TransGrid

NEW SOUTH WALES

ANNUAL PLANNING REPORT

2003

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Executive Summary

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

- i Continuing load growth in NSW, and
- ii The pivotal role of the NSW network in facilitating the National Electricity Market.

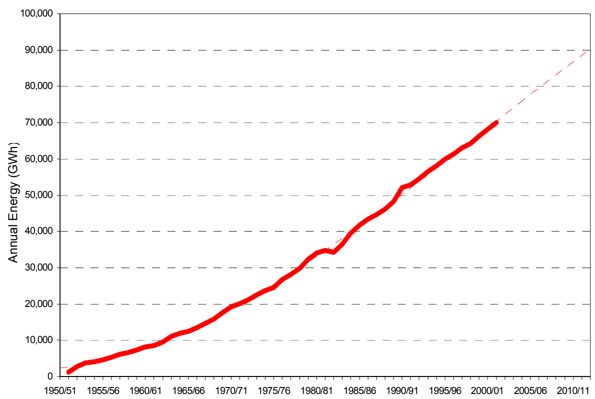
An additional important factor at this time is the considerable uncertainty associated with possible new large industrial developments in NSW, especially in the Newcastle area. Also the replacement of some ageing assets will continue to be required.

Load and Energy Growth

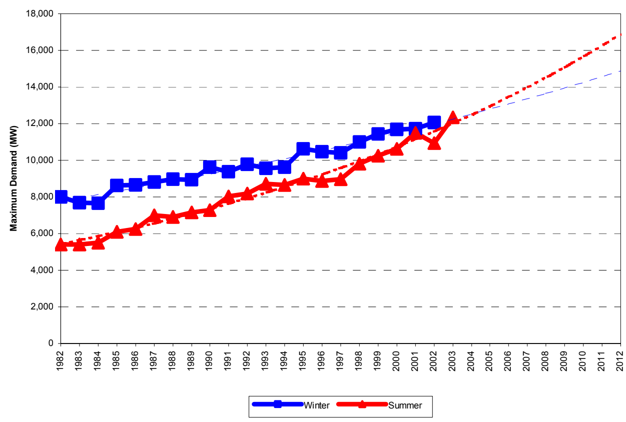
Energy growth in NSW has continued at approximately 1600 GWh per annum over the past 20 years.

In that same period, winter demand has increased by about 270 MW per annum, and summer demand at about 350 MW per annum. This level of growth has occurred despite a concerted effort by the NSW Government and the electricity industry to curb demand through demand side initiatives. Although substantial work is proposed to dampen future load growth, options must be developed to meet the growing demand to ensure the ongoing economic activity of the State.

Historical NSW Energy Use



Historical NSW Winter & Summer Demand



Local Generation and Demand Management (DM)

TransGrid adopts a multi-faceted approach to encouraging local generation and Demand Management options so as to reduce the need for capital investment in network that is necessary to meet the growing load in NSW. One of the primary aims of the Annual Planning Report is to provide advance information to the market participants and interested parties on the nature and location of emerging network constraints so that feasible local generation and DM options may be formulated to reduce the growth rate and defer or avoid the need for new transmission or distribution network investment.

TransGrid's joint planning with the NSW distributors provides a mechanism to identify opportunities for local generation and DM options. TransGrid, with the relevant DNSPs, has conducted specialist local generation and DM studies in areas such as Coffs Harbour and mid north coast, the western area of NSW, south – western NSW, and the Liverpool and Camden areas in Sydney. Specific Requests for Proposals for local generation and DM alternatives have been issued in these areas.

TransGrid, in association with Energy Australia and the Department of Urban and Transport Planning, has initiated a high priority project to implement a Demand Management strategy to defer or avoid network expansion in the inner Metropolitan Sydney area. TransGrid and Energy Australia are supporting the project by committing a total of $10 million to a dedicated fund over a five-year period.

It is imperative that the community and industry vigorously identify and pursue Demand Management opportunities so as to minimise the need for network expansions and to promote the most environmentally sound approach to sustainable development in NSW.

NSW Network Development

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

Over the past 20 years there have basically been only two major transmission links built in NSW: the Eraring to Kemps Creek 500kV link (which was commissioned in the early 1980s to match the commissioning of Eraring Power Station), and the Bayswater / Mt Piper to Marulan 500kV link (presently operating at 330kV) which was constructed in the late 1980s and early 1990s, in conjunction with the commissioning of Bayswater and Mt Piper power stations. Again, over this 20 year period, the load in NSW has virtually doubled.

Effect of the National Electricity Market

The other major network event in recent years was the connection of Queensland to an electrically remote part of northern NSW. The benefits in normalising spot prices in the National Electricity Market of that connection have been significant. However, its effect on the “tidal flows” impressed on to the NSW network has been marked.

Creation of the National Electricity Market has significantly changed the role of the NSW transmission system. The critical network that contributes to the efficiency of the National Electricity Market, in broad terms, sits between the regional reference nodes in Brisbane and Melbourne. Most of that network is embodied in NSW. Certainly, network connections to South Australia, and future connections to Tasmania have, and will have, critical importance to those States. However, the key network that facilitates efficient operation of the National Electricity Market interconnects Southern Queensland to Sydney, and then to Melbourne.

Clearly, constraints are now emerging within the NSW network, which arise from changed generation scheduling that is now dramatically different from that for which the existing NSW network was planned.

Prospective Industrial Load Growth

A number of major industrial loads have been foreshadowed for development in the Newcastle area. The full development of all of these proposals would see up to another 2000MW of load needing to be supplied in the Newcastle area. Development of even a small portion of these loads would have a major effect on the network supplying Newcastle. Any significant load increase in the Newcastle area could require the construction of a new transmission line from the Upper Hunter Valley power stations to the Newcastle area. This would expect to be a difficult line route to secure if lead times were short.

Also, any major new industrial load could be coupled with the development of additional generation capacity within NSW. Satisfactory connection of that generation to the main system would need to be accommodated.

Structure of the Annual Planning Report

The Annual Planning report contains four main sections and various appendices.

Section 2 contains a summary of planning processes in NSW and TransGrid’s obligations as a transmission network services provider and the Jurisdictional Planning Body for NSW.

Section 3 contains a summary of the latest NSW load forecast.

Section 4 contains a broad description of network capabilities, potential constraints and possible scenarios of development.

Section 5 contains details of identified and emerging constraints and options for their relief.

Other important information is contained in the appendices, including details of the most recent load forecasts that have been made available to TransGrid by distribution network services providers in NSW.

Contents

1. Introduction

The 2003 New South Wales Annual Planning Report documents process and outcomes of the New South Wales Annual Planning Review carried out since the publication of the previous issue. The purpose of the Planning Review and the Report is to:

- Identify emerging constraints in New South Wales transmission networks over appropriate planning horizons;
- Provide advance information on the nature and location of the constraints. The level of information included in this document is intended to be sufficient to encourage Market participants and interested parties to formulate and propose options to relieve the constraints, including those that may include components of local generation and Demand Management (DM) or other options that may provide economically efficient outcomes;
- Discuss options, that have been identified, for relieving each constraint including network, local generation, DM and other options;
- Comply with National Electricity Code requirements in respect of preparation of a Transmission Network Service Provider's Annual Planning Report and the associated consultation on proposed New Small Network Assets;
- Provide further details on the load forecast data that has been provided to NEMMCO's Inter-regional Planning Committee for consolidation into its annual Statement of Opportunities;

  and
- Provide a basis for annual reporting to the New South Wales Minister for Energy on the outcome of the Annual Planning Review.

The Annual Planning Review process for 2003 included:

- Ongoing planning analysis and identification of network constraints;
- An update of TransGrid's NSW load forecast that took account of actual peak loads for winter 2002 and summer 2002/2003;
- Provision of load forecast data for inclusion in NEMMCO's 2003 Statement of Opportunities;

  and
- Publication of this Annual Planning Report for 2003.

It is intended that the Annual Planning Report 2003 will provide Electricity Market participants and interested parties with information that will help them contribute to the optimum development of transmission networks in New South Wales.

2. Planning and Development Processes

2.1. TransGrid's Obligations

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

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

In this role it:

- Represents the NSW Jurisdiction on NEMMCO's Inter-regional Planning Committee (IRPC);
- Provides jurisdictional information to the IRPC to enable it to assist NEMMCO in producing its annual Statement of Opportunities;
- Carries out an Annual Planning Review during which it:
  - Prepares an Annual Planning Report (APR) for NSW;
  - Holds a public forum that considers the APR and related planning matters;
  - Reports to the Minister on matters arising from the Annual Planning Review; and
  - Reports to the Minister on matters arising from the Statement of Opportunities.

Secondly it is registered with NEMMCO as a Transmission Network Service Provider (TNSP) in the NSW region of the National Electricity Market. In relation to a TNSP's responsibilities for planning and development of networks the National Electricity Code (the Code) requires 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 Distributor's network;
- Carry out joint planning with Distributors to determine options for the relief of constraints that can be considered by Code Participants and interested parties;
- Coordinate a consultative process for consideration and economic analysis of the options in accordance with the ACCC's Regulatory Test 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 June 30 of each year.

The Code requires that the Annual Planning Report must include:

- Results of annual planning reviews with Distributors during the current year;
- Load forecasts submitted by distributors;
- Planning proposals for future connection points;
- Forecast of constraints over 1, 3 and 5 years;
- Summary information for proposed augmentations;
- Consultation reports on proposed new small network assets (NSNA)

These obligations are described more fully in Chapter 5.6 of the Code and the ACCC's Regulatory Test.

Figure 2.1 illustrates the main tasks and interrelationship of TransGrid's dual roles and Figure 2.2 shows the main tasks carried out during the Annual Planning Review.

The Code distinguishes between the planning processes that should be followed when applying the ACCC's Regulatory Test in the following cases:

- Where consultations commenced prior to 8th March 2002 the Code provisions in effect prior to that date should be followed. This is illustrated in Figure 2.3.
- Where consultations commenced on or after 8th March 2002 there are different provisions depending on whether the proposed augmentation would be a new small network asset (asset cost between $1 Million and $10 Million) or a new large network asset (asset cost greater than $10 Million) or a funded augmentation. This is illustrated in Figure 2.4.

2.2. Context of NSW Annual Planning Review in the NEM

The New South Wales Annual Planning Review is one of a number of annual planning reviews that take place throughout the NEM. These reviews cover the broad areas of supply demand balance, transmission networks planning and distribution networks planning. They are mandated through a variety of legislative and policy directives and therefore overlap to some extent. Nevertheless these documents form an effective framework for the dissemination of network planning information throughout the NEM. The relationship of the various annual planning review documents is depicted in Figure 2.5.

The following table provides summary information for the current editions of these documents.

Table: - Summary Information for Annual Planning Review Documents

Document Title	Organisation	Last Published	Covers	Internet Site
Statement of Opportunities for the National Electricity Market	NEMMCO	July 2002	Opportunities in the NEM	www.nemmco.com.au
New South Wales Annual Planning Report	TransGrid	June 2003	Transmission Planning in NSW	www.transgrid.com.au
Annual Planning Report (Draft)	ESIPC	June 2003	Supply Demand Balance/Transmission Planning Summary in South Australia	www.esipc.sa.gov.au
Planning Statement	Transend System Controller	Dec 2002	Supply Demand Balance and Transmission Planning Summary in Tasmania	www.transend.com.au
Annual Planning Report	Powerlink	July 2002	Transmission Planning in Queensland	www.powerlink.com.au
Electricity Annual Planning Review	VENCorp	April 2002	Transmission Planning in Victoria	www.vencorp.com.au
Annual Electricity System Development Review	EnergyAustralia	May 2003	Transmission and Distribution Planning.	www.energy.com.au
Network 2013 Annual Planning Statement	Integral Energy	June 2003	Distribution Planning.	www.integral.com.au
Annual Electricity System Development Review	Country energy	May 2003	Distribution Planning.	www.countryenergy.com.au

Detailed contact information relating to TransGrid's Annual Planning Review appears in Appendix 5.

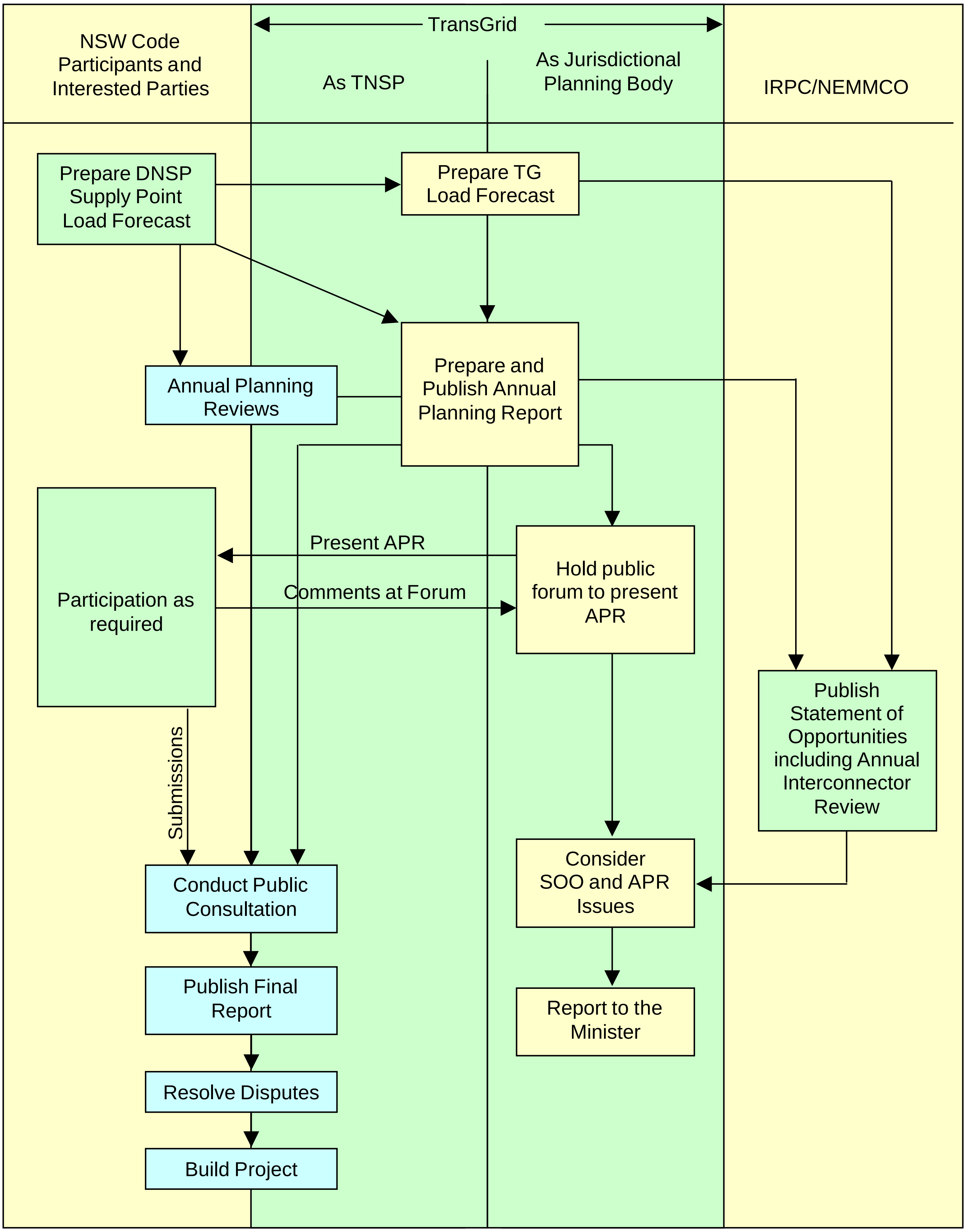


Fig 2.1 TransGrid's Planning Roles

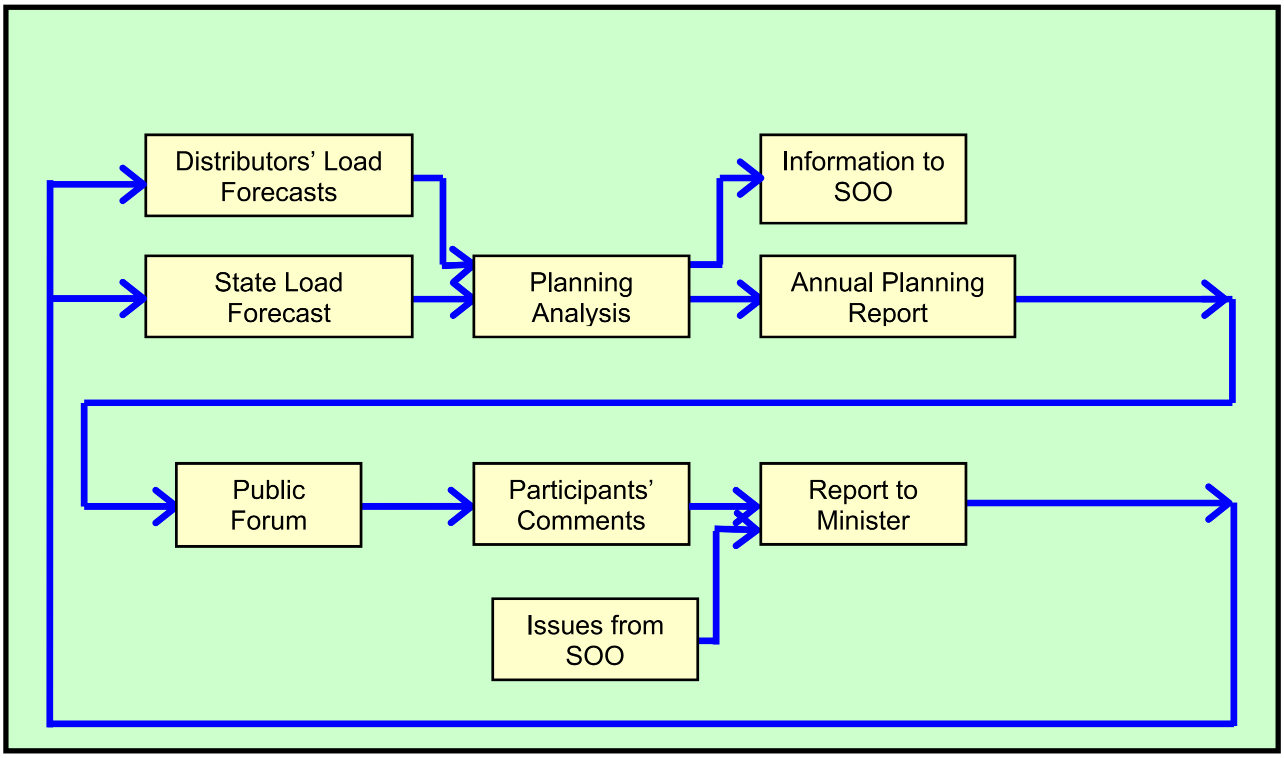


Fig 2.2 Annual Planning Review Process

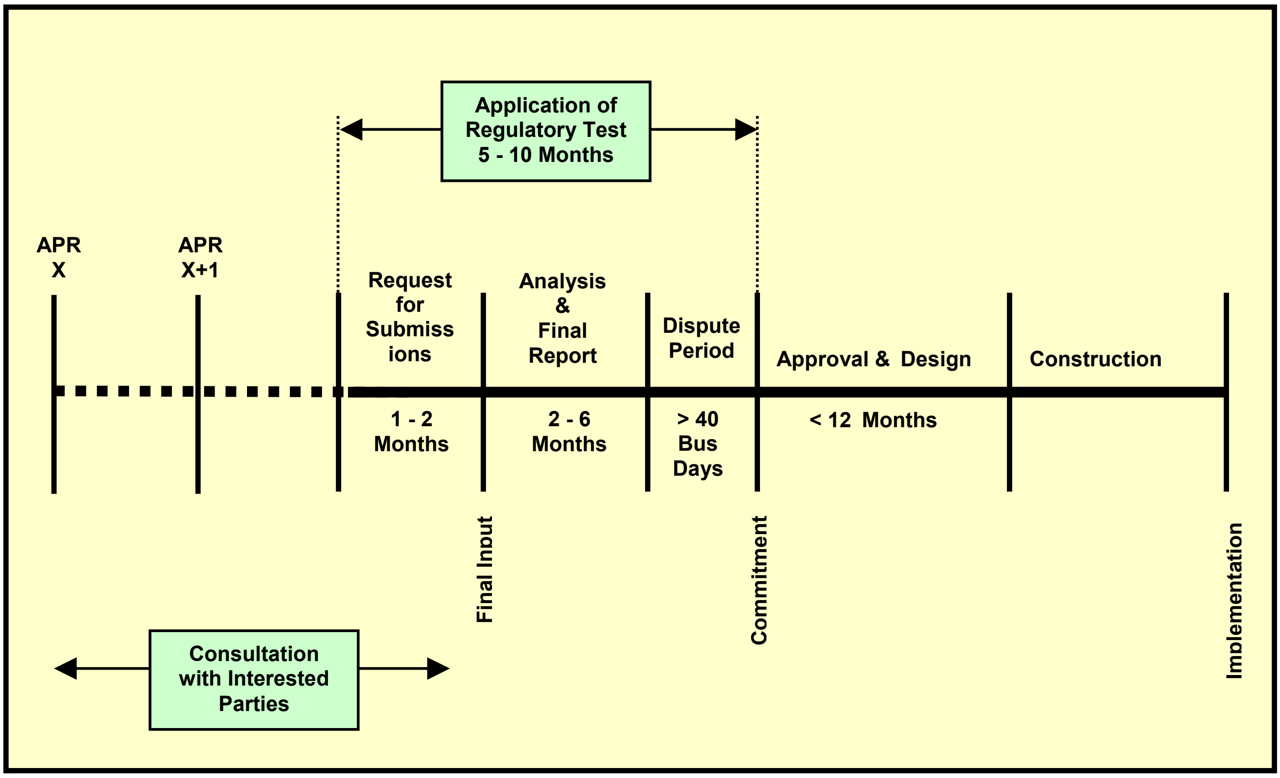


Fig 2.3 Consultation Process for Individual Constraints: Old Code Provisions

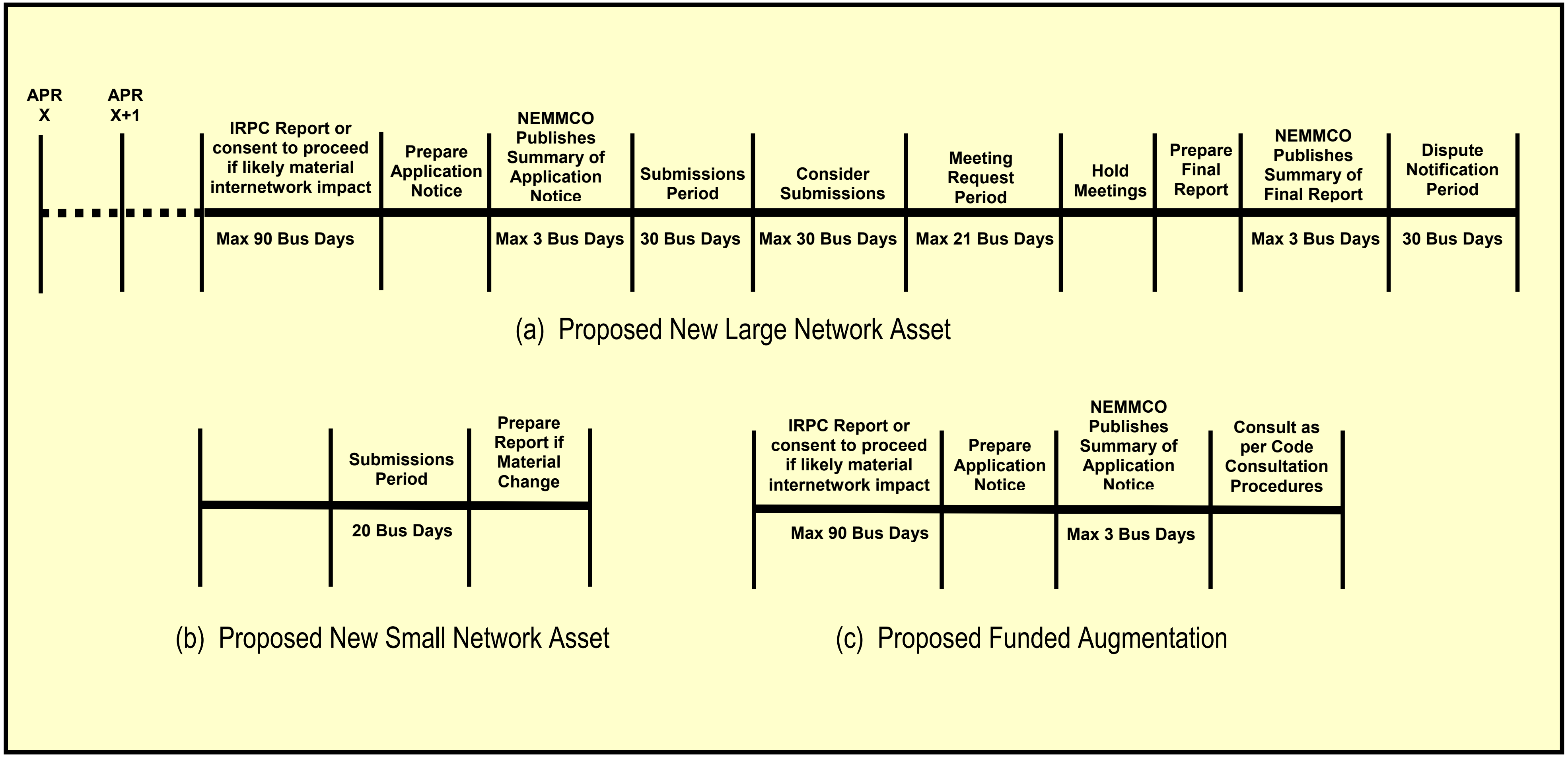


Fig 2.4 Consultation Processes – New Code Provisions

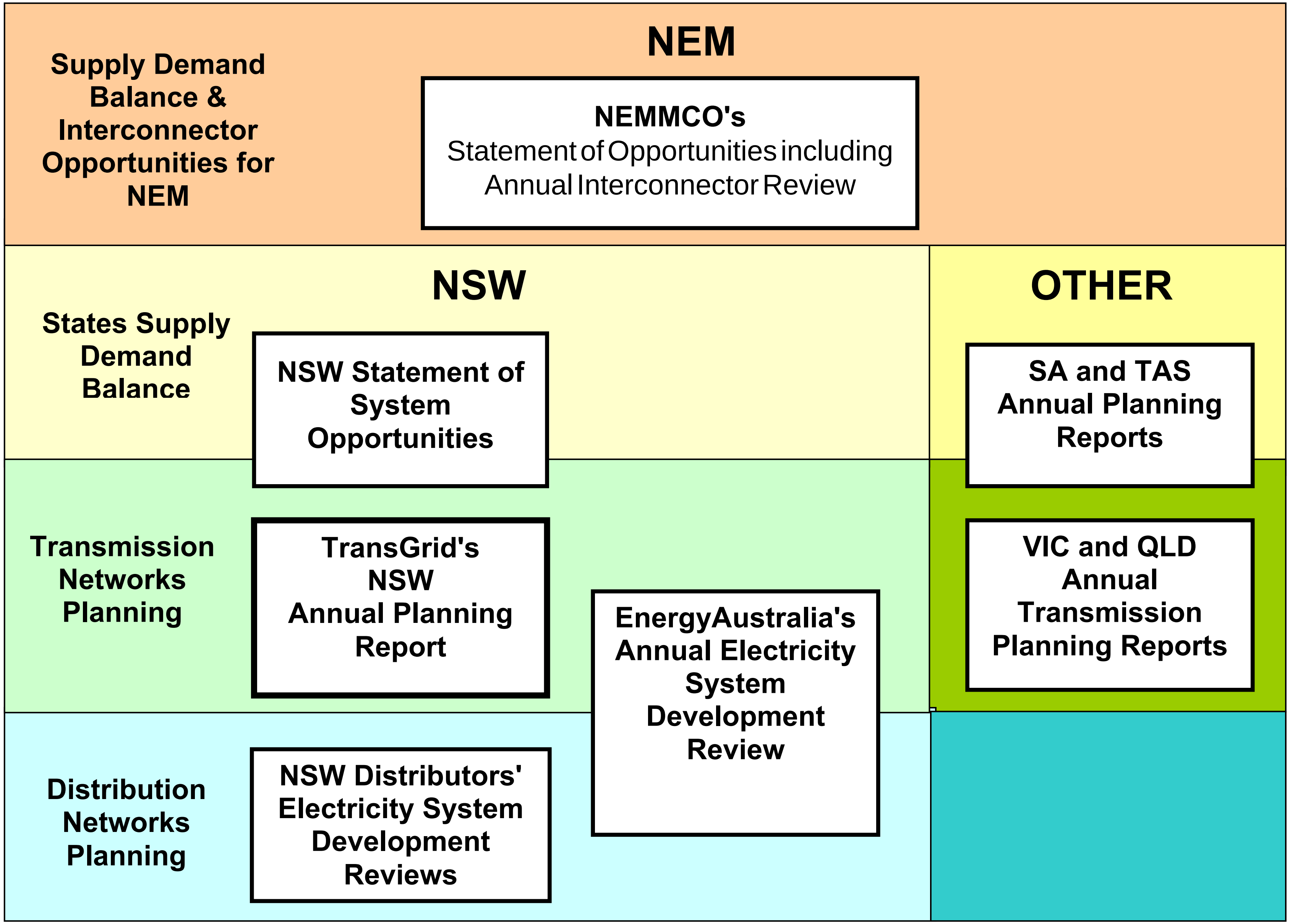


Fig 2.5 NEM Annual Planning Review Documents

2.3. Consideration of Local Generation and DM Options by TransGrid

One of the main aims of the Annual Planning Report is to provide 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 options, including local generation and DM options, to relieve the emerging constraints. Contact details for initial enquiries by the interested parties are given in Appendix 5.

The advantages that local generation and DM options offer in relieving transmission 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. In particular they may reduce emissions of greenhouse gases such as CO_2 and noxious gases such as NO_2 and SO_2.

TNSPs consider local generation, DM and bundled options on an equal footing with network options when applying the ACCC's Regulatory Test.

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

Obviously for an option to be recommended for implementation after the evaluation and analysis, it must pass the Regulatory Test. It must also have a proponent who is committed to implement the option and to accept the associated risks, responsibilities and accountabilities.

At this point in time it is expected that local generation and DM options would emerge either from joint planning with distributors, the Market or from interested parties.

TransGrid's joint planning with the NSW distributors provides a mechanism to identify opportunities for local generation and DM 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 generation and DM options.

Local Generation

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

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

Demand Management (DM)

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

- Reduction in electrical energy consumption through increases, at points of end-use, of:
  - Improved energy efficiency devices and systems;
  - Thermal insulation;
  - Renewable energy sources such as solar; and
  - Alternative reticulated energy sources such as natural gas.
- Reduction in peak electricity consumption through increases, at points of end-use, of:
  - Tariff incentives;
  - Load interruption and reduction incentives;

- Energy storage systems;
- Standby generators; and
- Power factor correction equipment.

Promotion of Local Generation and DM Options by TransGrid

TransGrid actively promotes local generation and DM options through:

- Identifying opportunities for DM and local generation options through joint planning with the Distributors and engaging expert external consultants.
- Informing the market of constraints via the Annual Planning Review and consultations for alleviating individual constraints and proposed new large network augmentations.
- Participating in the review of the Demand Management Code of Practice for Electricity Distributors in NSW.
- Participation in initiatives and reviews by the Ministry of Energy and Utilities and IPART that include consideration of demand management and its relationship to the development of electricity networks.

Dedicated fund for DM and Local Generation in Sydney CBD Area

As part of the joint planning for electricity supply to the Sydney CBD and inner suburbs, TransGrid, Energy Australia and the Department of Urban and Transport Planning have initiated a high priority project to implement a Demand Management strategy to defer or avoid network expansion in greater Sydney area. The project will investigate and identify feasible demand management and local generation opportunities. TransGrid and Energy Australia are supporting the project by committing a total of $10 million towards a dedicated fund by contributing $1 million per year each over a five-year period.

Price Signals

It is recognised that clear and consistent price signals to customers, reflecting actual costs, will provide incentives for local generation and DM.

From 1 July 2002, TransGrid's transmission charges have provided stronger locational signals to customers. Prices now include a usage charge which is different at each transmission connection point. This charge is calculated using the Cost Reflective Network Pricing methodology set out in the National Electricity Code. The NSW distributors are required by their regulator, IPART, to preserve these signals, where practicable, when allocating transmission charges to end use customers.

TransGrid currently applies the usage charge as two rates – one based on monthly maximum demand and one based on energy used in peak and shoulder periods. As a result, for customers who see transmission charges in their monthly bills, there is an immediate benefit through reduced transmission charges if they are able to reduce their demand.

2.4. Annual Planning Review with Distributors

In accordance with Code 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;
- Review the load forecast provided by the distributor

TransGrid also conducts planning meetings with major customers.

2.5. Annual Planning Review for New South Wales

TransGrid, as the JPB for New South Wales, carries out an annual planning review of Transmission networks in New South Wales. The purpose of the Review is to focus on an optimum level of transmission investment by encouraging interested parties to propose options for the relief of transmission constraints that may involve components of local generation and DM. The National Electricity Code underpins this by requiring all TNSPs to carry out annual planning reviews with distributors and publish the results in an annual planning report.

