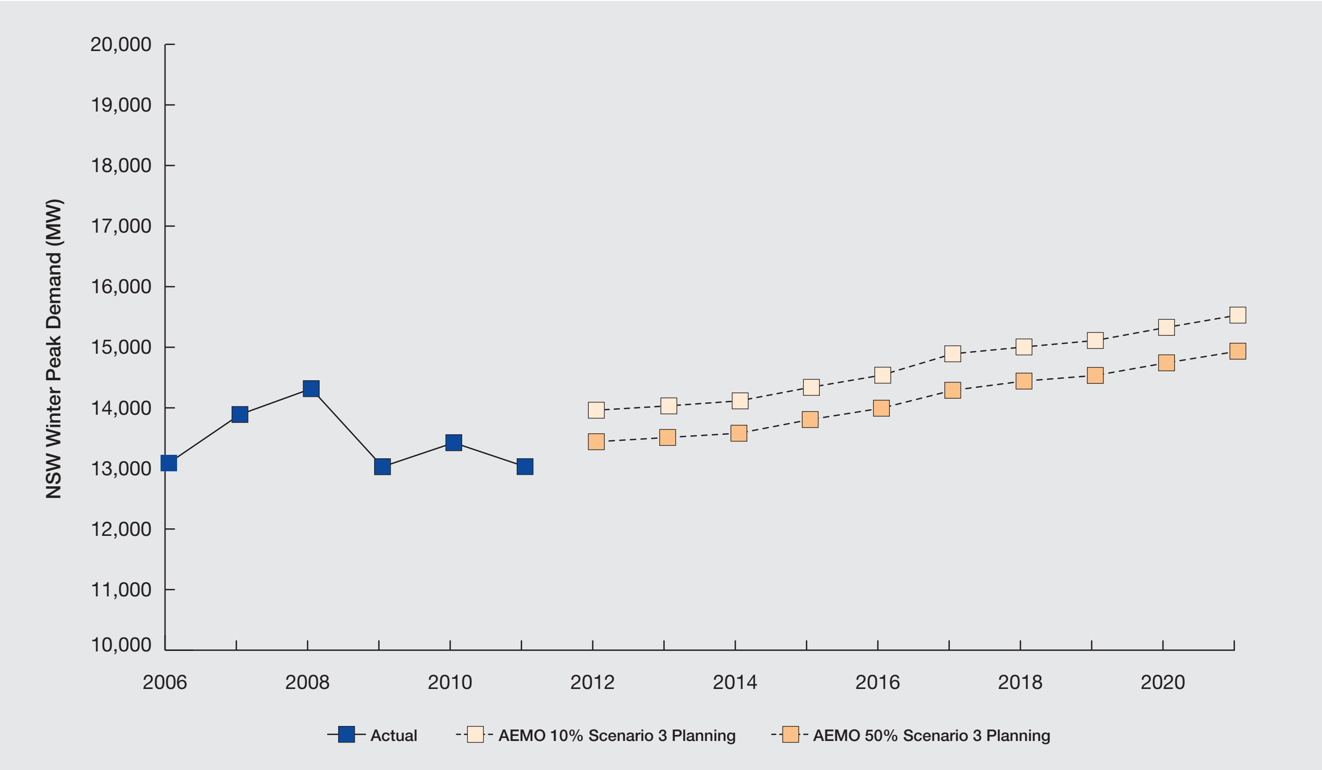


Figure 4.5 – NSW Region 2012 Winter Demand Projections and Actual Demands



4.4 Comparison with DNSP and Customer Projections

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 AEMO. 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 AEMO 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.

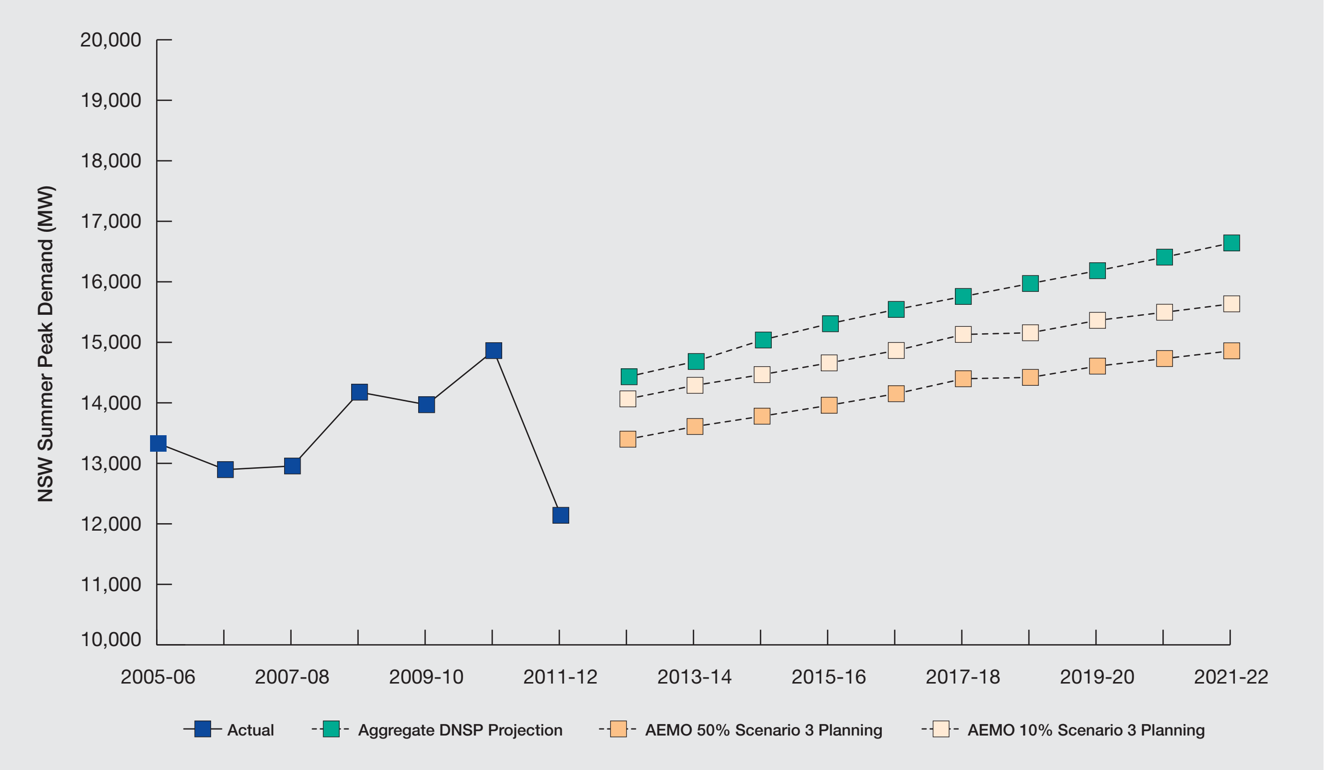
TransGrid therefore attempts to account for some of the aforementioned limitations by:

- 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, AEMO's 10% POE and 50% POE (Scenario 3 Planning) projections of summer and winter peak demand are compared to the aggregate DNSP (connection point) projections.

Figures 4.6 and 4.7 show the comparison between DNSP projections and AEMO's 10% POE and 50% POE (Scenario 3 Planning) top down summer and winter maximum demand projections.

Figure 4.6 – AEMO and Aggregate DNSP Projections of NSW Summer Peak Demand



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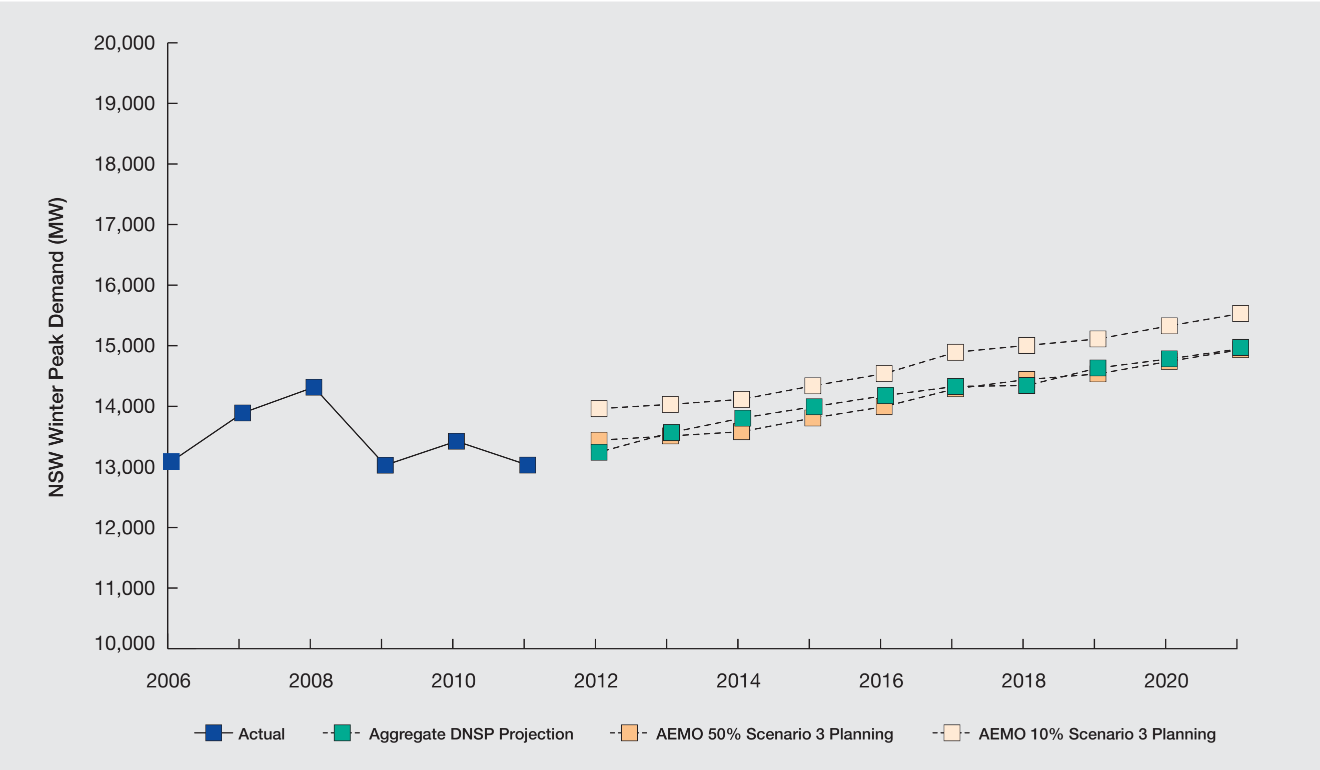
NSW Region Energy and Demand Projections

Figure 4.7 – AEMO and Aggregate DNSP Projections of NSW Winter Peak Demand



CHAPTER 5

Completed, Committed and Planned Augmentations

CHAPTER 5

Completed, Committed and Planned Augmentations

5.1 Recently Completed Augmentations

This section describes augmentations that have been completed since publication of the APR 2011.

5.1.1. Establishment of Orange North 132 kV Switching Station

To meet the present and emerging limitations, TransGrid has established Orange North 132 kV Switching Station to the north of the existing Orange 132/66 kV Substation to increase the capacity of the transmission network supplying the Orange area. The switching station works were completed in March 2012 with the line rearrangements due to be completed in August 2012.

5.1.2. Glen Innes – Inverell 132 kV Line

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

These works were completed in May 2012.

5.1.3. New Kempsey – Port Macquarie 132 kV Line

To meet limitations in the network supplying the mid north coast of NSW TransGrid and Essential Energy 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 were completed in May 2012.

5.1.4. Manildra – Parkes 132 kV Line

To meet limitations in the network supplying the Cowra, Forbes and Parkes area, TransGrid and Essential Energy 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 expected to be completed in June 2012.

5.1.5. Murray Switching Station Rehabilitation

Murray Switching Station was transferred from Snowy Hydro to TransGrid in 2002.

Rehabilitation works at the site were completed in October 2011.

5.1.6. Establishment of Williamsdale 330/132 kV Substation

The construction of Williamsdale 330/132 kV Substation was completed in October 2011. This includes the provision of 330 kV switchbays at Canberra 330/132 kV Substation completed in January 2012.

5.1.7. 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 2011.

Table 5.1 – Completed Line Switchbays for Distributor Requirements

Location	Installation	Completion
Beryl 132/66 kV Substation	One new 66 kV line switchbay to connect Essential Energy's new frequency injection equipment	July 2011
Cooma 132/66 kV Substation	An additional 132 kV switchbay to supply Essential Energy's Bega Substation	August 2011
Griffith 132/33 kV Substation	Five new or augmented 33 kV switchbays to support Essential Energy works in the Griffith area	October 2011
Finley 132/33 kV Substation	Connection of new Essential Energy Mulwala 132 kV line to existing 132 kV line switchbay	March 2012

5.1.8. 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 2011.

Table 5.2 – Substation Fault Rating Upgrades

Location	Installation	Completion
Sydney North 330/132 kV Substation	Equipment replacements to ensure that the 132 kV fault rating is at least 38 kA	July 2011

5.1.9. Transformer Replacements and Capacity Upgrades

The following table summarises transformer replacements and capacity upgrades that were included as proposals in previous APRs and completed since publication of the APR 2011.

Table 5.3 – Transformer Replacements and Capacity Upgrades

Location	Installation	Completion
Vineyard 330/132 kV Substation	Installation of a third 330/132 kV 375 MVA transformer	September 2011
Wallerawang 330/132 kV Substation	Replacement of No. 1 and No. 2 330/132 kV transformers with two 375 MVA units. One new transformer is in service. The other will be placed in service when the new Wallerawang 132/66 kV substation is commissioned.	March 2012
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 2012
Yass 132/66 kV Substation	Replacement of No. 3 transformer	June 2012

5.1.10. 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 2011.

Table 5.4 – Reactive Plant Installations

Location	Installation	Completion
Nil		

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 ESOO 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 comprehensive testing of the facility will need to be completed. Testing of the facility has been underway as appropriate system conditions arise and is expected to be completed in 2012.

5.2.2. Supply to the Sydney CBD and Inner Metropolitan Area

To meet present and emerging limitations, TransGrid and Ausgrid are undertaking works to increase the capacity of the transmission system supplying the Sydney inner metropolitan area. The major components include:

- Construction of sections of a 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 330/132 kV Holroyd Substation;
- Construction of the new Holroyd Substation and associated connections to the existing 132 kV network;
- Construction of the new 330/132 kV Rookwood Road Substation and associated connections to the existing 132 kV network; and
- Installation of two 330 kV cables between the new Holroyd substation and the new Rookwood Road Substation.

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.

These works are planned to be completed by late 2013.

5.2.4. Establishment of Williamsdale 330/132 kV Substation

To meet reliability and security requirements of the ACT government, TransGrid and ActewAGL have established Williamsdale 330/132 kV Substation and associated 132 kV connections to ActewAGL's network supplying Canberra.

The final component of the works, conversion of 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, is planned to be completed by late 2012.

5.2.5. Wallerawang 132/66 kV Substation Replacement

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 in early 2014.

5.2.6. Upper Tumut Switching Station Rehabilitation

Upper Tumut Switching Station was transferred from Snowy Hydro to TransGrid in 2002.

Minor rehabilitation works at the site have been completed with more major works including replacement of high voltage equipment and secondary systems programmed for completion progressively through to 2014.

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

TransGrid is replacing the 132 kV gas insulated switchgear at Beaconsfield West 330/132 kV Substation that is nearing the end of its serviceable life and providing 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.

CHAPTER 5 Completed, Committed and Planned Augmentations

5.2.8. 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 has completed a new single transformer 132/33 kV substation together with associated 33 kV line works to connect it to the local 33 kV network.

Provision of short sections of 132 kV line by TransGrid to connect the new substation to the 963 Tomago – Taree 132 kV transmission line is expected to be completed in June 2012.

5.2.9. Supply to the Lower Mid North Coast

To meet present and emerging limitations TransGrid and Essential Energy are proposing to increase the capacity of the transmission system supplying the Lower Mid North Coast in two stages. The first stage involves:

- 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; and
- Connections to establish a new Tomago – Stroud 132 kV circuit and a Tomago – Brandy Hill 132 kV circuit.