The Annual Planning Review for 2003 commenced in October 2002 with a request by TransGrid for updated load forecasts by Distributors. These forecasts take into account electrical loads experienced during winter 2002. TransGrid also provided a revised NSW load forecast to NEMMCO for inclusion in its 2003 Statement of Opportunities that is to be published by 31st July 2003. Based on these revised load forecasts TransGrid has updated its short term (1, 3 and 5 years) and longer term (5-10 years) analyses of current and emerging network constraints and has summarised the results in this Annual Planning Report for 2003.

3. Load Forecasts

TransGrid uses load forecasts to identify future transmission constraints within or adjoining its network and to quantify any associated transmission development proposals. To this end, forecasts of winter and summer peak demand (measured in both MW and MVar) for points of supply from TransGrid's network are developed in conjunction with distributors. In addition, forecasts of the NSW Region load in aggregate are developed independently by TransGrid, using empirical modelling and economic scenarios provided on a consistent NEM-wide basis by NEMMCO.

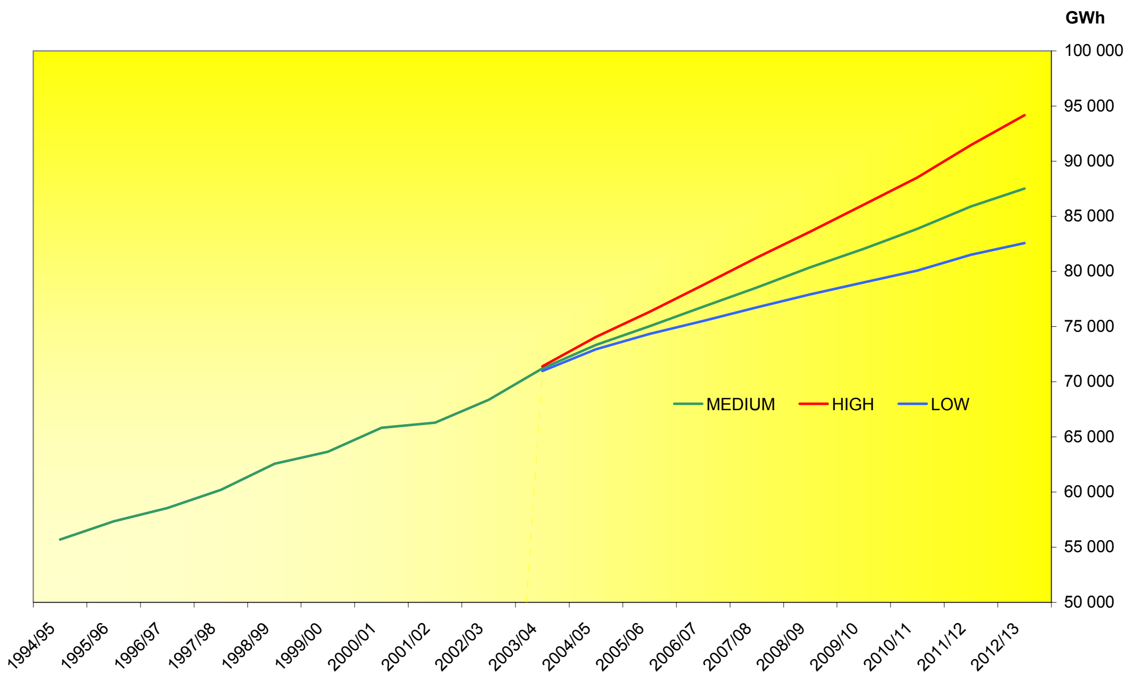
A brief description of the NSW load forecast and the geographic distribution of energy and peak demand growth is given below. The development of the NSW load forecast is outlined in Appendix 2 and detailed tables of the NSW load forecast and Distributor supply point forecasts can be found in Appendix 3.

3.1. NSW Energy Forecasts

"Energy sent out" includes supply to the NEM from Scheduled NSW generators plus net imports from other Regions. As such, energy sent out includes transmission losses but excludes consumption by power station auxiliaries. Energy sent out has grown by 1.6 TWh per annum for the last ten years. For the next ten years further growth is expected to supply growing end-use due to increases in population, real income and the cost of substitute fuels. However, this growth will be offset to some extent by rising real electricity prices and substitute generation from renewable sources as well as demand side initiatives.

Energy sent out is projected to grow on average by 2.5 per cent per annum under the Medium scenario, and within a range of 1.9 per cent to 3.3 per cent under the Low and High scenarios respectively (see Figure 3.1). These scenarios assume that NSW renewable energy targets are disproportionately met by sources of generation in other Regions. If NSW were to meet its share of MRET targets (i.e. Mandatory Renewable Energy Targets) entirely by sources of generation within NSW this would imply an additional 1.2 TWh of renewable energy in 2010 above that assumed for these forecasts. In turn, this would reduce the amount of energy that needs to be supplied by Scheduled generators for any given level of end-use consumption.

Figure 3.1: NSW Energy Sent Out

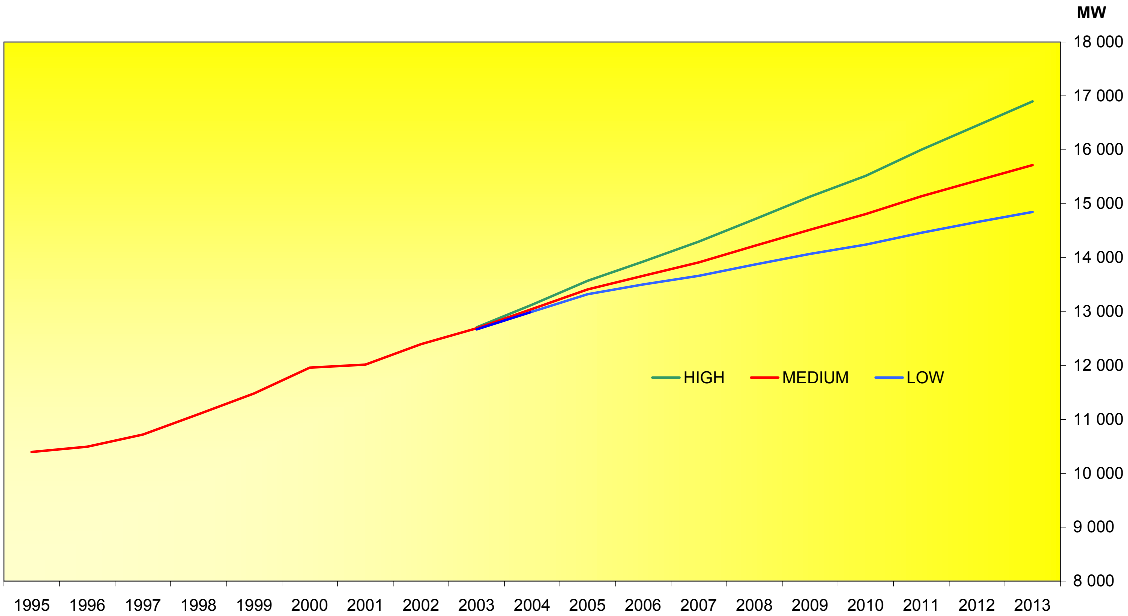


3.2. NSW Peak Demand Forecasts

Peak demands are defined for each of winter and summer in terms of the maximum output of NSW Scheduled Generators plus net imports from other Regions, averaged over a half-hourly trading period. Because daily maximum demand during winter and summer is highly correlated with the prevailing weather conditions, current trends are not readily discernable without temperature correction. Each winter and summer peak demand is therefore adjusted to the level that would have occurred at standard temperatures. These temperatures are chosen to represent percentiles of extreme conditions, such that probabilities of being exceeded can be attached to the associated demand levels. A projected "10% Probability of Exceedance" (PoE) winter peak demand for a particular year, for example, describes the level of demand during winter of that year that has a 10 per cent chance of being exceeded.

Apart from the temporary influence of weather, peak demand in the longer term reflects the underlying growth in energy. In winter the relationship between peak demand and seasonal energy use (represented by the load factor) is relatively stable. However, in recent years the summer load factor has been declining, as higher peak demands outstrip energy growth. This is principally due to an increasing temperature-sensitive component of the summer daytime load as air-conditioning becomes more prevalent. Since the trends associated with increased air-conditioning installation (high-rise residential construction in Sydney and retro-fitting of residential air-conditioning units) show no sign of abating, recent high trend growth in summer demand is likely to continue and actual demands will vary to a greater extent than they have in the past in response to extreme temperatures.

Figure 3.2: NSW Winter Peak Demand (50% PoE)



On a 50% temperature corrected basis, winter peak demand grew on average by around 270 MW per annum over the last ten years. The average increase over the forecast period is projected to be 300 MW under the Medium scenario, within a range of 220 to 410 MW provided by the Low and High scenarios, respectively, over a range of temperatures (see Figure 3.2).

NSW Summer Peak Demand Exceeds Preceding Winter for first time

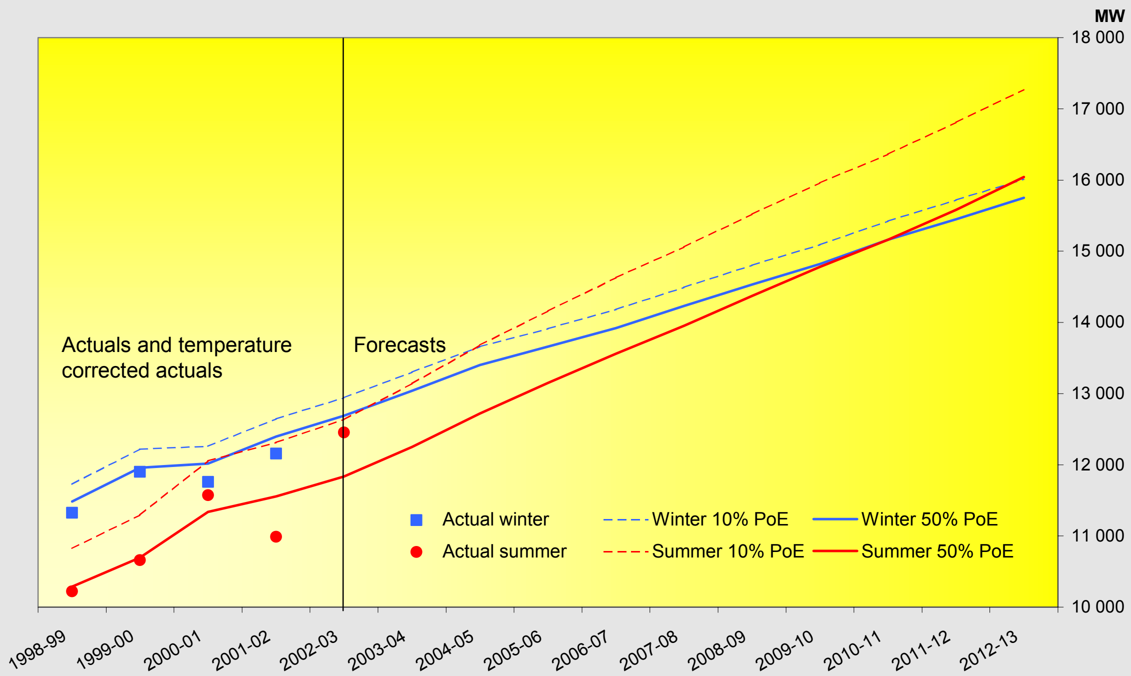
In the afternoon of 30 January 2003, NSW experienced a record half-hourly demand of 12 456 MW, which was 300 MW higher than the preceding winter peak. Historically, record demands in NSW have always occurred during winter and never before has a maximum demand for summer exceeded the maximum demand of the preceding winter.

As summer and winter peak demands have drawn closer together, the 'cross-over' from winter to summer peaking has been widely anticipated. The experience of January 2003 confirms that on very hot days, the potential already exists for NSW demand to exceed winter peak demand levels. Milder than average temperatures in winter 2002 combined with a period of very hot weather during summer 2003 contributed significantly to this result. Notwithstanding these events, however, it remains unlikely that NSW summer peak demands will regularly exceed the immediately *following* winter peak demands until later in the decade.

The sensitivity of demand to temperature is greater in summer than in winter. Combined with greater temperature variation during summer, actual summer peaks can potentially fall within a wide range of values. Under relatively mild conditions, such as during summer 2002, significantly lower summer demands can be expected.

The forecasts set out in Appendix 2, shown below, allow for the possibility that a NSW summer peak will exceed the *following* winter peak by around 2004-05 based on 10% PoE temperatures for both summer and winter.

NSW Summer and Winter Peak Demand

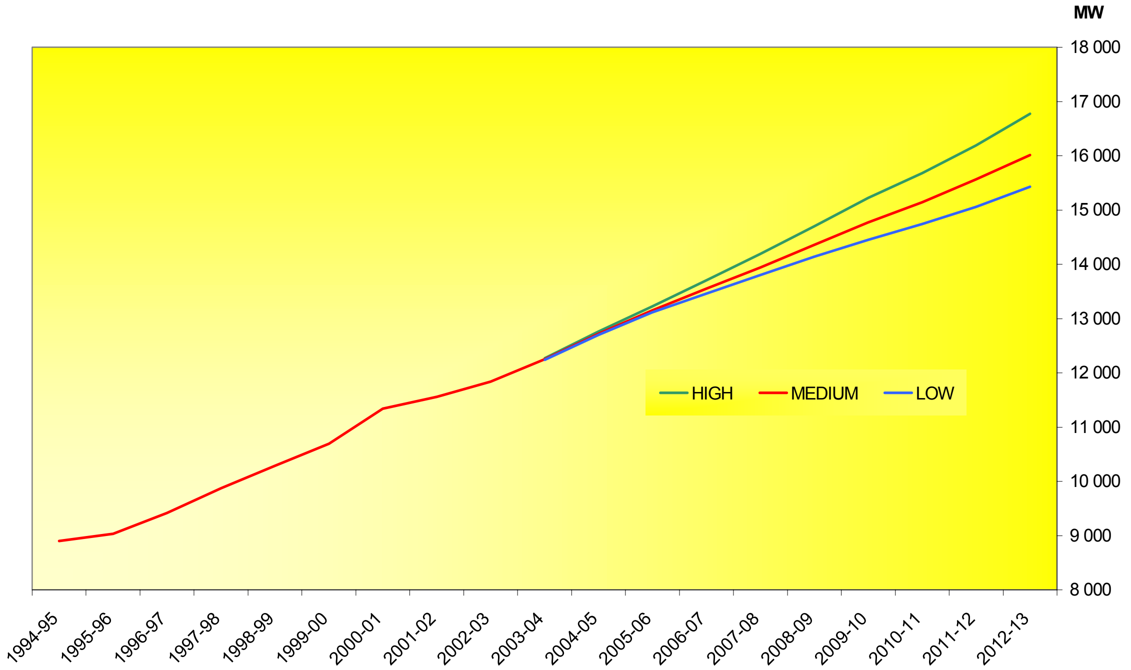


Under 50% PoE temperatures, however, summer demand is forecast to remain below the following winter demand until late in the decade. When compared to the preceding winter, however, summer peak demand is forecast to exceed winter demand from around summer 2007-08.

Ultimately, however, the actual demand set in each period, and the extent to which one is greater or less than the other, will depend on the relative temperature conditions in each period. It is expected, therefore, that over the forecast period, summer demands will exceed winter demands in some years but not in others.

Summer peak demand, corrected to 50% temperatures, increased at a faster rate of around 340 MW per annum over the last ten years and is projected to grow by 420 MW per annum to 2012-13, with the Low and High scenarios providing bounds of between 330 and 540 MW per annum (Figure 3.3).

Figure 3.3: NSW Summer Peak Demand (50% PoE)



If NSW were to meet its share of MRET targets by sourcing renewable generation wholly within NSW, then, for any given level of end-use demand, the peak (Scheduled) generation requirement would be reduced by around 50 MW by 2010.

Similarly, any new demand management initiatives undertaken in the future may also reduce the projected growth in generation requirements

3.3. Geographic Distribution of Growth Forecasts

Figures 3.4 and 3.5 show the relative distribution of 2000-01 energy and 2002 winter peak demand[1] between the five distribution areas[2]. The areas broadly covered by the respective distribution networks are as follows: EnergyAustralia – from coastal Sydney to Newcastle and lower Hunter Valley; Integral Energy – western Sydney, south coast and Blue Mountains; Country Energy – north, central and southern country NSW; ActewAGL – the Australian Capital Territory; Inland Energy – western NSW. The difference between the distribution of energy vis-à-vis peak demand is primarily a result of the operation of the major industrial loads which account for a higher proportion of annual energy compared with peak demand.

The distributor forecasts indicate that peak demand growth is expected to be fastest in the Integral Energy and Country Energy (southern) regions, particularly in summer. This is expected to result in a slight increase in the overall proportion of NSW load concentrated in the Integral Energy network

[1] The distribution of summer peak demand is similar to winter but with a slightly higher proportion located within the Integral Energy network and slightly lower proportions in the Energy Australia and Country Energy Networks.

[2] Major industrial loads including aluminium smelters, paper mills and steel plants have been included in the relevant geographic area where the load is located. Some of these loads are, however, supplied directly from TransGrid's network rather than the relevant distributor.

over the forecast period with small compensating changes in the other distribution areas. Detailed information on both the NSW and supply point forecasts can be found in Appendices 2 and 3.

Figure 3.4: NSW Energy Distribution 2001-02

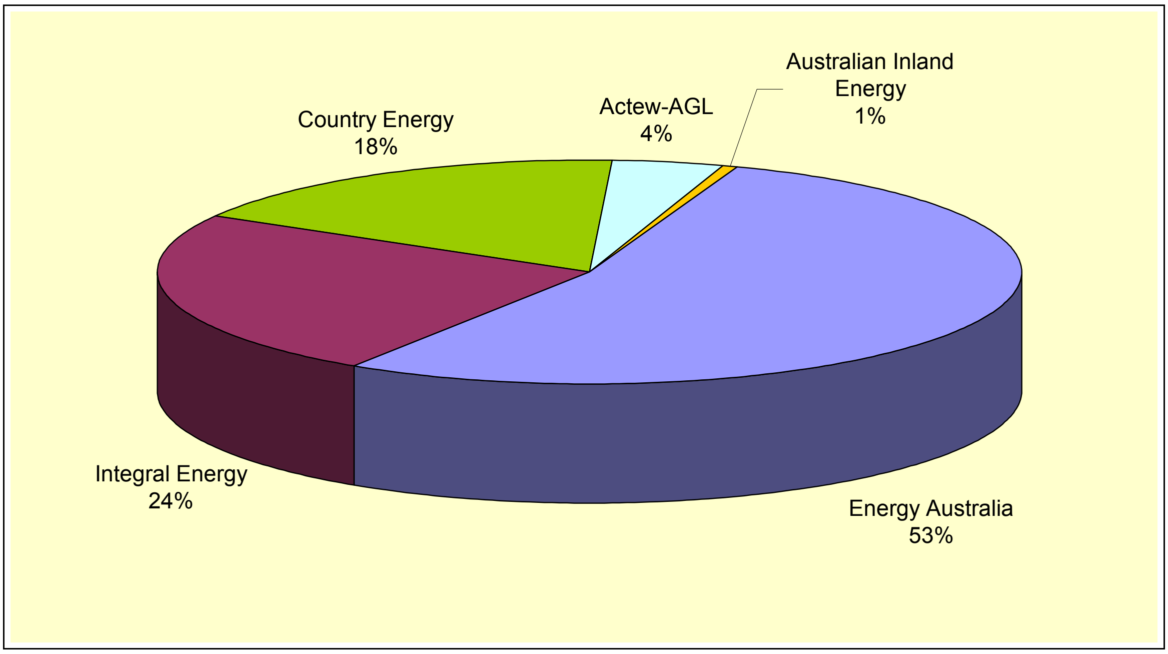
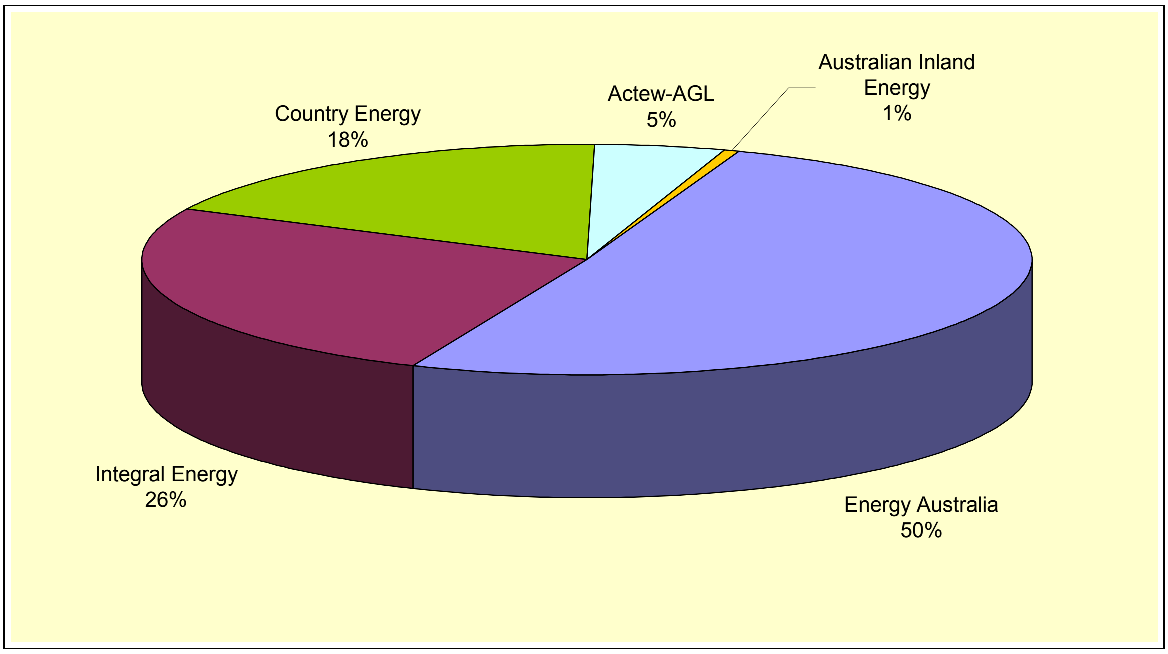


Figure 3.5: NSW Peak Demand Distribution: Winter 2002



4. Outline of Main Network Capabilities and Potential Constraints

This section describes the NSW main network and its adequacy to meet system loading and generation conditions over the next ten years.

The New South Wales high voltage network was designed to transfer power from the coalfields power stations located in the Hunter Valley, Central Coast and Lithgow areas to the major load centres. Also, the network was designed to transmit the NSW/ACT share of Snowy generation towards Canberra and Sydney. The development of the NEM and interconnection with Queensland will increasingly impose a wider range of loading conditions on the network than was planned.

Some significant network augmentations will be required over the next decade to ensure that intra-regional constraints do not markedly limit the economic operation of the NEM nor adversely affect reliability of supply to NSW load centres.

To assess the potential impact on the New South Wales transmission network of possible future load and generation developments within the NEM, TransGrid has considered a number of load/generation scenarios. Where the timing or extent of constraints is materially affected by NEM load/generation developments, this is indicated in the following sections.

Further details of the scenario planning approach are included in Appendix 1.

Sydney is surrounded by some major national parks to the north, south and west as well as increasingly densely populated urban areas. Even 20 years ago, when the route of the existing Eraring-Kemps Creek 500 kV line was being secured, it was recognised that the likelihood of securing any further new easements for major transmission lines into Sydney would be remote. Consequently any additional transmission capacity to Sydney and indeed in other congested parts of NSW should focus on re-building existing lines to higher capacity.

The removal from service of a line while it is being rebuilt would be expected to place severe constraints on that part of the network. In general it is not cost effective or practicable to expect a line to be rebuilt at intervals of less than 20 years or so. Consequently the optimum capacity for a new line needs considerable judgement and consideration of practicable alternatives. This process increases the complexity of the already difficult process of assessing optimum transmission works that need to be undertaken to ensure future system capacity is prudently developed in the most cost effective manner.

The NSW main network is interconnected with the Victorian network via the Snowy system, Jindera and Buronga, and NSW is also interconnected with the Queensland network. The NSW network is thus an integral part of the interconnected south eastern Australian system. Its adequacy and performance is heavily influenced by the power flows between the state systems.

Figure 4.1 on the following page shows in stylised form the main connections between the NSW generation and load centres with indicative loads in each area as at present. Each connecting link is made up of a number of 330 kV and 500 kV lines. The power flow between the centres is a function of load, generation dispatch and interconnector flows.

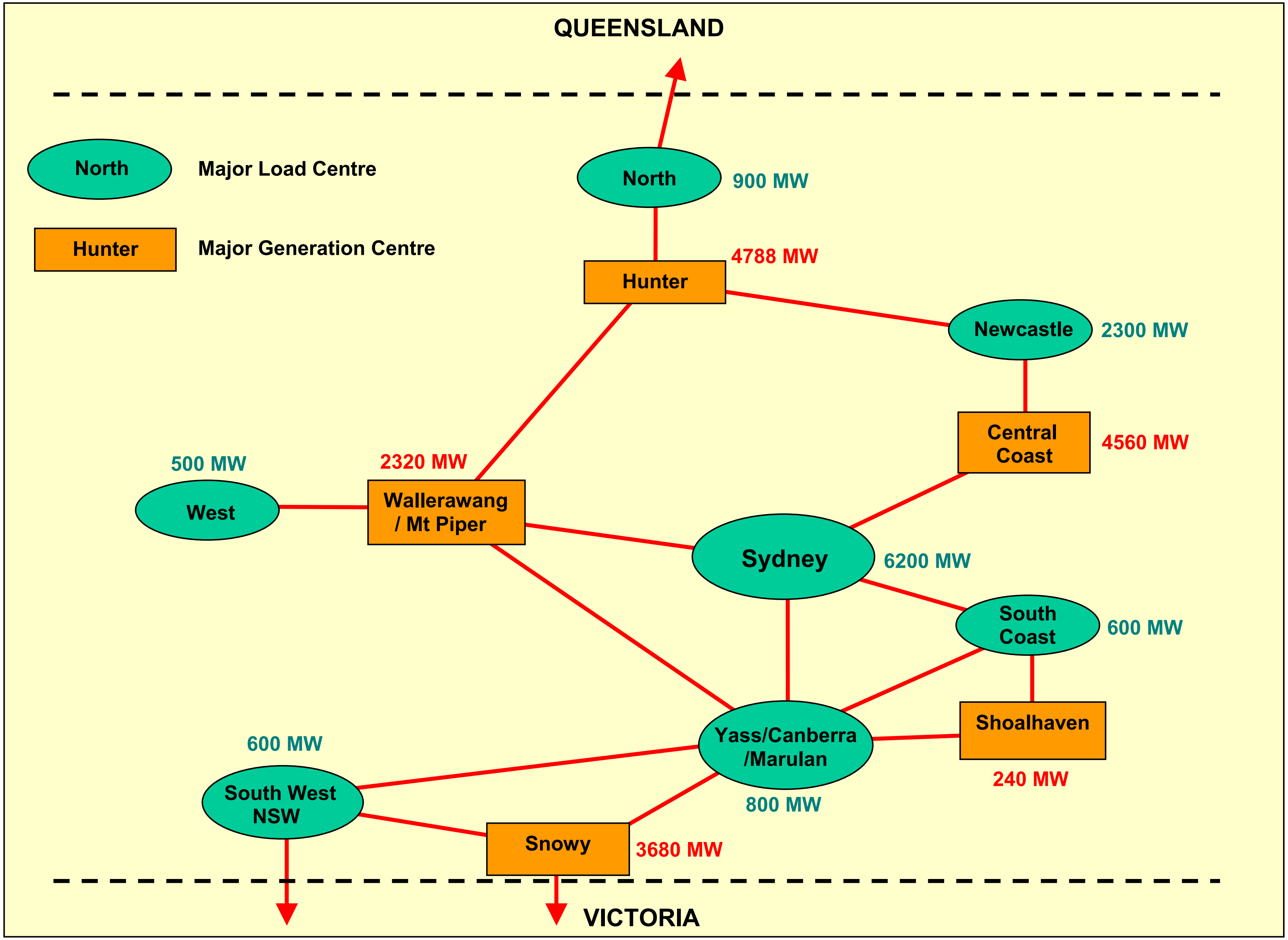


Fig 4.1 NSW Generation and Load Centres

The installed generation in each centre, ignoring minor gas turbine stations, is as follows (with the approximate installed MW capacity):

Generating Centre	Power Stations	Rated Generation MW
Hunter Valley	Bayswater Liddell Redbank	4788
Central Coast	Eraring Vales Point Munmorah	4560
Western	Mt Piper Wallerawang	2320
Snowy	Guthega Murray 1 & 2 Tumut 1, 2 & 3	3680
South Coast	Bendeela Kangaroo Valley	240
South West NSW	Blowering Hume	130

The capability to transfer power over the NSW - Queensland and NSW –Snowy -Victoria interconnections is as follows:

Interconnection	Indicative Capability
NSW - Queensland	The NSW export capability (QNI and Directlink) ranges from about 400 MW at times of high load to about 700 MW at times of lighter load. The NSW import capability over QNI is presently up to about 950 MW but this is expected to increase to about 1100 MW under favourable loading and generator dispatch conditions, following further testing of the interconnection.
NSW – Snowy – Victoria	NSW import capability from Snowy is about 3000 MW. NSW/Snowy import capability from Victoria is typically 1000 MW to 1100 MW. NSW export capability to the Snowy/Victoria regions ranges from about 600 MW at times of high NSW load to about 1000 MW at times of light load.

The overall capabilities of the various sections of the main NSW network are as follows:

4.1. Snowy Region to New South Wales

The Snowy region to NSW system comprises the system between switching stations in the Snowy NEM region and the Yass / Canberra area and thence to the south coast of NSW. It comprises the following 330 kV lines:

- Upper Tumut Switching Station to Yass

- Upper Tumut Switching Station to Canberra
- Lower Tumut Switching Station to Wagga
- Lower Tumut Switching Station to Yass
- Lower Tumut Switching Station to Canberra
- Yass to Canberra
- Yass to Marulan (two lines)
- Yass to Sydney
- Canberra to Dapto via Kangaroo Valley.

The south west area of NSW, comprising the load centres of Wagga, Jindera, Darlington Pt and Broken Hill is also supplied from the Snowy area.

Transmission line thermal rating and reactive power constraints limit the total firm New South Wales import capability from the Snowy region and Victoria to approximately 3000 MW.

The 3000 MW capability is utilised to supply the NSW south west and to transport the power north towards the south coast and Sydney.

Because the Snowy region supplies the NSW south west area, the capability for power transfer north from the Snowy region towards the south coast and Sydney increases with increasing southwest area load.

4.2. NSW to Victoria and to the Snowy Region

The New South Wales network is presently interconnected with Victoria at 330 kV via two Murray to Dederang lines and the Wagga to Jindera to Wodonga link, and at 220 kV between Buronga and Red Cliffs.

For the purpose of facilitating generation dispatch and interconnector transfers in the NEM, NEMMCO has established a second region (designated Snowy) within the NSW jurisdiction. This includes the Snowy generating and pumping stations. The region extends across the south of the state so that all power transfer between the NSW and Victorian regions takes place through the Snowy region.

Ownership of 330 kV assets within the Snowy region were transferred from Snowy Hydro to TransGrid in mid 2002. Since taking ownership TransGrid has not changed the rating of the 330 kV transmission lines. Constraints can occur within this region due to the thermal rating of these lines. TransGrid is presently reviewing these lines with the aim to maximise their thermal rating.

The capability to export power from New South Wales to the south, to supply both Victoria and any pumping load in the Snowy area, is determined by transient stability limitations applicable in the event of a fault on a critical 330 kV transmission line in New South Wales, and by the thermal rating of plant in southern NSW.

4.3. NSW / Snowy to Victoria via the NSW South West

The interconnection between NSW and Snowy to the Victorian system has one path via the NSW south west system in the Wagga area.

The interconnection between Jindera and Wodonga and the supply system in the Wagga area is supported by a single 330 kV transmission line from Lower Tumut to Wagga and a 132 kV transmission system from Yass. The 132 kV transmission system is made up of three 132 kV lines which also supply intermediate load substations at Tumut, Burrinjuck, Murrumburrah and Gadara.

The import of power by Victoria from the NSW and Snowy regions has a significant impact on conditions in the Wagga, Jindera and Buronga section of the NSW main network and on the Yass to Wagga 132 kV system. The growth of loads in this region, coupled with a requirement for heavy transfer of power south from the Snowy region, will require an augmentation to the Wagga area system.

In recent years Victoria has improved its capability for import south from the Snowy area to meet potential high loads during periods of hot summer weather. Series compensation has been installed in the link from Snowy to Melbourne and lines have been uprated to increase its capacity. To support increased power flows to the NSW southwestern system and Victoria, additional reactive power support has also been installed in the Wagga area. Ongoing load growth in the area will require the continued installation of additional reactive power support to overcome a decline in the Victorian import capability.

4.4. West and South of Wagga

The far south-western sector of NSW is supplied via a 330kV line from Wagga to Darlington Point, three 132kV lines from Wagga to Yanco and Finley, as well as a 132kV line from Albury to Mulwala. This network is heavily loaded and it is expected that additional augmentation, most likely by the construction of a further 330kV line to the region, would be required within the next 5 years or so. In addition to that, Country Energy's 66kV network, especially to the Moama area from Deniliquin is reaching its capacity. In conjunction with Powercor and SPI PowerNet, TransGrid and Country Energy have been considering the need to reinforce supply to the load areas along the Murray River.

In TransGrid's 2002 APR, the main option given in augmenting this network was the construction of the second 330kV line to Darlington Point, and lower voltage lines to the Deniliquin / Moama area. A further option is now under consideration to construct a 330kV line from Wagga to Finley, and then on to the Moama / Echuca area to augment not only the main transmission supplies, but also to avoid proliferation of the new 66kV or 132kV lines to the Murray River region. This option could be further extended to connect to the 220kV network in Victoria and, consequently, to increase inter-regional NSW to Victoria power flow capability.

4.5. South Coast to Yass / Canberra Area

Four 330 kV lines presently extend from Sydney and the South Coast into the South West and Snowy areas. The lines carry the full load of the Yass/Canberra area and the NSW south west and interconnection power flow with the Snowy region and Victoria.

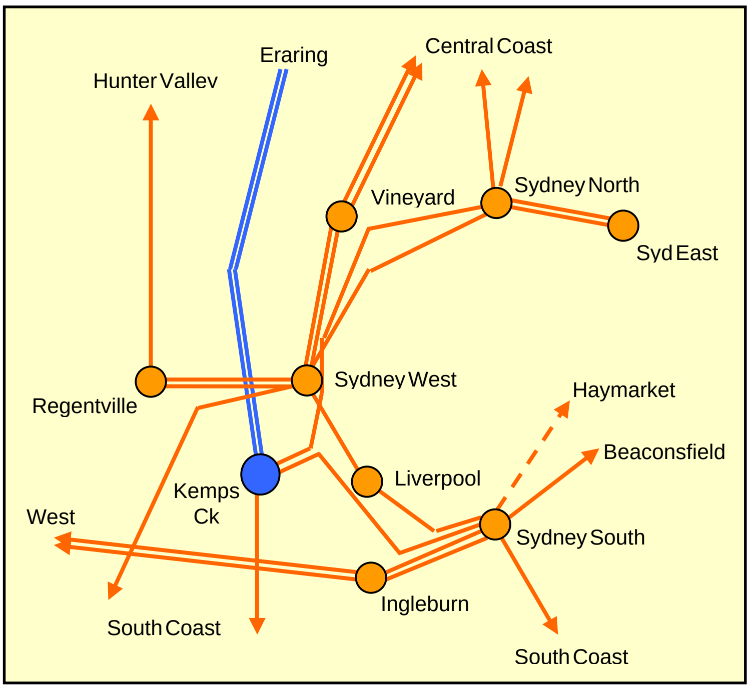
Power flow in this network is subject to tidal patterns governed by power transfers between the generators in QLD, NSW, Snowy and Victorian regions.

The four lines to the south share load unequally due to their different lengths and terminal points. Under some load and interconnector power transfer conditions this section of the network can reach its rating. This limitation is exacerbated by the growth of the South West area load and potential future increases in power export from NSW and/or Snowy to Victoria.

4.6. Sydney Area

The Sydney area is supplied by the following substations that are heavily interconnected with the remainder of the main system:

- Sydney North 330/132 kV
- Sydney East 330/132 kV
- Sydney West 330/132 kV
- Sydney South 330/132 kV
- Liverpool 330/132 kV
- Vineyard 330/132 kV
- Regentville 330/132 kV
- Beaconsfield West 330/132 kV
- Ingleburn 330/66 kV



- Kemps Creek 500/330 kV.

The interconnected 330 kV system in the Sydney area carries the combined load of these substations (about 6000 MW at present). Some limitations are emerging particularly in the southern part of this system that feeds the Liverpool to Sydney South area and from Sydney South to the inner city area.

4.7. West of Wallerawang and Mount Piper

Supply to the Wellington and western and central western areas comprises a single 330 kV line from Mount Piper with a supporting 132 kV system operating in parallel and supplying intermediate 132 kV substations. Between the Wallerawang/Mt Piper and Wellington areas there are four 132 kV circuits. One of these, the Wallerawang to Orange line, has a relatively small conductor.

An outage of the 330 kV line has a significant impact on this system. Voltage levels throughout the western area will be at critically low levels during such an outage, at times of moderate to high loads, particularly at Wellington and areas to the west.

To address this constraint a new 330 kV line is being proposed in the area (refer Section 5.4.2).

4.8. Hunter Valley to the Western Area, Central Coast and Sydney

The Hunter Valley is connected to the western area by a double circuit 500 kV line that presently operates at 330 kV. A double circuit 330 kV line connects the Hunter Valley to Sydney and two 330 kV lines connect to the Newcastle area.

The power flow from the Hunter Valley to the west, Sydney and Newcastle areas is governed by the following factors:

- The level of generation in the Hunter Valley;
- The NSW import/export over QNI;
- The generation in the Central Coast;
- The load in NSW north of the Hunter Valley and on the far north coast; and
- The load level in the Newcastle area which comprises the Newcastle metropolitan area load, the aluminium smelter loads and the load in the southern parts of the mid north coast of NSW supplied from Newcastle.

With completion of the Queensland – NSW Interconnection (QNI), Directlink and Redbank Power Station the existing transmission capability of this system is heavily utilised. The system cannot accommodate any significant additional generation in the Hunter Valley or further north, without reinforcement.

The transmission capability is governed by line thermal ratings and reactive power considerations. Any significant generation development would necessitate an upgrading of the network by uprating or reinforcement of transmission lines.

The development of additional relatively small generators in the Hunter or variations of the generation dispatch patterns under NEM operation from patterns that have predominated in the past, can be expected to require additional reactive power support. This would have a relatively short lead time.

There is presently a significant focus on major smelter and industrial load development in the Newcastle area that may also have associated generation developments. Major load developments in the Newcastle area may require network reinforcement as these will result in increased loading in the circuits from the Hunter Valley to the Newcastle area. The increase in the flows in these lines relative to flows in the other lines south of the Hunter Valley results in an overall reduction in the capacity south from the Hunter Valley.

4.9. Liddell to the North and Far North Coast

The 330 kV transmission network north of Liddell supplies virtually all of the northern section of the State. There is very little local generation and there is limited capacity available to transfer loads to Newcastle via the 132 kV system south of Port Macquarie.

This northern network also supports export or import over Directlink (refer below) and the main interconnection to Queensland (QNI).

There are two 330 kV single circuit lines extending from Liddell to Armidale via Tamworth and Muswellbrook. The transmission system has limited capacity to supply the area load plus interconnecting flows when any one of the 330 kV lines is unavailable for service. Generator dispatch may need to be rescheduled in the event of a critical line being opened.

The allowable interconnecting flow northward will also diminish as the area load grows. The transmission system capability may be improved in the short term through the installation of reactive power support plant. There is also potential for a limited degree of line uprating. To secure the long-term supply to the northern area of the state, additional transmission line capacity will be required north of the Liddell/Newcastle area.

Beyond Armidale, transmission to the far northeast of NSW comprises one 330 kV line to Lismore 330/132 kV Substation and an interconnected 132 kV network that supplies substations in the far north eastern area of the state at Coffs Harbour, Koolkhan and Lismore. This area is experiencing a high population growth and a significant increase in demand for electricity.

Directlink forms a high voltage direct current entrepreneurial/ merchant interconnection between NSW and Queensland and can control its power flows according to prevailing market conditions. When Directlink exports to Queensland it imposes a significant additional load on the northern NSW network. Line upratings and the installation of emergency control schemes have been necessary to enable Directlink to transfer power to its design capability with all network elements in service.

Additional support to the area will be required to supply the growing load.

4.10. NSW - Queensland Interconnection (QNI)

QNI comprises double circuit 330 kV and 275 kV lines from Armidale in NSW to Tarong Power Station in Queensland. QNI passes via intermediate substations at Dumaresq in NSW and Bulli Creek and Braemar in Queensland. The QNI project included the upgrading of transmission facilities in northern NSW and extensive control, communication and monitoring equipment at various locations on the NSW system. It was commissioned in late 2000.

The NSW export capability (QNI and Directlink) ranges from about 400 MW at times of high load to about 700 MW at times of lighter load.

The NSW import capability over QNI is presently up to about 950 MW but this is expected to increase to about 1100 MW under favourable loading and generator dispatch conditions, following further testing of the interconnection.

The capabilities for NSW export and import are governed by considerations of line thermal ratings, voltage stability and transient stability. System damping limitations are considered to be less limiting than other constraints at the present power transfer levels.

The growth of the NSW northern loads will result in a gradual decline in NSW export capability that may be partially addressed by line uprating and reactive plant installations.

Significant upgrading of the interconnector capability would require new line developments and probably power system control developments to overcome stability constraints.

4.11. Mid North Coast

The mid north coast of NSW, comprising the load areas supplied from Kempsey, Port Macquarie and Taree substations, is supplied at 132 kV via coastal lines north from Newcastle and a line from Armidale. A 132 kV line from Coffs Harbour to Kempsey via Nambucca that provides some support to the mid north coast system was commissioned in 2002.

This system is loaded to near its capability.

The network also operates in parallel with the 330 kV lines between Liddell and Armidale and hence the loading on the 132 kV system is partially affected by power transfers over QNI and Directlink. NSW export over QNI and Directlink causes a small increase in 132 kV line loadings in a northerly direction and NSW import over QNI and Directlink has the opposite effect. Loading on this 132 kV system can impose constraints on QNI flows.

4.12. System Voltage Control

The security of supply to all of NSW is dependent on ensuring that an adequate supply of reactive power is available for network voltage control. This reactive supply must be available in sufficient quantities and with an adequate response time. The reactive supply is intended to control and arrest declining voltages following outages on the system at times of high loading and to limit the potential for over voltages under light loading conditions.

System voltage control is provided by the following facilities:

- Generator automatic excitation systems;
- Synchronous condensers in the Sydney and Snowy areas;
- Shunt switched capacitor banks at most substations;
- Shunt switched reactors at various locations;
- Static var compensators at key locations; and
- On load tap changing transformers at all substations.

Planning and operation of the system in NSW relies on being able to make use of the present rated reactive capability of generators, which may exceed the National Electricity Code mandatory requirements for generators.

In general, significant generation or load developments will require additional reactive support to be provided. This is also the case for any significant increase in power flow through the system as a result of increased interconnector flows.

4.13. Scenarios of Development over the Next 15 Years

4.13.1. Main System Development

The planning of the main transmission system must take into account the potential for the development of major generation sites and major loads. TransGrid aims to develop the transmission system in an environmentally and socially responsible and cost effective manner.

Consistent with this objective is the concept of progressively completing a high capacity ring linking the Sydney, Newcastle and Wollongong load centres with major generating centres located in the Central Coast, Western coalfields and Hunter Valley. This development would enable future generating plant to be connected both within the existing generating centres as well as at other possible future power station sites. It would be capable of being extended for interconnection with Victoria and Queensland in the very long term and would also avoid a concentration of lines through the Sydney area thus providing diversity of the main transmission paths from north to south in the state.

The Eraring - Kemps Creek 500 kV line was the first segment of the ring constructed. This was completed to connect Eraring Power Station. The second segment completed was the Bayswater - Mt Piper line associated with the development of Bayswater Power Station. The Mt Piper - Marulan line was developed as the third segment to connect Mt Piper Power Station.

Development of power stations has diminished since the construction of Mt Piper Power Station and no further segments of the ring are expected to be required within the next few years. Nevertheless the segments of the ring that have been put in place provide an effective, secure and low loss transmission system.

Future segments that may eventually be required include:

- Hunter Valley to Central Coast - this may be precipitated by the development of major loads in the Newcastle area, additional generation in the west, Hunter valley or in the north, the import of power from Queensland or the development of western NSW power stations;
- Central Coast to Sydney - this may be required for northern power station developments or significant load developments in the Newcastle area;
- Marulan to Sydney - this may be required for any major power station development in the south coast or south of the state or to facilitate greater import of power to or from Victoria.

Loss considerations may be one driver in the further development of this system.

4.13.2. Power Station Developments

Possible power station developments include the re-development of existing stations and the development of greenfield stations. The developments could apply a range of technologies including open cycle gas turbine, combined cycle gas turbine, co-generation, coal-based and renewable sources.

Re-development of existing stations may involve additional output from the site and hence there may be a need for reinforcement of the transmission system in the vicinity of these sites.

The possible greenfield generation developments that would impact on the New South Wales system can be categorised as southern, Sydney area, western and northern (which includes the Hunter Valley). These may include, for example:

Southern:

Oaklands (south west of Wagga), Wagga area, Wollongong/South Coast area

Sydney area:

Botany, Kurnell, Other Co-generation opportunities

Western:

Ulan, Wollar, Cobar

Northern:

Hunter Valley area

Narrabri - Gunnedah area

Sugar mill generation in the far north

In addition, there is potential for large scale wind generation in a number of areas of NSW

The transmission systems that may be required for these categories are dependent on:

- The scale of the generation development;
- Whether it is base load, peaking or seasonal generation;
- Whether the generation is to be firmly connected to the bulk transmission system or whether it is to make use of available capacity in the existing transmission system;
- Loss impacts;
- Whether the power station output will be supplied across existing regional boundaries.

Hence it is not possible to be prescriptive about the extent and nature of the longer term transmission developments. Advantage may be able to be taken of the high capacity ring concept. Alternatively further 330 kV or lower voltage line development may be economic.

Some options are as follows:

Sydney Area

New generation is likely to be embedded in the Distributor systems and hence the major impact on TransGrid's system tends to be increased fault duty at existing substations.

Southern Generation

The Marulan to Sydney section of the main system could be developed. This may be able to be achieved through reconstructing lines, such as the existing Yass - Sydney West single circuit 330 kV line, or by developing new lines on new routes.

Western Generation

The transmission capability from the area is limited. It is likely that, due to the presence of national parks to the west of Sydney, major line development would need to be restricted to development of the ring from Marulan into Sydney or from the Hunter Valley towards Sydney. The re-development of existing lines would be considered.

Northern Generation

There is no scope for the present transmission system south of the Hunter Valley to accommodate significant amounts of new generation in the Hunter Valley or further north without either major line works or limitations on imports from Queensland. This assumes no further development of major loads in the Newcastle area.

Further development of the ring could be achieved by the re-development of existing 330 kV lines although in some areas lines on new routes may be required. TransGrid has maintained possession of some line easements on the central coast that may facilitate such developments. A new 500/330 kV substation may also be required in the Newcastle area, associated with any 500 kV line development. Uprating the Bayswater/Mt Piper/Marulan line to its design level of 500 kV may be required within the next five years.

4.13.3. Major Load Developments

Mining, mineral processing, smelting and arc furnace loads may be developed at a number of sites throughout New South Wales. Each may require transmission developments.

Further development of the aluminium smelters in the Newcastle area will require local transmission works and possibly more significant line developments.

The development of arc furnace loads, possibly on or near Kooragang Island, may also require large scale transmission works.

Mining in the western area constitutes a large part of the load of the area. There is potential for a number of new load developments. Because individual mines may have a limited life there is considerable uncertainty surrounding the future development of the system in the area.

Load development in Western NSW between the Yass area and the Central West may also require a significant reinforcement of the system due to the present limitations in the 132 kV system serving the area.

4.13.4. Interconnection Development with Queensland

Depending on the future development of generation in New South Wales and Queensland and the development of loads in the New South Wales north coast there may be a need to reinforce this interconnection.

This reinforcement may involve 330 kV line development and may be associated with enhancement to the reactive supplies on the system and application of advanced power system control facilities.

4.13.5. Interconnection Development with Victoria / South Australia

A deteriorating supply/demand balance situation in Victoria and South Australia imply the need for enhanced interconnection or further generation development.

TransGrid is progressing the development of the SNI project to link New South Wales and South Australia. Also a High Voltage Direct Current (HVDC) connection between Victoria and South Australia (Murraylink) is now operating.

A range of interconnection augmentation options between New South Wales and Victoria are also under consideration. Small increments in capacity can be achieved by the installation of control equipment and reinforcement of critical sections of the interconnected network. TransGrid has proposed the “NEWVIC 2500” project for service by about 2007. This project would result in an increased capacity of the existing Snowy region – Victoria capacity to about 2500 MW.

4.13.6. Application of HVDC, FACTS Devices and Control Schemes

Loading limits on transmission systems may sometimes be overcome by application of HVDC, Flexible AC Transmission systems (FACTS) and control systems.

The FACTS devices include controlled series and shunt compensation. TransGrid will consider the application of such technologies and controls where is it economic to do so.

4.13.7. Reactive Power Support

The ongoing load growth in the system and the increasing utilisation of the system by generators and inter-state power flows results in a need for an ongoing program of installation of reactive power support. This can take the form of switched shunt capacitors, dynamic support such as that provided by static var compensators and also series compensation of transmission lines.

There is an ongoing need for at least 100 MVars of capacitor support annually in the Sydney area, supplemented by the infrequent need for installation of dynamic support.

The lead-time of such plant is typically one to three years and hence firm plans will be developed a relatively short time ahead of the need. There is however a need for an overall strategy in the long term, to ensure the short term installations are economic. TransGrid is currently developing a longer-term plan for reactive support (refer Section 5.6.26).

4.13.8. Western Sydney Area

In the long term there may be a need for development of additional 330/132 kV supply points in the western Sydney area. Some potential substation sites are at Holroyd, Mason Park, Mt Druitt, Catherine Fields, Cobbitty and near Campbelltown.

4.13.9. Port Macquarie - Taree Area

The growing load in the area may require the development of a 330 kV system to the area. Options available include a development from Newcastle, Armidale or the Coffs Harbour area. Reinforcing of the 132 kV system from Armidale or from Coffs Harbour may also provide viable alternatives.

4.13.10. Wagga to Darlington Point Area

Extensive load development in the Murray and Murrumbidgee areas may require reinforcement of 330 kV supply to the area, possibly with a second Wagga - Darlington Point 330 kV line or a 330 kV line from Wagga to Finley and/or Moama. Such a line could form part of a new inter-regional link between NSW and Victoria.

5. Network Constraints Within NSW, Proposed New Network Assets and Other Options

5.1. General

The following sections describe specifically identified current and emerging constraints within TransGrid's network over 1, 3 and 5 years. Where new small or new large network assets are proposed to relieve these constraints these are detailed as required by the Code. Where there is no proposed new network asset one or more options for relief of the constraint may be described.

Section 5.2 describes constraints that are being relieved by committed augmentations.

Section 5.3 describes constraints that are proposed to be relieved by new small network assets. The consultation process for these will follow Code requirements that came into operation on 8th March 2002 (refer Fig 2.4(b)). These requirements provide for proposed new network assets to be described in the annual planning report including an explanation of the ranking of reasonable options as per the regulatory test.

Interested parties have 20 business days from the publication of this Annual Planning Report 2003 to make written submissions in respect to these proposals. The last day for submissions is 25th July 2003. Contact details appear in Appendix 5.

Section 5.4 describes constraints that are proposed to be relieved by new network assets where the consultation process commenced before 8th March 2002 and will follow the Code requirements in operation immediately before that date (refer Fig 2.3).

Section 5.5 describes constraints that are proposed to be relieved by new large network assets and the consultation process will follow Code requirements that came into operation on 8th March 2002 (refer Fig 2.4(a)).

Section 5.6 describes constraints where there is, as of June 2003, no proposed new network asset. One or more options for the removal of the constraint are described.

Section 5.7 describes constraints that may occur within a five to ten year planning horizon and some options for their relief.

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

5.2. Constraints Being Relieved by Committed Augmentations

5.2.1. Turn in of Newcastle – Vales Point 24 Line in to Eraring

A need for augmentation of the network between the Central Coast power stations and Newcastle was identified the Annual Planning Statement 2002 as being due to:

- An emerging need to gain greater support of the Newcastle area voltage using the reactive power generation capability of Eraring Power Station
- The potential to reduce system losses in the case of system augmentations
- Potential constraints on the operation of Central Coast power stations

A new small network asset was proposed as the turning in of the Newcastle – Vales Point 330 kV line no 24 to Eraring.

There were no responses received to this proposal, which is now committed.

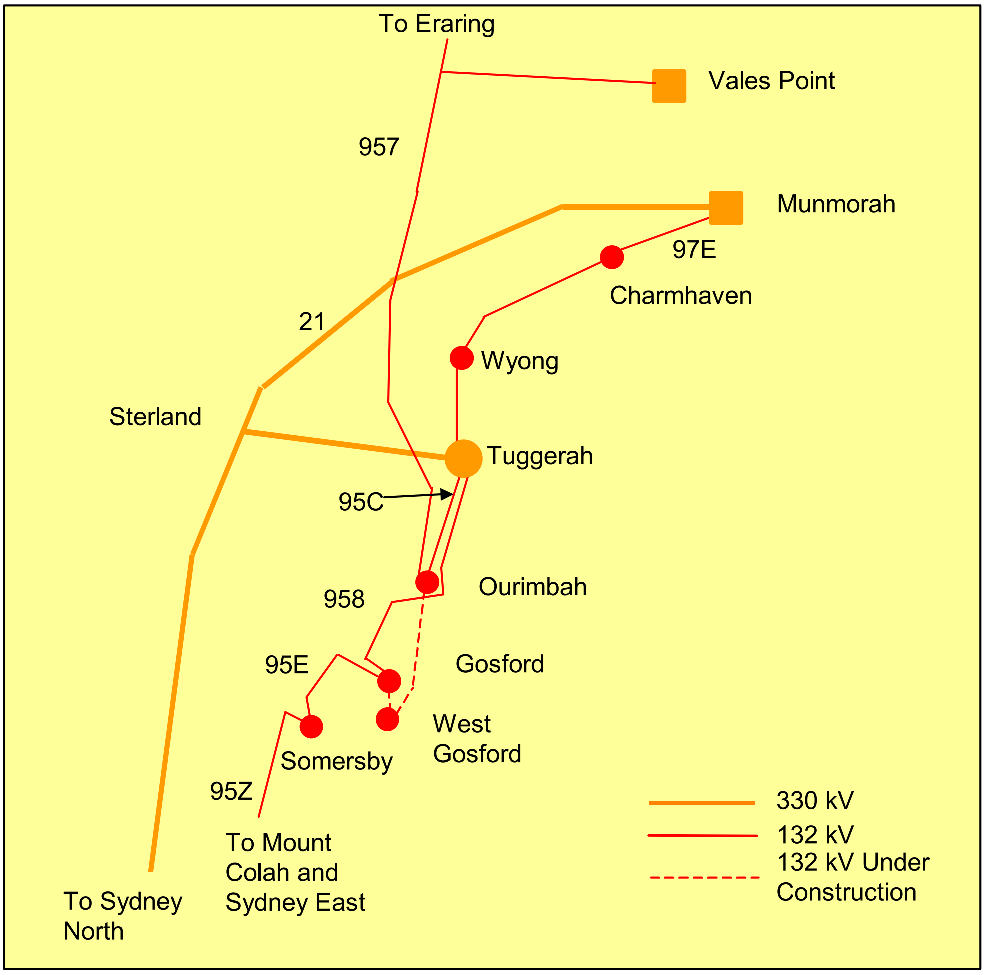
5.2.2. Reconstruction of the Tuggerah – Sterland 330 kV Line

Over recent years the Central Coast has experienced rapid load growth, due primarily to population growth and the associated residential development and supporting services. This is expected to continue with the summer load being forecast to continue to grow at around 4.5% (14 MW to 20 MW) p.a. Further mining developments in the area are also possible.

The majority of the Central Coast area is supplied from Tuggerah and Munmorah 330/132 kV substations. Tuggerah substation is equipped with a single 330/132 kV transformer and is supplied by a single 330 kV line tee connected to the Munmorah – Sydney North 330 kV line at Sterland. The 330 kV and 132 kV network supplying the area is shown in the figure below.

Following installation of two 132 kV capacitor banks at Tuggerah, the capacity of the system is limited by the thermal rating of EnergyAustralia's 957 Vales Point – Ourimbah and 97E Munmorah – Charmhaven 132 kV lines, on outage of the 330 kV line to Tuggerah or the Tuggerah transformer.

330 kV and 132 kV Network Supplying the Central Coast



Studies undertaken by EnergyAustralia and TransGrid indicate that, based on the current load forecast, this limit will be exceeded by summer 2008/09 or on establishment of a possible new mine.

TransGrid has consulted with Code participants and other interested parties and applied the regulatory test. The recommended action is reconstruction of the existing 330 kV line between Tuggerah and the tee at Sterland as a double circuit 330 kV line. This is expected to occur during low load periods in spring 2003 and, if necessary, autumn 2004 (to ensure adequate supply security during the reconstruction period).

5.2.3. Supply to the Sydney CBD and Inner Suburbs - 330 kV MetroGrid Project

Constraint:

Supply to the Sydney Central Business District (CBD) and its inner suburbs is currently provided by Energy Australia's 132 kV network which links to TransGrid's 330/132 kV substations at Beaconsfield West, Sydney South (Picnic Point) and Sydney North (Dural). Beaconsfield West 330/132 kV substation is supplied via a single 330 kV cable from Sydney South.

Failure of Sydney South – Beaconsfield 330 kV cable and any one of approximately thirty other critical circuits or transformers in Energy Australia's network supplying the Sydney area would result in the peak summer load not being fully supplied in summer 2003/04 and onwards.

Augmentation:

Extensive economic analyses were carried out on a large number of alternative augmentations including DM and embedded generation options. The analyses and consultations were carried out in accordance with the National Electricity Code and the ACCC's regulatory test. A final report with the recommended option was published in February 2000. The recommended option involves construction of a 330 kV cable from Sydney South to a new 330/132 kV substation at Haymarket, a new 132 kV substation at Surry Hills and associated 132 network augmentations. The EIS process included extensive consultations with the public, affected property owners, Councils and agencies and other interested parties. The EIS for the 330 kV cable and the 330 kV substation at Haymarket was approved in April 2002. The project is scheduled for completion to meet the summer peak demand of 2003/04.

DM, Embedded Generation and End Use Efficiency

As part of the MetroGrid project, TransGrid, along with Energy Australia, will be participating in and contributing to a $10 Million fund to investigate and promote DM, embedded generation and end use efficiency programs to reduce the growth in electricity demand in the CBD and inner metropolitan area. See Section 2.3 for more detail.

5.2.4. Replacement of Sydney South Transformers

The southern and inner city areas of Sydney are supplied primarily by Sydney South and Beaconsfield West 330 /132 kV Substations. Sydney South currently has six 250 MVA transformers each of which consist of three single phase units. These transformers are between 33 and 43 years of age and some are approaching the end of their serviceable life due to their deteriorating condition.

Two of the transformers are connected directly to 132 kV feeders and the other four to the 132 kV busbar. It is intended to replace the transformers connected to the 132 kV busbar with three 375 MVA three phase units over the next three years. These three new transformers will provide the same capacity (on an 'n-1' basis) as the four existing 250 MVA units. As such, this is not an augmentation under the Code.

5.2.5. Yass 330 kV Substation Equipment Replacement

Yass 330/132 kV substation is a key location on the New South Wales main grid. Most of the interconnecting lines to the Snowy system are bussed at the substation. The substation was established in 1959 and considerable difficulty is now being experienced in maintaining the substation equipment and infrastructure.

From a system security viewpoint it is considered necessary to decommission the existing 330 kV switchyard, 132 kV switchyard, 330/132 kV transformers and ancillary equipment. A new 330 kV and 132 kV switchyard will be constructed next to the existing substation to minimise outage requirements.

This work will also involve alteration of the transmission line connections immediately outside the substation.

5.2.6. South Australia – New South Wales Interconnector (SNI)

TransGrid's proposed South Australia to New South Wales Interconnector (known as SNI) consists of 275 kV transmission network system upgrade from Darlington Point to Buronga in New South Wales and a new 275 kV transmission line from Buronga to Monash and Robertstown in South Australia and associated works in New South Wales, Snowy and South Australia. SNI is expected to provide up to 250 MW transfer capacity to South Australia from New South Wales.

In April 1998, TransGrid submitted the SNI proposal to NEMMCO and its Inter-regional Planning Committee (IRPC) for evaluation for regulated status in accordance with the ACCC's regulatory test. The IRPC carried out extensive technical, economic and market modelling analyses of the SNI proposal, and also conducted extensive public consultations with Code participants and interested parties.

In November 2001 the IRPC in its Final Report on SNI recommended to NEMMCO that the SNI project passes the ACCC's test for regulated status.

After a period of further consultation and additional analysis, on 6 December 2001 NEMMCO released its determination that SNI proposal is justified as a regulated interconnector.

Subsequently, the South Australian Independent Industry Regulator (SAIIR)), now the Essential Services Commission of South Australia, released its decision to grant a transmission license to TransGrid to operate SNI in South Australia.

TransGrid is now awaiting the environmental and development approvals from planning authorities in New South Wales, South Australia and the Commonwealth. The target commissioning date for SNI is summer of 2004/05, subject to timely environmental and development approvals.

5.2.7. Koolkhan 132/66 kV Substation Transformer Replacement

The peak load at Koolkhan 132/66 kV Substation exceeds the firm capacity of two 30 MVA transformers.

One of the two 30 MVA transformers at Koolkhan has been replaced by a 60 MVA unit and the other is being replaced.

5.2.8. New Capacitor Banks at Tuggerah 330 kV Substation

Over recent years the Central Coast has experienced rapid load growth, due primarily to population growth and the associated residential development and supporting services.

The capacity of the existing system is limited by unacceptably low voltages in EnergyAustralia's subtransmission systems supplied from Gosford and Ourimbah substations, on outage of the 330 kV line to Tuggerah or the Tuggerah transformer.

Two 40 MVar, 132 kV capacitor banks are being installed at Tuggerah.

5.2.9. Development of Supply to the Molong, Manildra, Cumnock and Cudal Areas

Constraint:

The Manildra, Cumnock and Cudal areas are situated about 30 km north west of Orange and are supplied via a radial 66 kV line from Orange 132/66 kV substation. An increase in load due to the expansion of the flour mill at Manildra has resulted in the capacity of the 66 kV line being reached.

Molong Township is supplied from the recently commissioned Molong 132 kV substation.

Augmentation:

The staging of the components of the augmentations is as follows:

- Establishment by TransGrid of a 132/66 kV Substation near Molong. This was completed in early 2001,
- Replacement of Country Energy's Manildra 66/11 kV Substation by a new 132/11 kV substation by late 2003; and

- Construction by TransGrid of a 132 kV line from Molong to Manildra to match the commissioning of the Manildra 132 kV substation.

5.2.10. Sydney West Static Var Compensator

Two synchronous condensers (syncons) are presently in service at Sydney South 330/132 kV Substation. These syncons are now more than 40 years old and have reached the end of their service life. They are being replaced by a Static Var Compensator (SVC).

The new SVC is to be located at Sydney West 330/132 kV Substation and is expected to be available for service during 2004.

Once the SVC is proven in service it is expected that the syncons will be retired. The SVC is expected to maintain present levels of voltage control in the Sydney area and is also expected to broadly maintain existing power transfer capabilities, governed by transient stability, for NSW export to Queensland and to Snowy / Victoria.

5.3. Proposed New Small Network Assets

This section details constraints that are proposed to be relieved by new small network assets. The consultation process for these will follow Code requirements that came into operation on 8th March 2002 (refer Fig 2.4(b)). These requirements provide for the proposed new network asset to be described in the annual planning report including an explanation of the ranking of reasonable options as per the regulatory test.

Interested parties have 20 business days from the publication of this Annual Planning Report 2003 to make written submissions in respect to these proposals. The last day for submissions is 25th July 2003. Contact details appear in Appendix 5

5.3.1. 330 kV Line Rearrangements near Vales Point

The 500 kV and 330 kV system connecting the three Central Coast power stations (Eraring, Vales Point and Munmorah) to Sydney consists of:

- One 500 kV double circuit line;
- One 330 kV double circuit line; and
- Two 330 kV single circuit lines.

There is also one double circuit and one single circuit 330 kV line connecting these power stations to Newcastle.

Munmorah power station presently has three line connections, two to Sydney and one to Vales Point. Vales Point has four line connections, one to Sydney, two to Newcastle and one to Munmorah. Over recent years Munmorah has operated only occasionally and consequently the Vales Point – Munmorah line has been heavily loaded by flows to Sydney.

Previous constraints imposed by the Vales Point - Munmorah line have been overcome by uprating line terminal equipment. However it is expected that within the next two to three years the constraint will re-emerge, that is the rating of the Vales Point – Munmorah line will be more regularly exceeded on outage of the Vales Point – Sydney North line at times of high NSW generation and high import from Queensland.

Also, fault levels at Vales Point and Munmorah are approaching the ratings of the switchyard equipment. An existing series reactor at Munmorah can be switched into the Vales Point – Munmorah line to limit fault levels at Vales Point and Munmorah. At present, under many circumstances it cannot be used as its load current rating of 750 MVA (which is only about 60% of the summer day line rating) would be exceeded.

Two options to overcome these constraints have been considered:

1. Rearrangement of the 330 kV lines on the Central Coast near Vales Point to remove a line crossing. This would result in Munmorah having one line to Sydney, one to Newcastle and one to Vales Point, and Vales Point having two lines to Sydney, one to Newcastle and one to Munmorah. This is expected to cost around $2.5 million.