These works are now committed and are to be carried out in a staged manner with completion dates from 2012/13.

The second stage would involve reinforcing the transmission system between Stroud and the Taree area. Based on the most recent load forecast that is now expected to be required by the early 2020's.

TransGrid and Essential Energy are presently reviewing the available options. A key component of all network options is construction of a new transmission line between Stroud and the Taree area. The two possible transmission line developments are, broadly:

- Construction of a 330 kV line; and
- Construction of a 132 kV line initially and a 330 kV line later.

At this stage it is expected that the options considered will consist of the two possible transmission line developments together with various combinations of other works including:

- Non-network options such as demand management and embedded generation;
- Establishment of a 132/66 kV substation in the Herons Creek area which would reduce the amount of load presently supplied from Taree Substation; and
- Replacement or major refurbishment of Taree 132/66/33 kV Substation, which is approaching the end of its serviceable life.

To reduce its lead-times, which would enable it to better respond to changing circumstances, TransGrid intends to continue with acquisition of a new line route between Stroud and the Taree area.

As part of the normal joint planning process, TransGrid and Essential Energy will continue to develop a range of options which would enable the most appropriate development to be identified.

5.2.10. 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
Orange North 132 kV Switching Station	132 kV switchbay for supply to Cadia	Late 2012
Broken Hill 220/22 kV Substation	Uprate 2 x 22 kV line switchbays	2012/13

5.2.11. 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
Nil		

5.2.12. 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	November 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	Mid 2013	
Wallerawang 330/132 kV Substation	Replacement of Nos. 1 and 2 330/132 kV transformers with 375 MVA units	To align with Wallerawang 132/66 kV Substation replacement	One new transformer has been commissioned. The other will be commissioned as part of the Wallerawang 132/66 kV Substation replacement

5.2.13. Committed Capacitor 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 2012	
Beaconsfield West 330/132 kV Substation	Install two new 132 kV 160 MVAr capacitor banks	Late 2012	In conjunction with 132 kV GIS replacement. One bank is in service and operating at 100 MVAr
Coffs Harbour 132/66 kV Substation	Replace the existing 7.5 MVAr 66 kV capacitor bank with a new 16 MVAr unit	Late 2012	The existing assets are nearing the end of their serviceable life
Port Macquarie 132/66 kV Substation	Replace the existing 7.5 MVAr 66 kV capacitor bank with a new 16 MVAr unit	Late 2012	The existing assets are nearing the end of their serviceable life

5.2.14. 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	Replacement of secondary systems	Late 2013	
Liddell 330 kV Switchyard	Provide dual switching on 330 kV line No. 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.
Sydney West 330 kV Substation	Provide a 330 kV bus coupler circuit breaker	2013	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 Substation
Various 330 kV Substations	Install surge arrestors on 330 kV line entries to substations	Progressive completion from 2013	To provide necessary surge protection for substation equipment
Various 330 kV Substations	Installation of Phase Angle Measurement units at ten sites between the Newcastle and Sydney area	From 2012	This is part of joint work with Ausgrid on the Smart Grid Smart City project
Vineyard area	Acquisition of a site to enable a future 500/330 kV Substation to be developed	2012	The site is required to meet the long-term needs for supply in the Sydney area
Sydney West 330 kV Substation	Acquisition of a site to enable the Sydney West 330 kV busbar to be extended	2012	The site is required to meet the long-term needs for the 330 kV system in the Sydney area

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.

Supply to the area is limited by the thermal rating limitations on 132 kV lines on outage of either the Armidale – Coffs Harbour 330 kV line or the Coffs Harbour – Lismore 330 kV line. It is anticipated that with growing demand these limitations will be exacerbated.

The onset and severity of these limitations are dependent on the amount of network support available from Queensland via Directlink (the high voltage dc link between Mullumbimby and Terranora). Based on the most recent load forecast the limitations are expected to arise in winter 2016 if no support from Directlink is available, or winter 2022 if one pole of Directlink can be relied upon to be available.

The following works are proposed 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 reactive equipment at Lismore and Dumaresq; and
- Provide 330 kV switchgear at Dumaresq and Lismore to connect the new line and the reactive equipment.

To reduce lead-times, which would enable TransGrid to better respond to changing circumstances, it is intended to continue the environmental approval process and easement acquisition for the 330 kV line. Also as part of the normal joint planning process, TransGrid and Essential Energy will continue to:

- Monitor summer and winter maximum demands;
- Monitor the availability of Directlink; and
- Work with Directlink to identify opportunities to improve its capacity and/or availability where this is cost effective.

TransGrid has undertaken to apply the RIT-T to the proposed development. To ensure that the most up to date information is used in that process, it would be undertaken as close as possible (considering the time necessary to complete the RIT-T process) to when lead times dictate that a commitment to the project is required.

5.3.2. Redevelopment of Orange 132/66 kV Substation

Orange 132/66 kV Substation was commissioned in 1954 and the 66 kV equipment and secondary systems are nearing the end of their serviceable lives. Now that Orange North Switching Station is completed, it is planned to remove most of the 132 kV equipment from Orange Substation and to replace the 66 kV equipment and secondary systems. The opportunity will be taken to install an additional 66 kV capacitor.

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 5.2.4.)

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 (completed).

TransGrid is consulting with the ACT Government about the timing of these works.

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 and a request for proposals for non-network services was issued in early 2012.

5.3.5. Supply to Lake Munmorah and Reinforcement of Central Coast Supply

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 132 kV switchyard and at or near Munmorah 132 kV supply point.

The works are expected to be completed progressively from 2012.

CHAPTER 5

Completed, Committed and Planned Augmentations

5.3.6. Reinforcement of Supply within the Sydney Inner Metropolitan Area

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 TransGrid and Ausgrid has identified an emerging constraint and a need to reinforce the cable network within the inner metropolitan area by 2012. Further, due to the condition and reduced rating of the 41 Sydney South – Beaconsfield West 330 kV cable, there is a need to provide additional supply capacity to the inner metropolitan area as soon as can be achieved.

The preferred solution to address the 2012 constraint is to establish an additional cable link between Beaconsfield West and Haymarket 330/132 kV Substations. To meet longer term requirements this link would comprise primarily of a 330 kV cable, initially operating at 132 kV, with some sections of 132 kV cable.

The preferred solution to provide additional capacity to the inner metropolitan area is likely to be a 330 kV cable due to the infeasibility of constructing a transmission line through the inner urban area. The shortest route would be from Rookwood Road to Beaconsfield West and then to Haymarket. However, route selection to determine the most feasible and economic route is currently being undertaken. The Beaconsfield West to Haymarket 330 kV cable would likely utilise the sections of 330 kV cable installed in 2012.

The preferred solution which addresses the need to reinforce supply within the inner metropolitan area in 2012 and facilitates the later reinforcement of supply to the inner metropolitan area entails:

- Ausgrid installing a 700m section of 132 kV cable between Beaconsfield West Substation and the MetroGrid cable tunnel portal;
- TransGrid installing a 330 kV cable in the MetroGrid tunnel to Haymarket. This cable would be connected to Ausgrid's 132 kV cable and operated initially at 132 kV; and
- Ausgrid connecting 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. The installation of the 330 kV cable section which forms the 132 kV circuit between Haymarket and Beaconsfield West Substations is expected to be completed late 2012.

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

It is necessary to uprate the Marulan – Avon, Marulan – Dapto and Kangaroo Valley – Dapto 330 kV lines to accommodate higher flows to the Sydney/Wollongong area from the south of NSW. The development of the Western 500 kV conversion project coupled with the development of generation in southern NSW are the main drivers for the upgrading of these three lines. The works were included in the regulatory consultation for the western 500 kV conversion project. The works are expected to be completed about 2015.

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

Location	Installation	Completion	Comments
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 after site measurements have been completed	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
Murray – Guthega 132 kV line rehabilitation	Restore rating for longer term requirements	Late 2013	
Newcastle 330 kV Substation, provide 330 kV bus coupler circuit breaker		2016	Newcastle is a critical substation supplying large urban loads. The works are being combined with transformer work.
Sydney South 330 kV Substation, provide 330 kV bus coupler circuit breaker		Around 2014	Sydney South is a critical substation supplying large urban loads

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	2014	
Quality of supply monitoring	Progressive installations starting in the second half of 2013	TransGrid is identifying the optimal plant requirements to achieve accurate monitoring
Real time line rating monitoring systems	Progressive installations starting in the second half of 2013	Real time monitors are being progressively developed across the network in NSW

5.3.10. Proposed Substation Fault Rating Upgrades

The following table summarises proposed fault rating upgrades that have previously been reported.

Table 5.12 – Proposed 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 at least 38 kA	Late 2015	

5.3.11. 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 5.13 – Proposed Transformer Replacements and Upgrades that have Completed the Regulatory Process

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	Condition based replacement of the three remaining banks of single phase 330/132 kV transformers by new 375 MVA three phase units	2016 (with the first in 2013)	
Yanco 132/33 kV Substation	Condition-based replacement of two 45 MVA 132/33 kV transformers by two new 60 MVA units	2014	
Griffith 132/33 kV Substation	Condition-based replacement of three 45 MVA 132/33 kV transformers by three new 60 MVA units	2014	
Munyang 132/33 kV Substation	Condition-based replacement	2013	Gas insulated transformers to meet environmental requirements
Kempsey 33/66 kV Substation	Condition-based replacement	2014	

5.3.12. 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 5.14 – Proposed Line Switchbays for Distributor Requirements Previously Reported

Location	Installation	Completion	Comments
Sydney West 330/132 kV Substation	One new 132 kV switchbay	2013	DNSP requirement
Newcastle 330/132 kV Substation	One new 132 kV switchbay	2015	DNSP requirement
Tamworth 132/66 kV Substation	One new 66 kV switchbay	2013/14	DNSP requirement
Williamsdale 330/132 kV Substation	One new 132 kV switchbay	2018/19	DNSP requirement

5.3.13. Proposed Replacement Transmission Network Assets

The following table summarises proposed replacement transmission network assets.

Table 5.15 – Proposed Replacement Transmission Network Assets

Location	Installation	Completion	Comments
Broken Hill 220/22 kV Substation	Replace the control systems and some plant on both SVCs	2014	
Kemps Creek 500/330 kV Substation	Replace the control systems and some plant on both SVCs	2013/14	
Armidale 330/132 kV Substation	SVC refurbishment work is required to maintain its reliability. Extent of work is currently being assessed		An important consideration will be the SVC outage requirements and the impact of this on the reliability of the system and operation of the market
999 Yass to Cowra 132 kV line uprating	Restoration of line rating	2014	Any cost effective augmentation opportunities identified during detail design work would be pursued
94B Wellington to Beryl 132 kV line	Replacement of poles	2014	
Dapto 330/132 kV Substation	Dapto – Sydney South line rehabilitation	2014	

5.3.14. Proposed System Reactive Plant Requirements Previously Reported

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

Table 5.16 – System Reactive Plant Requirements

Location	Details	Indicative Date
Sydney South 330/132 kV Substation	Install a new 200 MVAr 330 kV capacitor bank to maintain adequate power transfer and voltage control capability to the loads of southern Sydney	2012/13
Sydney West 330/132 kV Substation	Expansion of one 80 MVAr 132 kV capacitor bank to 160 MVAr	2012/13
Regentville 330/132 kV Substation	One new 80 MVAr capacitor bank	After 2015
Canberra 330/132 kV Substation	Expansion of an existing 80 MVAr bank to a 120 MVAr 132 kV capacitor bank as part of refurbishment works, to maintain adequate power transfer capability from the southern generators towards Sydney and the NSW south coast as the load grows. It is aimed to ensure that voltage control constraints are no more limiting than line thermal rating capability.	2013/14
Yass 330/132 kV Substation	One new 80 MVAr 132 kV capacitor bank. To maintain adequate power transfer capability from the southern generators towards Sydney and the NSW south coast as the load grows. It is aimed to ensure that voltage control constraints are no more limiting than line thermal rating capability.	About 2013/14

5.4 Network Replacement Projects Summary

The following Table 5.17 lists a summary of network replacement projects proposed or committed covered in this chapter of the APR.

Table 5.17 – Summary Network Replacement Projects Proposed or Committed

Project	Clause	Purpose	Proposed Completion Date
Yass 132/66 kV No. 3 transformer replacement	5.1.9	Condition based replacement	2012
Wallerawang 330/132 kV Nos. 1 & 2 transformer replacements	5.1.9 5.2.12	Condition based replacement	2012 2014
Sydney South 330/132 kV Substation No. 4 transformer replacement	5.1.9	Condition based replacement	2012
Wallerawang 132/66 kV Substation replacement	5.2.5	Condition based replacement	2014
Upper Tumut 330 kV Switching Station refurbishment	5.2.6	Condition based renewal	2014
Beaconsfield West 330/132 kV Substation, 132 kV GIS switchgear replacement	5.2.7	Condition based replacement	2012
Narrabri 132/66 kV Substation transformer replacements	5.2.12	Condition based replacement	2013
Coffs Harbour 132/66 kV Substation capacitor bank replacement	5.2.13	Condition based replacement	2012
Griffith 132/33 kV Substation capacitor bank replacement	5.2.13	Condition based replacement	2012
Port Macquarie 132/66 kV Substation capacitor bank replacement	5.2.13	Condition based replacement	2012
Dapto – Sydney South 330 kV line rehabilitation	5.2.14	Condition based replacement	2013
Dapto 330/132 kV Substation replacement of secondary systems	5.2.14	Condition based replacement	2013
Sydney South – Haymarket cable tunnel life extension	5.3.6	Condition based renewal	2013
Murray – Guthega 132 kV line rehabilitation	5.3.8	Condition based renewal	2013
Wallerawang – Orange 132 kV line replacement	5.3.9	Condition based replacement	2014
Newcastle 330/132 kV Substation single phase transformer replacements	5.3.11	Condition based replacement	From 2013
Yanco 132/33 kV Substation transformer replacements	5.3.11	Condition based replacement	2014
Griffith 132/33 kV Substation transformer replacements	5.3.11	Condition based replacement	2014
Munyang 132/33 kV transformer replacements	5.3.11	Condition based replacement	2013
Kempsey 33/66 kV transformer replacements	5.3.11	Condition based replacement	2014
Broken Hill 220/22 kV Substation SVC control systems replacements	5.3.13	Condition based replacement	2014
Kemps Creek 500/330 kV Substation SVC control systems replacements	5.3.13	Condition based replacement	2013/14
Wagga 132/66 kV Substation replacement	5.3.13	Condition based replacement	2015
Beryl – Wellington 94B 132 kV line pole replacement	5.3.13	Condition based replacement	2014
Sydney West 330/132 kV Substation capacitor bank replacement	5.3.14	Condition based replacement	2012/13

5.5 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.

5.5.1. Forecast Constraint Information

The required forecast constraint information with respect to proposals in Chapter 5 is provided in Table 5.18.

Table 5.18 – 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	• With no Directlink support – Winter 2016; 10 MW • With Directlink support (1 pole) – Winter 2022; 4 MW
Supply to the Lower Mid North Coast (Stage 2: Stroud–Taree)	Thermal overload	Taree	Early 2020s
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

5.5.2. Intent to Issue Request for Proposal

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

Table 5.19 – 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 (Stage 2: Stroud – Taree)	Issued	Issued 2010
Development of Southern Supply to the ACT	No	
Supply to the Tomerong/Nowra Area	Issued	Issued 2012
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		
• Transpose Wallerawang – Sydney South/Ingleburn 330 kV line	No	
• Multiple Contingency Protection 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 Monitoring	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	EoI covering NSCAS has been issued, RfP 2012	EoI 2012




CHAPTER 6

Constraints and Proposed Network Development within Five Years

CHAPTER 6

Constraints and Proposed Network Development 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.