   This option has the advantage of reducing loadings on the Vales Point – Munmorah line to the level where the series reactor (which is presently normally out of service as its rating of 750 MVA would be significantly exceeded) can be utilised to manage fault levels.

2. Further uprating of line terminal equipment together with a major switchgear replacement program to increase the fault level capability at Munmorah and Vales Point. This is expected to cost significantly more than $2 million, but would not be as effective in relieving the constraint because rearranging the 330 kV lines and further operating restrictions would be required to manage loading on the Vales Point to Munmorah line.

A third option of constraining generation at Vales Point, Eraring, Bayswater and Liddell and/or constraining imports on QNI was dismissed as large reductions in generation and/or import would be required to effect small changes in the flow on the Vales Point – Munmorah line.

The Proposed Development

It is proposed to partially implement both options. Uprating some line terminal equipment will provide some additional line capacity until the line rearrangements can be completed (expected in 2004/05).

The line rearrangements would be a new small network asset. In addition to relieving the constraint imposed by the rating of the Vales Point – Munmorah line, they would facilitate management of fault levels at the Central Coast power stations; they would reduce the loading on the Vales Point – Munmorah line sufficiently to allow the reactor to be used when required to limit fault levels. They are therefore a reliability augmentation.

Reliability Augmentation: YES. Material Inter-network Impact: NO

5.3.2. Snowy Assets Rehabilitation

The transmission assets developed in conjunction with construction of the Snowy scheme were transferred from the former Snowy Mountains Hydro-Electric Authority (SMHEA – now Snowy Hydro) to TransGrid in mid 2002. Most of these assets are now more than 40 years old and are in various stages of a rehabilitation program commenced by the SMHEA some years ago.

Works are needed at both Upper Tumut Switching Station and Murray Switching Station to complete that rehabilitation program.

Also, TransGrid is currently undertaking a detailed review of the condition of the major 330kV lines in the Snowy area. It is expected that works will be required to ensure those lines are in a satisfactory condition for the short to medium term future.

These works do not constitute an augmentation but are foreshadowed here for completeness.

5.3.3. Wellington, Vineyard, Armidale and Yass 330/132 kV Transformers

As part of its asset management strategy and to facilitate increasing the firm 330/132 kV transformer capacity at Wellington, it is proposed to:

- Relocate a 200 MVA transformer released from Vineyard to Yass;
- Replace a 200 MVA transformer at Wellington by a 375 MVA unit; and
- Relocate the 200 MVA transformer from Wellington and the second 200 MVA transformer released from Vineyard to Armidale.

Replacement of the Vineyard transformers by 375 MVA units is covered in Section 5.3.4.

As part of the refurbishment of Yass 330/132 kV substation it is intended to replace the two existing 43 year old, 150 MVA, single phase banks of transformers. One new transformer has been purchased. The other will be a 200 MVA unit relocated from Vineyard. This will result in an increase in the firm transformer capacity at Yass. As such it is an augmentation as defined by the Code, even though it stems from the replacement of existing aged transformers, which are in poor condition, by units of the smallest standard size presently used by TransGrid.

Wellington 330/132 kV substation is the main supply for the west and central west of the state. It is equipped with one 190 MVA and one 200 MVA transformer. If one transformer is out of service, the other becomes heavily loaded at times of moderate to high load. While load growth is moderate and the transformer loading can be managed to some extent, by opening 132 kV lines, larger transformers are likely to be required within the next five years. It is proposed that the 200 MVA transformer be replaced by a 375 MVA unit. The older 190 MVA unit is not suitable for relocation due to its condition. Replacement of the 200 MVA transformer will not increase the firm transformer capacity and is therefore not an augmentation as defined by the Code.

Two of the 150 MVA 330/132 kV transformers at Armidale are deteriorating and approaching the end of their effective serviceable life and will need to be replaced within the next few years. It is proposed that 200 MVA units released from Vineyard and Wellington be installed at Armidale. As in the case of Yass, this constitutes an augmentation under the Code, even though it stems from replacement of aged transformers by units of the smallest standard size presently used by TransGrid.

The cost of replacing the Wellington transformer and relocating 200 MVA units to Yass and Armidale is expected to be around $5 million.

These augmentations are the most cost effective overall solution to the transformer limitations at the four sites, (as relocation and re-use of transformers minimises the number of new units required to be purchased) and are considered to be the only reasonable network option.

Reliability Augmentation: YES Material Inter-network Impact: NO

5.3.4. Vineyard 330 kV Transformer Replacement and 132kV Switchbays

The load in the north west of the greater Sydney area is growing rapidly, primarily as a result of population growth and the increased use of air conditioners. To accommodate this increasing load, Integral Energy proposes to progressively upgrade the 132 kV network supplying the area. This will increase the loading on Vineyard 330/132 kV Substation. Based on the present forecast, it is expected that the firm capacity of the two 200 MVA transformers at Vineyard will be exceeded by summer 2004/05.

Options that have been considered to address this constraint include:

1. Replacement of the existing two transformers by larger capacity units.

   The substation has been designed to accommodate 375 MVA transformers. Installation of two 375 MVA transformers would also release the existing 200 MVA units for reuse elsewhere (refer to Section 5.3.3).

   This option is considered to be reasonable.

2. Installation of a third transformer and associated 330 kV and 132 kV switchbays.

   Installation of a third transformer would involve extension of the substation and modification of the 330 kV mesh busbar. This option would be more costly than Option 1 considering that it does not release the existing 200 MVA units. Due to the more extensive works required it is likely to take longer to complete than Option 1.

   This option is considered to be feasible but technically more complex and significantly more expensive than Option 1.

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

   The scope for Integral Energy to transfer loads is very limited and not sufficient to delay the onset of the constraint.

   Therefore this option is considered to be not feasible.

4. Reduction of transformer loading via power factor correction.

   Vineyard presently has one 60 MVar 132 kV capacitor. Installation of additional capacitors would not delay the onset of the constraint.

   Therefore this option is considered to be not feasible.

5. Reduction of transformer loading via demand management programs or local generation;

   Due to the rapid load growth being experienced, it is considered that demand management or local generation options would not delay the onset of the constraint.

   Therefore this option is considered to be not feasible.

The only reasonable options are Option 1 and Option 2. Option 1 is proposed on both technical and cost grounds.

It is proposed to replace the two 200 MVA transformers by 375 MVA units and provide two additional 132 kV line switchbays to connect Integral Energy lines, at a cost of around $9 million, by summer 2004/05.

Replacement of one 200 MVA transformer is planned for autumn 2004, to enable it to be relocated to Yass (refer to Section 5.2.5). The other 200 MVA transformer, is to be relocated to Armidale (refer to Section 5.3.3).

This proposal is considered to be a reliability augmentation because TransGrid's planning obligations require action to be taken when the load at Vineyard exceeds the firm transformer capacity.

Reliability Augmentation: YES Material Inter-network Impact: NO

5.3.5. Liverpool Third 330/132 kV Transformer

Liverpool 330/132 kV substation supplies the Liverpool area as well as some of the load in the Camden area. In recent years, development in the Liverpool/Camden/Campbelltown area has resulted in high growth in demand for electricity, which is expected to continue.

The firm capacity of the two 375 MVA 330/132 kV transformers at Liverpool 330/132 kV Substation was exceeded last summer and, based on Integral Energy's most recent forecast, is expected to be exceeded in future summers.

Options that have been considered to address this constraint include:

1. Replacement of the two existing transformers by larger capacity units.

   The Liverpool transformers are the largest standard size in use by TransGrid. To be effective replacements, the new units would have to have significantly larger capacity than the existing units, but not be significantly physically larger. At this stage is this is not considered to be feasible. Even if it were feasible, the cost of this option would be more than double the cost of Option 2, although it would release the two existing transformers for possible use elsewhere. As the new transformers would be the first of their size, this option involves increased risk associated with new transformer designs.

   This option is not considered to be reasonable.

2. Installation of a third transformer and associated 330 kV bus section switchbay.

   In implementing this option TransGrid considers that it is *good engineering practice* to install a third 375 MVA unit and an associated 330 kV bus section circuit breaker: The transformer would be a standard size that would compatible with existing system spares.

   This option is considered to be reasonable. It would not be possible to complete the works until after summer 2003/04, so there would be some risk of interruptions over that summer.

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

   Joint planning with Integral Energy has determined that load transfers from Liverpool during peak load periods are likely to result in overloads of elements of its network without the establishment of a major new 330 kV supply point.

   Therefore this option is considered to be not feasible.

4. Reduction of transformer loading via power factor correction.

   Installation of capacitors either at Integral Energy's West Liverpool 132/33 kV substation or within the 33 kV or 11 kV networks supplied from that substation, would reduce the loading on the Liverpool 330/132 kV transformers. However, it is unlikely that capacitors could be installed until after summer 2003/04. From summer 2004/05 even complete compensation of the reactive load would not overcome the constraint.

   Therefore this option is considered to be not feasible.

5. Reduction of transformer loading via demand management programs or local generation;

   Both Integral Energy and TransGrid have published requests for proposals for demand management or local generation in the area. Neither of these requests has elicited any proposals.

   Therefore this option is considered to be not feasible.

The only reasonable option is Option 2. Therefore, to cater for the growing load at Liverpool, the installation of a third 375 MVA transformer together with an associated 330 kV bus section switchbay at Liverpool, is proposed as a new small network asset. These works are expected to be completed by summer 2004/05 and to cost approximately $7 million.

This proposal is considered to be a reliability augmentation because TransGrid's planning obligations require action to be taken when the load at Liverpool exceeds the firm transformer capacity.

This proposal is not considered likely to have a material inter-network impact.

Reliability Augmentation: YES Material Inter-network Impact: NO

5.3.6. Armidale 132/66 kV Transformer Replacement

The load supplied at 66 kV from Armidale is growing moderately. It has exceeded the firm rating of the two 30 MVA 132/66 kV transformers over the past several winters. However, should it be necessary, it would be possible for Country Energy to reduce loadings at peak time by temporarily modifying the operation of their load control system. It is presently expected that the firm transformer capacity will be exceeded by winter 2006, allowing for the load control strategy.

In addition the Armidale 132/66 kV transformers are approaching 40 years of age and there are concerns about their condition.

Options that have been considered to address these constraints include:

1. Replacement of the two existing transformers by larger units.

   Replacement of the existing 30 MVA transformers by 60 MVA units would relieve both the transformer capacity and condition constraints.

   This option is considered to be reasonable.

2. Installation of a third transformer and associated 132 kV and 66 kV switchbays.

   This option would not address the concerns about the condition of the existing transformers. Also, it would be difficult to connect a third transformer to sections of 132 kV and 66 kV busbar separate from those to which the existing transformers are connected.

   This option is considered to be not feasible.

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

   There is no scope to transfer load to other substations. Therefore this option is considered to be not feasible.

4. Reduction of transformer loading via power factor correction.

   Whilst installation of capacitors would reduce the loading on the transformers, it would not address the concerns about the condition of the existing transformers.

   Therefore this option is considered to be not feasible.

5. Reduction of transformer loading via demand management programs or local generation;

   This option has already been implemented to defer the date at which the firm transformer capacity is expected to be exceeded to 2006: The impact of local generation at Oakey power station is already incorporated in Country Energy's demand forecast; in addition a load control strategy, described above, is in place to reduce transformer loading if required.

   Additional local generation or demand management would not address the concerns about the condition of the existing transformers.

   Therefore further action on this option is considered to be not reasonable.

The only option that relieves both constraints is Option 1. It is proposed to replace the existing 30 MVA 132/66 kV transformers by 60 MVA units. These works are expected to cost approximately $3 million and to be completed by winter 2004.

This is a reliability augmentation because TransGrid's planning obligations require action to be taken when the load at Armidale exceeds the firm transformer capacity. It has been advanced to winter 2004 for asset condition reasons.

Reliability Augmentation: YES Material Inter-network Impact: NO

5.3.7. Port Macquarie 132/33 kV Transformer Replacement

The load at Port Macquarie has grown rapidly over recent years due to developments in Port Macquarie and surrounding areas. This development and consequent load growth is expected to continue. Country Energy's most recent forecast is shown in Appendix 3.

Port Macquarie 132/33 kV substation presently has three 30 MVA fixed ratio transformers and associated 33 kV voltage regulators. These transformers and voltage regulators are 49 years old and are approaching the end of their serviceable life. It is planned to replace the three transformers and voltage regulators by two 60 MVA 132/33 kV transformers in the next two years. As the firm transformer capacity will not increase this is not an augmentation as defined by the Code but it is described here for completeness.

It is expected that the firm transformer capacity will be exceeded by winter 2006. Options that have been considered to address this constraint include:

1. Replacement of the existing transformers by larger capacity units.

   Installation of two 120 MVA 132/33 kV transformers was considered to relieve both the 3 x 30 MVA transformer capacity and condition constraints. However, it was found to be less cost effective than the staged installation of 3 x 60 MVA units due to the larger transformers being installed prior to when the full capacity is required and the need to uprate transformer switchbays to cater for higher loadings associated with the larger transformers.

   Also, if 120 MVA units were to be installed they would be TransGrid's only 132/33 kV units of that size, which is undesirable in terms of spare transformers.

   This option is not considered to be reasonable.

2. Installation of a third 60 MVA transformer.

   Replacement of the 3 x 30 MVA transformers by 60 MVA units is more cost effective than Option 1. It can be staged to relieve both the transformer condition and capacity constraints when they arise. It has the additional advantage of using transformers of a standard size.

   This option is considered to be reasonable.

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

   The scope to transfer load to other substations is very limited. Therefore this option is considered to be not feasible.

4. Reduction of transformer loading via power factor correction.

   There are presently two 7.5 MVAr 33 kV capacitor banks at Port Macquarie. Installation of additional capacitors either at Port Macquarie 132/33 kV substation or within Country Energy's 33 kV or 11 kV networks supplied from that substation, would reduce the loading on the 132/33 kV transformers.

   To delay the onset of the capacity constraint by one year, it would be necessary to install another approximately 15 MVAr of capacitors. One additional 7.5 MVAr bank could be installed at Port Macquarie, but the balance would need to be located, in smaller sizes, within Country Energy's system. The cost of the additional capacitors is estimated to be up to $0.4 million.

   Therefore while this option is considered to be feasible it is less cost effective than Option 2.

5. Reduction of transformer loading via demand management programs or local generation;

   A request for proposals for demand management or local generation that was published in mid 2002 elicited no responses. Consequently, demand management and local generation are not considered to be feasible.

The most cost effective reasonable option is Option 2. Therefore, to cater for the growing load, the installation of a third 60 MVA 132/33 kV transformer at Port Macquarie is proposed as a new small network asset. These works are expected to be completed by winter 2006 and to cost about $2 million.

This proposal is considered to be a reliability augmentation because TransGrid's planning obligations require action to be taken when the load at Port Macquarie exceeds the firm transformer capacity.

This proposal is not considered likely to have a material inter-network impact.

Reliability Augmentation: YES Material Inter-network Impact: NO

5.3.8. Capacitor Bank at Darlington Point

Darlington Point 330/220/132kV substation is a point of supply to Country Energy customers and Inland Energy customers in the south west of NSW as well as for Broken Hill and Victoria via Buronga 220kV switching station.

Load levels on Darlington Point substation have risen to the point where loss of the Wagga to Darlington Point 330kV circuit during high load periods will result in unacceptable voltage levels in the area.

To meet the peak load periods during the summer of 2003/04 undervoltage loadshedding will be installed at Deniliquin substation. A 40MVAr 132 kV capacitor bank is proposed at Darlington Point in 2004 to provide sufficient reactive margin to maintain acceptable voltage levels under outage conditions.

This proposal is considered to be a reliability augmentation because TransGrid's planning obligations require action to be taken when the load at Darlington Point would be such as to impose a risk of unacceptable voltage conditions occurring during an outage condition.

Reliability Augmentation: YES Material Inter-network Impact: NO

5.3.9. Capacitor Bank at Canberra

Growing loads in the southern area of NSW will require the installation of capacitor banks at a number of major substations in the near future (refer to Section 5.6.26). The first of these, a 120 MVar capacitor bank at Canberra 330 kV Substation, is required to maintain acceptable voltage levels at times of high NSW export to Snowy and high NSW import from Snowy. It will also reduce loading on the Canberra 330/132 kV transformers and so delay any need for transformer augmentation.

This proposal is considered to be a reliability augmentation because TransGrid's planning obligations require action to be taken when system loading would be such as to impose a risk of unacceptable voltage conditions occurring.

Reliability Augmentation: YES Material Inter-network Impact: NO

5.4. New Network Assets: Consultations Commenced Prior to 8th March 2002

The following details proposals for new network assets where the consultation process commenced before 8th March 2002. In these cases the consultation process will follow the Code requirements in operation immediately before that date (refer Fig 2.3).

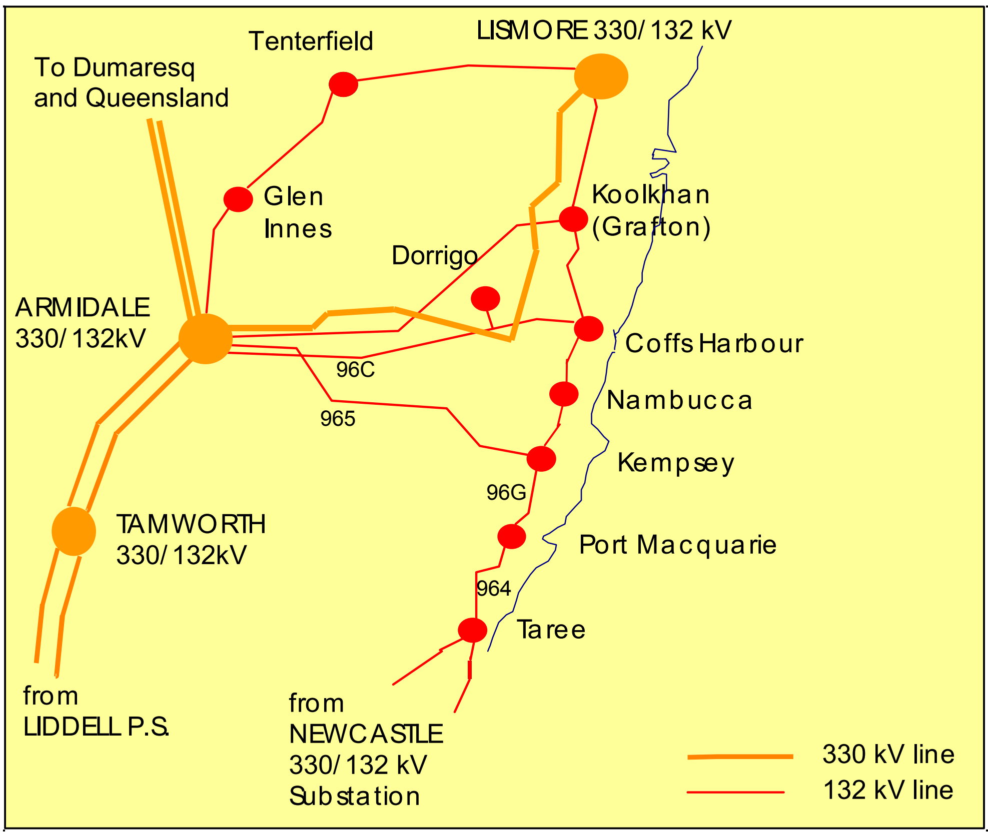
5.4.1. Coffs Harbour 330/132 kV Substation

The mid north coast is supplied via long 132 kV lines from remote 330/132 kV substations at Lismore, Armidale and Newcastle. The 330 kV and 132 kV system supplying the north coast is shown in the figure below.

Over recent years load growth in the Coffs Harbour to Port Macquarie area has been approximately 4% p.a., significantly above the level for the state overall. Above average growth is expected to continue. Country Energy's most recent forecast, which includes the supply points in this area, is given in Appendix 3.

The 132 kV network between Armidale and Newcastle operates in parallel with the 330 kV network. The loading on the 132 kV network is partially determined by flows on QNI. NSW import on QNI causes a small increase in flows in a southerly direction and NSW export over QNI has the opposite effect.

Supply System on the North Coast



Constraint

The capacity of the 132 kV system supplying the area is limited by unacceptably low voltages at Port Macquarie and Kempsey on outage of the 965 Armidale - Kempsey 132 kV line and at Coffs Harbour on outage of the 96C Armidale – Coffs Harbour 132 kV line.

It is expected that the capacity of this system will be exceeded by winter 2005.

Proposed Solution

To overcome these constraints, it is proposed to construct a 330/132 kV substation adjacent to the existing 132/66 kV substation at Coffs Harbour, supplied from the existing Armidale – Lismore 330 kV line which passes close to Coffs Harbour 132/66 kV substation by winter 2006.

It is expected to cost approximately $17 million.

Following commissioning of Coffs Harbour 330/132 kV Substation, both it and Lismore 330/132 kV Substation will be supplied from Armidale via one 330 kV line. It is proposed that a second 330 kV switchbay for that line be provided at Armidale to improve the security of supply to Coffs Harbour and Lismore and to allow maintenance of the existing switchbay at Armidale to be carried out without taking the 330 kV circuit out of service. This additional switchbay is expected to cost approximately $1-2 million and be completed by winter 2005.

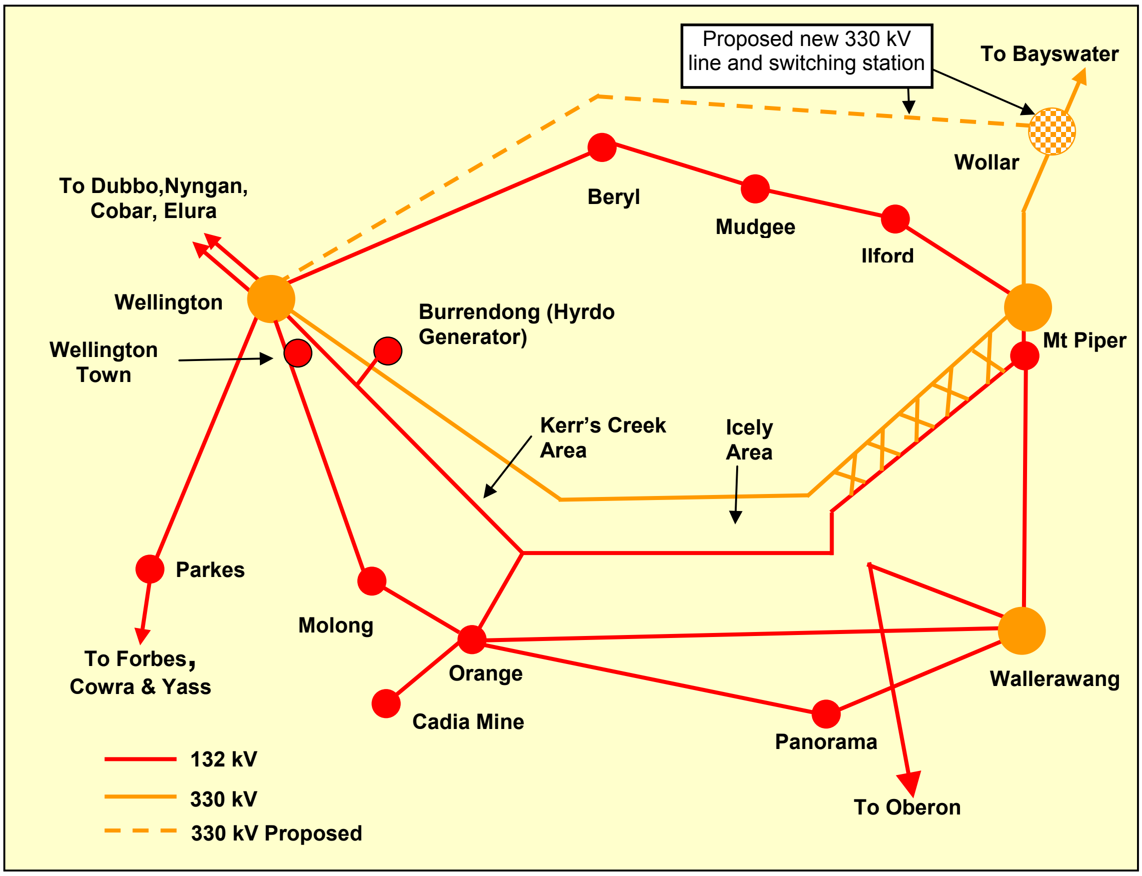
Other Options

Other potential options include:

- Construction of additional 132 kV lines;
- Local generation; and
- DM.

TransGrid has commenced consultation with interested parties. It is intended that an application of the regulatory test to these and other options be carried out and a recommended option selected by August 2003.

5.4.2. Development of Supply to the Western Area of NSW



Constraint:

The transmission network in the Western area has limited capability. A number of system constraints, that may affect supply during outages of the Mt Piper - Wellington 330 kV line, presently exist or are expected to emerge. As the area load continues to grow the severity and likelihood of these constraints will increase.

- Adequate voltage levels may not be maintained at (or west of) Wellington, nor at Forbes and Parkes;
- 132 kV line thermal ratings may be exceeded; and
- The loading limit on the 330/132 kV transformers at Wallerawang may be exceeded.

Options to Relieve Constraints

Three network augmentation proposals that have been developed to address these limitations are outlined below:

1. Construction of a 330 kV switching station on the Bayswater to Mt Piper line at Wollar (north east of Mudgee) and construction of a 330 kV transmission line from Wollar Switching Station to Wellington 330 kV substation by 2007. The cost of this option is approximately $61 million.

   A 500/330 kV substation would need to be installed at Wollar if and when the Bayswater to Mt Piper line is operated at its design voltage of 500 kV. In the longer term a 330/132 kV substation, possibly in the Icely or Kerr’s Creek areas, could be established as local needs dictate.
2. Construction of a 330/132 kV substation in the Kerr’s Creek area and a 330 kV transmission line from Yetholme to Kerr’s Creek by 2007, at an estimated cost of $63 million. In the longer term a 330 kV line from Kerr’s Creek to Wellington, could be constructed as local needs dictate.
3. Construction of a 330 kV transmission from Yetholme to Wellington via Kerr’s Creek and a section of 132 kV line from Wallerawang or Mount Piper to Yetholme by 2007 at an estimated cost of $73 million. In the longer term a 330/132 kV substation, possibly in the Kerr’s Creek or Icely areas, could be established as local needs dictate.

Other Options

Other options that have been investigated to meet the above constraints include a range of demand management, local generation options and bundled options.

Progress of Consultation

TransGrid and Country Energy commenced consultation with Code Participants and interested parties on these and other options in January 2002. In July 2002 they published a paper that details the constraints affecting the area. In May 2003 they published a paper that details the results of a preliminary application of the regulatory test to the above options.

Proposed Solution

On the basis of both a technical and economic comparison of the above options, and in the absence (to date) of proposals for other options from interested parties, Option 1 is the proposed solution. In support of this position TransGrid is also consulting with various stakeholders on the environmental and community impacts of this project.

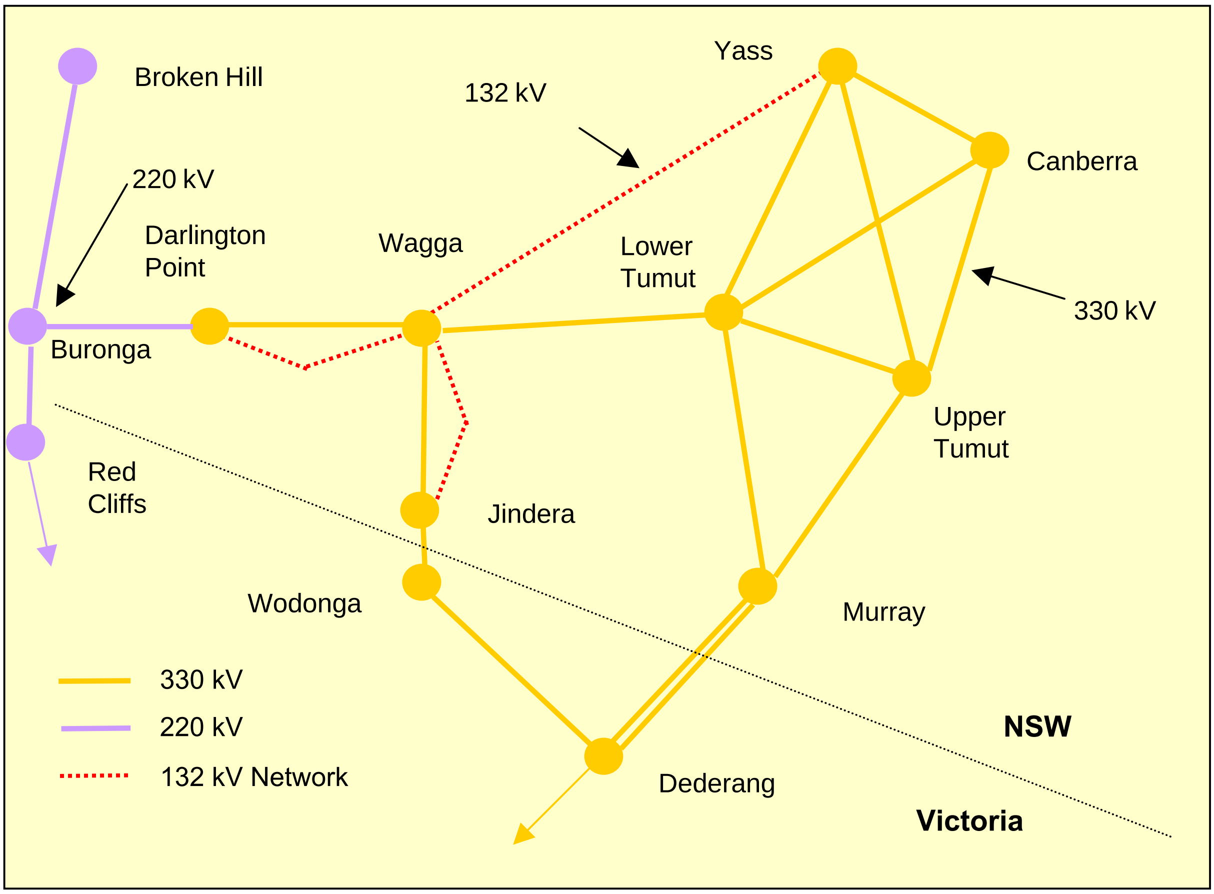
A decision on the solution to be adopted will be published in the final report of the regulatory consultation.

5.4.3. Yass – Wagga 330 kV Line Development

The 330 kV system and underlying132kV system is shown in stylised form in the Figure below. The 132 kV system is shown as simple links operating in parallel with the 330 kV system. Yass and Canberra are connected to the north to the remainder of the NSW system. Dederang is connected to the Victorian 330 kV and 220 kV system. Similarly Red Cliffs is connected to the western Victorian 220 kV network.

Power from the Snowy Hydro generators that are connected to the switching stations at Murray, Lower Tumut and Upper Tumut is transmitted to the south west area loads and to the north and south via the 330 kV system. Power flow between NSW and Victoria (in either direction) is superimposed on this loading.

Victoria relies on a capability for import from NSW/Snowy regions of a nominal 1,900 MW at times of peak summer load. Following completion of the SNI project this capability will rise to a nominal 2,100 MW. For convenience the capabilities are often quoted as single fixed numbers but in reality the actual capabilities are functions of load levels and dispatch of generation.



At times when Victoria is importing power and the NSW system load is relatively high there will be a relatively high power flow from Murray towards Dederang and from Lower Tumut to Wagga, Jindera and thence to Victoria. Part of the overall Victorian import is also carried west from Wagga to Buronga and thence Red Cliffs.

If all elements are in service, the 330 kV network is expected to be capable of adequately supplying the loads in the immediate Wagga - Yass area over the next ten years. With all elements in service only minor upgrading of existing elements and the installation of voltage support plant may be required.

However, under conditions of high area load and high Victorian import the following become critical contingencies:

i) An outage of the Lower Tumut - Wagga 330 kV line results in a high loading in the Yass 330/132 kV transformers and 132 kV lines from Yass to Wagga. High loadings in the Murray – Dederang lines also occur.

ii) An outage of one of the two Yass 330/132 kV transformers causes a high loading in the remaining transformer.

iii) An outage of the Lower Tumut - Wagga line leads to reactive power deficiencies (low voltages) in the Wagga area.