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

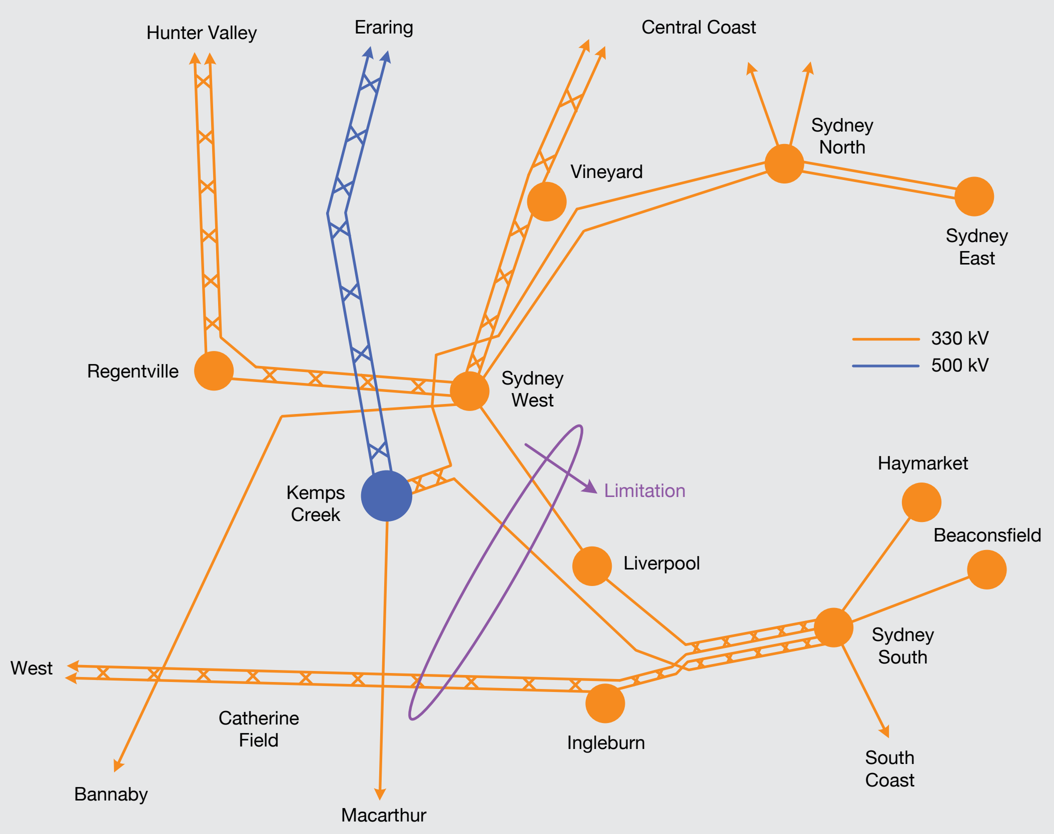
6.1 Proposed Network Developments within Five Years

This section describes constraints that are expected to emerge within a five year planning horizon, for which there are augmentation proposals.

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 may however 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:

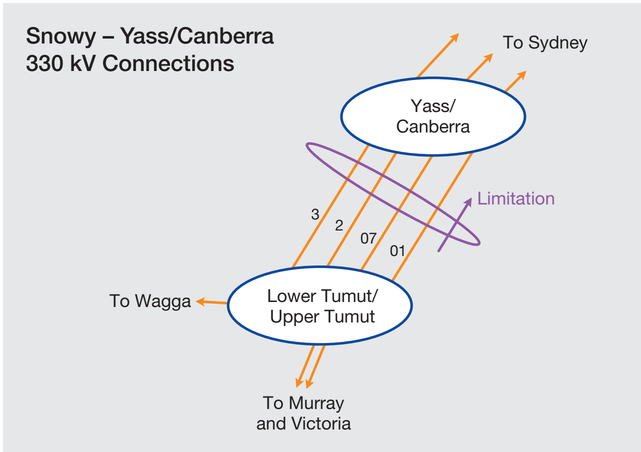
- Because of the high cost of developments in this urban area development options will have to provide sufficient capacity for long-term needs;
- Maximum use will be made of existing easements where possible. It is preferred that any new lines would be of double circuit construction;
- Options will need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

Whilst the existing system is expected to provide an adequate supply capability until late this decade the development of a new line will require the removal of an existing 330 kV line for reconstruction and hence it is necessary to commence this project in the near future.

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

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



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 recent upgrade of the Snowy generators, 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 Upper Tumut – Canberra No. 01 and Upper Tumut – Yass No. 02 330 kV lines presently operate with a design temperature of 85°C. The Lower Tumut – Yass and Lower Tumut

CHAPTER 6

Constraints and Proposed Network Development within Five Years

– 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.

Some refurbishment work is expected to be required on the Upper Tumut – Yass and Upper Tumut – Canberra 330 kV lines to bring them to an acceptable standard. It is feasible to further raise the conductor clearances on these 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 coordination 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 may comprise the combination of:

- The implementation of a system protection scheme; and
- Either the upgrading of the No. 01 and No. 02 330 kV lines or the installation of power flow control plant at Yass and/or Canberra.

Reactive support plant would be required to ensure that the full line ratings could be utilised without being limited by voltage control constraints. It is anticipated that the following reactive plant will be required:

- One new 200 MVAr 330 kV capacitor bank at Canberra; and
- One new 120 MVAr 132 kV capacitor bank at Canberra.

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 supplying 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 and TransGrid are proposing the construction of a 132/66 kV substation in the Hallidays Point 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 Hallidays Point Substation on completion of the works, which is anticipated by late 2013.

The regulatory consultation process addressing these limitations has commenced.

6.1.4. Voltage Control in the Snowy Area

The maximum voltage level at Upper Tumut Switching Station (UTSS) is limited by the voltage rating of Snowy Hydro's generator transformers. There are four generator transformers connected at UTSS.

To date the voltage limitation has been managed by AEMO contracting with Snowy for operation of some of the Snowy units as synchronous generators or operating the generators to absorb VArs. The contracting takes place as part of the NSCAS arrangements. Typically the voltage issue needs to be managed each day over the several hours of low system load and low power transfers between Victoria and NSW.

Following recent Rule changes TransGrid will need to take over the contracting for the voltage control services or devise another means for managing the voltage control.

TransGrid is considering the following options for voltage control:

- Replacement of the limiting generator transformers at Upper Tumut. It is understood that one of these may have already been upgraded.
- Installation of shunt reactors.
- Contracting with critical generators for the absorption of VArs.

The Rule change takes effect in 2012 but TransGrid will be required to undertake a RIT-T assessment of options before it can progress to the optimal solution. Hence AEMO is extending its contracting arrangements for the time being.

The TransGrid RIT-T activities will progress in 2012.

6.1.5. Voltage Levels at Kangaroo Valley

Kangaroo Valley 330 kV Switching Station effectively connects the 240 MW of Kangaroo Valley and Bendeela generators to the system. 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 augmentation 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. Preliminary investigations indicate there are three viable augmentation options:

- A new 330 kV shunt reactor at Kangaroo Valley;
- A new 330 kV shunt reactor at the new Tomerong site (expected late 2015); and

- Uprating the Kangaroo Valley transformer bushings for +10% over voltage.

The cost of the reactor installation is approximately $6 million. This reactor could be installed in about three years.

The uprating of the transformers bushing would involve liaison with Eraring Energy.

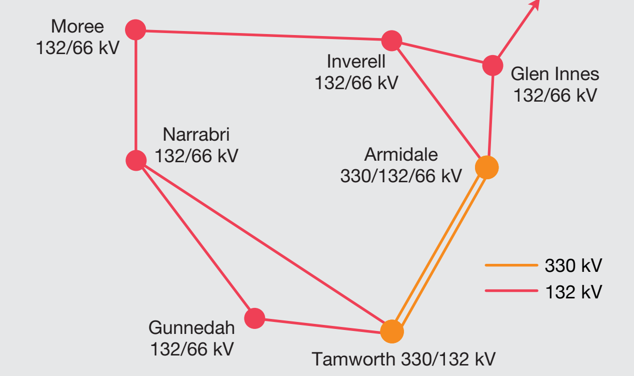
Both the Kangaroo Valley generation and Capital Wind Farm (including Woodlawn Wind Farm) are connected to the single circuit 330 kV line extending between Dapto and Canberra. During particular line outage conditions there is a risk of over-voltages occurring, depending on the generating units connected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

6.1.6. 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 recently dismantled Tamworth – Gunnedah 66 kV line No. 875;
- Construction of a 330 kV line (initially operating at 132 kV) from Tamworth to the Narrabri area;
- 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 recently dismantled 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 published in March 2011. As submissions to the Report indicated that cost effective non-network options may be available a Request for Proposals for non-network options was published in January 2012.

6.1.7. 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.

In its NSCAS considerations AEMO has determined that there is sufficient reactive support in the NSW system, particularly in the Sydney area, over the next few years, allowing for the MVAr capability set out in the Registered Performance Standard of each generating unit and allowing for TransGrid's committed capacitor bank projects. Hence TransGrid will not be seeking additional reactive support from NSW generators this year.

6.1.8. 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.

Similar controls were also installed at sites in NSW by TransGrid but the communication links between the sites and Murraylink have not been completed. It is proposed that these runback controls be completed and the owners of Murraylink will then acquire the communication links.

6.1.9. Smart Grid Applications

TransGrid aims to maximise the capability of the existing network through the use of non-network alternatives, deferring as much as possible any large-scale network developments. Two types of non-network alternatives are the use of network support arrangements as discussed in Sections 2.10 and 7.1 and advanced control systems often described as Smart Grid applications. The NSW system presently contains a range of control and protection systems which can be categorised as Smart Grid applications. The systems include:

- 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 coordinated across areas of the system;
- System Protection Schemes to extend the capability of the system, by the automatic switching of plant and the opening of network connections; and
- The extensive application of high-speed disturbance monitoring across the system.

Many of these systems have been used to improve the power transfer capability of the existing network, thereby minimising the need for network developments. SVC controls have been used to co-ordinate the switching of external reactive plant items to provide improved voltage control and to extend the capability of the existing system.

Oscillatory damping control is applied to generators and SVCs, effectively minimising the impact of damping issues on the operation of the system. QNI is the only section of the network now limited by damping considerations and this occurs under NSW import conditions. The extensive use of damping controls has enabled the NSW import capability to be maximised and further attention to the Armidale SVC is expected to provide additional capability.

Controls on network connections can be applied to automatically open selected network elements following a contingency. This then removes some network limitations that may otherwise limit power transfer capability. These schemes have been installed in the Darlington Point area, the Yass – Wagga area and the NSW north coast. These transmission systems are then able to operate to their maximum capability.

TransGrid has implemented an extensive network of high speed monitors. In conjunction with the conventional high speed fault recorders fitted to protection relays, this monitoring enables detailed investigations of system behaviour following a disturbance to the system, such as a fault or tripping of a load or generator.

Smart Grid applications are being further developed through joint work with Ausgrid on the Smart Grid Smart City project. A number of monitors are to be installed at 330 kV substations between Newcastle and Sydney to coordinate with Ausgrid's installations. The monitors will record voltage phasor information in real-time and the data will be compiled in a data collector. Initially it will be used for off-line analysis. TransGrid will apply this data to improve models of the system with the aim of further improving the system analysis that underpins planning for the future system.

TransGrid is further considering 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.

Two research projects are presently under way:

- The application of wide-area measurements to the overall control of the dynamic performance of the system. There is an opportunity to improve the power transfer capability of the system governed by stability considerations.
- A pilot scheme to test the application of post-contingency load controls. There is an opportunity to control loads following a contingency to alleviate system constraints. This may provide a non-network solution to an emerging supply issue.

With respect to the second of these projects, one example is the utilisation of high speed communications to access the Smart Meters installed in the DNSP system that control elements of consumer loads. The pilot scheme aims to control the load in an area down to the DNSP customer level following a contingency. Taking for example the Newcastle system, should one of the 330 kV lines supplying the Newcastle area fail then the Smart Grid control would be used to effectively reduce the Newcastle area load to within the capability of the remaining 330 kV transmission system. In principle it is possible to interrupt non-essential loads such as pool pumps and air-conditioners to reduce an area load and maintain the area load within the capability of the 330 kV supply system. As the system capability varies over the minutes and hours following the contingency the area load could be sculptured to match.

The advantage of a post-contingency control is that a critical contingency is likely to happen only very rarely and the scheme would therefore only need to operate rarely. The impact on consumers would then be minimised and hence the cost to consumers would be relatively small. It is likely that such a scheme would be more readily accepted by consumers over other schemes that may aim to curtail demand under normal system conditions.

By managing the area load to within the capability of the system following a contingency it is possible then to defer the need for major network reinforcements. In the Newcastle case this may enable the deferral of a 500 kV line.

6.1.10. Replacement of 41 Cable Capacity

The Sydney inner metropolitan area and CBD network is presently supplied by two 330 kV cables from Sydney South 330/132 kV Substation and Ausgrid's underlying 132 kV network. The 41 cable runs between Sydney South and Beaconsfield West substations to supply the inner metropolitan area, and 42 cable runs between Sydney South and Haymarket substations to supply the Sydney CBD.

Cable 42 is fitted with a distributed temperature sensing system which enables accurate measurement of the ground temperature along the entire route of the cable. Cable 41 and 42 cross a similar non-homogenous route, and hence the ground temperature measurements are applicable to both for rating purposes. Since the commissioning of 42 cable in 2004, the distributed temperature sensing has indicated higher ground temperatures than originally assumed when the design for 41 cable was undertaken during the 1970s. These higher ground temperatures impact on the amount of heat that can be dissipated away from the cable, and therefore reduce the maximum rating of the cable.

Inspections of the 41 cable route in recent years have uncovered the leaching of key materials from the backfill and the creation of voids in the bedding. The loss of this material makes the bedding and backfill material thermal resistivity quite variable and highly

sensitive to ground moisture levels. As a consequence the thermal resistivity of the backfill and bedding material is very poor at low ground moisture levels compared to the original design, limiting its capacity to dissipate the heat.

As a result of changes to the condition of the bedding and backfill the cable's summer nominal cyclic rating for summer 2011/2012 was reduced from 663 MVA to 575 MVA, assuming sufficient ground moisture to maintain this rating. Weather conditions including rainfall vary from season to season, and year to year. In the event of extended dry weather, the cable rating will need to be further reviewed and potentially reduced further during such dry spells to avoid damage to the cable. The 41 cable rating will therefore be revised on at least a yearly basis.

The capacity of cable 41 is proposed to be replaced by the new supply to the inner metropolitan area, described in Section 6.1.11.

6.1.11. Supply to the Sydney Inner Metropolitan Area

The Sydney inner metropolitan area is presently supplied by two 330 kV cables from Sydney South 330/132 kV Substation and Ausgrid's underlying 132 kV network. The 41 cable runs between Sydney South and Beaconsfield West substations and 42 cable between Sydney South and Haymarket substations.

A number of 132 kV cables within Ausgrid's network are approaching the end of their serviceable lives.

Recent investigations regarding the condition of the 41 cable installation resulted in a reduction of the cable's continuous cyclic load-carrying capability for summer 2011/12 from 663 MVA to 575 MVA (refer to Section 6.1.10). This re-rating results in a constraint on the inner metropolitan supply that does not allow the present 'modified n-2' planning criteria to be met.

Various network options to reduce risk exposure in the short term have been identified and investigated, including:

- Installation of a larger series reactor on 41 cable at Sydney South substation, to limit power flow on 41 cable;
- Installation of a phase shifting transformer on 41 cable at Sydney South substation, to limit power flow on 41 cable;
- Works within the Ausgrid 132 kV network; and
- Rearrangement of existing series reactors at Sydney South substation to increase the series reactance associated with 41 cable.

At this stage it is expected that installing a larger series reactor on 41 cable, together with works within Ausgrid's 132 kV network, will be the most practical short term option.

The rating of 41 cable will be reviewed at least annually with the prospect of it being further reduced should the bedding material dry out, such as may occur during dry spells. Consequently, it is not possible to rely on 41 cable having any particular capacity in the medium term. To cater for this uncertainty, it is proposed to provide additional capacity to the inner metropolitan area. This would enable 41 cable to be retired should its condition dictate or to be removed from service should the backfill material dry out and its rating be reduced significantly.

A number of options are presently being investigated, including provision of one or more 330 kV circuits to the inner metropolitan area from:

- Sydney South;
- Sydney East;
- Sydney North; and
- Rookwood Road.

At this stage installation of a new 330 kV cable from Rookwood Road to Beaconsfield West is expected be the most cost effective option. As the new cable would have a higher rating than 41 cable (similar to the rating to 42 cable), once completed, it would increase the capacity of the network supplying the inner metropolitan area. However, it is presently expected that further additional capacity will be required within a few years to accommodate expected increased load and the retirement of Ausgrid 132 kV cables.

6.1.12. Minor Augmentation Proposals

The NER requires annual planning reports to include information pertinent to all proposed augmentations to the network irrespective of their cost. Table 6.1.2 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.

Table 6.1 – Minor Augmentation Proposals

Proposal	Need	Completion	Cost ($M)	Other Options Considered	Comments
Increase the bay ratings at Waratah West 330/132 kV Substation for lines 96X and 96Y	Removal of secondary systems limitations	2013	0.05		Requested by distributor
Increase the bay ratings at Newcastle 330/132 kV Substation for lines 960 and 961	Removal of secondary systems limitations	2017	0.15		Requested by distributor

6.1.13. Proposed Replacement Transmission Network Assets

The NER requires annual planning reports to include information pertinent to all asset replacement proposals where the capitalised expenditure is estimated to be more than $5 million. These proposals are detailed in Table 6.2. Network or non-network alternatives are considered. Submissions for non-network alternatives are invited. Where submissions for non-network alternatives are received these will be acknowledged in the next Annual Planning Report.

Table 6.2 – Proposed Replacement Transmission Network Assets

Project	Purpose	Possible Commissioning Date	Indicative Cost	Credible Alternatives
Albury 132 kV Substation secondary systems replacement	Condition based replacement	2016	$10 million	None identified
Beaconsfield West 330/132 kV Substation Nos. 1 & 2 transformer replacement	Condition based replacement	2016, 2017	$45 million	Non-network alternative for transformer capacity
Buronga 275/220 kV Substation line No. X2 220 kV reactor replacement	Condition based replacement	2016	$14 million	None identified
Burrinjuck 132 kV Substation renewal	Condition based renewal	2016	$14 million	Establish new 132 kV substation
Canberra 330/132 kV Substation No. 2 transformer	Condition based replacement	2016	$10 million	Non-network alternative for transformer capacity
Cooma – Munyang 132 kV line rebuild	Condition based remediation	2016	$11 million	Build new line
Cooma 132 kV Substation replacement	Condition based replacement	2015	$52 million	Refurbish on existing site
Griffith 132/33 kV Substation secondary systems replacement	Condition based replacement	2015	$15 million	None identified
Line No. 96H Coffs Harbour – Koolkhan pole replacements	Condition based replacement	2015	$15 million	Rebuild line
Line No. 993 Gadara – Wagga Wagga pole replacements	Condition based replacement	2016	$7 million	Rebuild line
Line No. 99F Uranquinty – Yanco pole replacements	Condition based replacement	2016	$15 million	Rebuild line
Line No. 99J Yanco – Griffith rebuild	Condition based replacement	2014	$12 million	Replace poles
Line No. 9U3 Gunnedah – Narrabri pole replacements	Condition based replacement	2016	$16 million	Rebuild line
Marulan 330/132 kV Substation No.4 transformer replacement	Condition based replacement	2017	$14 million	Non-network alternative for transformer capacity
Molong 132/66 kV Substation secondary system replacement	Condition based replacement	2015	$8 million	None identified
Murray and Lower Tumut 330 kV Switchyards, 11 kV switchboard replacements	Condition based replacement	2017	$10 million	None identified
Orange 132/66 kV Substation, 66 kV and secondary system refurbishment	Condition based replacement	2014	$34 million	Establish new 66 kV substation
Sydney North 330/132 kV Substation Nos. 1 & 2 132 kV capacitor bank replacement	Condition based replacement	2017	$7 million	Non-network alternative for reactive capacity

Table 6.2 – Proposed Replacement Transmission Network Assets (continued)

Project	Purpose	Possible Commissioning Date	Indicative Cost	Credible Alternatives
Sydney West 330/132 kV Substation secondary system replacement	Condition based replacement	2016	$32 million	None identified
Tamworth 132/66 kV Substation rebuild	Condition based replacement	2016	$50 million	Refurbish substation on existing site
Tumut 132/66 kV Substation secondary systems replacement	Condition based replacement	2014	$11 million	Establish new 132 kV substation
Vales Point 330 kV Switchyard rebuild	Condition based replacement	2018	$72 million	Establish new 330 kV substation
Wagga Wagga 132/66 kV Substation rebuild	Condition based replacement	2016	$51 million	Refurbish substation on existing site
Yanco 132/33 kV Substation renewal	Condition based replacement	2016	$37 million	Establish new 132 kV substation

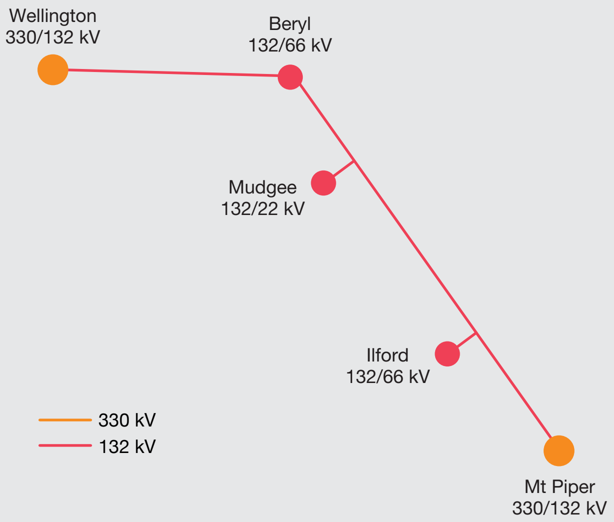
6.2 Other Constraints Emerging within Five Years

Within five years, a number of constraints, for which there are presently no firm proposals, are expected to emerge. 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



During outages 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;
- Establishment of a second Wellington – Beryl 132 kV line, possibly utilising part of the route of an 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.

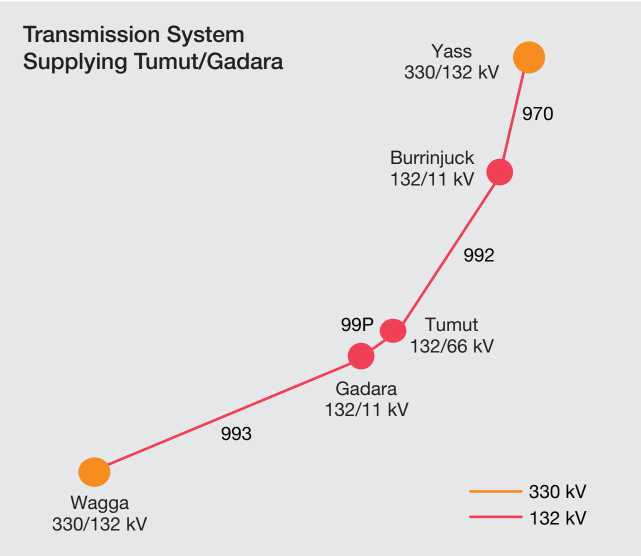
It is presently expected that the regulatory consultation process will start during 2012.

6.2.2. Supply to Mudgee

Supply to Essential Energy's Mudgee 132/22 kV Substation is presently via a tee connection to the 132 kV line from Beryl to Mt Piper. To meet reliability and security requirements as a result of load growth in the Mudgee area, Essential Energy has proposed to convert the tee connection to a loop-in connection. The details of the supply system can be seen in the diagram in Section 6.2.1.

6.2.3. Supply to Tumut/Gadara

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



An expansion of the Visy mill at Gadara has 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.

The condition of the transmission lines in this system is being assessed and any constraint arising may be partially or wholly addressed with any remedial works required to restore the condition of the following transmission lines:

- Burrinjuck – Tumut 132 kV transmission line No. 992;
- Burrinjuck – Yass 132 kV transmission line No. 970;
- Wagga 330 – Gadara 132 kV transmission line No. 993; and
- Gadara – Tumut 132 kV transmission line No. 99P.

6.2.4. 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 was 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 and network developments that will change the previous findings and conclusions. 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 Queensland transient stability power transfer capability;
- Introduction of the Regulatory Investment Test for Transmission (RIT-T) to replace the Regulatory Test; and
- Various generation developments.

As a result TransGrid and Powerlink signed a MOU in 2010 to re-evaluate the options, the market benefits and the optimal timing for the upgrade.

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

In December 2011, the TransGrid and Powerlink issued a press release to inform the NEM that QNI could be upgraded. The two organisations published the Project Specification Consultation Report in June 2012.

The Project Specification Consultation Report includes the following augmentation options:

- Series compensation of the interconnecting 330 kV lines between Armidale, Dumaresq and Bulli Creek;
- Line series compensation and a second Armidale SVC;
- A new SVC at Armidale;
- Augmentations to protection systems to improve line fault clearing times;
- A second HVAC interconnection at 330 kV between Bayswater and the Queensland Western Downs;
- A new Armidale – Dumaresq – Bulli Creek HVAC 330 kV development;
- A second HVAC interconnection at 500 kV;
- A HVDC back-to-back scheme in QNI; and
- A braking resistor in the Hunter Valley.

In each of these options there is a range of supporting works in the NSW and Queensland systems.

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

The double circuit 330 kV line (circuits No. 76 and No. 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.

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

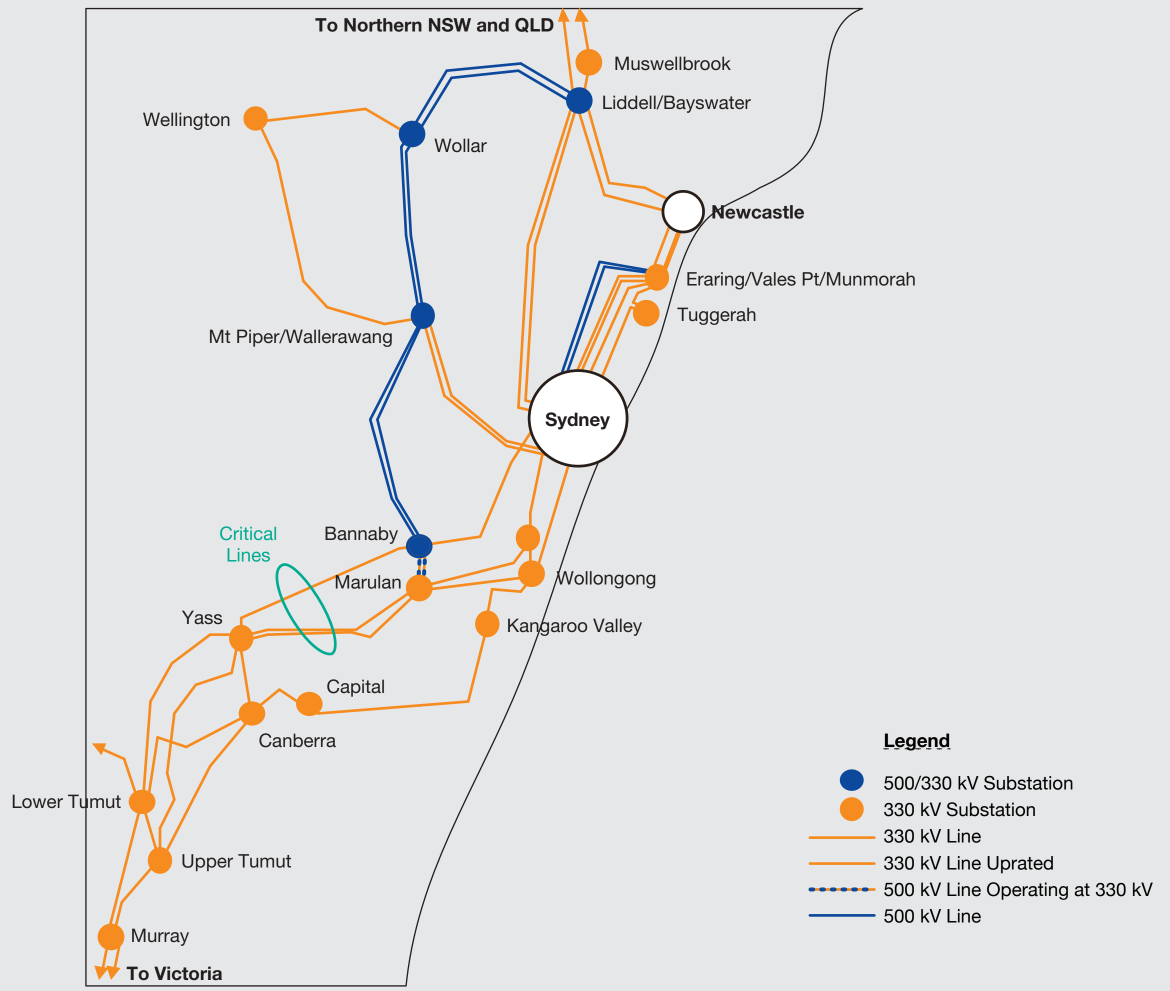
Following the development of the Bannaby 500/330 kV Substation in 2010 the transmission connections between Bannaby/Marulan and the Yass area are now as shown in the figure below. The connections consist of the Bannaby – Yass single circuit No. 61 330 kV line and the two Marulan – Yass single circuit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



CHAPTER 6

Constraints and Proposed Network Development within Five Years

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 to 3,300 MW in summer and the NSW import often reaches this limit at times of NSW peak load.

Section 6.1.2 discussed the upgrading of the transmission capability north of Snowy. This upgrade would improve the ability of the system to accommodate 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. Significant southern generation development, coupled with import from existing southern NSW generation and 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. 61 line to higher thermal rating. Relatively minor work on a limited number of spans is required.

Upgrading of the No. 4 and No. 5 lines is expected to require more significant work in modifying towers and other line work.

For all three lines it is expected that no new line development would be required.

An alternative to upgrading the 330 kV lines is to install power flow control plant.

It is expected that the upgrading of the lines or installation of the power flow control plant will be required in association with the expected generation developments in the area in the near future.

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.

6.2.7. Spare Armidale SVC Transformer

The Armidale SVC provides an essential role in voltage control and transient stability control on QNI. Shortly the SVC power oscillation damper will also be completed making the SVC also operate to control damping on the system. The SVC provides many hundreds of MWs of capability on QNI.

The SVC is connected via a single 330 kV transformer. Whilst the various components of the SVC carry some level of redundancy or can be readily repaired following a failure, the SVC transformer has no backup.

The transformer has operated well over its 12 years of life. A failure of the transformer is expected to be a rare event. Nevertheless should the transformer fail it may be out of service for 12 months or more. It is considered prudent to now procure a spare transformer.

6.2.8. 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.

Consideration is being given to the feasibility of re-constructing the switchyards within the existing site boundaries. TransGrid is also presently in the process of identifying potential sites for the new switchyards should it not be feasible to achieve an in-situ development.

6.2.9. Supply to the Darlington Point Area

The south western area centred around Darlington Point includes the major load areas of Griffith, Yanco, Deniliquin and Finley. The network supplying the Darlington Point area is shown in the diagram below.

The area is supplied by a single 330 kV line from Wagga supported by the underlying 132 kV network that extends west from Wagga. The 220 kV system extends west from Darlington Point to Broken Hill and to Victoria at Red Cliffs.

The 220 kV network carries power towards Red Cliffs when Victoria is importing from NSW and Snowy and can transmit power towards Darlington Point at other times. The 220 kV system can therefore be viewed as imposing an extra load on the Darlington Point area or can provide supporting supply.

At present this system in its normal configuration is not able to withstand a forced outage of the Wagga – Darlington Point 330 kV line at times of relatively high area loads. At times of high load in the future the 132 kV network would be segregated prior to any contingency to avoid overloading of 132 kV lines or loss of voltage control. At times of high loads there will therefore be a loss of supply following a 132 kV contingency.

The planning of this system, in consultation with the DNSP, accepts that there will be a certain level of risk to supply under system normal conditions.

The forced outage of the Wagga – Darlington Point 330 kV line also requires the 220 kV system to be opened when necessary to remove any additional burden on the remaining underlying 132 kV network. This is achieved by an automatic system protection scheme.