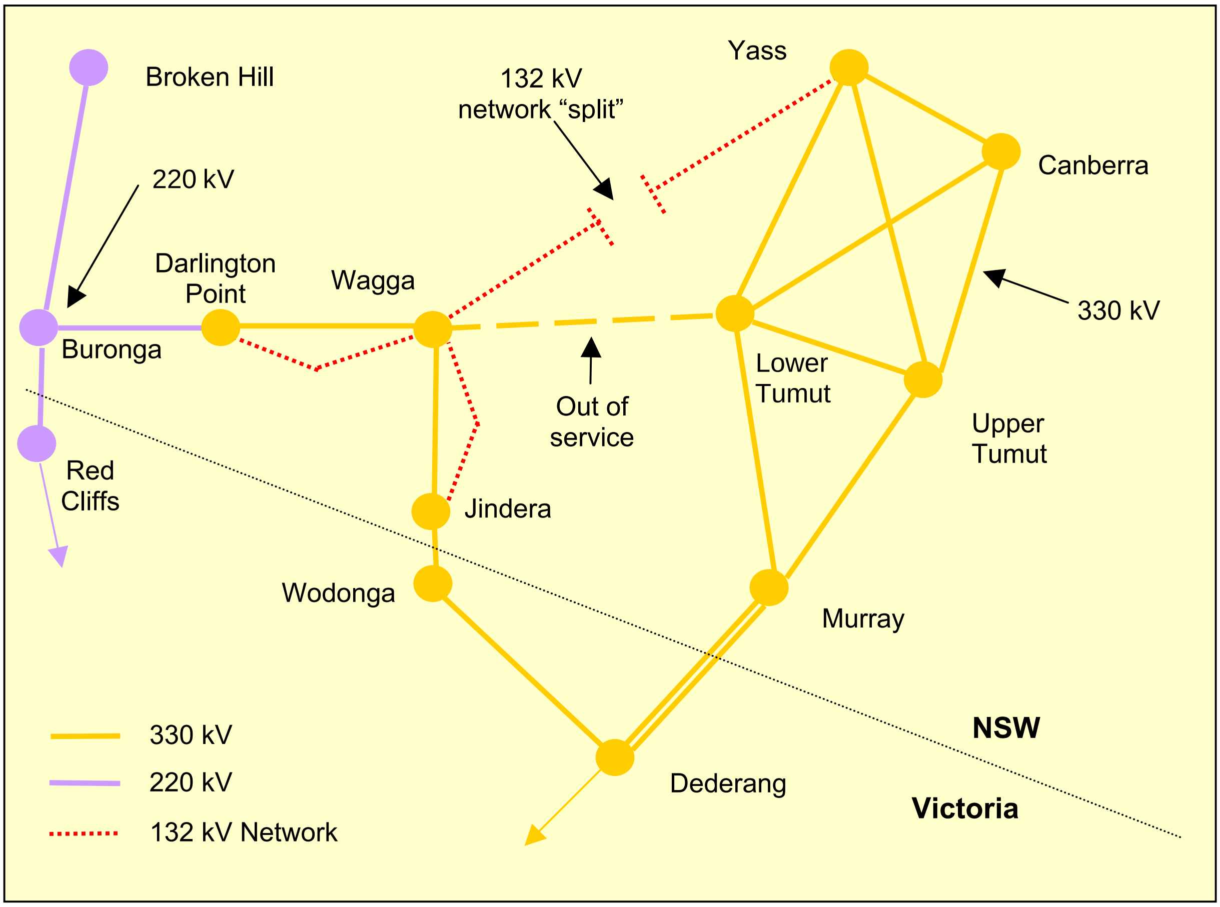
iv) An outage of a Murray - Dederang line results in a high loading in the Lower Tumut - Wagga line and the remaining Murray – Dederang line.

Continuing growth of NSW loads in this region, coupled with a requirement for power transfer from Snowy to Victoria, will exacerbate the potential overloading of lines and transformers. Unless new generating developments can be made available in Victoria it is expected that the frequency of high power flows through the Wagga area will rise.

Each of the critical contingencies is addressed in turn:

Outage of the Lower Tumut – Wagga 330 kV Line

An outage of the Lower Tumut Wagga 330 kV line results in the arrangement below.



When the Lower Tumut – Wagga line is forced out of service there would normally be a very high loading on the Yass to Wagga 132 kV system and Yass 330/132 kV transformers. The loading on the 132 kV system can be sufficiently high such that the rating of this system would normally result in a severe restriction to Victorian import capability.

In order to relieve this constraint and allow a relatively high Victorian import level a Network Control Scheme has been installed on the 132 kV system that automatically opens the 132 kV system when overloads occur. Should the scheme operate the 132 kV system is opened at defined points and the overload is relieved. This scheme is armed when the Victorian import rises above about 900 MW.

Under this arrangement should the Network Control Scheme operate the 132 kV loads would be radialised. The loads at Murrumburrah, Tumut and Gadara would be interrupted if there were subsequent trips of the 132 kV lines supplying these locations.

This network arrangement is retained until either the Lower Tumut – Wagga 330 kV line is able to be restored to service or Victorian import reduces to a level where the 132 kV system can be closed. Hence should this tripping scheme be activated following a contingency the existing system will no longer provide firm supply to the 132 kV substations between Yass and Wagga. The system is also exposed to the risk of loss of supply for any further contingency. This supply system may not meet the reliability expectations of the customers in the area. The reliance on this tripping scheme will increase as Victoria's dependence on imported power increases, particularly over summer months.

The open point in the 132 kV system results in Tumut and Murrumburrah being supplied from Yass. The remainder of the Wagga, Darlington Pt and Broken Hill supply area is seen to be carried over the Murray – Dederang lines. This load is superimposed on the Victorian import carried over the Murray – Dederang lines.

Hence the rating of the Murray – Dederang lines imposes an upper limit to the combined total load of Victorian import and south west NSW area load.

The Murray – Dederang lines were uprated to what is considered their maximum rating as part of the development of the SNOVIC 400 scheme in 2002.

Hence the network capability to supply the combined Victorian import and the NSW south west area load is a fixed quantity. As a result of growing loads in the NSW south west there will be a decline each year in the ability to service Victorian import or the ability to meet the new area load.

An additional consequence of an outage of the Lower Tumut – Wagga 330 kV line is a reactive deficiency in the supply system. This would normally lead to unacceptably low voltages in the Wagga area or loss of control over voltage. It is generally economic to install capacitor banks to overcome such supply conditions and TransGrid aims to maintain existing supply conditions by regularly installing capacitor supply plant.

The first additional capacitor banks are considered to be required in service as soon as possible to cover the local load and nominal 1900 MW Victorian import. The earliest timing for capacitor support is summer 2004/5 and TransGrid is presently developing installation options and will apply the Regulatory Test in the near future.

The installation of this plant will suffice for a couple of years. Eventually a point will be reached however where inexpensive capacitors will no longer suffice and more radical solutions will be required.

Outage of a Yass 330/132 kV Transformer

There are two 330/132 kV transformers at Yass. An outage of a Yass transformer can lead to overload of the remaining transformer. To avoid a very restrictive constraint on Victorian import the Yass – Wagga 132 kV Network Control Scheme (discussed above) is applied.

Yass substation and the two 330/132 kV transformers are now over 40 years old and are at the limits of their serviceable life. TransGrid has commenced refurbishment of the substation and as part of this process the two transformers will be changed for new units. The new units will have higher rating. Hence within a few years this network constraint will be able to be removed.

Outage of a Murray - Dederang Line

An outage of a Murray – Dederang line results in a high loading in the remaining parallel line and a high loading in the Lower Tumut - Wagga line.

As part of the SNOVIC400 project the Lower Tumut – Wagga line has been uprated.

The rating of either of the remaining Murray – Dederang line or the Lower Tumut – Wagga line imposes a limitation on the ability of the network to service the combined needs of Victorian import and the peak NSW south west loads.

Hence as a result of growing loads in the NSW south west there will be a decline each year in the Victorian import capability or the ability to meet the new area load.

Network Maintenance Issues

The network must be maintained whilst ensuring ongoing supply to consumers. Maintenance outages are normally only taken at times of off peak load. Nevertheless in the Wagga area the opportunities to take lines out of service for maintenance are becoming increasingly limited.

A maintenance outage of any of the 330 kV lines from Dederang to Wodonga, Wodonga to Jindera, Jindera to Wagga or Wagga to Lower Tumut normally requires special measures. Should a remaining critical 330 kV line be forced out of service during maintenance outages it would not be possible to retain supply to loads in the Wagga to Albury/Wodonga area even at times of moderate load.

The direct 132 kV line from Yass to Wagga is considered to require substantial expenditure to maintain it in a serviceable condition.

Interconnection Issues

Victoria presently relies on a capability for import from NSW/Snowy of 1,900 MW at times of peak summer load.

Following completion of the SNI works the Victorian import capability will rise to about 2,100 MW at times of peak summer load.

A number of projects to increase the capability to supply power to Victoria and South Australia have been proposed by various parties, including TransGrid.

These projects would increase the capacity by between 400 MW and 1,600 MW.

All of these projects would result in higher power flows through the Wagga area and it has been necessary to include works within each project to reinforce the network in the NSW south west.

Supply Augmentation Options

TransGrid has considered a range of options for addressing the limitations on supply capacity in the Wagga area including:

- Construction of a new line to Wagga;
- Uprating of the Yass to Wagga 132 kV system;
- Power flow control over lines in the area;
- Limiting Victorian import capability;
- Demand management; and
- Development of local generation.

The new line to Wagga could originate at Yass or Lower Tumut. The route from Yass is longer than the route from Lower Tumut but there are expected to be loss and capability advantages with a line from Yass.

Proposed Yass – Wagga 330 kV Line Development

The development of a Yass - Wagga 330 kV line would remove the need for the Yass tripping scheme, firm up supply to the south west area and support increased power transfer capacity to the Victorian and South Australian regions.

For many years the direct 132 kV line No.990 from Yass to Wagga has been seen as a candidate for reconstruction to 330 kV. Careful consideration needs to be given to fully utilise the capacity of this valuable route to minimise the need for further line developments over this sector.

Even if the 132 kV route was not able to be used for a new 330 kV line the 132 kV line would be dismantled.

Planning for the Yass – Wagga line must also take into account possible options for augmenting the interconnection with Victoria involving power flow control equipment and new transmission line development.

A number of possible projects have been considered. Some of these schemes involve alternating current and HVDC links from southwest NSW to Victoria.

New interconnecting line options would aim to provide a high power capability connection from south west NSW to near Melbourne. Virtually all of the options involve the development of a transmission line that passes through the Wagga area. In most of the options it may be possible to integrate the development of the interconnecting line with the reinforcement of the supply to the Wagga area.

There is a range of possible line developments that may meet the short and longer term needs of an interconnection augmentation and a Yass - Wagga connection, including:

- A single circuit 330 kV line;
- A double circuit 330 kV line;
- A double circuit 500 kV line initially operating at 330 kV;
- A hybrid dc/ac line consisting of a bipole HVDC line and a single circuit 330 kV line sharing common towers.

Project Status

TransGrid is undertaking planning analysis to identify the optimal network development and has carried out preliminary environmental studies associated with a Yass – Wagga line. At this stage a double circuit or hybrid ac / dc line is the preferred development but a single circuit line may be developed depending on environmental requirements. Other options will be addressed in turn.

The cost of a Yass – Wagga development is estimated to at least $70 million, or more depending on the type of line, with commissioning in 2007/8.

TransGrid has also commenced regulatory consultation with interested parties. It is intended that an application of the regulatory test to a Yass – Wagga line and other options be carried out and a recommended option selected by late 2003.

5.5. Proposed New Large Network Assets

This section details constraints that are proposed to be relieved by new large network assets and the consultation process will follow Code requirements that came into operation on 8th March 2002 (refer Fig 2.4(a)). These consultation processes have either commenced since 8th March 2002 or it is expected that they will do so before publication of the Annual Planning Report for 2004.

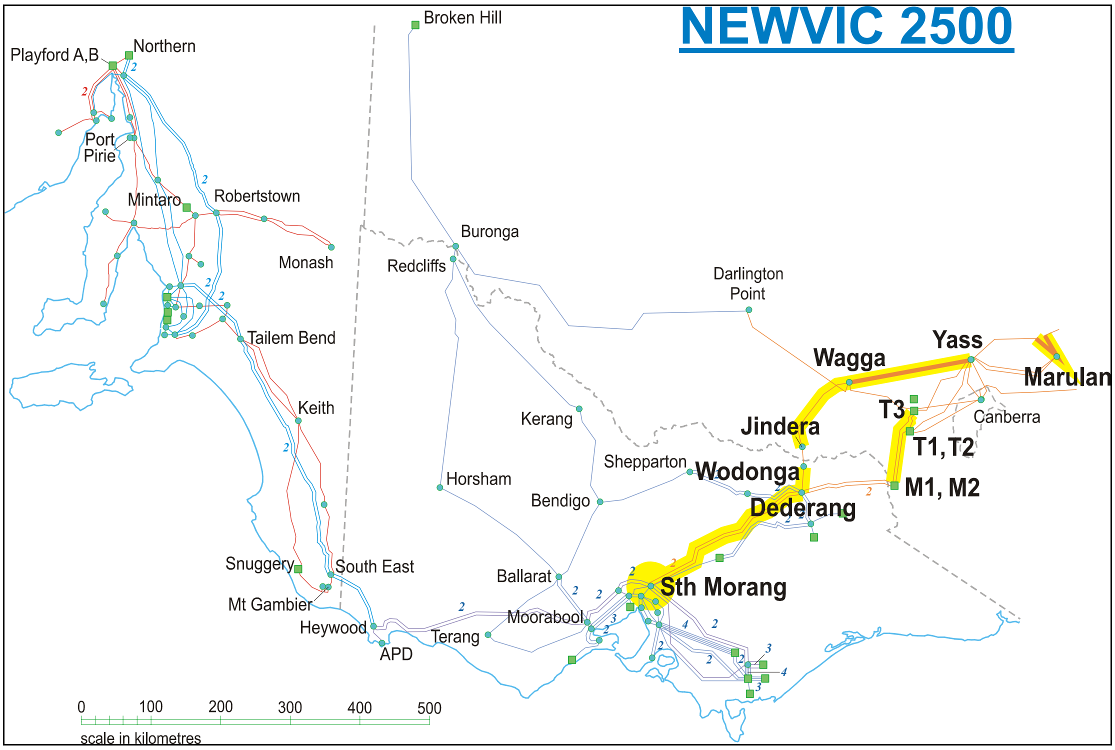
5.5.1. NEWVIC 2500 Interconnection Proposal

The NEWVIC 2500 project proposal upgrades the network in southern NSW and the existing NSW – Snowy – Victoria interconnection. The works would include the thermal upgrading of existing lines, re-configuration of line connections, installation of line series compensation, transformer augmentation and reactive power support.

The project aims to relieve thermal limitations and voltage control limitations on the system following the completion of the SNOVIC 400 project and the SNI project. It assumes the prior construction of a Yass – Wagga 330 kV line. It is aimed to provide an additional 400 MW Victorian import capability.

The NEWVIC 2500 project builds upon the following projects:

- SNOVIC 400 – which is in service;
- SNI – which is being progressed; and
- Upgrade of the Yass – Wagga 132 kV system with a 330 kV line development, this new line being series compensated for the NEWVIC project if the new line is of single circuit construction. Double circuit construction would avoid the need for series compensation at this stage.



The project works extend across southern NSW and Victoria to South Morang as shown in the figure above.

The works include:

- Reactive power support in the Victorian system;

- Further thermal upgrade of the South Morang – Dederang 330 kV lines and upgrade of the associated series capacitors;
- Transformer augmentation and switching works at South Morang;
- Line series compensation of the existing Wagga – Jindera and Wodonga – Dederang 330 kV lines and Victorian 220 kV lines;
- Uprating of a number of 330 kV lines including those between Marulan and Yass, the Wagga – Jindera line and lines within the Snowy region;
- The connection of the Yass – Sydney West 330 kV line to Marulan;
- Uprating of 132 kV systems in NSW;
- Augmentation to the phase angle regulator installed at Jindera for SNI;
- Modification of NSW network control schemes; and
- Reactive power support in the NSW system at sites including Canberra, the Darlington Pt area, the NSW south coast and the Snowy region.

TransGrid has commenced the processes set out in the Code and Environmental Assessment to relieve present limitations imposed by the Yass – Wagga 132 kV system. Supply reinforcement is scheduled for completion in 2007/8. It is expected that the works of the NEWVIC 2500 project would be able to be completed at the same time. The project cost is estimated to be of the order of $160M.

It is intended that a consultation process and application of the regulatory test to this proposal and other options be commenced in the near future. Some technical matters remain to be resolved including the fault rating and thermal rating of some Snowy area plant.

As this proposed new large network asset is considered likely to have a material inter-network impact it will be submitted to the IRPC for technical review under the NEC prior to making an application notice available to Code participants

5.5.2. Second Kempsey – Port Macquarie Line

Port Macquarie 132/33 kV substation is supplied by the 96G Kempsey – Port Macquarie and 964 Taree – Port Macquarie 132 kV lines. The 330 kV and 132 kV system supplying the north coast is shown in the figure below.

Constraint

The capacity of the 132 kV system supplying Port Macquarie is limited by unacceptably low voltages at Port Macquarie on outage of the 96G Kempsey – Port Macquarie 132 kV line.

To date this contingency has been managed by installation of capacitors. Four banks of capacitors, totalling 39 MVar have been installed at Port Macquarie and five banks totalling 52 MVar at Taree. Installation of additional capacitors is of marginal benefit as the reactive loads at each location are already more than fully compensated.

Load Forecast

Over recent years load growth in the Port Macquarie area has been approximately 4% p.a., significantly above the level for the state overall. Above average growth is expected to continue.

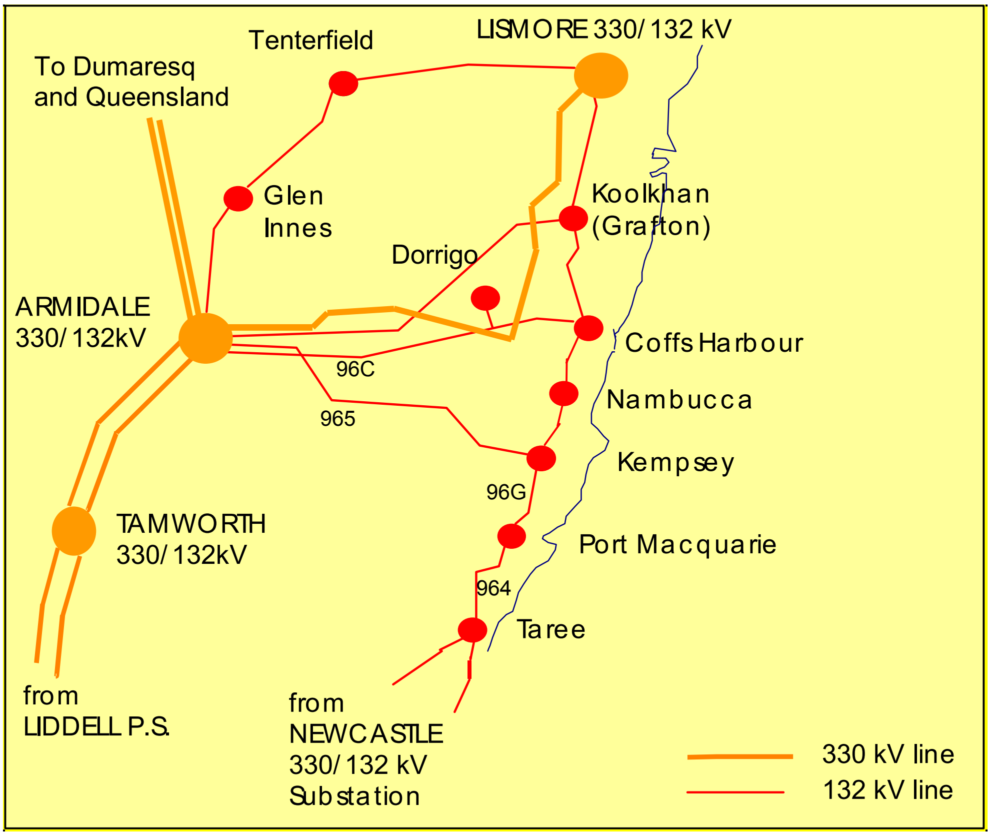
Country Energy's most recent load forecast, which includes Port Macquarie, is given in Appendix 3. Based on this forecast, the capacity of this system is expected to be exceeded by around winter 2004.

Proposed Solution

To overcome this constraint, it is proposed to construct an additional transmission line between Port Macquarie and Kempsey. This line would be primarily of 330 kV construction. It would initially operate at 132 kV, but in the medium term it is anticipated that it would form part of a 330 kV supply to the area.

It is considered that this new line is not likely have a material inter-network impact. It is expected to cost approximately $20 million.

Supply System on the North Coast



Other Options

Other potential options include:

- construction of additional 132 kV lines;
- local generation; and
- DM.

It is intended that a consultation process and application of the regulatory test to this proposal and other options be commenced in mid to late2003.

5.5.3. Establishment of 330/132 kV Transformation at Waratah West

Section 5.5.2 of the NSW Annual Planning Report 2002 described a network constraint expected to result from increasing load at the Tomago smelter and proposed a New Small Network Asset (establishment of 330/132 kV transformation at Waratah West) to overcome this constraint. At that stage the Waratah West transformation was expected to cost between $7 million and $8 million.

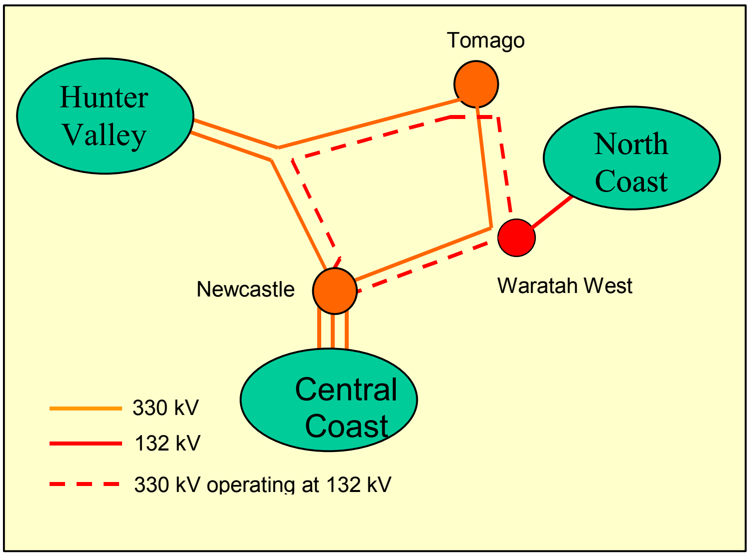
Subsequent investigations have lead to an expansion of the scope of the project to include:

- Relocation and expansion of a 330 kV capacitor bank at Tomago;
- Provision of an additional switchbay at Newcastle for the new Newcastle – Tomago line; and
- Additional works at Waratah West to facilitate establishment of a 330 kV busbar at a later time.

These additional works, together with difficulties in locally sourcing a 330/132 kV transformer which has resulted in the need to use an imported transformer, has resulted in the estimated cost now exceeding $10 million. Consequently, the proposed development would be a New Large Network Asset. TransGrid considers this to be a material change and proposes to consult in accordance with the Code requirements for regulatory approval of New Large Network Assets. A consultation paper is expected to be issued in mid to late 2003.

The Constraint

The 330 kV network supplying Tomago smelter is shown opposite.



Tomago Smelter will increase the load on the Tomago 330kV substation to accommodate changes within the Smelter. The Tomago load changes have commenced and will ramp up over several years.

Under these increased load conditions the existing supply over two 330 kV circuits does not provide adequate supply reliability: it will not be possible to meet the minimum voltage requirements at Tomago, as specified in the Supply Agreement, following an unplanned loss of the Newcastle-Tomago 330kV line.

The Options Considered

The three options which have been considered to address the constraint are:

Option 1 – Permanently connect the existing Newcastle–Tomago-Waratah West 132kV circuit (95W) for operation at its design voltage of 330kV. Establish a 330/132kV transformer at Waratah West to maintain the second point of supply to Waratah West.

Option 2 – Permanently connect the existing Newcastle–Tomago 132kV circuit (95W/2) for operation at its design voltage of 330kV. Establish a 330/132kV transformer in a temporary location at Tomago to maintain the second point of supply to Waratah West.

Option 3 – Establish a new 330kV switching station at Richmond Vale (west of Newcastle).

Demand management and distributed generation options are not available for the Tomago smelter arrangements.

TransGrid's Preferred Option

TransGrid's preferred option is Option 1.

This augmentation is a reliability augmentation and would not have a material inter-network impact.

5.5.4. Site Acquisitions

To cater for growing load within the state, it is intended to acquire sites at strategic locations on which substations could be established in the future. The sites are:

- Catherine Field, south west of Liverpool near the intersection of the Kemps Creek – Avon and Wallerawang – Sydney South 330 kV lines.
- Cobbity, west of Catherine Fields near the intersection of the Sydney West – Yass and Wallerawang – Sydney South 330 kV lines;
- Port Macquarie.

Acquisition of sites is also being considered at:

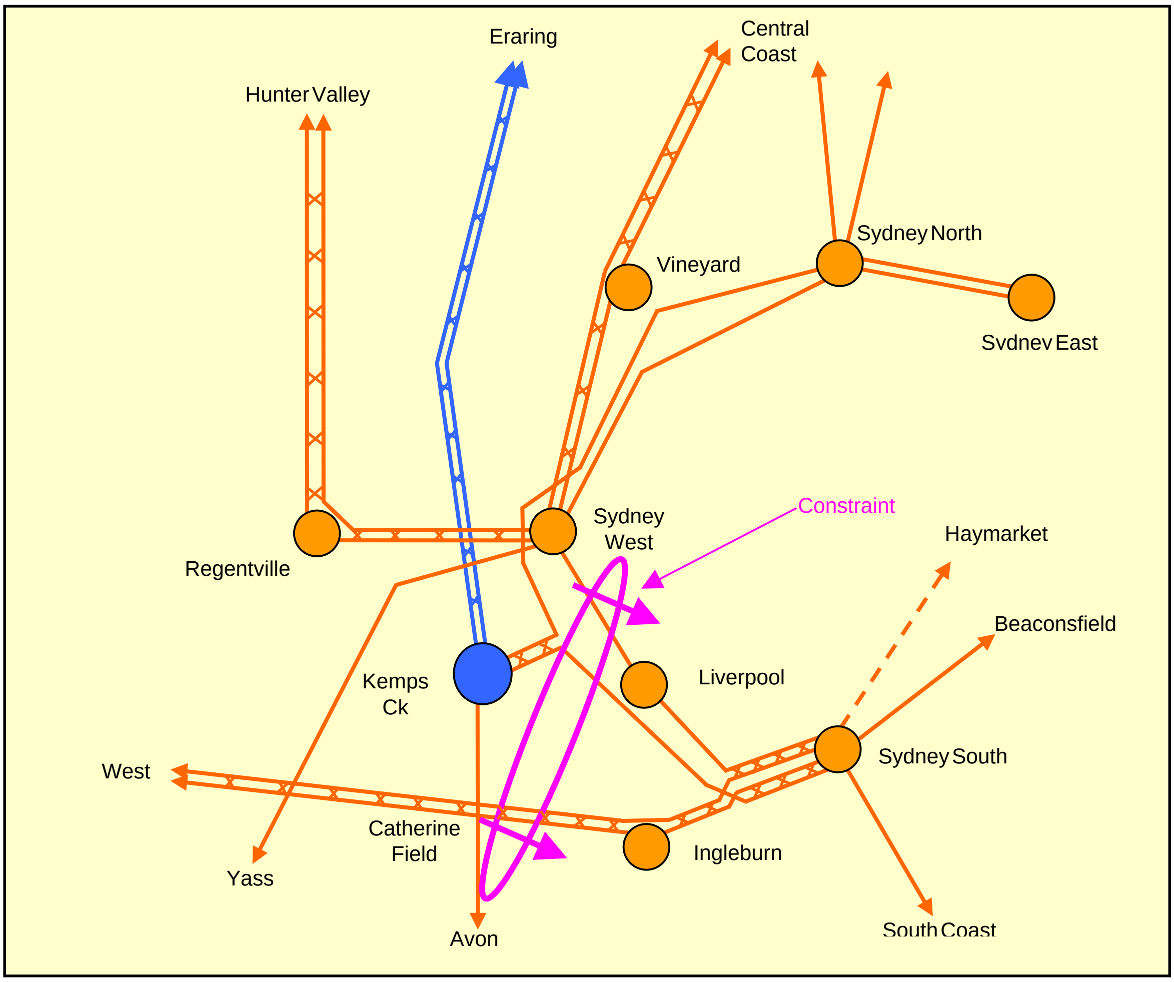
- Warrabrook, near Mayfield West in Newcastle;
- Richmond Vale, west of Newcastle; and
- Mount Annan.

Whilst the acquisition of a site is not, by itself, an augmentation this item has been included for completeness, as the substations that may be established on these sites would be new network assets, and the sites would then form part of those assets.

5.6. Constraints Emerging to 5 Years and Options to Relieve Them

This section describes constraints where there are, as of June 2003, no proposed new network assets. One or more options for the removal of each constraint are described.

5.6.1. Kemps Creek – Sydney South Development



As depicted in the diagram above, supply to the greater Sydney area is provided via major 500 kV and 330 kV substations at Sydney North, Sydney East, Sydney West, Kemps Creek and Sydney South Vineyard, Regentville, Liverpool, Ingleburn and Beaconsfield. They are interconnected with the state's power stations to the north and west of Sydney and the main grid to the south. A new 330 kV substation at Haymarket is being established (refer section 5.2.3).

Constraint:

The load areas of Sydney South, Liverpool and Ingleburn and the CBD substations at Beaconsfield and future Haymarket are, in effect, supplied by four 330 kV overhead circuits from the west and north. The Sydney South - Dapto line carries power from Sydney South to the south coast.

The need for reinforcement of supply to these areas to meet the growing load in Sydney arises from the need to consider the impact of outages of the overhead lines. At times of high area load these outages may load the remaining lines to their thermal ratings. The present load forecast indicates that this system may require reinforcement from late in this decade. The timing of this reinforcement is dependent on any changes to the load forecast in the intervening period and potential reinforcement of supply to the inner areas of Sydney.

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. New lines will thus 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 align new lines with planned infrastructure developments such as the Western Sydney orbital road. There is also potential to close corridor new lines and remove sections of existing single circuit lines that are in the vicinity of heavily developed residential areas.
- 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.

Proposed Solution

It is necessary to undertake early planning for an increase in the capacity of supply to these areas. It may be necessary to take early action to secure line easements to allow for later use. Consultation will be undertaken with the local Councils and community and other infrastructure developers.

A proposal that satisfies the above principles is the construction of a new double circuit overhead line from Kemps Creek to Sydney South via Liverpool. This may be associated with some installations of special high temperature conductors to increase the available capacity of the lines.

The cost of acquisition of easements may be a significant part of the overall cost of any project that involves the development of new line sections.

There will need to be extensive community consultation before the precise format of this proposed new large network asset can be determined.

In the longer term it is anticipated that a second double circuit line between Kemps Creek and the Glenfield area may be required. It is considered that, subject to community consultation, it would be prudent to secure routes for both double circuit lines in the near future. This should reduce the risk that subsequent community developments would prevent replacement of both the existing single circuit lines between the Kemps Creek area and the Glenfield area by double circuit lines should that be required in the longer term.

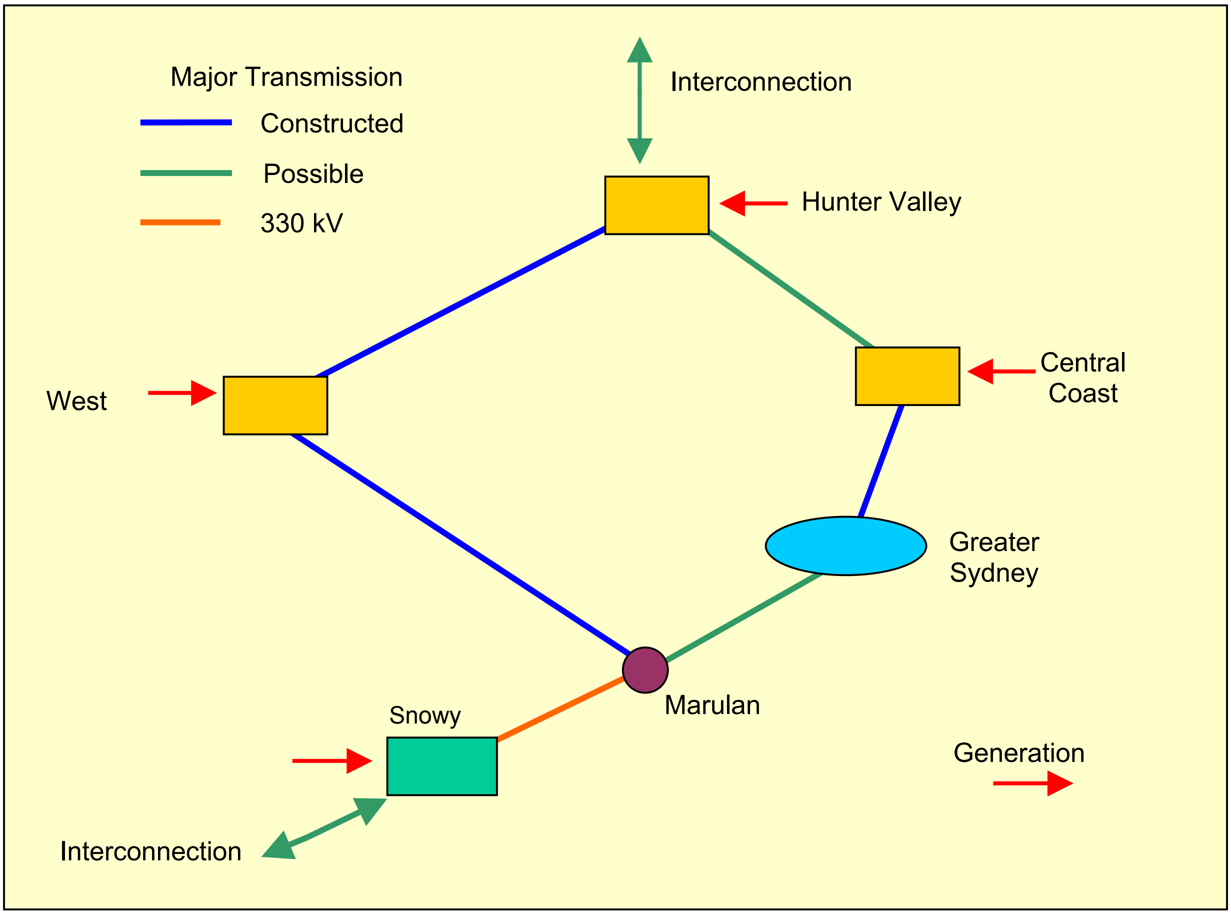
Other Options

Other possible developments that may form part of this proposal or other options include:

- Replacement of two single circuit sections of line by one double circuit section at a number of locations; and
- Development of a Catherine Field 330 kV Switching Station near the crossing of the Wallerawang - Ingleburn and Kemps Creek - Avon lines and reconstruction of the Kemps Creek - Avon line from Kemps Creek to Catherine Field as a double circuit line.