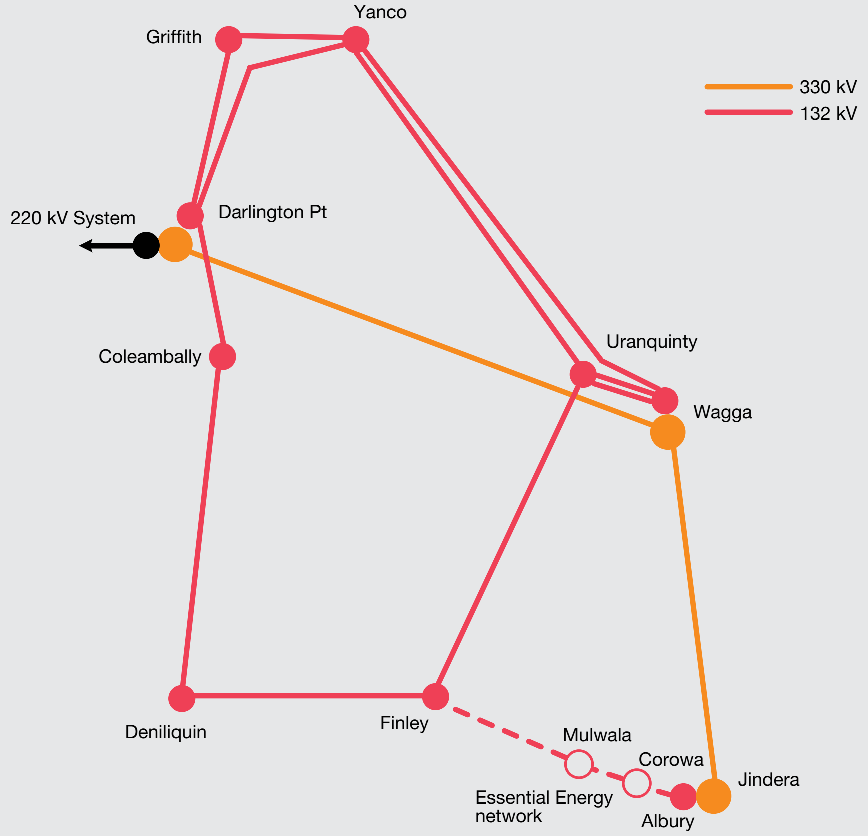
The load in the area is growing and there is an emerging need to reinforce supply to the area to reduce the risk and potential market cost of a loss of supply.

TransGrid is considering a number of options:

- Development of the 330 kV network to the Darlington Point area;
- Reactive support;
- Development of the 330 kV network to the Finley area;
- Development of the 220 kV network from the Victorian system, across the Murray River, to support the area;
- Further development of the 132 kV system in the area;
- Non-network support such as load reduction at times of high load or embedded generation; and
- Extension of the 500 kV system south from the Wagga area, which may form part of an interconnection with Victoria such as via NEMLink.

At this stage a 330 kV line development between Wagga and Darlington Point is the preferred network augmentation.

Existing system in the Wagga – Darlington Point area



CHAPTER 6

Constraints and Proposed Network Development within Five Years

6.2.10. 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 6.2 – Line Switchbays for Distributor Requirements Within Five Years

TransGrid Location	Details	Indicative Date	Distribution Devlopment
Tumut 132/66 kV Substation	One 66 kV switchbay	2013/14	Supply to Batlow
Wellington 330/132 kV Substation	One 132 kV switchbay and a short section of double circuit line construction	2013	Supply to the Dubbo area
Lismore 330/132 kV Substation	Two 132 kV switchbays	2015-17	DNSP requirement
Vineyard 330/132 kV Substation	132 kV switchbays	2017	Endeavour Energy
Wagga North 132/66 kV Substation	132 kV switchbay	2014	Essential Energy, supply to Temora

6.2.11. Transformer Capacity Upgrades and Replacements

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

Table 6.3 – Transformer Capacity Upgrades and Replacements Within Five Years

TransGrid Location	Details	Indicative Date
Tumut 1 & Tumut 2 Power Stations	Replacement of the generator transformers at Tumut 1 and Tumut 2 power stations is being considered to relieve voltage rating limitations	2014

6.2.12. System Reactive Plant Requirements

The growing load on the network requires ongoing installations of reactive support plant where this is economic.

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 6.4 – System Reactive Plant Requirements

TransGrid Location	Details	Indicative Date
Yass	One new 132 kV, 80 MVAr capacitor bank	2013/14
Canberra	Upgrading an existing 132 kV capacitor bank	2013/14
Canberra	A new 120 MVAr 132 kV bank and a new 200 MVAr 330 kV bank associated with an upgrade of the Snowy to Yass/Canberra system, see Section 6.1.2	From 2014/15
Sydney area	Further capacitor bank installations	From 2014/15
Snowy/Canberra/Yass area	Approximately 700 MVAr of shunt reactors associated with the control of voltage at Upper Tumut Switching Station, see Section 6.1.4	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 6.5 – Longer Term Constraints and Indicative Developments

Constraint	Indicative Development(s)	Time Frame (Years)
Hunter Valley – Tamworth – Armidale system	See Section 6.3.1 below	> 5
Kemps Creek 500/330 kV transformer augmentation	See Section 6.3.2 below	> 5
Newcastle – Sydney – Wollongong load area. Further development of the 500 kV system supporting the area.	See Section 6.3.3 below	> 5
Supply to Sydney East	See Section 6.3.4 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 6.2.6 on the Yass – Bannaby and Yass – Marulan 330 kV lines	> 5
Tamworth 330/132 kV Transformer	Replacement of one of the existing 150 MVA transformers, most probably by a 375 MVA unit	> 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
Canberra 330/132 kV Substation	Refurbishment or replacement of the switchyard	About 5
Supply to Albury area	See Section 6.3.8 below	> 5

Table 6.5 – Longer Term Constraints and Indicative Developments (continued)

Constraint	Indicative Development(s)	Time Frame (Years)
Supply to the Muswellbrook area	Additional 330/132 kV transformer capacity	> 5
Supply to Kew Laurieton and Lake Cathie Areas	Establishment of a 132/66 kV Substation in the area would enable the deferral of limitations in the network supplying Taree from the south. See Section 6.3.9 below	> 5
Supply to Mid North Coast, Coffs Harbour 330/132 kV transformer capacity	Coffs Harbour second 330/132 kV transformer	> 5
Thermal capacity of Raleigh – Kempsey 132 kV line	Turn Raleigh – Kempsey 132 kV line into Nambucca	> 5

6.3.1. Hunter Valley – Tamworth – Armidale 330 kV System

The northern NSW supply system is shown in the figure overleaf. 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 and underlying 132 kV systems. 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.

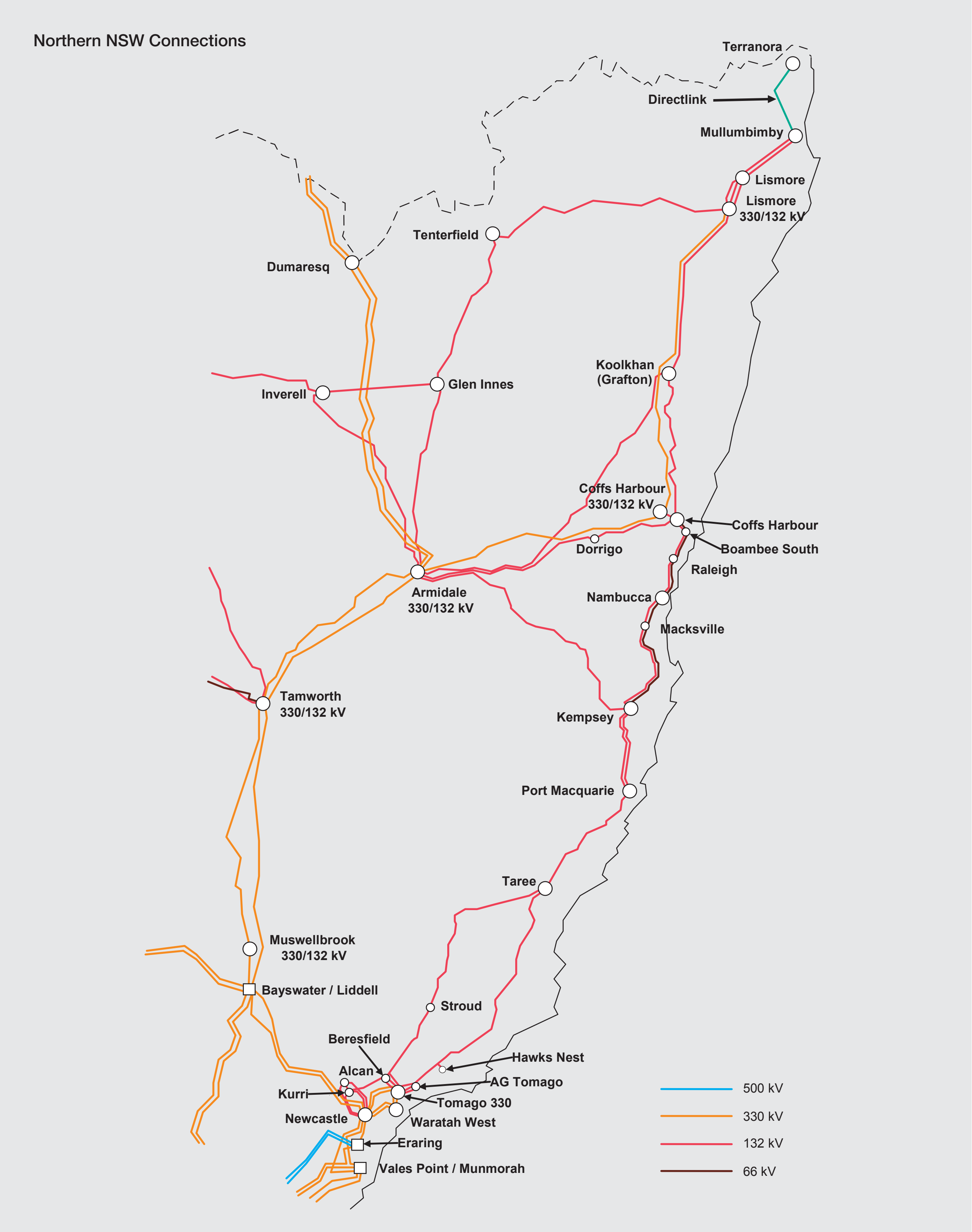
It is aimed to reinforce supply to the Lismore area with a 330 kV line from Dumaresq to Lismore.

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
Terranora
Directlink
Mullumbimby
Lismore
Lismore 330/132 kV
Tenterfield
Dumaresq
Koolkhan (Grafton)
Glen Innes
Inverell
Coffs Harbour 330/132 kV
Coffs Harbour
Boambee South
Dorrigo
Raleigh
Armidale 330/132 kV
Nambucca
Macksville
Tamworth 330/132 kV
Kempsey
Port Macquarie
Taree
Muswellbrook 330/132 kV
Bayswater / Liddell
Stroud
Beresfield
Hawks Nest
Alcan
AG Tomago
Kurri
Tomago 330
Newcastle
Waratah West
Eraring
Vales Point / Munmorah
500 kV
330 kV
132 kV
66 kV

6.3.2. 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.

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

The Newcastle – Sydney – Wollongong area includes significant urban, commercial and industrial loads. At the time of peak demand in NSW this area represents about three quarters of the NSW total load and about one third of the total load across the NEM. The area is supplied from remote power stations in NSW over a 500 kV and 330 kV network and from power stations within the area on the Central Coast, South Coast and Sydney area.

One supporting power station at Munmorah on the Central Coast may close in the near future (refer to the AEMO Statement of Opportunities).

The load in the area is growing. It is expected that this load growth will be partially met by new 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 or alternative non-network solutions. The network reinforcements are expected to be achieved through a sequence of reactive plant installations followed by the further 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. In addition it may be feasible to initially operate the new 500 kV developments at 330 kV so as to defer the installation of the relatively high cost terminal equipment.

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

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

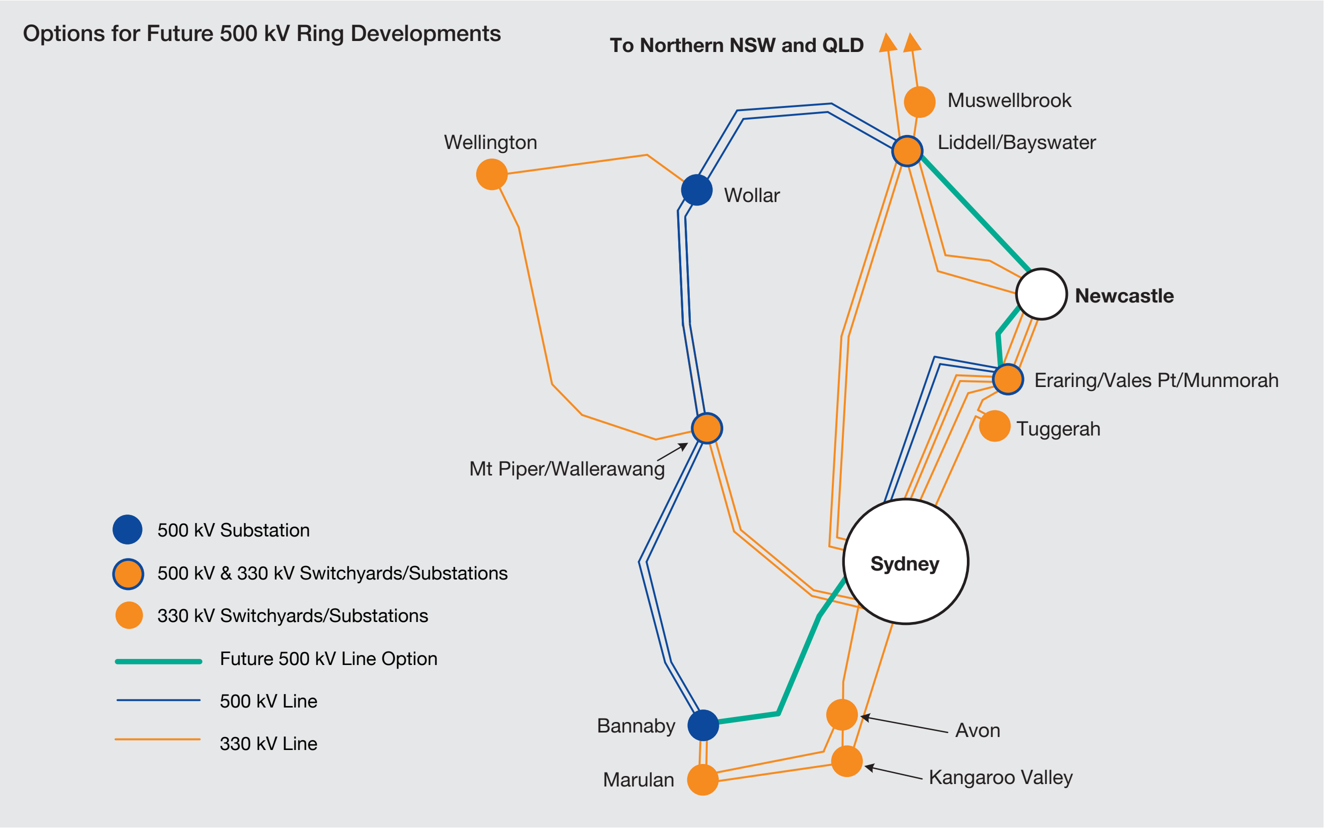
- The ability to control voltage at all points on the network to within acceptable limits for customers and to maintain the integrity of the overall supply system, particularly with respect to the Sydney area; and
- The thermal rating of transmission lines, particularly under high ambient temperature 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.

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.



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

- 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 generation expansion scenarios that 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 analysis indicates 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 centres 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 of 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 the near future. 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.

CHAPTER 6

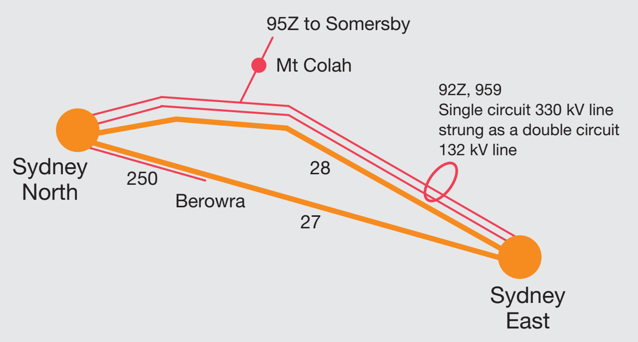
Constraints and Proposed Network Development within Five Years

6.3.4. 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 circuits. The growing Sydney East load will require support.

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

Connection between Sydney North and Sydney East



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

6.3.5. 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 interconnection could be developed as a 500 kV AC link or a HVDC link or a combination of both.

This interconnection 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 near 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 in providing options analysis to this process and is continuing to investigate these options and the connection into the NSW 500 kV system.

6.3.6. 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.

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 of AEMO's NEMLink option in the 2010 NTNDP.

The 2010 NTNDP identified the development of a phase shifting transformer between Buronga and Red Cliffs requiring early attention. TransGrid is undertaking a preliminary feasibility assessment and will continue to work with AEMO on this option.

6.3.7. 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 and has been retired as a result of its physical condition.

The 2011 ESOO indicated that the Munmorah Power Station will be retired after winter 2014. Following decommissioning of 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 location of any generation development that replaces Munmorah. 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.

TransGrid is assessing the feasibility of installing the series reactor at Vales Point Power station.

6.3.8. Supply to the Albury Area

The 132 kV transmission lines between Jindera, ANM and Albury substations form a high capacity ring out of Jindera 330 kV substation. Albury 132 kV substation also supplies Essential Energy's Corowa and Mulwala loads radially through 997 line. Essential Energy has constructed a 132 kV line between Mulwala and Finley to provide firm backup for Mulwala and Corowa from Finley. An outage of either 99H or 99B line would overload the remaining in-service line under certain operating scenarios.

A tripping scheme on 997 Mulwala-Finley 132 kV line has been implemented to trip that line in such an event to alleviate the thermal constraint. However, as the load in the area grows, the constraint is expected to re-emerge.

Options to relieve the limitation include:

- Provision of an additional 132 kV line between Jindera and Albury;
- Installation of capacitors at Albury or within Essential Energy's 132 kV and 22 kV networks supplied from Albury; and
- Demand management and local generation.

6.3.9. 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. Establishment of a 132/66 kV substation in the area would enable the Kew/Laurieton load to be transferred away from Taree. That would enable the date at which limitations in the network supplying Taree from the south emerge to be deferred. Refer to Section 5.2.9.

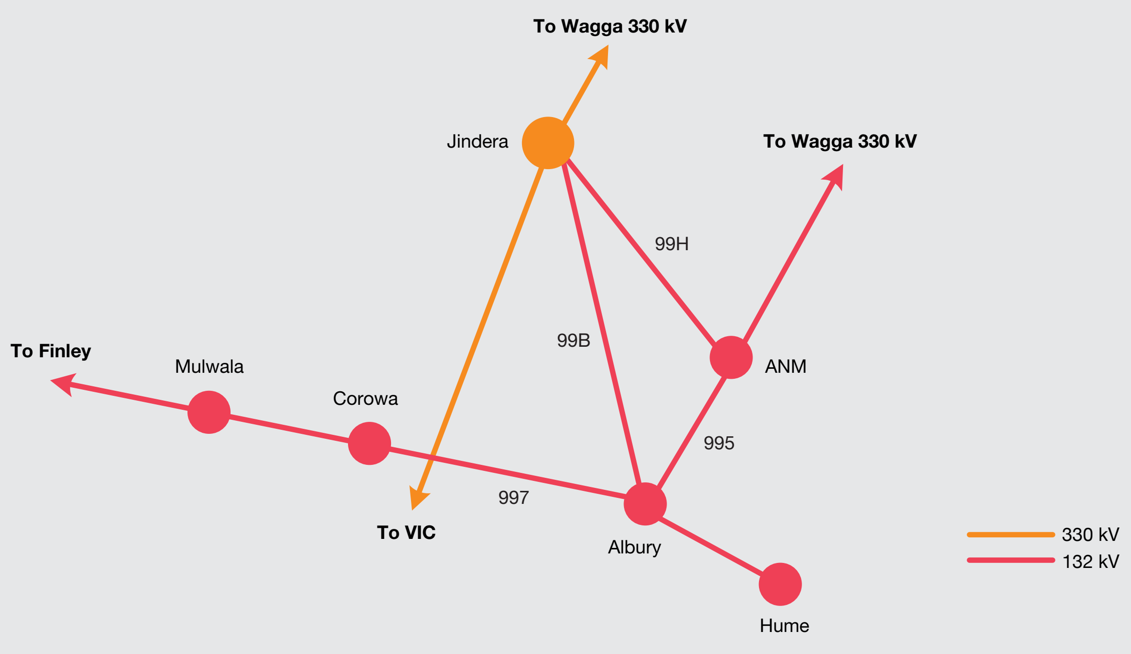
6.4 NER Rule 5.6.2A Reporting

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 6.6.

Transmission System in the Albury Area



Constraints and Proposed Network Development within Five Years

Table 6.6 – 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
Supply to Gunnedah, Narrabri and Moree Areas	Thermal overload	Gunnedah/Moree Area	Summer 2012/13; 8 MW
Supply to the Inner Metropolitan Area of Sydney	Thermal overloads	See Section 6.1.11	See Section 6.1.11
Supply to Beryl	Voltage control	Beryl	Summer 2013/14; 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
Yass – Bannaby Yass – Marulan 330 kV lines	See Section 6.2.6	See Section 6.2.6	See Section 6.2.6
Supply to the Darlington Point Area	See Section 6.2.9	See Section 6.2.9	See Section 6.2.9

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 Table 6.7.

Table 6.7 – 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	
Supply to Gunnedah, Narrabri and Moree Areas	Yes	2012
Supply to the Inner Metropolitan Area of Sydney	Yes	To be assessed
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	
System Reactive Plant Requirements	To be assessed	
Further Development of Supply to the Newcastle – Sydney – Wollongong Area	Yes	To be assessed

CHAPTER 7
Other Planning Issues in NSW

CHAPTER 7

Other Planning Issues in NSW

7.1 Sustainability

7.1.1. Consideration of Non-Network Options by TransGrid

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

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

TransGrid considers DM, local/embedded generation and bundled options on an equal footing with network options when planning its network augmentations and applying the AER's regulatory test 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 other 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 6.

7.1.2 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; 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.

7.1.3. 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.

7.1.4. Promotion of DM and Local Generation Alternatives by TransGrid

TransGrid actively promotes DM and local generation alternatives through:

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

On 10 May 2012, TransGrid hosted a DM Innovation Forum in Sydney involving all distributors, universities and advisors participating in the DM programs with TransGrid. At the forum, progress reports on all of the joint projects were presented. The participants also discussed the ways in which DM can be further promoted in NSW. The forum was very well received by all participants as a result of open exchange of information.

7.2 Recent Non-Network Projects

During 2011/12, TransGrid issued Requests for Proposals (RfP) seeking network support:

1. Network support for the Tamworth-Gunnedah-Narrabri area. The RfP requested proposals for network support starting from summer 2012/13 to winter 2020. Responses received cover some support from 2013/14 to 2020.
2. Network support for the south coast of NSW. The RfP was issued in April 2012 seeking proposals for non-network solutions from potential service providers for the NSW area from summer 2012/13 to winter 2021.
3. Development of a triage DM database.

TransGrid is required under the RIT-T to assess the potential for non-network solutions to allow deferral or optimisation of traditional network augmentation projects. TransGrid takes this requirement seriously and in the past several years has identified opportunities for deploying non-network alternatives that could maintain system reliability while also reducing cost.

One such project, which deferred the Sydney-Newcastle-Wollongong 500 kV augmentation for a year, is the largest non-network project ever undertaken in Australia. The triage database

would allow TransGrid to quickly ascertain whether there is sufficient non-network capability (including demand response and embedded generation) to allow deferral or optimisation of growth-related system augmentation projects. This project is being undertaken in conjunction with DNSPs and others.

7.3 Current and Future DM and other Non-Network Projects

TransGrid expects to implement a number of DM innovation projects and initiatives in the next five years.

TransGrid has signed agreements with the NSW and ACT distributors to cooperate in the field of demand management innovation under the auspices of a Demand Management Innovation Allowance (DMIA). Joint projects include initiatives to reduce peak demand, to educate consumers how to use energy wisely and some research and development projects.

TransGrid has engaged the Melbourne RMIT University to carry out a project that would examine consumer behaviour and energy usage patterns.

The University of Queensland and the UTS have also formed partnerships with TransGrid in the field of research to reduce peak demand.

Oakley Greenwood is assisting TransGrid with the preparation of a state-wide database of potential DM opportunities that could assist TransGrid and NSW DNSPs seeking network support.

TransGrid has identified and is acting on an opportunity to introduce a green and renewable energy supply to a regional centre, if practical, to reduce electricity demand at the centre. The intention is to source the electricity (or energy) supply from available and emerging technologies such as photovoltaic, solar thermal, tri-generation, wind, fuel cell and energy storage systems. TransGrid is working together with Worley Parsons to investigate, develop and implement the project.

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

- Acquisition of 40 MW of support from non-network sources for Sydney Metropolitan region for 2012-13 summer.
- 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.

7.4 Price Signals and Financial Incentives to Encourage DM and Local Generation

As a provider of bulk transmission network services, TransGrid 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 (NER) 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.

CHAPTER 7

Other Planning Issues in NSW

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, 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 apparent 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 area.

7.5 Gas, Wind and Solar Generation

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 embedded within the distribution networks. This includes the Tallawarra gas fired power station embedded within Endeavour Energy's 132 kV network and the Cullerin Range Wind Farm, the Gunning Wind Farm and the Jounama Hydro Power Station embedded within Essential Energy's distribution network.

During the 2012/13 financial year, an increased level of connection activity is expected to emerge once carbon related policies and funding impacts on the energy sector are finalised.

On 1 July 2011, the AEMC authorised a change to the NER that introduced the concept of a Scale Efficient Network Extension (SENE). This change is intended to assist prospective small scale generators to combine and cooperate with the local NSP under the Rules process and benefit from sharing the costs of connecting to a distribution or transmission network. TransGrid is supportive of this initiative from the AEMC and encourages intending generators to engage in this process.

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 customers.

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 are usually classified as 'Non-Regulated Transmission Service' and allow TransGrid and generation proponents scope to negotiate connection arrangements bilaterally and thus provide a degree of flexibility in those arrangements.

7.6 Industrial Loads

In parallel with the activity of new generation in NSW, during the year there has been a significant increase in demand for network services to supply energy to new large scale mining operations across the state.

Mining activities predominately emerge in rural parts of the state where the existing electricity transmission infrastructure was originally designed and built to supply a typical rural load, such as farmhouses and small townships. The introduction of large industrial or mining facilities in a region is likely to require network augmentation and extension to both connect and support the load increase. In some cases special protection schemes or control systems are installed to quickly enable "opportunity supply" to be provided in advance of the network augmentation.

7.7 The Impact of Climate Change Policies on NSW Transmission

The Renewable Energy Target (RET) scheme and the Federal Government's emissions control schemes (*Clean Energy Act 2011*) are factors which could promote increased wind and other renewable generation development activity in NSW.

NSW has a large amount of wind generation resource near existing transmission lines. Generation development connections adjacent to existing lines do not require the construction of new major transmission links and can be developed relatively quickly.

It is expected that the government's existing and future climate change policies will enhance the prospects of one or several large scale renewable generation projects emerging in NSW. As each project emerges and develops, its impact on the network may be included in TransGrid's regulated planning processes when considering future transmission network augmentations for NSW.

APPENDICES

APPENDIX 1

TransGrid's Network Planning Approach

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 has 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 the NER 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 Annual Planning Report the constraints that appear over long term time frames are considered to be indicative. The timing and capital cost of possible network options to relieve them may change significantly as system conditions evolve. TransGrid has published outline plans for long term developments.

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.

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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 and is 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 also recognises 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 a detailed assessment of each individual case is made.

A1.2.1. Main Transmission Network

The NSW main transmission system connects the major power stations and load centres and provides the interconnections from NSW to Queensland and Victoria. It includes most 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. This is 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;
- 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. 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.

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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 DNSP 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% 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 sometimes 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 DNSP 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 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.

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A1.3 Protection Requirements

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, errors in measurement 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 following factors determine the need for reactive plant installations:

- 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

TransGrid gives consideration 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 the maximum expected 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.

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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 AEMO's forecasts to be used in the next NTNDP. These are published in the APR and by AEMO in the forthcoming ESOO. 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; and
    - Impacts of energy related developments such as gas pipeline projects.
3. Modelling of the NEM for load and generation scenarios to quantify factors which affect network performance, including:
    - Generation from individual power stations; and
    - Interconnector flows.
4. Modelling of network performance for the load and generation scenarios utilising the data from the market modelling.

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

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

APPENDIX 2

Deterministic and Probabilistic Planning Criteria

Appendix 2 – Deterministic and Probabilistic Planning Criteria

A safe, reliable and efficient electricity supply is essential to the well being of people and for continued growth of the economy. Hence the criteria applied to transmission planning and development must be prudent with the right balance between mitigating risks to reliability and continuity of supply and economic efficiency.

In November 2010, the AEMC recommended that a national framework should be adopted to promote consistency in reliability standards[1]. The AEMC argued[2] that transmission reliability standards should be economically derived using a customer value of reliability or similar measure. The standards could then be expressed in a deterministic manner, either as specified pre-set standards or through reporting on an equivalent basis.

As the AEMC awaits a formal response from the Standing Council on Energy and Resources (SCER) to its Updated Final Report on transmission reliability standards, TransGrid considers it timely to examine the issue of planning standards in this APR 2012.

A prudent planning standard should lead to planning and developing the system as economically as possible while maintaining the system to an acceptable level of reliability commensurate with community expectations and regulatory and jurisdictional requirements. The principle of economic efficiency is embodied in the National Electricity Objective. The challenge is to adopt a planning approach that is best equipped to satisfy this objective while being robust to the uncertainties surrounding the input parameters to network investment decisions.

TransGrid notes that there has been an extensive and protracted debate in Australia regarding transmission reliability standards and planning criteria. It is sometimes argued that there is a stark choice between probabilistic planning as adopted in Victoria, and deterministic planning as practiced in all other States. It has also been suggested[3] that the deterministic approach will likely lead to inefficient levels of investment.

TransGrid's view is that the probabilistic method cannot prudently and wholly replace the deterministic criteria but adds one more dimension to enhance the transmission planning process in allowing for some inherent uncertainties in the process. For this reason, TransGrid's deterministic criteria encapsulates relevant sources of uncertainty in the process, such as variation in load demand profiles, generation profiles and scenario analysis. TransGrid's system planning approach is more holistic than merely applying any probabilistic approach on its own and includes societal, environmental, technical, and economical assessments with probabilistic reliability evaluation as part of the whole process. It is noted that TransGrid's planning criteria has been erroneously described by AEMO as strictly and solely deterministic – which it is not.

The AEMC's findings in relation to a national transmission reliability standard and the criticisms that are sometimes made of deterministic planning standards have led TransGrid to examine whether the current NSW planning standards are appropriately underpinned by sound engineering and economics.

For this review, TransGrid engaged Professor Mark Colyvan, ARC Future Fellow and Director of Australian Centre of Excellence for Risk Analysis at the University of Sydney, and Harding Katz Pty Ltd, Economic and Regulatory Consultants, Melbourne. In addition, the review included an assessment of the current NSW planning standards with reference to:

- The Reliability Panel's review of transmission reliability standards in the National Electricity Market[4];
- KEMA's International Review of Transmission Reliability Standards[5];
- a report by Oakley Greenwood for AEMO on the value of customer reliability[6];
- Working papers from the Fundamental Review of the Great Britain Security and Quality of Supply Standards; and
- Academic papers on decision theory, risk and uncertainty[7,8,9].