It is intended that a consultation process and application of the regulatory test to this proposal and other options be commenced late in 2003.

5.6.2. Transfer Capacity Constraints from Hunter Valley to NSW Load Centres



Planning of the main transmission system must take into account the potential for the development of major generation sites and major loads. TransGrid aims to develop the transmission system in an environmentally and socially responsible and cost effective manner.

Consistent with this objective is the concept of a high capacity ring linking the Sydney, Newcastle and Wollongong load centres with major generating centres located in the Central Coast, Western coalfields and Hunter Valley. The 500 kV ring is shown in conceptual form in the Figure above.

This development would enable future generating plant to be connected both within the existing generating centres as well as at identified sites for future power stations. It would be capable of being extended for interconnection with Victoria and Queensland. It would also avoid a concentration of lines through the Sydney area thus providing diversity of the main transmission paths from north to south in the state.

The Eraring - Kemps Creek 500 kV line was the first segment of the ring constructed. This was completed to connect Eraring Power Station. The second segment completed was the Bayswater - Mt Piper line associated with the development of Bayswater Power Station. The Mt Piper - Marulan line was developed as the third segment to connect Mt Piper Power Station. The segments of the 500 kV ring between Bayswater and Mt Piper and between Mt Piper and Marulan presently operate at 330 kV.

Future segments that may eventually be required include:

- Hunter Valley to Central Coast - this may be precipitated by the development of major loads in the Newcastle area, additional generation in the Hunter valley or further north, the import of power from Queensland or the development of western NSW power stations;
- Central Coast to Sydney - this may be required for northern power station developments or significant load developments in the Newcastle area or load development in the northern areas of Sydney;

- Marulan to Sydney - this may be required for any major power station development in the south coast or south of the state or to facilitate greater import of power from Victoria.

Load growth and development of power stations has diminished since the construction of Mt Piper Power Station and the timing of the development of further segments of the ring cannot be identified with certainty at this time. Nevertheless the segments of the ring that have been put in place provide an effective, secure and low loss transmission system.

It is possible that major industrial load development in the Newcastle area may require the development of the links between the Hunter Valley and Central Coast within the next few years. Potential new aluminium and steel arc furnace loads have been mooted. The timing of the 500 kV development is critically dependent on the timing of the load development.

There is a growing trend for power flows from the north of the state, including import over QNI, to the south of the state to supply growing NSW loads and to augment the supply needs of Victoria and South Australia. This power transfer may load the present network to its full capability and require the upgrading of the Bayswater – Mt Piper – Marulan links to 500 kV.

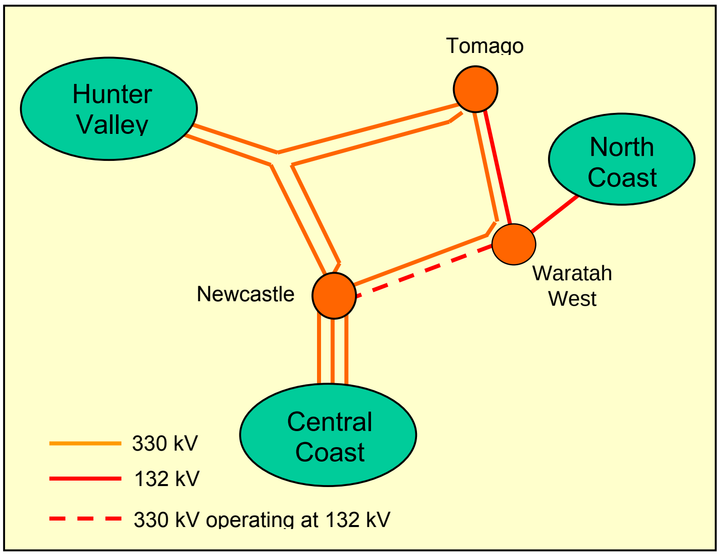
There are a number of other factors which may require the upgrading to 500 kV, including:

- The transient stability performance of the system;
- Loss considerations; and
- Reactive power requirements of the system.

5.6.3. Supply to the Greater Newcastle and Lower North Coast Areas

Load in the Newcastle area comprises the metropolitan area load, smelter loads at Kurri Kurri and Tomago and supply to the mid north coast. There is presently interest in the development of major new industrial loads in the area as well as increasing the existing smelter loads.

Two 330kV lines from the Hunter Valley and three 330kV circuits from the Central Coast power stations supply the area. A double circuit 330kV line connects Newcastle and Tomago substations with one of the circuits operating at 132kV. The system following establishment of Waratah West 330/132 kV Substation (refer Section 5.5.3) is shown opposite.



Waratah West 132kV switching station currently supplies some industrial customers near the Hunter River and also supplies coastal loads north of Newcastle.

To meet increased load requirements at Tomago smelter a third 330kV circuit will be connected to Tomago from Newcastle. A 330/132kV transformer is also to be established at Waratah West to ensure a firm supply to the substation (Refer Section 5.5.3). This will provide windows of opportunity for major planned maintenance of the Newcastle 330/132kV transformers and meet the increasing load levels in the Newcastle Region.

Constraints:

The need for further augmentation to the supply in the area is driven by the following factors:

- The need to carry out major planned maintenance of the Newcastle 330/132 kV transformers;

- General load growth in the area (the existing 330/132kV transformers are expected to operate at their firm capacity by 2004/2005);
- Development of additional aluminium smelting loads;
- Development of significant loads in the Tomago area; and
- Development of significant loads on Kooragang Island.

One of the new steel making developments under consideration proposes to use electric steel making technology. This would impose a substantial new load on the system and may require substantial local 330kV system developments as well as reinforcement of the 330kV system from the Hunter Valley and/or Central Coast power stations.

Options to Relieve Constraints:

There is a degree of uncertainty as to whether some of the proposed developments will occur and the timing of the developments if they do eventuate. Accordingly, a range of options has been developed to respond to the maintenance needs at Newcastle, general load growth in the area and possible industrial load increases. These include:

- Development of demand management options;
- Development of local generation;
- 330kV line reconnection in the Central Coast area to improve load sharing on 330 kV lines;
- Construction of local 330kV and 132kV lines to supply new large industrial customers;
- Construction of a double circuit 330 kV line (or 500kV line initially operating at 330kV) to reinforce the main grid to meet the large new loads;
- Construction of a new 330kV switching station west of Newcastle. This would allow 330kV lines from the Hunter Valley to be marshalled and could form part of a future 500/330kV substation in the Newcastle area;
- Provision of additional 330/132 kV transformer capacity, most probably by installing an additional transformer and a 330 kV busbar at Waratah West; and
- Provision of additional reactive compensation.

5.6.4. Development of Supply to the Central Coast: 132 kV Line Thermal Ratings

Over recent years the Central Coast has experienced rapid load growth, due primarily to population growth and the associated residential development and supporting services. This is expected to continue with the summer load being forecast to continue to grow at around 4.5% (14 MW to 20 MW) p.a. Further mining developments in the area are also possible.

Reconstruction of the Tuggerah – Sterland 330 kV line is planned as the first stage of a programme to increase the capacity of the transmission system supplying the area (refer to Section 5.2.2). Following reconstruction of this line, the capacity of the system is limited by the thermal rating of EnergyAustralia's 957 Vales Point – Ourimbah and 97E Munmorah – Charmhaven 132 kV lines, on outage of the 330 kV line to Tuggerah or the Tuggerah transformer. This limit is expected to be reached by summer 2008/09 or on establishment of a possible new mine.

Options being considered to relieve the constraint include:

- Demand management;
- Local generation;
- Establishment of a new 330/132 kV substation; and
- Completion of the 330 kV mesh busbar at Tuggerah and installation of a second 330/132 kV transformer.

5.6.5. Supply to the Southern and Inner City Areas of Sydney

The southern and inner city areas of Sydney are presently supplied primarily by Sydney South (Picnic Point) and Beaconsfield West 330 /132 kV substations. Commissioning of Haymarket 330/132 kV substation and associated 330 kV cable will provide a third major supply to the area.

These substations are connected to each other and to Sydney North (Dural) by EnergyAustralia's underlying 132 kV network. This 132 kV network parallels the 330 kV network within the Sydney region. Consequently the loading on Sydney South, Beaconsfield West and, in the future, Haymarket substations depends on:

- Loads, particularly those in the southern and inner city areas of Sydney, but also those in the northern suburbs;
- Generation patterns which determine power flows on the 330 kV network and the underlying 132 kV network; and
- Outages within the underlying 132 kV network or the 330 kV system supplying the 330/132 kV substations.

Load Forecast

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

Constraints

Failure of either of the Sydney South – Beaconsfield West or Sydney South – Haymarket 330 kV cables and any of approximately thirty other critical circuits or transformers would result in the rating of some remaining network elements being exceeded. Also it is expected that it will become increasingly uneconomic to maintain some deteriorating 132 kV cables in the area in a satisfactory condition.

Studies to identify the constraints, when they may be reached (including consideration of possible generation patterns) and options to overcome them are being undertaken, however it is presently expected that some may be reached by as early as 2005/06.

Options to Relieve the Constraints

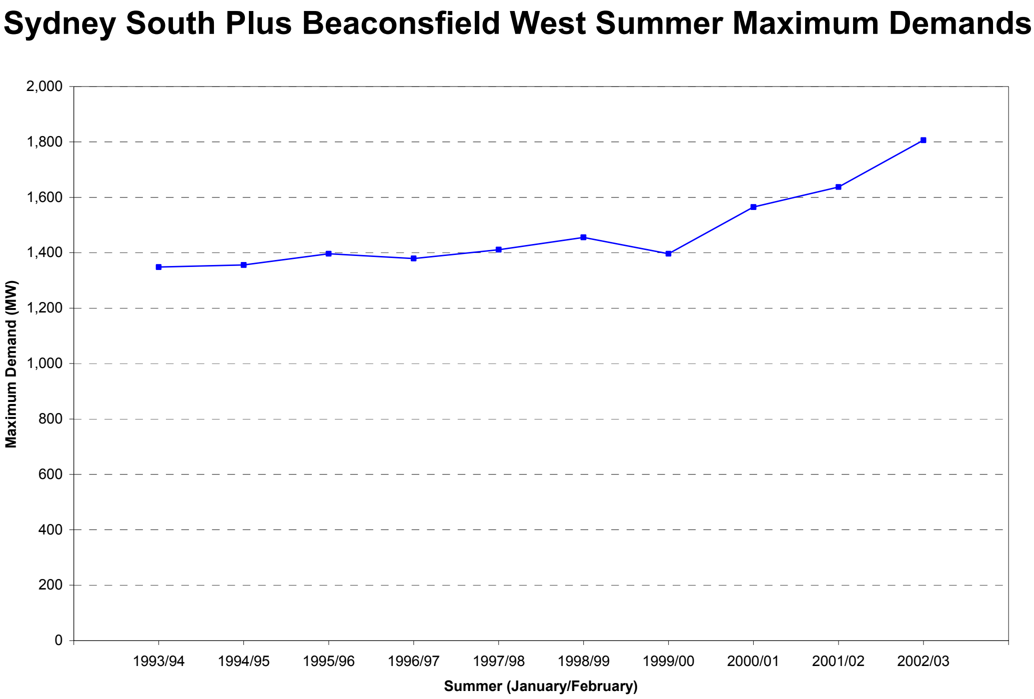
A number of options are being considered. Broadly, these are:

- Reinforcing EnergyAustralia's 132 kV network;
- Establishment of an additional 330/132 kV substation and associated 330 kV supply;
- Local generation; and
- DM.

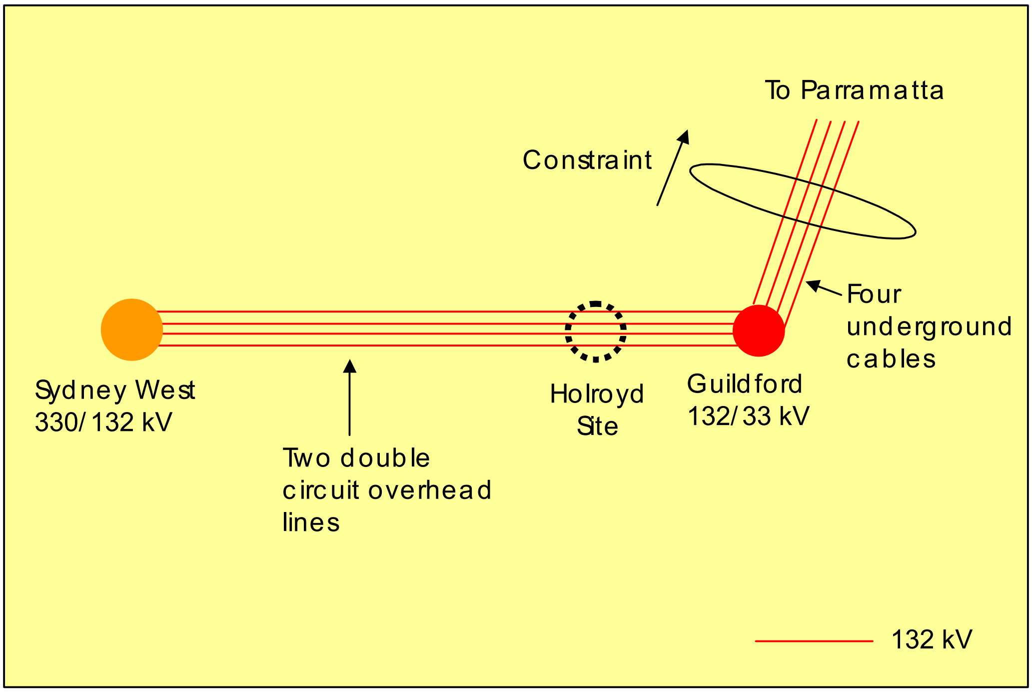
Options to reinforce EnergyAustralia's 132 kV network include installation of phase shifting transformers to control power flows and installation of additional 132 kV cables. These options would increase the capacity of the 132 kV system within southern Sydney. Increased 330/132 kV transformer capacity at Sydney South, as mentioned in Section 5.8.1, would also be required.

It is likely that the existing series reactor (connected to the existing Sydney South – Beaconsfield West 330 kV cable) would need to be replaced by one of higher impedance to ensure better sharing of load between the 330 kV and 132 kV systems.

Establishment of a 330/132 kV substation in the Homebush/Chullora area would increase supply capacity to the inner west of Sydney, which would relieve the loading on the existing 330/132 kV substations, particularly Sydney South. Such a substation would initially be supplied by a 330 kV cable from Holroyd. In the medium to longer term a second cable from Holroyd may be required. A substation in the Homebush/Chullora area may be a suitable location to connect a 330 kV cable supplying a new substation in the inner western metropolitan area, should one be required in the longer term.



5.6.6. Supply to the Greater Parramatta Area



The transmission and distribution system supplying the greater Parramatta area is shown in the figure above. It consists of:

- Two high capacity double circuit lines between Sydney West and Guildford (owned by Integral Energy);
- Integral Energy's Guildford 132/33 kV substation; and
- Four 132 kV underground cables supplying 132 kV substations in the Parramatta area from Guildford.

Guildford substation is over forty years old and operating restrictions to maintain fault levels within the capability of the switchgear and associated equipment, have been in force for many years.

Over recent years demand in the Parramatta area has grown strongly due to various developments, particularly office and commercial developments within the CBD area and medium and high density housing developments. This strong growth is expected to continue.

The capacity of the system supplying the area is limited by the rating of the three remaining 132 kV cables from Guildford to the Parramatta area, when one of them is out of service at times of high load. This constraint is expected to emerge within the next few years.

Options being considered to relieve the constraint are:

- DM and Local Generation.

  Integral Energy is presently preparing a request for expressions of interest in providing DM or local generation in the area.

and

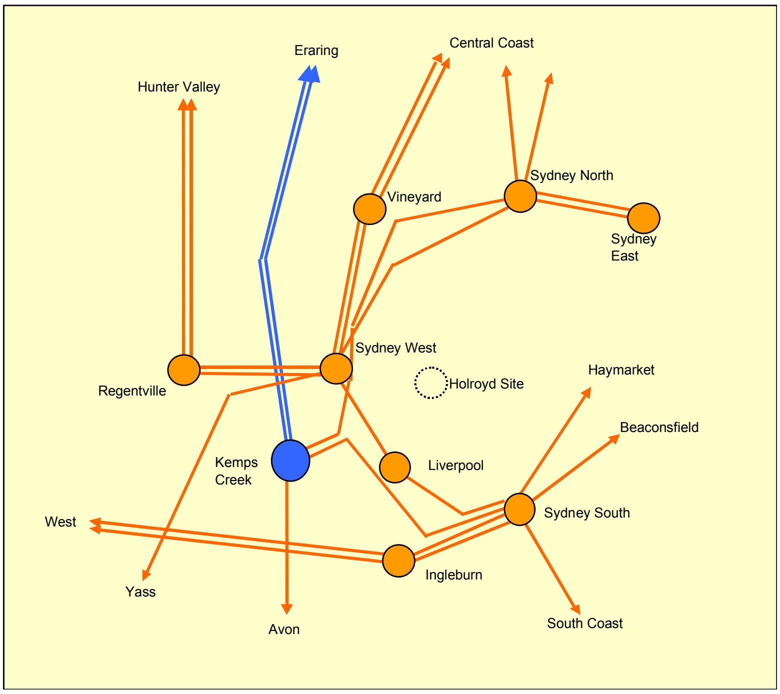
- Reinforcing the 132 kV Cable Network

  This would entail installation of additional 132 kV cables to the Parramatta area.

  Guildford substation would not be a suitable point to connect these cables, due to its condition and limited capacity. Consequently a new 132 kV busbar would be established at Holroyd (at a site owned by TransGrid for the long term development of a 330/132 kV substation). This busbar could become the first stage of a future Holroyd 330/132 kV Substation. Its establishment would also enable the line and cable connections at Guildford Substation to be revised, which would permit some, if not all, of the existing operating restrictions to be removed.

5.6.7. Supply to the Western Sydney Area

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



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

An additional transformer has been installed at Sydney West and it is intended to install one at Liverpool (refer to Section 5.3.5). Despite this, it is expected that the constraint imposed by the 330/132 kV transformer capacity in the area will re-emerge within around five years.

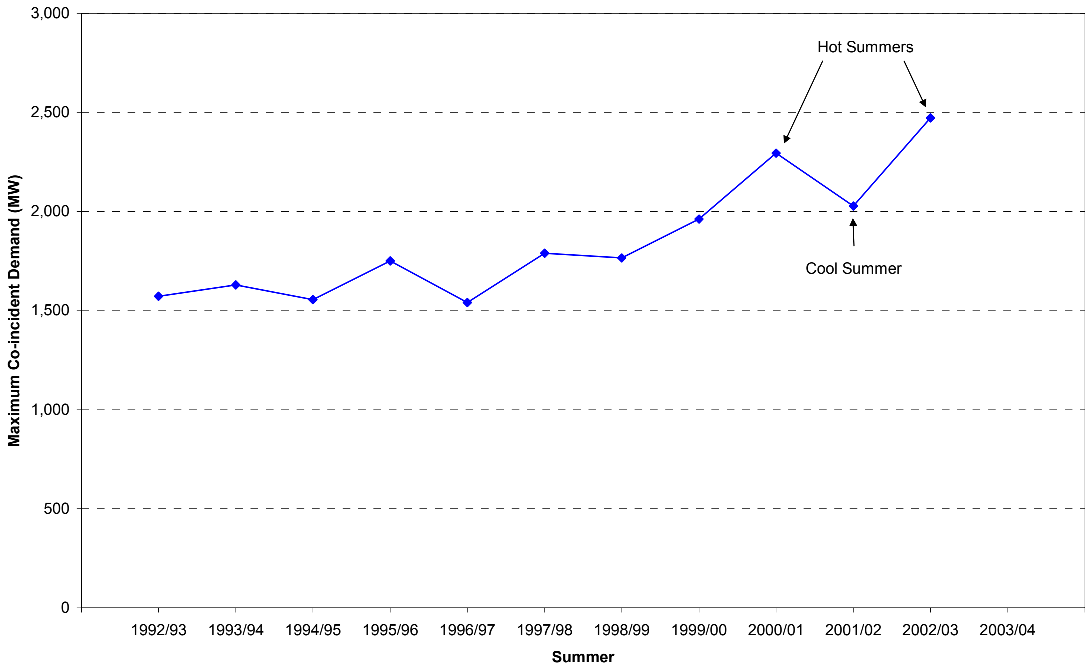
The options to relieve this constraint include:

- DM and local generation;

- Replacement of the Sydney West transformers by larger (around 600 MVA) units; and
- Establishment of an additional 330/132 kV substation.

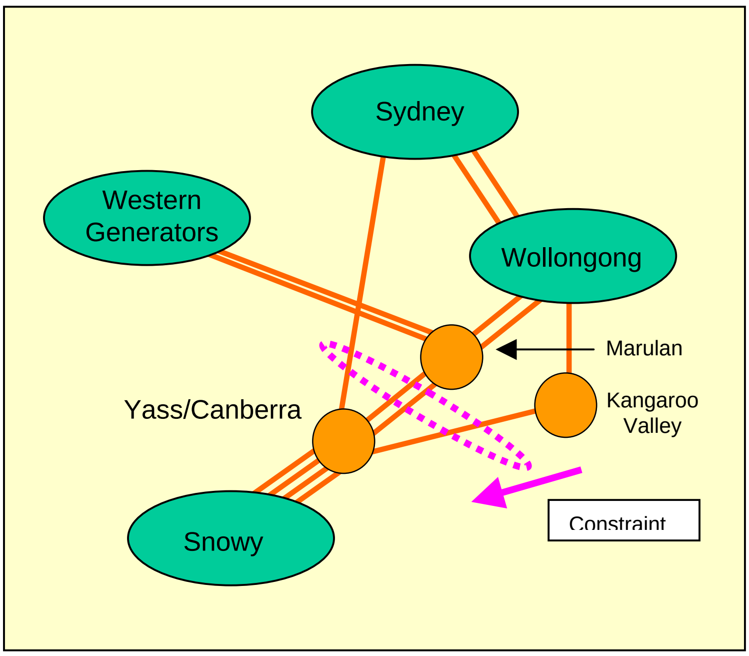
Should an additional substation be established, it would most probably be located on an existing site at Holroyd. There are two double circuit lines between Sydney West and Guildford, which pass through the Holroyd site. Between Sydney West and Holroyd, one line is of 330 kV construction and the other of 132 kV construction that may be suitable for conversion to 330 kV. Due to development in the Wetherill Park/ Smithfield area since the lines were constructed, it would be necessary to relocate sections of at least one of these lines to enable them to operate at 330 kV.

Establishment of a 330/132 kV substation at Holroyd is also a component of network development options to relieve constraints in supply to the greater Parramatta area (refer to Section 5.6.6) and the southern and inner city areas (refer to Section 5.6.5).



5.6.8. Reinforcement of Supply Between Marulan and Yass / Canberra

Constraint:



Four 330 kV lines presently extend from Sydney and the south coast to the south west of NSW and the Snowy region as shown in the Figure opposite. The capability of this system immediately south of Marulan to transfer power from Snowy to the north or from the Sydney area into the southwest area of NSW is limited.

Power transfer north from Snowy is dictated by the dispatch of Snowy Hydro generation and Victorian export into NSW. Power transfer to the south is governed by load levels in the southwest area, the operation of the Snowy region in the National Electricity Market and power transfer from NSW to Victoria.

The transmission system will need to be supported to supply the growing southwest area load. Reinforcement by transmission development would also increase the capability for the export of power from NSW to Victoria and possibly from Victoria to NSW.

Options to Relieve Constraint:

TransGrid has undertaken uprating of the existing lines between Marulan and Yass in recent times. Further upgrading is planned over the next few years to relieve the system limitations due to ongoing load growth.

TransGrid has considered a number of options for further relieving the supply constraints, including:

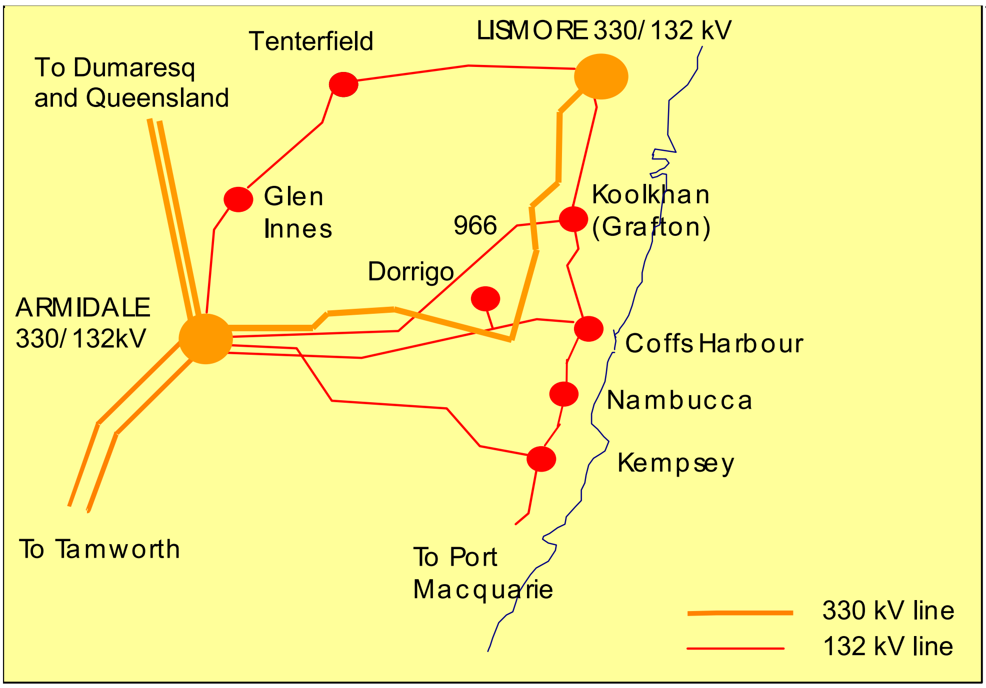
- Diversion of the existing Sydney West to Yass 330 kV line into Marulan;
- Establishing a substation at the intersection of the Mt Piper – Marulan lines and the Yass – Sydney West line;
- Installation of power flow control equipment on the 330 kV lines; and
- Construction of new transmission lines between Marulan and Yass, which may include 500 kV line development options.

At this stage one indicative network option that will achieve a low level upgrade of the system capability is the diversion of the Sydney West - Yass 330 kV line into Marulan. This may be achievable in 2006/7. The staging of further upgrading works is under consideration.

5.6.9. Supply to the Lismore Area (966 Rating and Lismore Voltage Constraint)

The far north coast is supplied by a single 330 kV line between Armidale and Lismore, together with an underlying 132 kV network. This system is shown in the figure below.

Supply System on the North Coast



In 2000 Directlink (a high voltage direct current link between Mullumbimby and Terranora) commenced operation. Export of power from NSW to Queensland over Directlink imposes additional load on the northern NSW system, whilst import of power reduces it. To facilitate export of power to Queensland, a control scheme has been installed to trip Directlink (if it is exporting power) following an outage of the Armidale – Lismore 330 kV line.

Increased Bagasse fuelled generation at sugar mills in the Murwillumbah and Lismore areas has been proposed. Depending on the number of generating units and their mode of operation, this generation may be able to provide some network support.

Constraints

The capacity of the 132 kV system is limited by the thermal rating of the 966 Armidale – Koolkhan 132 kV line on outage of the 89 Armidale – Lismore 330 kV line. The Armidale – Koolkhan 132 kV line was built in the early 1960s. It was the first 132 kV line in the area. As it was designed for a lower conductor operating temperature than later lines, it has a lower thermal rating than other 132 kV lines in the area.

This constraint is expected to be reached by summer 2005/06.

For the same outage, unacceptably low voltages can occur at Lismore. In recent years a number of capacitor banks have been installed in the area, and in 1999 a Static Var Compensator (SVC) was installed at Lismore to provide dynamic reactive support. Consequently, installation of additional capacitors is likely to provide only a marginal benefit.

This constraint is expected to emerge by winter 2006.

Load Forecast

Over recent years load growth on the far north coast has been approximately 4% p.a., significantly above the level for the state overall. Above average growth is expected to continue. Country Energy's most recent forecast, which includes the supply points in the area, is given in Appendix 3.

Options

Options to overcome the constraints include:

- Uprating the 966 Armidale – Koolkhan 132 kV line. This would not overcome the voltage limitation;
- Use of Directlink to provide network support.
- Construction of an additional 330 kV line, most probably from Dumaresq to Lismore;
- Construction of additional 132 kV lines;
- Local generation; and
- Demand management;

5.6.10. Glen Innes 132 kV Busbar

Glen Innes 132/66 kV substation was established in 1970 as a low cost temporary substation. It has two transformers tee connected to the Armidale – Tenterfield 132 kV line. Outages of this line, both planned and unplanned, result in supply to the substation being interrupted. The load at Glen Innes is around 20 MW. To improve the security of supply to Glen Innes and surrounding areas, it is proposed that a 132 kV busbar be established so that the existing tee connection can be replaced by separate line switchbays for the Armidale and Tenterfield lines.

This is expected to cost around $4 million and is proposed to be completed in 2006/07.

5.6.11. Supply to the Mid North Coast

Over recent years load growth on the mid North Coast has been approximately 4% p.a., significantly above the level for the state overall. Above average growth is expected to continue. Country Energy's most recent forecast, which includes the Taree, Port Macquarie, Kempsey, Nambucca and Coffs Harbour loads, is given in Appendix 3.

The 132 kV system is heavily loaded and the scope to continue to reinforce it with 132 kV developments is limited. It is expected that despite the developments foreshadowed in sections 5.4.1 and 5.5.1 unacceptably low voltages and overloading of some network elements will occur in the medium term, on outage of key elements of the network. It is expected that establishment of a

330 kV supply to the area will be necessary to cater for the growing loads. It is presently anticipated that this could entail:

- Operating both circuits of the Coffs Harbour – Nambucca – Kempsey 132 kV double circuit line at 132 kV. This would most probably require:
    - Conversion or reconstruction of Country Energy's Raleigh and Sawtell 66/11 kV zone substations which are presently supplied from the circuit which is operating at 66 kV;
    - Provision of a second transformer at Nambucca 132/66 kV substation;
    - Construction of a section of line to supply Newee Creek from Nambucca 132/66 kV substation. In the longer term a 66 kV line between Newee Creek and Nambucca Heads could be required to form a 66 kV ring supplying those 66 kV zone substations from Nambucca;
- Construction of a 330 kV line between the Armidale and Kempsey areas. This may require reconstruction of parts of the existing 965 Armidale – Kempsey 132 kV line;
- Construction of a 330/132 kV substation near Port Macquarie, supplied from Armidale via an Armidale – Kempsey 330 kV line and a new section of 330 kV line between Kempsey and Port Macquarie (refer to Section 5.5.2).

In the longer term it is anticipated that a 330 kV system between the Newcastle area and Armidale, supplying 330/132 kV substations at Port Macquarie and Taree may be required and could form part of increased interconnection capacity between NSW and Queensland.

5.6.12. Supply to the Bulahdelah Area

The capacity of Country Energy's 33 kV system supplying the Bulahdelah area from Stroud is expected to be exceeded within the next two to five years.

Options to overcome this limitation include:

- demand management;
- local generation;
- reconstruction/uprating of parts of Country Energy's 33 kV network from Stroud; and
- establishing a 132/33 kV substation in the Bulahdelah area, supplied from the existing Tomago - Taree 132 kV line.

Establishment of a 132 kV substation may relieve the loading on the Country Energy 132/33 kV transformers at Stroud, which are expected to be heavily loaded by that stage. It also has the potential to:

- balance the loadings on the 132kV lines supplying Taree and Stroud; and
- depending upon how the 33 kV network is configured, support parts of EnergyAustralia's network.

5.6.13. Supply to the Central Coast - New Switchbays at Tuggerah

Over recent years the Central Coast has experienced rapid load growth, due primarily to population growth and the associated residential development and supporting services.

The majority of the Central Coast area is supplied from Tuggerah and Munmorah 330/132 kV substations.

In recent years, EnergyAustralia has converted parts of its 33 kV network to 132 kV to increase its capacity. Conversion of Berkley Vale substation to 132 kV is expected to be required by around 2007. To meet EnergyAustralia's requirements, an additional 132 kV line switchbay and a 132 kV bus section circuit breaker would be required at Tuggerah, at a cost of around $1million.

5.6.14. Sydney North 330/132 kV Substation - Fault Level Rating Limitations

Switching of 132 kV lines is currently undertaken to control the fault level at Sydney North 132 kV busbar to within equipment ratings.

The establishment of additional supply capacity to the inner metropolitan area and/or generation developments is expected to result in increased fault levels. In particular the fault level at Sydney North 330 kV Substation 132 kV busbar (which was commissioned almost 40 years ago) is expected to exceed the equipment short circuit ratings.

The options available to address this limitation include:

- implementation of an equipment replacement program at this site;
- further operational limitations on switching of circuits.

It is likely that equipment upgrading will be the most cost-effective solution. It is anticipated that the works may be required by about 2006.

5.6.15. Orange 132 kV Busbar Replacement

Orange 132/66 kV substation was established in 1954. The scope to upgrade the substation is limited by lack of space on the present site. Following connection of the 132 kV feeder supplying the Cadia mine, there has been no space for additional 132 kV switchbays.

The load supplied from Orange is around 140 MW and provision of a 132 kV bus section switchbay is appropriate.

Establishment of a new 132 kV busbar on a close but separate site is being investigated. This would enable:

- A 132 kV bus section switchbay to be provided;
- An additional 132 kV line switch bay installed, which would allow the Mount Piper – Wellington 132 kV line which is presently tee connected to Orange to be looped in;
- New transformers to be installed to replace the three 30 MVA 132/66 kV transformers which are now 50 years old and in a deteriorating condition; and
- The present 132 kV busbar and associated switchgear to be retired and removed, thus reducing the maintenance workload and freeing space in the existing switchyard.

Preliminary indications are that this work will cost around $7 million. It is presently expected to be completed by around 2007.

At this stage the only other feasible network option is establishment of a new 132/66 kV substation in the Orange area.

5.6.16. Supply to the Parkes/Forbes/Cowra Area

The Parkes/Forbes area is supplied via a 132 kV transmission network emanating from 330/132 kV substations at Yass and Wellington. This system, on completion of the Molong – Manildra 132 kV line (refer to Section 5.2.9) is shown in the figure below.

Constraints

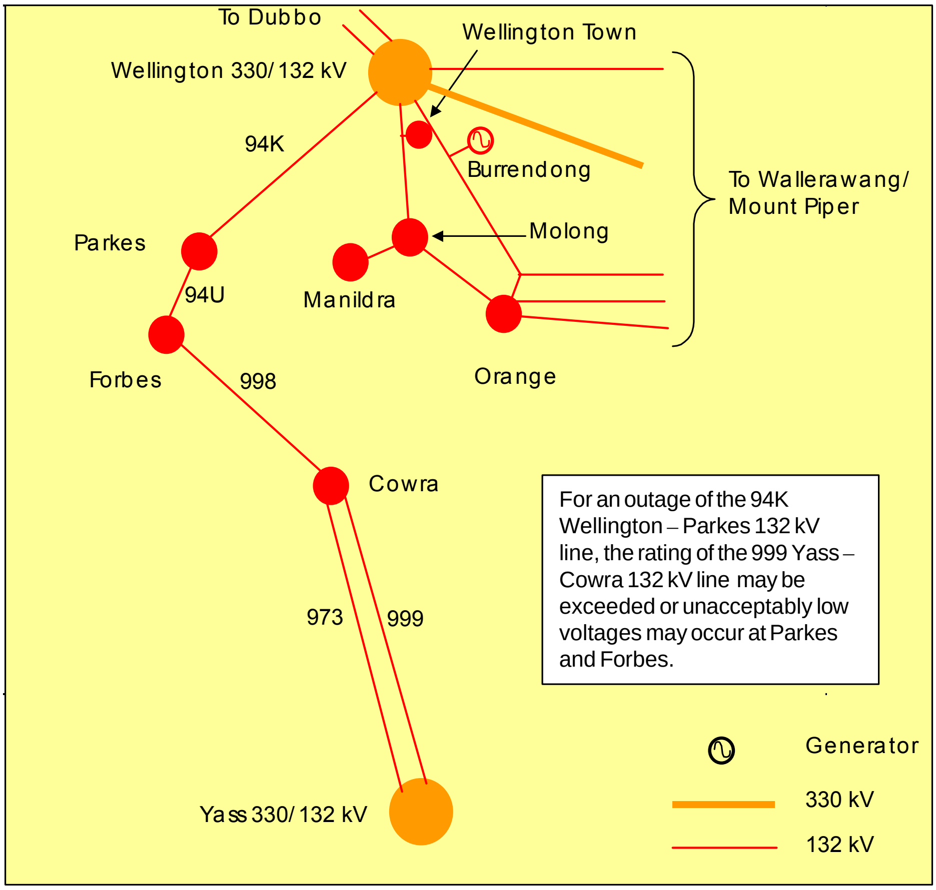
The capacity of the existing 132 kV system has two limitations on outage of the 94K Wellington – Parkes line. These are:

1. Unacceptably low voltages at Parkes and Forbes in winter; and
2. The rating of the 999 Yass – Cowra 132 kV line in summer.

The load supplied from Parkes and Forbes has exhibited moderate growth in recent years and this is expected to continue, although there is potential for “spot loads”, such as mines, to eventuate.

Based on the most recent load forecast (included in Appendix 3), the capacity of the 132 kV system is expected to be exceeded within the next five years. However, should a "spot load" eventuate, the constraint could emerge at an earlier date.

Supply System in the Central West



Options

The options being considered include:

- Construction of an additional 132 kV line to the area;
- Provision of additional capacitors;
- Uprating of the 999 Yass – Cowra line;
- Local generation; and
- Demand management.

In the short term, the four latter options have the potential to defer or avoid the need for an additional 132 kV line. Should a major development proceed and an additional line be required, construction of a 132 kV line from Manildra to Parkes is presently considered to be the most promising option.

5.6.17. Supply to the Parkes Area

The Parkes area is supplied by a single transformer 132/66 kV substation that was established in 1993. A 66 kV line from Forbes provides a backup supply when the transformer or the 66 kV line from the 132/66 kV substation to Parkes 66/11 kV substation is out of service. This system is shown in the figure above.

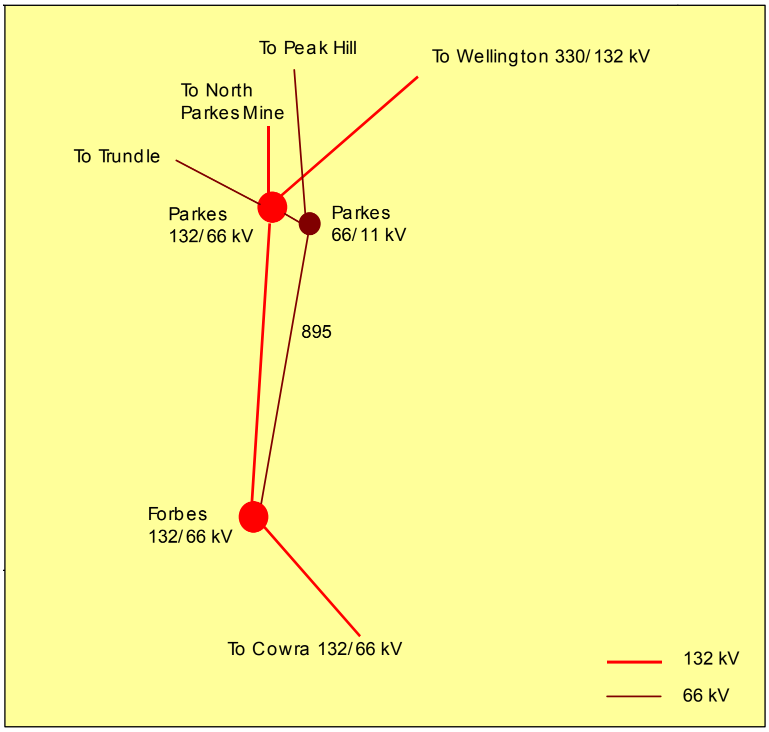
The capacity of this system is limited by the rating of the 895 Forbes – Parkes 66 kV line on outage of the transformer at Parkes 132/66 kV Substation in summer.

Over recent years the Parkes load has exhibited moderate growth. This is expected to continue. However, a major expansion of Parkes airport to accommodate international air freight and associated storage facilities (such as cool stores), has been mooted.

Based on Country Energy's most recent forecast (included in Appendix 3) the capacity of the system supplying Parkes is expected to be exceeded by around 2006 or when the airport expansion commences operation (should that occur).

The options being considered include:

- Installation of a second132/66 kV transformer at Parkes, together with a second 66 kV line between the 132/66 kV and 66/11 kV substations;
- Provision of additional capacitors at Parkes, Peak Hill or Trundle 66/11 kV substations;
- Supplying the airport development (should it eventuate) at 132 kV;
- Uprating of the 895 Forbes – Parkes 66 kV line;
- Local generation;
- Provision of additional capacitors; and
- Demand management.



In the short term, local generation and demand management have the potential to defer or avoid the need for transmission works. Should the airport development proceed and additional transmission capacity be required, installation of the second transformer and construction of a second 66 kV line between the 132/66 kV and 66/11 kV substations is presently considered to be the most promising option.

5.6.18. Supply to Narrandera and Lockhart

Constraint

Country Energy has indicated that the existing 66/11kV transformers at the Narrandera 66/11kV substation and the 66kV supply to Lockhart area have reached the limit of their capacity and need reinforcement.

Options to Relieve the Constraint

The options available to address the Narrandera 66/11kV transformer capacity limitations and 66kV supply to Lockhart include:

- Augmentation of the Narrandera 66/11kV transformers, establishment of a 66kV voltage regulator between Wagga and Lockhart combined with uprating of the Wagga-Narrandera 66kV line.
- Establishment of a 132kV switching station adjacent to the Country Energy Narrandera 66/11kV substation with a point of connection for a Country Energy 132/66kV or 132/11kV transformer;
- Demand management;
- Development of local generation.

5.6.19. Limitations in Line Ratings from Wagga 330/132 kV Substation to Wagga 132/66 kV Substation

Constraint:

Wagga 132/66 kV substation is supplied over two 132 kV lines from Wagga 330/132 kV substation and a long 132 kV line from Yass.

Based on the current load forecast, the 132 kV transmission line capacity from Wagga 330/132 kV substation to Wagga 132/66 kV substation is expected to be exceeded by the summer of 2004/2005.

A new gold mine is proposed near Lake Cowal that would be supplied from the Country Energy system at 132kV from Temora in late 2004. Temora is in turn supplied from Wagga 132/66kV substation. If this proposed development proceeds then the additional loading on the Wagga 132/66kV substation will further exacerbate the loading on the 132kV circuits between Wagga 330/132kV and Wagga 132/66kV substations to the point where obtaining outages on either circuit may be extremely difficult and loadshedding schemes would be required in response to an unscheduled outage on either of these circuits.

It is also possible that the establishment of a new Yass to Wagga 330 kV line may involve a full or partial reconstruction of the 132 kV line from Yass, which would exacerbate the loading on the 132 kV lines to Wagga 330/132 kV substation.

Options to Relieve the Constraint:

The options available to maintain supply to the Wagga load include:

- A new Wagga North 132 kV switching station and 132 kV line rearrangements;
- 132 kV line upgrading;
- Development of a 132 kV ring system by the local distributor;
- Demand management; and
- Development of local generation.

5.6.20. Darlington Point-Colleambally-Deniliquin-Finley 132 kV System Constraints

Constraints:

The Darlington Point-Colleambally-Deniliquin-Finley 132 kV system is expected to reach the point where an outage any one of several lines may result in the need to shed load during high demand periods by 2003/04.

The capacity of the 132kV system is limited by a combination of factors including:

- Long line lengths between Wagga and Deniliquin and Darlington Point and Deniliquin;
- Relatively heavy load levels given the line lengths;
- Teed substation at Finley; and

The Deniliquin 132/66kV substation supplies the Country Energy 66kV system in the area. One area of particular concern is the supply to the Moama area, adjacent to Echuca near the Murray River. Moama is supplied by a single 70km long 66kV line. The load forecast indicates steady future growth and it is expected that the current 66kV arrangements will reach their capacity by 2007/8. Country Energy is investigating the possibility of a 66kV connection to the Powercor system in Victoria to reinforce supply to the area.

This is not expected to significantly relieve the constraints on the TransGrid 132kV system supplying Deniliquin.

It is planned to implement undervoltage loadshedding at Deniliquin for 2003/04 to minimise the effects on customers, should an unscheduled outage during peak demand periods occur, until supply augmentation is achieved.

Options to Relieve the Constraint:

Options to relieve the constraints on the Darlington Point-Colleambally-Deniliquin-Finley 132 kV system include:

- Construction of a second Darlington Point to Deniliquin 132 kV line;
- Construction of a Mulwala to Finley 132 kV line and associated 66kV works;
- Construction of a Darlington Point to Deniliquin 220kV or 330kV line;
- Upgrading the teed 132 kV connections at Finley with line switchbays to allow faster and more effective sectioning of lines and operational flexibility;
- Development of a higher voltage 220 kV or 330 kV interconnection between Wagga or Darlington Point and Victoria via Deniliquin or Finley and appropriate Victorian load centres (Echuca);
- Demand management; and
- Development of local generation.

5.6.21. Deniliquin Transformer Thermal Rating Limitations

Constraint

Based on the current load forecast, the firm transformer capacity of this substation is expected to be exceeded in the summer of 2006/2007. Capacitor banks have recently been installed to relieve the loading on the transformers.

Options to Relieve the Constraint:

The options available to address the transformer capacity limitation in the longer term include:

- Installation of an additional 60 MVA transformer;
- Replacement of the existing transformers with two 120 MVA transformers;
- Transfer 66kV load to supply points at Echuca;
- Establish an additional substation in the area;
- Demand management; and
- Development of local generation.

5.6.22. Mulwala 132kV Supply

Constraint:

A single 132kV line from Albury and a 66kV line from Finley currently supply Mulwala 132/66kV substation. Country Energy owns both these lines and Mulwala 132/66kV substation.

The loading of Mulwala 132/66 kV substation is reaching a level where the loss of the 132 kV line at times of moderate to high demand will result in the loss of supply.

Finley 132/66kV substation is currently teed from the Wagga to Deniliquin 132kV line and has a single 132/66kV transformer. Backup for the 66kV supply at Finley is provided by 66 kV lines to Deniliquin and Mulwala.

The 132kV system supplying Finley 132/66kV Substation is not expected to be adequate to meet voltage constraints during 132kV line outage conditions by 2004/05. The capacity of the 66kV network from Finley (that supports Mulwala) is also limited at times of high demand.

Should either Country Energy or TransGrid construct a 132kV line between Finley and Mulwala, significant augmentations would be required at Finley Substation to connect the line (and provide a second transformer if the new line utilises part of the route of the existing 66 kV line).

Options to Relieve the Constraint:

The options available to maintain supply to Mulwala include:

- A new Mulwala to Finley 132 kV line & Finley substation augmentations;
- A new Mulwala to Jindera 132kV line;
- Demand management; and
- Development of local generation.

5.6.23. Supply to Bega

Constraint

Country Energy has identified the need to reinforce the 132 kV supply to Bega from Cooma. There are currently no spare 132kV switchbays available to accommodate the Country Energy 132kV circuit. Country Energy has indicated that the 132kV connection point will be needed in 2005/06.

Options to Relieve the Constraint

The options available to provide a connection point for the Country Energy 132kV circuit include:

- Establish an additional 132 kV switchbay at Cooma
- Construct a new 132kV circuit to the Cooma area from the Canberra area and connect it to the new 132kV circuit to Bega.

5.6.24. Supply to Cooma

Constraint

Studies into the supply to Cooma have identified the possibility of loss of load during some periods following the loss of one of the Canberra to Cooma 132kV circuits. Supply can be restored by transferring Cooma/Bega load from Canberra to the Murray -Munyang 132kV network. However supply to the Cooma/Bega load would be interrupted until the connection to Munyang is made. The Murray – Munyang 132 kV line has limited capacity and traverses the highest altitude of any line in Australia, which results in a lower reliability performance than most other network elements.

Establishing a closed 132 kV connection between the Murray 330/132kV and Canberra 330/132kV substations is not acceptable due to the possibility of high flows being imposed on the 132kV network as a result of high flows in the parallel 330kV network.

Options to Relieve the Constraint

The options available to relieve the constraints on the supply to Cooma and Bega include:

- Establishing a third line between the Canberra area and Cooma. This line could be 330 kV construction operating at 132 kV and connected to a 132 kV switching station in the Royalla area;
- Demand management;
- Development of local generation;
- Implementing undervoltage loadshedding.

5.6.25. South Western NSW and Possible further Interconnection to Victoria

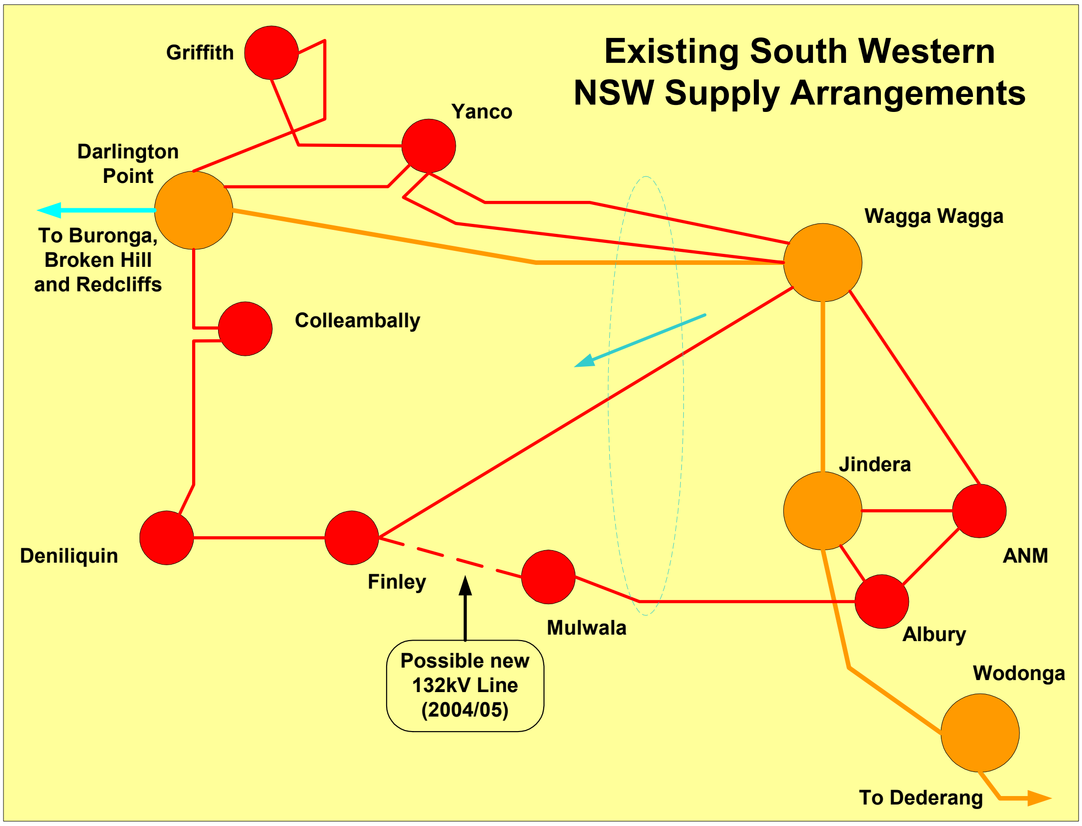
Constraint

The southwestern transmission system, west of Wagga Wagga and Albury, supplies:

- A 132kV system supplying Yanco and Griffith;
- A 132kV system supplying Coleambally, Deniliquin and Finley;
- A 132kV system supplying Mulwala;
- A 220kV system supplying Balranald, Broken Hill and Redcliffs; and
- Interconnections to Victoria via Redcliffs (220kV) and Wodonga (330kV).

The existing 132kV transmission system in the southwestern system has limited capacity to supply loads in the area.

In addition, following an outage of the Wagga – Darlington Pt 330 kV line the 132 kV system between Wagga and Darlington Pt also becomes loaded with the power transfer to Victoria at Buronga. The additional loading is influenced by the operation of Murraylink and overall Victorian import levels.



A network control scheme has been installed such that on outage of the 330 kV line the 220 kV system will be opened which effectively removes the influence of the interconnection power flows on the 132 kV system.

An outage of any one of the following lines is critical to the supply to the local loads:

- Wagga-Darlington Point 330kV line;
- Darlington Point-Coleambally 132kV line;
- Coleambally-Deniliquin 132kV line; or
- Wagga-Finley-Deniliquin 132kV line.

It is planned to install undervoltage load-shedding in Deniliquin prior to summer 2003/4 to minimise the potential impact on customers. It is also planned to install capacitor support in the area by the following summer.

In the longer term there is a need to further reinforce supply to the area.

The construction of a 132kV line between Finley and Mulwala is under consideration by Country Energy and TransGrid to relieve the limitations associated with both the Mulwala 132kV supply and the Wagga/Finley/Deniliquin/Coleambally/Darlington Point 132kV system.

If the Finley-Mulwala 132kV line is built then by 2007/08 supply limitations on loss of a main 132kV line into the area are expected to again arise.

Options to Relieve the Constraints

Options available to address these limitations include:

- Construction of Darlington Point-Deniliquin/Finley 132kV line;
- Construction of a Jindera-Finley 132kV line;
- Construction of a Wagga-Finley 330kV line either as a stand-alone project or as part of a Wagga-Finley-Echuca-Bendigo 220 kV or 330kV interconnection option;
- Construction of a Echuca-Finley 330kV line either as a stand-alone project or as part of a Wagga-Finley-Echuca-Bendigo 220 kV or 330kV interconnection option;
- Construction of a Darlington Point to Deniliquin 330kV line as a stand-alone project or as part of a Wagga - Darlington Point-Deniliquin-Echuca-Bendigo interconnection option;
- Construction of a Echuca-Deniliquin 330kV line either as a sole project or as part of a Darlington Point-Deniliquin-Echuca-Bendigo 330kV interconnection option;
- Development of local generation; and
- Demand management.

Load growth in the Murray River areas of Moama and Echuca may also eventually require augmentation to supply. There is potential to integrate any network developments in the Murray River area with a new interconnector between the south west NSW system and northern Victoria. TransGrid is working with the NSW Distributor Country Energy, the Victorian Distributor Powercor and VENCorp to plan supply developments to the area.

5.6.26. System Reactive Plant Requirements

Capacitors and reactors are installed on the system to ensure adequate control of voltage as discussed in Section 4.12.

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.

One requirement for capacitors can be to achieve an acceptable level of supply voltage to Distributors. By increasing voltage levels throughout a system they generally provide benefits in terms of MW loss reduction.

When they are applied to improve the power factor of individual loads they have benefits in off-loading lines and transformers. This can allow the deferral of significant capital expenditure.

Reactors are used to depress high system voltages that might occur at times of light system load. They are also applied to absorb excess reactive power generated by cable systems and lightly loaded transmission lines.

Reactive plant installations tend to have a local effect as it is inefficient and often impractical to transmit reactive power over significant distances. Reactive plant installations are therefore usually individual projects to meet individual system needs. Small-scale switched shunt capacitor and reactor installations with associated switchgear cost less than $1 Million with larger installations at major substations costing less than $3 Million. Hence most installations fall within the category of “New Small Network Assets”.

A number of installations are required throughout NSW in the near future. The installations can be categorised as meeting a main system requirement or a sub-system requirement. In some areas the sub-system reactive plant can also serve a dual role.

Reactive plant installations within 132 kV systems are co-ordinated with Distributors. It is often advantageous to correct load power factors at a low voltage. Where this cannot be accomplished the power factor correction may need to be undertaken at the 132 kV point of supply.

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

Alternatives to Reactive Plant Installations at TransGrid Sites

There are alternatives to reactive plant installations at TransGrid sites. These include:

Reactive plant installations in Distributor systems.

> These installations tend to be at a relatively low voltage, such as at 11 kV. Capacitor banks at low voltage can effect a reduction in subsystem loading and can achieve greater benefits than installation at the point of supply at TransGrid's substations under some circumstances.
>
> The limitations that can apply to low voltage installations are usually space requirements and limitations on the maximum size of plant that can be switched without exceeding the limits on short-time voltage change. Relatively large capacitor banks installed at TransGrid substations tend to have lower capital cost per MVar but cannot off-load low voltage systems.
>
> Co-ordination of installations with Distributors is required to achieve the most economic outcome. The ability of Distributors to undertake large scale installations of capacitor banks has been limited in the past. It is generally impractical for Distributors to install the equivalent of 80-120 MVar in a single year at low voltage. A number of Distributors in NSW have programs for the progressive installation of low voltage capacitor banks.

Demand management

> DM will lead to a reduction in demand and off-loading of transmission systems in general. DM can therefore reduce or remove the need to install capacitor banks.

Local generation

> Generation and Co-generation can offer benefits in terms of demand reduction and reactive power support.
>
> The development of embedded generation is reflected in the future load forecast for individual supply points. TransGrid's future reactive plant plan accommodates the Var effects of generation developments.

Transmission line development

> Reactive power deficiencies can arise due to high reactive power losses in the transmission system as a result of high MW loading relative to capability. The development of new transmission lines is one option for addressing the reactive power deficiency. It is however generally economic to defer any new line development with capacitor bank installations.

The cost of a 100 MVar capacitor bank at a TransGrid 132 kV bus can be of the order of $1M - $2M. The higher costs may occur due to harmonic filtering requirements and site space restrictions. The cost per kVar of large capacitor banks can therefore be relatively small from about $10/kVar. The cost per kVar of smaller banks is higher due to the influence of the switchgear costs.

There are many orders of magnitude difference between the cost of capacitor banks and any DM or generation alternatives.

TransGrid's program for reactive plant installations has been promulgated through Annual Planning Statements for some years.

Network Control Ancillary Service (NCAS)

The full reactive power generation capability of NSW generators has been relied on in reactive planning in NSW for many years. The reactive generation from the generators is an essential and cost-effective component in the overall voltage control throughout NSW.

NEMMCO has the responsibility for contracting for reactive power support as an ancillary service. In past years NEMMCO has contracted for approximately all of the reactive capability of NSW generators. However it is understood that this year NEMMCO has decided to limit the amount of MVar generation that will be contracted.

TransGrid will assess the situation once the contracting process is complete. There may be implications for power transfer capability across the network and for the program of future reactive plant installation throughout NSW.

To date there has been no committed reactive power supply development arising from market participants to meet the system reactive power needs expressed by NEMMCO's ancillary service contracting process.

Sydney Area

The Sydney area MW load has been steadily growing. There was a significant step increase in demand in summer 2000/01 under reasonably hot conditions. This growth increase was not maintained in summer 2001/02 due to milder weather conditions. However there was a significant increase in MW demand in summer 2002/03 as a consequence of heat wave conditions. In summer 2002/03 the peak demand was close to the 10 percentile forecast.

Coupled with the MW demand increase has been a significant increase in reactive power demand. This is understood to have been brought about by two factors:

- A growth in air conditioner load; and
- Increased subtransmission loading leading to increased var losses.

The increasing use of reverse cycle air-conditioners implies also a potential corresponding growth in winter loads.

The reactive demands on the transmission system in the Sydney area are heavily dominated by the load power factor, the actual MW load on the system and the level of power transmission from the north of the state to Sydney.

As the system load and the utilisation of the transmission network continue to grow, additional reactive power support will be required at intervals at various sites to ensure the ongoing security of supply.

Demand management will reduce the requirement for additional reactive power support.

The reactive capability support required can be supplied from the following sources:

- Installation of shunt or series capacitors;
- Customer power factor correction;
- New generators;
- Transmission line development.

TransGrid has undertaken the installation of large switched 132 kV shunt capacitor banks at various TransGrid substations in the Sydney area annually for many years. The capacitor banks have ranged from 80 MVar to 160 MVar in single switched banks. This installation program has amounted to about 100 to 120 MVar of capacitors per annum at a cost of about $1M per annum, including switchbay costs.

Space limitations and constraints on switching large banks have now resulted in almost all available Sydney 132 kV locations being fully occupied. As a consequence in 2003 a 200 MVar capacitor bank was commissioned at Sydney West connected at 330 kV.

Switched shunt capacitor banks provide a static source of reactive power (Vars). A Static Var Compensator (SVC) is being installed at Sydney West as discussed in Section 0 to provide a dynamic source of Vars. The SVC provides a replacement for the Sydney South synchronous condensers that are now over 40 years old.

The new SVC will enable the installation of large capacitor banks at some existing sites in subsequent years.

Sydney area distributors also have a program for capacitor installations.

The lead-time for new shunt capacitors is approximately 15 months. The lead-time for SVC's is about 3 years. Detailed plans will be developed as required following summer and winter peak loads. Over the next three years the following capacitor banks will be required:

Site	Timing	Capacitor bank rating MVar	Approximate cost
Tuggerah	2003	2 x 40 MVar	$1M
Sydney West	2003	80 MVar	See below
Regentville	2003	80	$1M
Sydney area (330 kV)	2005	200	$2M

The Tuggerah capacitor bank is a committed New Small Network Asset. It is covered in Section 5.2.8.

The Sydney West capacitor bank results from re-establishing an 80 MVar bank removed from service for site construction works associated with the 5^{th} 330/132 kV transformer.

The Regentville bank in 2004 is required to off-load the Regentville 330/132 kV transformers.

Southern System

The southern system covers the NSW south coast, the Yass / Canberra area and the southwest area of the state.

Capacitor banks have been recently installed at Finley and Deniliquin in the NSW southwest to support the local supply voltages and to relieve the loading on the Deniliquin Transformer.

Growing loads require the installation of capacitor banks at major substations in the near future. In addition a number of subsystem capacitor installations will be required over the next few years. These installations are set out in the following table:

Site	Timing	Capacitor bank rating MVar	Approximate cost
Canberra	2004	120	$1.2M
Darlington Pt area	2003-4	Approximately 40	$1M

The Canberra capacitor bank is required to maintain acceptable voltage levels at times of high NSW export to Snowy and high NSW import from Snowy. The Canberra capacitor bank will also off-load the Canberra 330/132 kV transformers.

The Darlington Pt area capacitors are required to support the Wagga – Yanco – Griffith – Deniliquin supply area on outage of the Wagga – Darlington Pt 330 kV line or outage of critical 132 kV lines.

A Network Control Scheme has been installed in the area to increase the capability for Victorian import from NSW/Snowy. Following a forced outage of the Wagga – Darlington Pt 330 kV line the 132 kV system is effectively opened at Darlington Pt to remove the influence of Victorian import on the 132 kV system. As a consequence the 132 kV system requires additional voltage support.

The outage of critical 132 kV lines requires voltage support at a number of sites due to the long and heavily loaded 132 kV system. Constraints on the switching of the capacitor banks will require them to be distributed. TransGrid is investigating the potential installation of small capacitor banks at Deniliquin, Finley, Griffith and Yanco. In addition TransGrid is investigating the installation of Under-voltage Load Shedding Schemes.

At this stage TransGrid plans to install a 40 MVar capacitor bank at Darlington Pt 132 kV to partially meet the needs of the Network Control Scheme. The overall cost of the capacitor banks will be approximately $1M. This capacitor bank has been included as part of the SNI works but its need is now seen as independent of the SNI project.

Capacitor banks required to maintain Victorian import capability

The SNOVIC 400 project was commissioned in late 2002 enabling Victoria to import a nominal 1900 MW from Snowy/NSW. The capability for Victorian import is partly governed by reactive power conditions in south west NSW. As the NSW south west area load grows the Victorian import capability reduces. The ongoing installation of additional capacitor support is required to maintain the 1900 MW import capability.

Preliminary system analysis shows that the Victorian import capability will fall below 1900 from summer 2003/4. This analysis indicates that in the order of 200 MVar of capacitor banks will be required to maintain adequate capability in summer 2003/4 and additional capacitors will be required in later years. More detailed analysis is presently being undertaken to establish the magnitude of the installation and optimum siting of the banks. It is expected that the cost of the banks would be less than $5M. Once the need for the capacitor support and its cost is firmly established further details relevant to the Regulatory Test will be completed.

The SNI project included such capacitor banks as part of the overall project. These capacitor banks are now seen as independent of the SNI project.

Future need for reactors in the Southern System

Voltages in the south of the state are largely controlled by the Snowy generators. There is presently a conflict in the need to maintain relatively high voltages in the area to facilitate Victorian import but low enough at times of low NSW import. The need for 330 kV reactors in the south of the state is being assessed.

Northern System

The northern NSW system extends from the Hunter Valley to Armidale and the Queensland border and from Newcastle north along the coast to Coffs Harbour and Lismore. There has been an ongoing program of capacitor bank installations in the area.

An upgrading of supply to the far north coast in 1999 required an SVC at Lismore and capacitor banks at Armidale and Coffs Harbour.

A number of capacitor banks were installed at Newcastle, Muswellbrook, Tamworth and Armidale associated with the development of QNI in 2000.

Capacitor banks were installed at Moree and Inverell in 2001 to support the local supply system.

A capacitor bank was installed at Port Macquarie in 2002 to support the mid-north coast system.

The Tomago smelter load is being upgraded and as part of the network developments for the project the existing 330 kV capacitor bank is to be expanded by 80 MVar.

In the near future an additional 200 MVar capacitor bank will be required in the Tomago / Newcastle area associated with the growing Newcastle area load.