The principal findings from TransGrid's examination of the issues surrounding deterministic and probabilistic planning are:

- Major economies around the world, including Germany, France, Great Britain and North America, continue to employ deterministic planning standards. Although there is an increasing level of interest in probabilistic planning techniques, KEMA describe probabilistic planning as being in its "infancy internationally"[10].
- Deterministic standards are sometimes described as 'redundancy standards'. However, redundancy is a well-accepted engineering concept that has many applications beyond electricity planning. It is a heuristic approach that provides for a margin of error or a backup system to minimise the adverse consequences from an unexpected overload or failure. The pervasive application of redundancy in engineering helps explain why deterministic standards continue to be employed in many transmission systems around the world.
- It is noted that provision of redundancy does not require duplication of network assets except in the case of a purely radial system in which case the decision to provide redundancy is driven by economic considerations as much as reliability.
- Probabilistic planning can take the form of a hybrid approach. For example, AEMO's probabilistic planning approach employs deterministic standards to identify potential problems on the transmission network.

1 AEMC, *Transmission Reliability Standards Review, Updated Final Report*, 3 November 2010, page 23.
2 Ibid, page ii.
3 VENCorp, Submission to AEMC's Transmission Reliability Standards Review, 13 February 2008, pages 2 and 3.
4 AEMC Reliability Panel, *Towards a Nationally Consistent Framework for Transmission Reliability Standards, Final Report*, 31 August 2008.
5 KEMA, *International Review of Transmission Reliability Standards. Summary Report* prepared for the Australian Energy Market Commission Reliability Panel, 27 May 2008.
6 Oakley Greenwood, *Valuing Reliability in the National Electricity Market, Final Report*, March 2011.
7 M. Granger, M. Henrion and M.Small, *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*.
8 Nassim Taleb, *The Black Swan: The impact of the highly improbable*, Random House, 2007.
9 Frank H Knight, *Risk, Uncertainty, and Profit*, 1921.

APPENDIX 2

Deterministic and Probabilistic Planning Criteria

- A review of AEMO's approach also shows the use of average outage statistics for elements of the network. This can be contrasted to the situation in NSW where most line outages occur at times of hot summer weather or under adverse winter conditions, showing a definite correlation with periods of high loading on the network. TransGrid's statistics also show that whilst many outages are relatively short, some outages can have extended durations and it is necessary to capture the outage distribution in any accurate application of probabilistic planning.
- Specifically, the NSW planning standard is not a 'pure' deterministic planning approach. It recognises that an N-1 deterministic standard may not be economic in some circumstances and therefore a level of risk of loss of supply may be acceptable[11].
- Probabilistic planning is based on a cost-benefit approach. However, depending on its application and particular circumstances, it may not necessarily deliver an economically efficient investment program because it focuses on maximising <u>expected</u> net market benefits. Insurance markets illustrate that risk averse customers will accept a lower expected value (by paying an insurance premium) for the benefit of avoiding the consequences of high impact, low probability events. By examining expected outcomes, probabilistic planning wrongly assumes that customers are risk tolerant rather than risk averse. As a consequence, probabilistic planning will tend to give insufficient weight to the benefits of network augmentations that minimise the consequences of high impact, low probability events, which are often the cause of widespread outages[12].
- Probabilistic planning also depends on accurately estimating the expected benefits of augmenting the network by assessing the probability of asset failures; the expected consequences of those failures in terms of loss of supply; and the value of customer reliability. However, contrary to the implicit assumption made in probabilistic planning, the consequences of asset failures are inherently uncertain, particularly for very low probability and very high impact events, because it is not possible to ascribe a known probability to these events. Probabilistic planning may therefore present a false degree of precision in its assessment of investment options.
- Another important source of uncertainty in relation to probabilistic planning is the true value of Value of Customer Reliability (VCR). VCR is a multi-faceted and inherently subjective parameter that varies across customers, time of day, seasons and outage durations. While estimates of the VCR have been provided through customer surveys, there is a wide band of uncertainty around the point estimates, which may be in the order of +/- 50%[13]. In addition, the outcome of all such surveys depends on the timing of the survey, language of the survey questions and demography of the respondents. Therefore such surveys can neither be accurate nor can it be extrapolated to different geographic and demographic sectors.
- The AEMC is correct in that probabilistic planning outcomes can be expressed as a deterministic standard. This is the approach that has been adopted in South Australia. However, it is equally true that a deterministic standard can be expressed in terms of an implied VCR. Given the shortcomings in probabilistic planning, it is not appropriate to rely entirely on its outcomes for the purposes of setting a national transmission reliability standard. Equally, it is not appropriate to apply a deterministic standard without a consideration of the costs and benefits, which include the benefits of avoiding the consequences of high impact, low probability events.

TransGrid's conclusion is that the planning standards in NSW are appropriate and based on sound engineering and risk management principles and are also consistent with the approach adopted by many major economies around the world.

The case for abandoning deterministic planning in favour of a probabilistic approach cannot be made at this time. However, it is also important to ensure that the deterministic standard is delivering value for money – either in terms of the implied VCR or in terms of addressing unacceptable risks to customers. The NSW planning standard already requires risks to be considered if the deterministic standard is to be relaxed. However, in light of the recent AEMC's review of NSW DNSP licence conditions, undertaken at the request of the NSW Government, a review of the Transmission Network Design and Reliability Standard for NSW may be warranted, in particular, to add clarity to the circumstances in which the deterministic standard may be relaxed.

TransGrid looks forward to further constructive discussion with the AEMC and other interested parties in the development of the national framework for transmission reliability standards.

10 KEMA, *International Review of Transmission Reliability Standards, Additional response regarding probabilistic planning methodologies*, 31 July 2008, page 14.
11 Industry and Investment NSW, *Transmission Network Design and Reliability Standard for NSW*, December 2010, page 10.
12 KEMA, *International Review of Transmission Reliability Standards – Additional response regarding probabilistic planning methodologies*, 31 July 2008, page 2.
13 AEMO, *National Value of Customer Reliability*, 19 January 2012, page 5.

APPENDIX 3

Individual Connection Point Projections

Appendix 3 – Individual Connection Point Projections

TransGrid's customers have 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 A3.1 to A3.12 of this appendix.

Certain large and relatively stable industrial loads that TransGrid isolates for 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. Other industrial loads are included within connection point forecasts provided by distributors. Aggregate projections for all identified major industrial loads (including some that are also in the connection point forecasts) are presented in Tables A3.11 and A3.12.

Note that Tables A3.1 to A3.12 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 – Ausgrid Connection Point Summer Peak Demand[1]

	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beaconsfield West	472	63	426	85	441	100	408	129	418	150	419	157	514	172	603	175	609	186	615	197
Rookwood Rd	0	0	328	80	340	95	348	103	352	116	382	121	337	142	262	156	267	167	271	175
Haymarket	582	76	534	101	553	112	585	120	602	137	605	144	584	163	666	168	677	177	689	184
Liddell	33	27	33	25	33	25	33	25	34	25	34	25	34	26	34	26	35	26	35	26
Munmorah	175	53	173	46	169	46	169	47	172	50	172	44	174	48	178	50	181	49	183	51
Muswellbrook	245	92	264	104	268	107	271	107	274	110	278	111	281	113	285	115	288	118	291	119
Newcastle	605	182	620	192	633	200	647	209	622	227	635	237	649	246	662	256	675	266	686	274
Sydney East	792	271	816	282	829	291	840	298	848	306	860	309	868	316	873	319	881	331	891	335
Sydney North	1054	202	1124	279	1134	297	1134	303	1141	317	1162	323	1172	340	1176	360	1193	376	1210	392
Sydney South	1481	373	1302	344	1310	353	1397	368	1426	373	1435	376	1452	379	1407	383	1427	393	1446	394
Tomago	238	30	249	37	256	40	260	45	287	44	291	49	300	52	309	55	318	59	325	62
Tuggerah	263	155	254	157	259	161	262	163	265	166	269	169	272	172	275	177	279	182	282	188
Vales Point	88	8	96	10	101	16	102	17	103	17	104	18	105	18	107	19	108	19	109	20
Waratah West	92	17	94	17	96	17	97	18	111	17	112	17	115	17	118	18	121	121	124	198

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

Individual Connection Point Projections

Table A3.2 – Ausgrid Connection Point Winter Peak Demand[2]

	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	427	43	447	61	393	69	406	88	377	102	384	108	383	120	490	119	575	133	579	139
Rookwood Rd	0	0	0	0	293	68	301	70	307	81	306	85	339	98	290	112	216	119	220	120
Haymarket	512	54	538	72	479	79	495	85	524	96	534	100	535	114	507	120	582	127	593	127
Liddell	33	18	33	17	33	17	33	17	33	17	34	17	34	18	34	18	34	19	35	18
Munmorah	175	32	173	32	165	33	166	33	166	33	167	34	35	34	170	35	172	35	174	36
Muswellbrook	191	66	204	72	223	84	226	86	227	86	228	87	229	87	231	88	232	89	233	90
Newcastle	511	71	510	72	514	73	525	77	534	82	510	91	519	96	527	100	536	104	545	108
Sydney East	842	188	855	202	880	199	891	211	904	218	914	220	923	223	932	228	941	235	952	239
Sydney North	945	142	973	194	982	208	986	215	975	218	984	226	995	242	1000	257	1001	261	1013	269
Sydney South	1343	255	1362	240	1243	241	1269	246	1321	250	1341	253	1342	257	1344	266	1295	273	1309	278
Tomago	172	8	214	15	210	10	220	15	223	19	244	19	247	22	255	25	262	28	269	30
Tuggerah	252	108	254	111	246	112	250	113	254	115	261	117	261	122	264	125	267	127	269	134
Vales Point	88	5	98	7	104	11	104	12	104	12	104	12	105	12	105	13	107	13	108	13
Waratah West	85	21	85	22	87	24	89	24	89	24	99	23	100	23	102	23	104	23	106	24

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

Table A3.3 – Endeavour Energy Connection Point Summer Peak Demand[3]

	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Dapto	444	13	467	15	272	10	283	12	293	13	296	13	299	14	305	15	310	16	320	17
Holroyd	0	0	290	102	410	135	411	135	412	135	412	135	413	136	413	136	413	136	414	136
Ingleburn	136	30	132	30	133	30	133	30	133	30	133	30	133	30	134	30	134	30	134	30
Liverpool	340	72	372	79	387	82	395	84	405	86	413	87	421	89	428	91	434	92	439	93
Macarthur	309	102	317	104	343	113	358	118	368	121	379	125	391	129	404	133	417	137	430	141
Marulan	79	37	82	39	83	39	84	40	85	40	86	41	86	41	87	41	88	42	89	42
Mount Piper	39	19	48	23	48	23	48	23	48	23	48	23	48	23	48	23	48	23	48	23
Regentville	269	71	277	73	282	74	289	76	293	77	296	78	298	79	300	79	302	79	303	80
Sydney North	44	4	40	4	40	4	40	4	40	4	40	4	40	4	40	4	40	4	40	4
Sydney West	1676	60	1284	46	1287	46	1312	47	1338	48	1360	48	1380	49	1397	50	1412	50	1426	51
Tomerong	0	0	0	0	205	7	214	9	221	10	223	10	226	10	230	11	234	12	241	13
Vineyard	424	134	439	139	450	142	457	144	464	147	471	149	481	152	487	154	493	156	500	158
Wallerawang	71	27	71	27	71	27	71	27	71	27	71	27	71	27	71	27	71	27	71	27

Table A3.4 – Endeavour Energy Connection Point Winter 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
Dapto	513	1	517	1	315	1	319	1	332	3	336	3	339	4	340	4	345	5	352	6
Holroyd	0	0	0	0	334	85	335	86	335	86	336	86	337	86	337	86	338	86	338	87
Ingleburn	121	18	119	17	120	17	120	18	120	18	121	18	121	18	121	18	122	18	122	18
Liverpool	264	21	281	23	317	25	323	26	331	27	339	27	346	28	353	28	359	29	364	29
Macarthur	250	82	251	83	254	84	257	85	262	86	268	88	275	90	282	93	291	96	301	99
Marulan	85	25	88	25	89	26	90	26	92	27	93	27	94	27	95	28	97	28	98	28
Mount Piper	40	23	40	23	40	23	40	23	40	23	40	23	40	23	40	23	40	23	40	23
Regentville	213	56	207	55	217	57	218	58	220	58	221	58	222	59	224	59	225	59	226	60
Sydney North	34	19	29	16	29	16	29	16	29	16	29	16	29	16	29	16	29	16	29	16
Sydney West	1336	50	1386	52	1045	39	1073	40	1098	41	1123	42	1149	43	1170	44	1188	44	1204	45
Tomerong	0	0	0	0	238	1	241	1	251	2	253	3	255	3	257	3	260	3	266	4
Vineyard	265	50	303	58	309	59	313	60	318	60	323	61	329	63	335	64	341	65	348	66
Wallerawang	76	27	77	27	77	27	77	27	77	27	77	27	77	27	77	27	77	27	77	27

3 Individual projections extended for an additional year using linear interpolation.

APPENDIX 3

Individual Connection Point Projections

Table A3.5 – Essential Energy (North) Connection Point Summer Peak Demand

	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Armidale	32	10	32	11	33	11	33	11	34	11	34	11	34	11	35	11	35	12	35	13
Boambee South	16	3	17	3	17	4	18	4	19	4	20	4	20	4	21	4	22	4	23	4
Casino	30	8	31	8	31	8	32	8	32	8	32	8	32	8	32	8	32	8	32	8
Coffs Harbour	60	12	62	13	63	13	65	13	67	14	68	14	70	14	72	15	73	15	76	15
Dorrigo	3	1	3	1	3	1	3	1	3	1	3	1	4	1	4	2	4	2	4	2
Dunoon	6	2	6	2	6	2	6	2	7	2	7	2	7	2	7	2	7	2	7	2
Glen Innes	10	2	10	2	10	2	11	2	11	2	11	2	11	2	11	2	11	2	11	2
Gunnedah	27	8	28	8	28	8	28	8	29	8	29	8	29	9	30	9	30	9	30	9
Hawks Nest	8	3	8	3	8	3	9	3	9	3	9	3	9	3	10	3	10	3	10	3
Herons Ck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	4	16	4	15	4
Inverell	34	9	35	9	35	9	35	9	36	9	36	9	36	9	37	9	37	9	37	9
Kempsey 33 kV	30	9	31	9	31	9	31	9	32	9	32	9	32	9	32	9	33	10	34	11
Kempsey 66 kV	2	0	2	0	2	0	2	1	3	1	3	1	3	1	3	1	3	1	3	1
Koolkhan	53	9	54	9	54	10	55	10	56	10	57	10	58	10	59	10	59	10	61	10
Lismore	102	17	104	17	106	17	107	17	109	18	111	18	113	18	115	19	117	19	119	19
Macksville	9	2	9	2	10	2	10	2	10	2	10	2	10	2	11	2	11	2	11	2
Moree	28	7	29	7	29	7	29	7	29	7	30	7	30	8	30	8	31	8	32	8
Mullumbimby	31	8	32	8	32	8	33	8	33	8	34	8	34	9	35	9	35	9	35	9
Nabiac	0	0	30	6	31	6	31	6	32	6	32	7	33	7	34	7	34	7	38	9
Nambucca	8	3	8	3	8	3	9	3	9	3	9	3	9	3	9	3	10	3	11	3
Narrabri	55	18	55	18	56	18	57	19	57	19	58	19	59	19	59	19	60	20	61	21
Port Macquarie	60	11	62	11	64	11	66	12	68	12	70	12	72	13	74	13	77	13	81	15
Raleigh	9	2	9	2	9	2	10	2	10	2	10	2	10	2	10	2	10	2	10	2
Stroud	32	3	32	3	33	3	33	3	34	3	34	3	35	3	35	4	35	4	35	4
Tamworth	122	30	124	31	127	32	130	33	133	33	136	34	139	35	142	35	145	36	148	37
Taree 33 kV	29	12	30	12	30	12	31	12	31	12	31	12	32	13	32	13	34	13	35	15
Taree 66 kV	56	20	27	10	27	10	28	10	29	11	30	11	31	11	15	4	16	4	18	6
Tenterfield	5	2	5	2	5	2	5	2	5	2	6	2	6	2	6	2	6	2	6	2
Terranora	97	8	100	8	102	8	104	8	107	8	110	9	112	9	115	9	118	9	130	19

Table A3.6 – Essential Energy (North) Connection Point Winter 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	41	10	42	10	42	11	43	11	43	11	44	11	45	11	45	11	46	11	46	12
Boambee South	19	4	19	4	20	4	20	4	21	4	21	4	22	4	22	4	23	5	23	5
Casino	25	6	25	6	26	6	26	7	26	7	27	7	27	7	28	7	28	7	28	7
Coffs Harbour	64	16	65	9	66	9	67	10	68	10	69	10	70	10	71	10	72	10	73	10
Dorrigo	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1
Dunoon	7	1	7	1	7	1	7	1	8	2	8	2	8	2	8	2	8	2	8	2
Glen Innes	14	3	14	3	14	3	14	3	15	3	15	3	15	3	15	3	15	3	15	3
Gunnedah	25	9	25	6	26	6	26	6	26	7	26	7	27	7	27	7	27	7	27	7
Hawks Nest	8	0	8	3	8	3	9	3	9	3	9	3	9	3	10	3	10	3	10	3
Herons Ck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	4	16	4
Inverell	32	6	32	7	33	7	33	7	33	7	34	7	34	7	35	7	35	7	35	7
Kempsey 33 kV	33	7	33	7	34	7	34	7	34	7	34	7	35	7	35	7	35	7	35	7
Kempsey 66 kV	2	0	2	0	2	0	2	0	2	1	3	1	3	1	3	1	3	1	3	1
Koolkhan	54	14	55	14	55	14	56	14	57	14	57	14	58	15	59	15	59	15	60	15
Lismore	106	24	107	24	109	25	110	25	112	25	113	26	115	26	116	26	118	27	119	27
Macksville	11	3	11	3	11	3	11	3	12	3	12	3	12	3	12	3	12	3	12	3
Moree	36	9	36	9	37	9	37	9	37	9	37	9	38	9	38	9	38	10	38	10
Mullumbimby	35	7	35	7	36	7	36	7	37	8	38	8	38	8	39	8	39	8	40	8
Nabiac	0	0	35	7	36	7	36	7	37	7	37	8	38	8	39	8	39	8	40	8
Nambucca	10	3	11	3	11	3	11	3	11	3	11	3	11	3	12	3	12	3	12	3
Narrabri	58	19	58	19	58	19	58	19	60	20	61	20	61	20	61	20	61	20	61	20
Port Macquarie	79	16	80	16	81	17	83	17	84	17	85	17	86	18	88	18	89	18	90	18
Raleigh	11	3	12	3	12	3	12	3	12	3	12	3	12	3	13	3	13	3	13	3
Stroud	28	5	26	5	26	5	26	5	27	5	27	5	27	5	28	5	28	5	28	5
Tamworth	101	21	102	21	104	21	105	21	106	22	108	22	109	22	111	22	112	23	113	23
Taree 33 kV	28	11	28	11	29	11	29	12	29	12	30	12	30	12	31	12	31	12	31	12
Taree 66 kV	72	24	38	13	39	13	39	13	40	12	41	12	41	12	42	12	27	8	27	8
Tenterfield	6	2	6	2	6	3	6	3	7	3	7	3	7	3	7	3	7	3	7	3
Terranora	97	8	99	8	101	8	103	8	105	8	107	8	109	8	111	9	114	9	116	9

APPENDIX 3

Individual Connection Point Projections

Table A3.7 – Essential Energy (Central) Connection Point Summer Peak Demand

	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beryl	59	21	67	24	73	27	73	27	74	27	74	27	75	27	75	27	76	28	77	28
Cowra	33	8	34	8	35	8	35	8	36	8	37	9	37	9	38	9	39	9	39	9
Forbes	33	0	33	0	34	0	34	0	34	0	34	0	34	0	34	0	34	0	35	0
Manildra	11	4	11	4	11	4	12	4	12	4	12	4	12	4	12	5	12	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	7	25	8	25	8	26	8	26	8	26	8	27	8	27	8	28	9	28	9
Orange 66 kV	50	23	50	23	51	23	51	23	51	23	51	23	51	23	52	23	52	23	52	24
Orange 132 kV	136	55	144	63	147	63	146	64	146	65	146	65	146	66	147	66	155	67	164	68
Panorama	75	19	76	19	77	20	78	20	79	21	81	21	82	22	83	22	84	23	85	23
Parkes 66 kV	25	0	26	0	26	0	27	0	27	0	28	0	28	0	29	0	30	0	30	0
Parkes 132 kV	35	16	35	16	35	16	35	16	35	16	35	16	35	16	35	16	36	16	36	16
Wallerawang 66 kV	5	1	5	1	5	1	5	2	5	2	5	2	5	2	5	2	5	2	5	2
Wallerawang 132 kV	25	17	25	17	25	17	25	17	25	17	25	17	25	17	25	17	25	17	25	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	174	25	177	26	180	26	183	26	186	27	190	27	193	28	196	28	200	29	203	29

Table A3.8 – Essential Energy (Central) Connection Point Winter 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	61	18	62	18	77	22	77	23	78	23	79	23	80	23	80	23	80	23	81	23
Cowra	25	1	25	1	25	1	26	1	26	1	26	1	26	1	26	1	26	1	26	1
Forbes	25	0	25	0	25	0	25	0	26	0	26	0	26	0	26	0	26	0	26	0
Manildra	11	4	11	3	11	3	11	4	11	4	12	4	12	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	6	0
Mudgee	22	4	22	5	22	5	23	5	23	5	23	5	23	5	23	5	24	5	24	5
Orange 66 kV	64	21	65	21	65	21	66	22	66	22	67	22	67	22	67	22	68	22	68	22
Orange 132 kV	131	57	145	66	146	67	149	68	149	69	149	69	149	70	149	71	150	72	158	73
Panorama	77	9	78	9	78	9	79	10	79	10	80	10	81	10	81	10	82	10	82	11
Parkes 66 kV	19	0	19	0	20	0	20	0	21	0	21	0	22	0	22	0	23	0	23	0
Parkes 132 kV	35	15	35	15	35	15	35	15	35	15	35	15	35	15	36	15	36	15	36	15
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	24	15	24	16	24	16	24	16	24	16	24	16	24	16	24	16	25	16	25	16
Wellington 66 kV	10	2	10	2	10	2	10	2	11	2	11	2	11	2	11	2	11	2	11	2
Wellington 132 kV	145	20	145	20	145	20	145	20	145	20	146	20	146	20	146	20	146	20	146	20

Table A3.9 – Essential Energy (South and Far West) and ActewAGL Connection Point Summer Peak Demand

	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Albury	134	55	134	55	135	55	136	56	136	56	137	56	138	56	139	57	139	57	140	57
Balranald	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1
Broken Hill	34	16	35	17	36	17	36	17	37	17	37	18	38	18	38	18	39	18	39	19
Canberra	472	218	482	223	491	227	500	232	511	238	523	244	535	251	547	257	559	264	571	269
Coleambally	11	7	11	7	12	7	12	7	12	7	12	7	13	8	13	8	13	8	14	8
Cooma 11 kV	11	3	12	3	12	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	5	21	5	22	5	22	5	22	5	22	5	22	5
Cooma 132 kV	42	11	42	11	42	11	42	11	42	11	42	11	42	11	43	11	43	11	43	11
Darlington Pt	16	4	16	4	16	4	16	4	16	4	16	4	17	4	17	4	17	4	17	4
Deniliquin	45	12	45	12	45	12	46	12	46	13	46	13	46	13	46	13	47	13	47	13
Finley	19	7	19	7	19	7	19	7	19	7	19	7	20	7	20	7	20	7	20	7
Griffith	86	24	88	25	90	26	92	26	94	27	96	27	99	28	101	29	103	29	106	30
Marulan	53	19	54	19	54	19	55	20	56	20	57	20	57	21	58	21	59	21	59	21
Munyang	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	4	4	4
Murrumbateman	5	1	5	1	6	1	6	1	6	1	6	1	7	1	7	1	7	1	7	1
Murrumburrah	40	20	41	20	41	21	42	21	42	21	43	21	43	21	44	22	44	22	44	22
Queanbeyan	95	39	97	40	100	41	102	42	104	42	107	43	109	44	112	45	115	46	118	46
Snowy Adit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tumut	37	17	38	17	38	17	39	18	39	18	40	18	40	18	41	19	41	19	42	19
Wagga 66 kV	108	65	110	65	111	61	113	62	114	63	116	64	117	65	119	65	120	66	122	66
Wagga North 132 kV	55	6	56	6	56	6	57	6	57	6	58	6	58	6	59	6	59	6	60	6
Wagga North 66 kV	21	9	22	10	22	10	22	10	23	10	23	10	23	10	23	10	24	10	24	11
Williamsdale	126	104	129	106	132	108	135	111	138	113	143	116	147	119	152	122	156	125	159	127
Yanco	42	6	43	6	43	6	44	6	45	7	46	7	47	7	47	7	48	7	49	0
Yass 66	13	4	13	4	13	4	14	4	14	4	14	5	15	5	15	5	15	5	15	0

APPENDIX 3

Individual Connection Point Projections

Table A3.10 – Essential Energy (South and Far West) and ActewAGL Connection Point Winter 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	94	26	94	29	94	29	95	29	95	29	95	29	95	29	95	29	96	30	96	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	6	30	7	30	7	30	8	30	8	30	8	30	8	31	8	31	8	31	8
Canberra	525	125	482	130	484	130	486	131	489	131	489	132	492	132	494	133	496	133	498	134
Coleambally	7	4	7	4	8	4	8	4	8	4	8	4	8	4	8	4	9	5	9	5
Cooma 11 kV	15	3	15	3	15	3	15	3	15	3	15	3	15	3	15	3	16	3	16	3
Cooma 66 kV	31	5	32	5	32	5	32	5	33	5	33	5	34	5	34	5	35	5	35	6
Cooma 132 kV	48	8	48	9	48	9	48	9	49	9	49	9	49	9	49	9	50	9	50	9
Darlington Pt	14	2	14	2	14	2	14	2	14	2	15	2	15	2	15	2	15	2	15	2
Deniliquin	37	5	37	5	38	5	38	5	38	5	38	5	39	6	39	6	39	6	39	6
Finley	18	3	18	3	18	3	18	3	18	3	19	3	19	3	19	3	19	3	19	3
Griffith	51	11	51	13	52	13	52	13	53	14	54	14	54	14	55	14	56	14	56	14
Marulan	49	20	58	21	58	21	59	21	59	22	60	22	61	22	61	22	62	22	63	23
Munyang	31	19	32	18	32	18	32	18	32	19	32	19	33	19	33	19	33	19	33	19
Murrumbateman	6	1	6	1	6	1	7	1	7	1	7	1	7	1	7	1	8	1	8	1
Murrumburrah	35	10	35	10	35	10	36	10	36	10	36	11	36	11	37	11	37	11	37	11
Queanbeyan	101	33	105	33	107	33	108	35	110	35	111	35	113	36	114	37	116	37	117	38
Snowy Adit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tumut	35	8	35	8	35	8	35	8	36	8	36	9	36	9	36	9	37	9	37	9
Wagga 66 kV	91	30	91	30	92	30	92	29	92	29	92	29	93	29	93	29	93	29	94	29
Wagga North 132 kV	53	2	53	2	53	2	54	2	54	2	54	2	55	2	55	2	56	2	56	2
Wagga North 66 kV	19	7	20	6	21	6	21	7	21	7	22	7	22	7	22	7	23	7	23	7
Williamsdale	55	75	100	70	100	70	99	70	98	71	101	71	100	71	100	71	100	72	100	72
Yanco	33	5	33	5	33	5	33	5	34	5	34	6	34	6	34	6	35	6	35	6
Yass 66	13	3	13	3	14	3	14	3	14	3	14	3	14	3	15	3	15	3	15	3

Table A3.11 – Major Industrial Customers – Sum of Individual Summer Peak Demands

	2013 MW	2014 MW	2015 MW	2016 MW	2017 MW	2018 MW	2019 MW	2020 MW	2021 MW	2022 MW
Industrial Loads	1231	1231	1231	1231	1231	1231	1231	1231	1231	1231

Table A3.12 – Major Industrial Customers – Sum of Individual Winter Peak Demands

	2012 MW	2013 MW	2014 MW	2015 MW	2016 MW	2017 MW	2018 MW	2019 MW	2020 MW	2021 MW
Industrial Loads	1256	1259	1266	1266	1266	1266	1266	1266	1266	1266

APPENDIX 4

Connection Point Proposals

Appendix 4 – Connection Point Proposals

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

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

Table A4.1 Connection Point Proposals

Connection Point Proposal	Purpose	Proposed Service Date	APR 2011 Section
Holroyd and Rookwood Road 330/132 kV Substations	New 132 kV connection points	Summer 2013/14	5.2.2
Wallerawang 132/66 kV Substation	Substation replacement	2014	5.2.5
Beaconsfield West 330/132 kV Substation	Increase transformer capacity, additional 132 kV connections and capacitors	2012	5.2.7
Hawks Nest 132 kV Substation	New 132 kV connection point	2012	5.2.8
Brandy Hill 132/11 kV Substation	Connection to Ausgrid's Brandy Hill 132/11 kV Substation	2012/13	5.2.9
Orange North 132 kV Switching Station	New 132 kV switchbay connection	Late 2012	5.2.10
Broken Hill 220/22 kV Substation	Uprate two 22 kV switchbays	2012/13	5.2.10
Wallerawang 330/132 kV Substation	Replacement of two 330/132 kV transformers	Completed and 2014	5.2.12
Coffs Harbour 132/66 kV Substation	New 66 kV capacitor		5.2.13
Port Macquarie 132/66 kV Substation	New 66 kV capacitor		5.2.13
Orange 132/66 kV Substation	Replacement of 66 kV substation equipment and additional 66 kV capacitor	2016/17	5.3.2
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	From 2012	5.3.5
Haymarket 330/132 kV Substation	Increase reliability and capacity of connections to Haymarket	2012	5.3.6
Sydney East 330/132 kV Substation	Increase transformer capacity	2013	5.3.11
Yanco 132/33 kV Substation	Increase transformer capacity	2014	5.3.11
Griffith 132/33 kV Substation	Increase transformer capacity	2014	5.3.11
Tamworth 66 kV switchbay	New 66 kV connection to Quirindi	2013/14	5.3.12
Newcastle 330/132 kV Substation	New 132 kV connection to Argenton	2015	5.3.12

APPENDIX 4

Connection Point Proposals

Table A4.1 Connection Point Proposals (continued)

Connection Point Proposal	Purpose	Proposed Service Date	APR 2011 Section
Sydney West 330/132 kV Substation	New 132 kV switchbay connection	2013	5.3.12
Williamsdale 330/132 kV Substation	New 132 kV switchbay connection	2018/19	5.3.12
Hallidays Point 132 kV Substation	New 132 kV connection point	Late 2012	6.1.3
Lismore 330/132 kV Substation	Two new 132 kV switchbay connections	2015-17	6.2.10
Tumut 132/66 kV Substation	New 66 kV switchbay connection	2013/14	6.2.10
Wellington 330/132 kV Substation	New 132 kV switchbay connection	2013	6.2.10

APPENDIX 5

Glossary

Appendix 5 – 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 New South Wales.
Annual Planning Report (APR 20XX)	A document that sets out issues and provides information to the market that is relevant to transmission planning in New South Wales. This document is the NSW APR 2012.
Clean Energy Bill, 2011	An emissions reduction scheme consisting of a fixed price carbon tax proceeding to a floating price emissions trading scheme. The legislation was approved in November 2011 and is set to take effect from July 2012.
Constraint	An inability of a transmission system or distribution system to supply a required amount of electricity to a required standard.
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	Gigawatt hour. A unit of energy consumption equal to 1,000 MWh or 1,000,000 kWh. 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 National Electricity Market that have been approved by participating State governments under the National Electricity Law. The NER supersedes the National Electricity Code (NEC or “the Code”) and is administered by the AEMC.
National Transmission Statement (NTS)	A one-off document produced by AEMO in 2009 and based on past ANTS. 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 National Electricity Market.
NTFP	National Transmission Flow Path.

Appendix 5 – Glossary (continued)

Term	Explanation/Comments
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 New South Wales Minister for Energy.
TNSP	Transmission Network Service Provider. A body that owns controls and operates a transmission system in the NEM.

APPENDIX **6**

Contact Details

Appendix 6 – Contact Details

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TransGrid

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