Additional capacitor banks may also be required in the Taree – Port Macquarie area to support voltages, compensating for the growing load.

Western System

The development of supply to the Western area is addressed in Section 5.4.2.

As part of the program for supporting supply to the area capacitor banks were uprated at Wellington in 2001.

Increased MW generation from existing generator units

At least ten of the twelve 660 MW generators in the Hunter valley, west and central coast areas have the capability for increased MW output. It is possible that the increased MW output may cause a corresponding decrease in MVar generation capability, when the units are operated at maximum MW output.

Associated with the MW increase a need for additional capacitive support for the system arises due to two effects:

- To offset the possible reduced MVar capability of the generators;
- To offset the MVar losses that will result from the increased MW transfer through the system.

The generating companies in NSW are now considering increased MW output and as plans are developed capacitor bank installations may be required. The capacitor banks would most likely be located in the power station switchyards or at major load centres.

Long-term Voltage Control Requirements on the NSW Main System

A program of installation of capacitor banks and SVCs over many years has enabled the main system of NSW to provide a secure system for the transmission of high levels of power from the north of NSW to Sydney and to the south, minimising the need for development of new transmission lines.

Market modelling indicates a trend for increased power flow from the north to the south of the State in the future. This arises from increased exports from Queensland, the potential upgrading of 660 MW generators in NSW, the growing supply deficiencies in Victoria and South Australia and the potential development of new generation under some market development scenarios. This trend is in conjunction with the growing Sydney area load.

The installation of shunt capacitor banks and SVCs will not be sufficient to overcome growing reactive power deficiencies on the main system as lines become more heavily loaded. One solution to relieve the loading is the construction of new transmission lines. However TransGrid aims to maximise the utilisation of existing lines, to their thermal rating where possible, avoiding the need for new line developments, or deferring new lines as long as possible where this is economic.

It will be necessary to resolve the reactive power deficiencies by considering the installation of series capacitors, the installation of FACTS devices and raising the operation of the Bayswater – Mt Piper – Marulan system to its design level of 500 kV. Operation of the western system at 500 kV would require reconnection of selected generators at Bayswater and possibly Mt Piper at 500 kV.

These works would fall within the category of “Large Network Assets”.

5.6.27. Line Terminal Uprating

The thermal rating of transmission lines is determined by the rating of the conductors and the line terminal switchbays. The line switchbays usually consist of circuit breakers, current transformers, disconnectors, voltage transformers, wavetraps and connections to the busbars. Line protection may also impose limitations on the power transfer across a line.

At various sites in NSW the line switchbays contain plant that limits the overall rating of the lines. The limitation may be relatively minor or such as to significantly constrain power flow on a line.

As loading grows it is necessary to upgrade limiting plant to make full use of the available conductor rating. This upgrading may range from the replacement of a low cost disconnector to upgrading of all the plant in the switchbay. In some cases only secondary systems require replacement.

The cost of the work ranges from thousands of dollars to the order of $1M for a full 330 kV switchbay.

The following 330 kV lines have switchbay plant that may require upgrading in the near future:

- Upper Tumut – Canberra
- Lower Tumut – Yass
- Lower Tumut - Wagga
- Canberra – Kangaroo Valley
- Marulan – Dapto
- Kemps Ck – Sydney South
- Sydney North – Kemps Ck
- Sydney South - Ingleburn
- Vales Pt – Munmorah
- Eraring - Newcastle
- Bayswater – Regentville
- Bayswater – Mt Piper
- Liddell – Tomago
- Mt Piper – Wallerawang
- Dumaresq – Bulli Ck
- Upper Tumut – Yass
- Lower Tumut – Canberra
- Yass – Marulan
- Yass – Canberra
- Liverpool – Sydney South
- Kemps Ck - Avon
- Sydney West – Liverpool
- Vales Pt – Sydney North
- Vales Pt – Newcastle
- Bayswater – Sydney West
- Bayswater – Liddell
- Bayswater – Wallerawang
- Liddell - Newcastle
- Armidale – Dumaresq

As the individual line ratings are approached minimal works will be undertaken where economically justified to relieve rating limitations. Two examples are the Bayswater – Liddell 330 kV lines and the Vales Pt – Munmorah 330 kV line.

Bayswater – Liddell 330 kV Lines

A double circuit 330 kV line connects Bayswater and Liddell Power Stations. The rating of this line has been seen to impose a limit on the power transfer between NSW and Queensland at infrequent times. The limit is exacerbated at times of relatively low Liddell generation and high Bayswater generation.

This line has conductors which have Sustained Emergency Ratings of 1430 MVA on a summer day and greater than 1530 MVA on a winter night.

The overall rating of the Bayswater – Liddell 330 kV lines is presently limited by terminal equipment ratings on summer nights, autumn and spring days, autumn and spring nights and winter day and nights. The summer day rating of the conductors is approximately matched by the rating of the most limiting terminal equipment.

It is feasible to change the terminal equipment to marginally increase the overall rating of the line on other than summer days. It is likely that only the line wave traps at Liddell require uprating and this may be achieved at a cost of less than $1M per line.

TransGrid intends to undertake uprating of the terminal equipment as soon as possible. Line outages will be required to undertake the switchyard works.

Vales Pt – Munmorah 330 kV Line

A single circuit 330 kV line connects Vales Pt and Munmorah Power Stations. Power flows on the Vales Pt – Munmorah line can be relatively high in the direction from Vales Pt to Munmorah at times when the Munmorah generation is relatively low and generation is high at Vales Pt and Eraring. The rating of this line has imposed a constraint on the operation of the central coast power stations at infrequent times. This can at times be reflected in constraints on interconnectors depending on the operation of NEMMCO's NEMDE.

This line has conductors that have Sustained Emergency Ratings of 1430 MVA on a summer day and greater than 1530 MVA on a winter night.

The overall rating of the Vales Pt – Munmorah 330 kV line is presently limited by terminal equipment ratings. The limiting terminal equipment includes CT's, disconnectors and wave traps at Munmorah and the wave trap at Vales Pt.

It is feasible to change the terminal equipment to remove their limitations. The overall cost is expected to be less than $2M.

TransGrid intends to undertake uprating of the terminal equipment as soon as possible. Line outages will be required to undertake the switchyard works.

5.7. Communication Network Possible Developments 2003-6

To support its transmission network, TransGrid owns and operates an extensive communication network. Development of this network is primarily driven by transmission network augmentations. However it is heavily influenced by rapid changes in communication technology, standards and regulation as well as the relatively short asset life of communication equipment.

TransGrid plans the development of its communication network using similar principles to that used to determine transmission network augmentations.

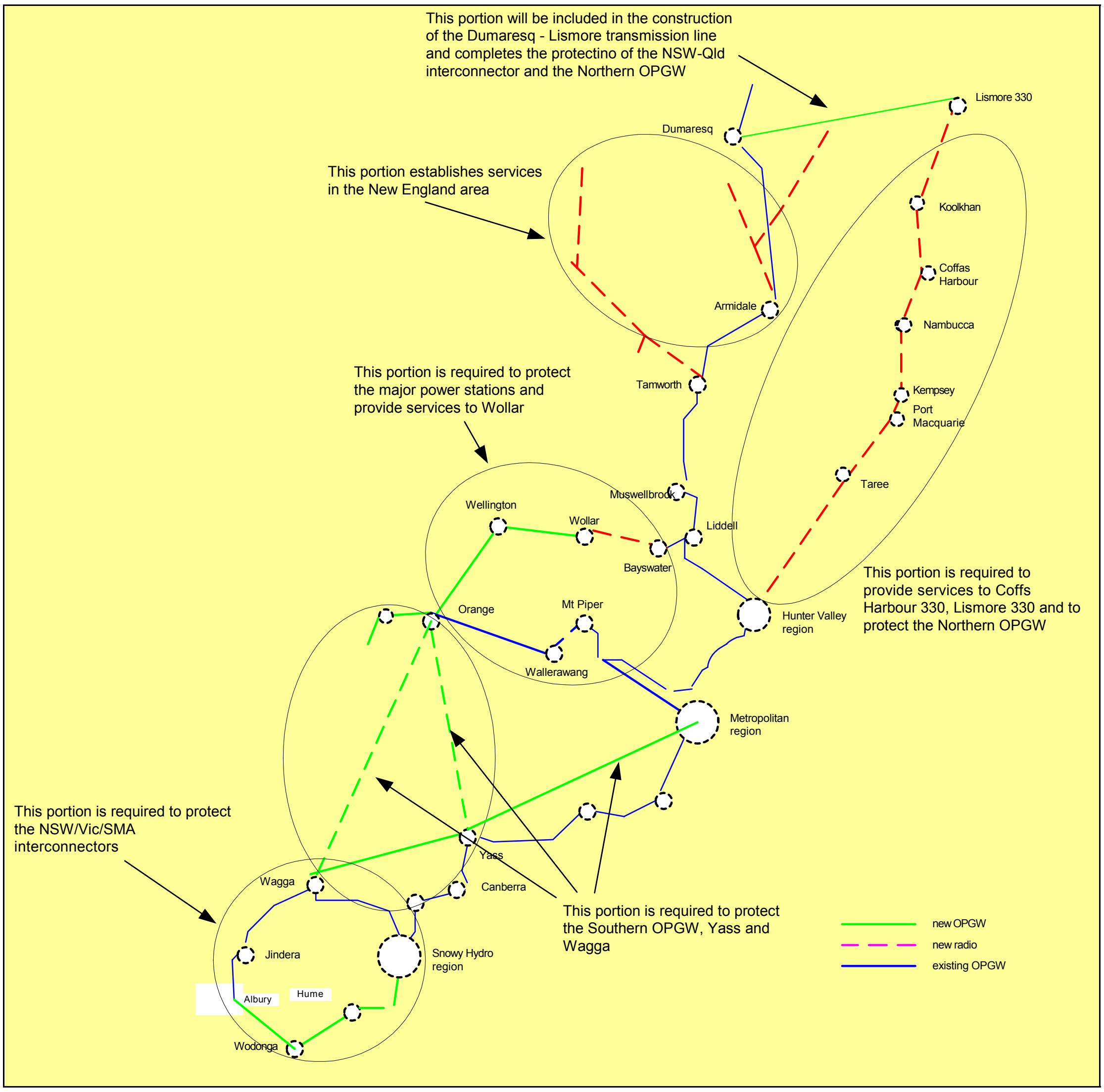
A number of options are developed that take into account:

- Proposed transmission system augmentations;
- Different communication technologies;
- Asset management strategies; and
- Communication regulatory requirements.

The option that is adopted will be the most cost effective in light of the above factors.

Proposals and options for major developments in TransGrid's communication network that are envisaged to take place in the period to 2006 are discussed below.

The estimated costs of network augmentation options include estimated costs of relevant communication network developments.



5.7.1. Provision of Communication Services to Wollar and Wellington

Issue:

Wellington currently relies on power line carrier technology for protection signalling, operational voice and SCADA channels.

A new 330kV transmission line supporting the supply to Wellington has been proposed. This is proposed to be connected at Wollar on the existing Bayswater to Mt Piper / Wallerawang line and may include an OPGW.

The requirements of the draft NEMMCO Data Communications Standard for SCADA may require broadband communications to Wollar and Wellington.

Telecommunications developments in the area will need to take into account the radio system requirements for Orange, the existing Mt Piper – Orange radio system being scheduled for maintenance replacement in 2004/5.

Options to provide services

The are a number of options available to meet the telecommunications requirements:

- OPGW from Bayswater to Wollar, OPGW from Wollar to Wellington
- Radio from Bayswater to Wollar, OPGW from Wollar to Wellington
- Radio from Bayswater to Wollar, radio from Wollar to Wellington
- Power line carrier protection signalling and leased services for SCADA

Two network augmentation proposals that have been examined are outlined below:

1. OPGW from Bayswater to Wollar (which would require retrofitting OPGW to 120km of transmission line) and OPGW from Wollar to Wellington (new line construction).
2. Radio from Bayswater to Wollar, which would require the establishment of two new radio repeater sites, and OPGW from Wollar to Wellington (new line construction).

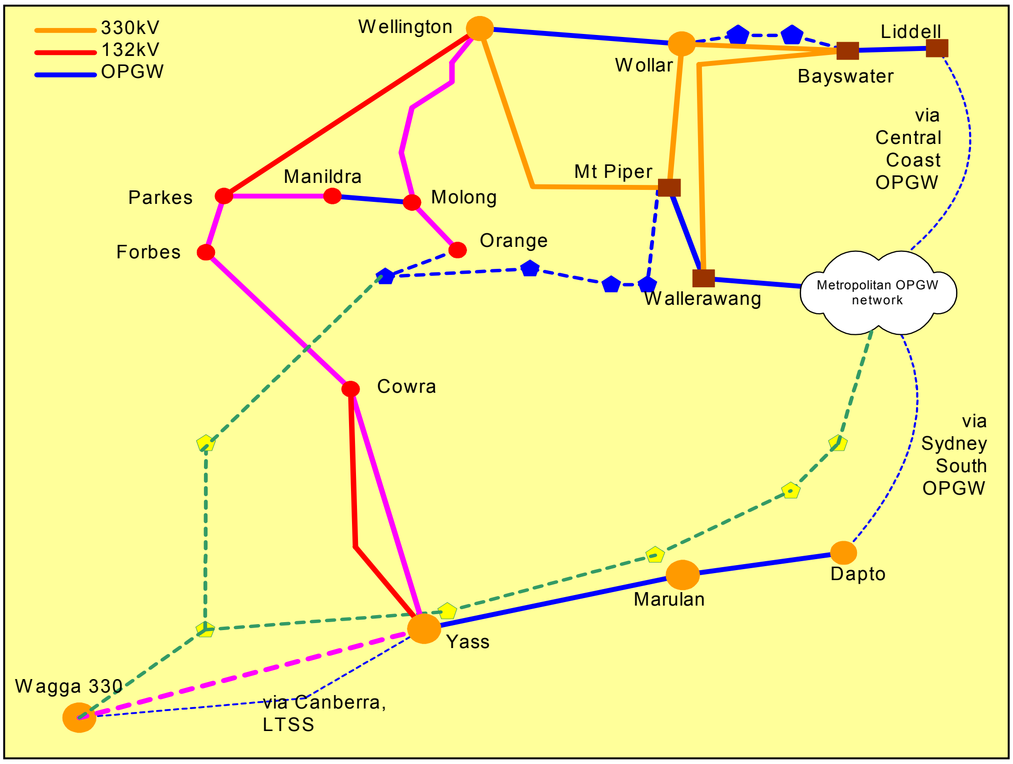
A complete path between Bayswater and Mt Piper OPGW terminal stations may be formed by the provision of radio from Orange (Mt Canobolas) to Wellington and the upgrade of the existing Mt Piper – Orange radio.

Completion of the complete path between Bayswater and Mt Piper will provide the opportunity to form a loop enclosing the Upper Hunter, Central Coast and Western major power stations, and provides two diverse paths between the Sydney area control centre and the Northern area control centre for the associated SCADA and control functions.

5.7.2. Communication Services Supporting the OPGW System South of Sydney

Issue:

A failure of the OPGW system south of Sydney will isolate the Yass control facilities and affect the ability to control the interconnections with Snowy and Victoria. A backup communication system is required.



Options to provide services:

The following options have been considered:

- Microwave radio using existing radio repeater sites
- DITM leased services in partnership with an external body to access the decommissioned southern radio repeater sites
- Microwave radio using new repeater sites between Wagga and Orange
- Fibre-based services using OPGW retrofitted to existing 132kV lines between Yass and the Orange region
- Leased services from a third party

Some options currently being investigated are:

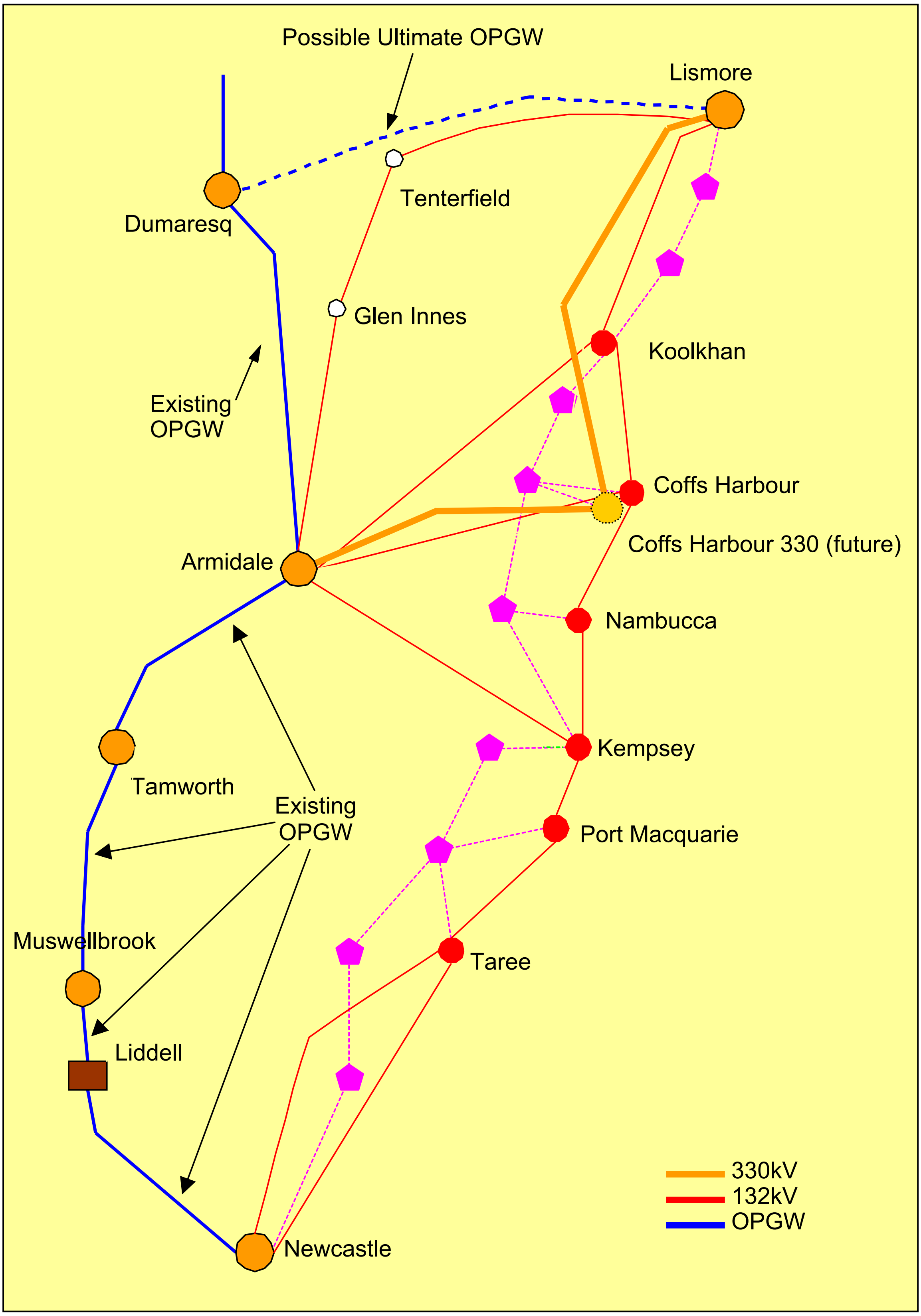
1. OPGW network augmentation will not be able to commence until Wollar substation is commissioned. OPGW may be included in any future reconstruction of southern 132 kV lines. Adequate backup to the interconnectors relies on the commissioning of OPGW through the Snowy region. This option is expected to be coordinated with line reconstructions and new line work.
2. Microwave radio between Orange and Wagga will require the establishment of new radio repeater sites. Adequate backup to the interconnectors relies on the commissioning of OPGW through the Snowy region.

3. The DITM service could be provided, for example, via a 5-year licensing arrangement. This arrangement will provide services to Jindera but does not protect the Snowy area interconnectors.
4. Redevelopment of the southern microwave network using alternative frequencies. Adequate backup to the interconnectors relies on the commissioning of OPGW through the Snowy area.

5.7.3. Communication services to the North Coast

Issue:

The capability of the existing communication services in the north coast system is very limited. Lismore 330kV substation is relatively isolated and the provision of broadband communications



suitable for SCADA or protection signalling services may prove difficult until a network augmentation to the area is undertaken, such as with a Dumaresq to Lismore 330kV transmission line. Such an augmentation is not expected before late in the decade.

Coffs Harbour 330/132 kV substation is expected in service in 2006. It also will not have ready access to broadband communication services.

A number of 132kV substations on the Central Coast and North Coast areas have a high system significance due to high load growth in the area, and the provision of good quality high speed communications facilities suitable for SCADA is essential to the secure operation of the network.

Options to provide services:

- Medium capacity radio system from the Newcastle area to Coffs Harbour and Lismore 330 kV substation sites, with spurs to 132kV substations with a high network significance.
- Retrofit OPGW to the Armidale – Lismore 330 kV line, with an optical repeater at the proposed Coffs Harbour 330kV substation.
- Retrofit OPGW to suitable 132kV transmission lines
- Leased communication links to substations with a high network significance to provide SCADA services

The piecemeal development of OPGW on the 132kV network as augmentations occur will not provide satisfactory communications before Coffs Harbour 330/132 kV substation is commissioned.

The cost of establishing the medium capacity radio network from the Newcastle area to Lismore is estimated to be moderate, and it would provide duplicated, high quality communications suitable for protection signalling and SCADA to Taree, Kempsey, Coffs Harbour, Koolkhan and Lismore Substations. For a small additional cost, the network could also include low capacity radio into Nambucca, Port Macquarie and Taree 132kV substations.

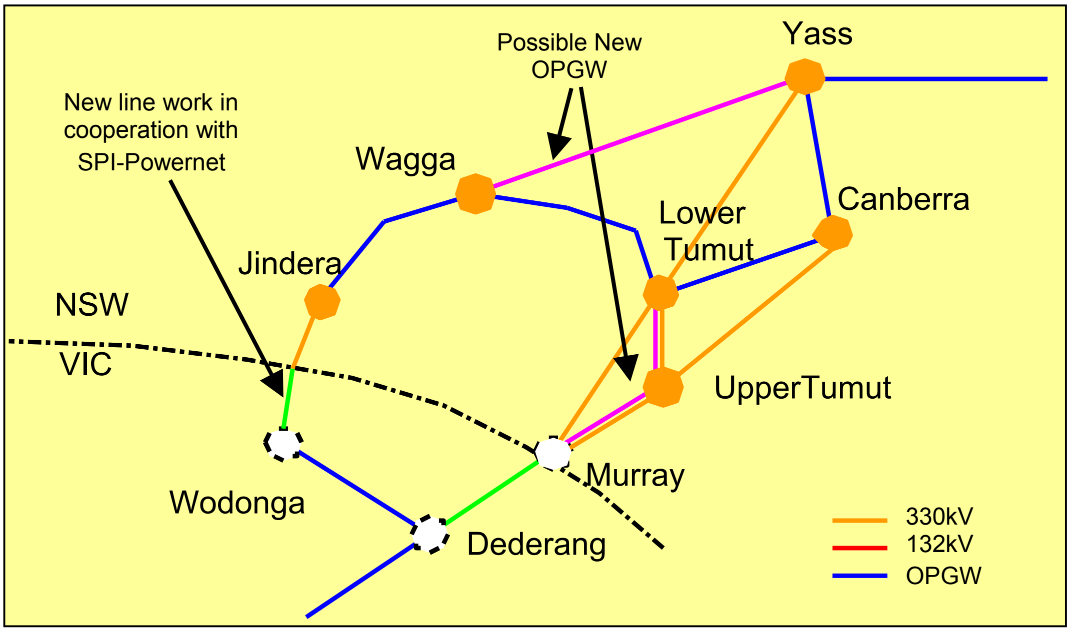
The radio system solution may also be commissioned before the Coffs Harbour 330/132 kV Substation project is completed, and does not require any 330kV line outages.

Benefits:

The establishment of a radio system to Lismore will permit a number of sites to access the SCADA system with a capacity and availability difficult to achieve in any other manner.

The establishment of the proposed Dumaresq – Lismore transmission line, with the associated OPGW, would provide a backup loop including the interconnectors at Dumaresq and the Directlink project, the emerging load-growth centres at Coffs Harbour and Lismore, and the major 330kV substations at Armidale and Tamworth.

5.7.4. OPGW Augmentation in the Snowy Region



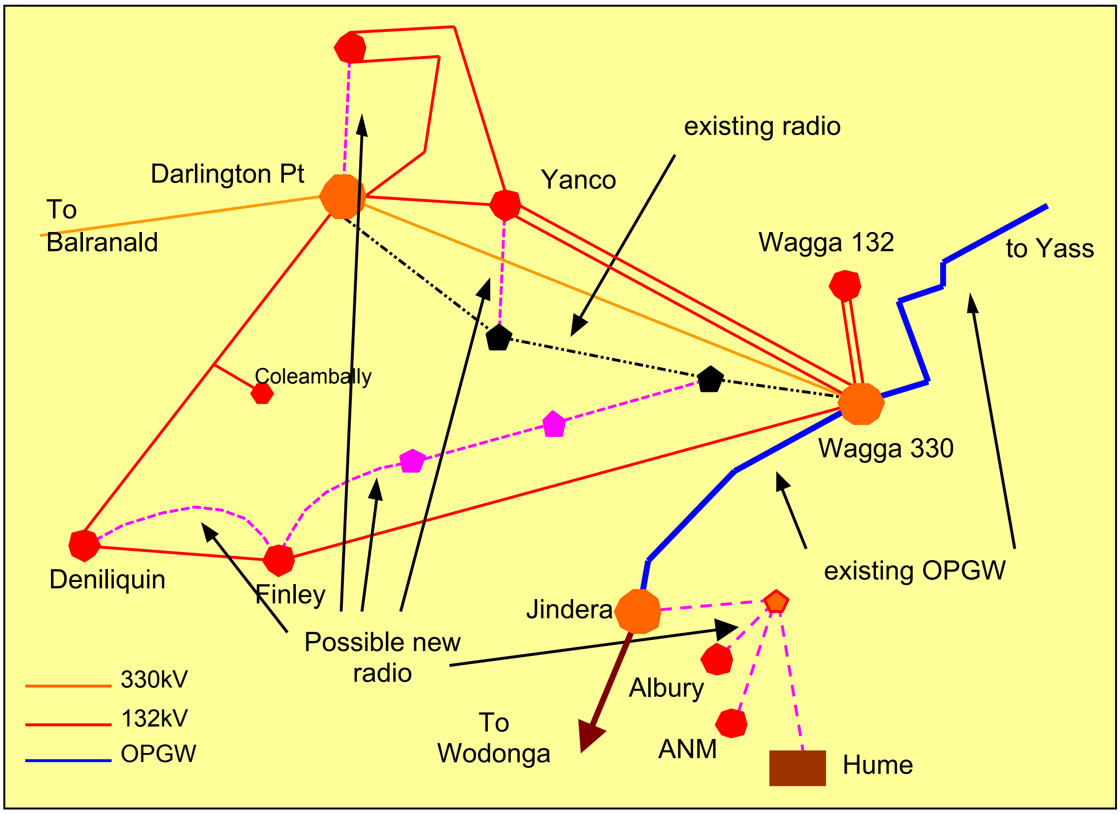
Issues:

The requirement for communications for interconnector substations under the draft Data Communications Standard demands a higher level of availability than normally required for 330kV substations. The loss of an OPGW-bearing line around the south-western portion of NSW would severely restrict the operational control of substations in the area. In such an event TransGrid would also have difficulty in satisfying its obligations to provide interconnector flow data.

Options to provide services:

- Complete the OPGW link between Jindera and Wodonga (jointly with SPI-PowerNet);
- Lease radio capacity from Snowy Hydro;
- Leased carrier services for SCADA to Jindera and Murray; and
- Satellite services for SCADA to Jindera and Murray;

5.7.5. South Western Radio System Development



Duplicated protection-grade communications is required to Darlington Pt Substation. In addition there is a need for augmented communications to the 132 kV substations in the area.

The communications systems may be developed in two stages. The first would involve the direct communications link with Darlington Pt.

Options to provide services:

- Radio system from Wagga to Darlington Point.

  A medium capacity radio system between Wagga and Darlington Point would require the establishment of a new radio repeater site and the construction of a tower at Darlington Point. Some cost savings could be achieved if low frequency, low capacity radios are found to be acceptable;

- Retro-fitting OPGW on the Wagga – Darlington Pt 330 kV transmission line.

  This would require an extended outage of the 330kV line;

- Satellite based communications channels for SCADA services; and
- Leased services for SCADA services.

The second stage would augment the communication capability to the 132 kV substations in the area.

Options to provide services:

- Low capacity radio systems to all substations;
- Power line carrier systems to all substations;
- OPGW to all substations;
- Leased services for SCADA services; and

- Satellite based communications channels for SCADA services.

Low capacity unduplicated radio, using existing repeater sites wherever possible, would be able to provide suitable services for SCADA. There would be limited corporate data network facilities. The cost would be moderate if suitable long-range low capacity radios can be shown to be feasible. The feasibility of this option is currently being investigated.

If power line carrier systems can be shown to be feasible SCADA services could be established at moderate cost. These facilities would not be able to support corporate data network requirements.

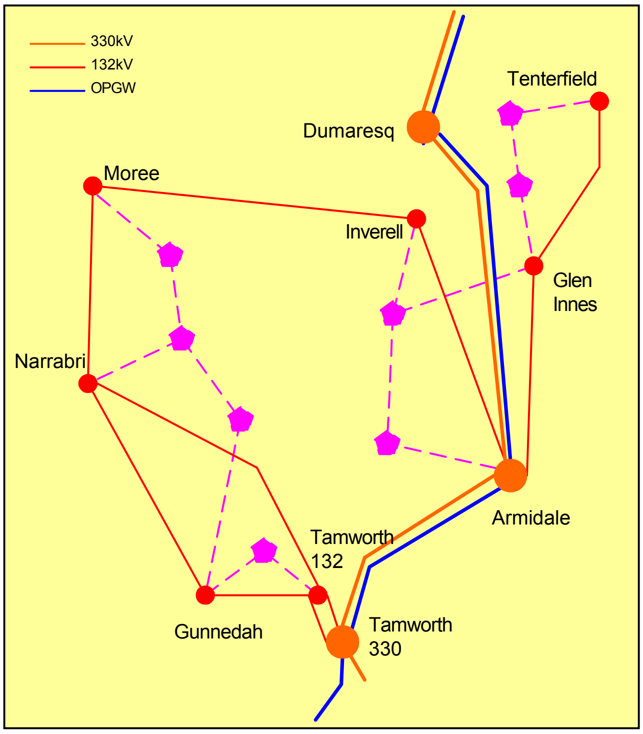
5.7.6. New England area SCADA

Issue:

A number of 132kV substations in the New England area will be difficult to provide with SCADA services without network augmentation.

Options to provide services:

- Establish low-capacity radio to the various sites;
- Use leased line facilities;
- Establish power line carrier to suitable substations and use satellite facilities for Narrabri and Moree;
- Establish microwave to the various sites; and
- Establish OPGW to the various sites.



Low capacity unduplicated radio, using existing repeater sites wherever possible, would be able to provide suitable services for SCADA with limited corporate data network facilities. Medium/high capacity radio would have similar cost to the low capacity radio, due to the high cost component in establishing new repeater sites in the district.

Power line carrier capacity suitable for SCADA channels could be established to some sites. Gunnedah, Inverell, Glen Innes and Tenterfield could be provided with SCADA access using this technology at moderate cost.

5.8. Constraints Envisaged to Emerge Within 5 – 10 Years and Options to Relieve them

This section describes some constraints that may occur within a 5-10 year planning horizon and some options for their relief.

5.8.1. Sydney South Transformer Capacity

Section 5.2.5 describes replacement of four of the six 250 MVA banks of single phase transformers by three 375 MVA three phase transformers. It is presently expected that the other two transformers will also need to be replaced within the next five to ten years due to their condition.

Installation of a fourth 375 MVA transformer and the possible replacement of the last two 250 MVA transformers to increase the substation capacity is presently being investigated as part of one option to meet the growing load in the southern and inner city areas of Sydney (refer to Section 5.6.5).

5.8.2. Supply to Darlington Point 330 kV Substation

Constraints:

Darlington Point 330/220/132 kV substation is the primary supply point for the 132 kV system in the south west of the state and for the 220 kV system supplying both Broken Hill and interconnecting to the Victorian and South Australian systems at Redcliffs.

An outage of the Wagga to Darlington Point 330 kV line may under the current arrangements require the splitting of the 220 kV system at Darlington Point to prevent voltage stability problems on the south west 132 kV system.

A number of factors may further exacerbate the adverse impacts of an outage of the Wagga to Darlington Point 330 kV line including:

- Increasing loads on the 132 kV system supplied from Darlington Point;
- Increasing power flows between New South Wales and Victoria on existing lines;
- The operation of MurrayLink connection between Victoria (Redcliffs) and South Australia (Berri) drawing load through the Darlington Point substation;
- Construction of the SNI system drawing additional load through the Darlington Point substation; and
- Options for further interconnection to Victoria from Darlington Point.

All of the factors above increase the need to maintain a reliable 330 kV supply to Darlington Point substation. It is presently expected that the capability of the network will be exceeded by the summer of 2008/2009.

Options to Relieve the Constraints:

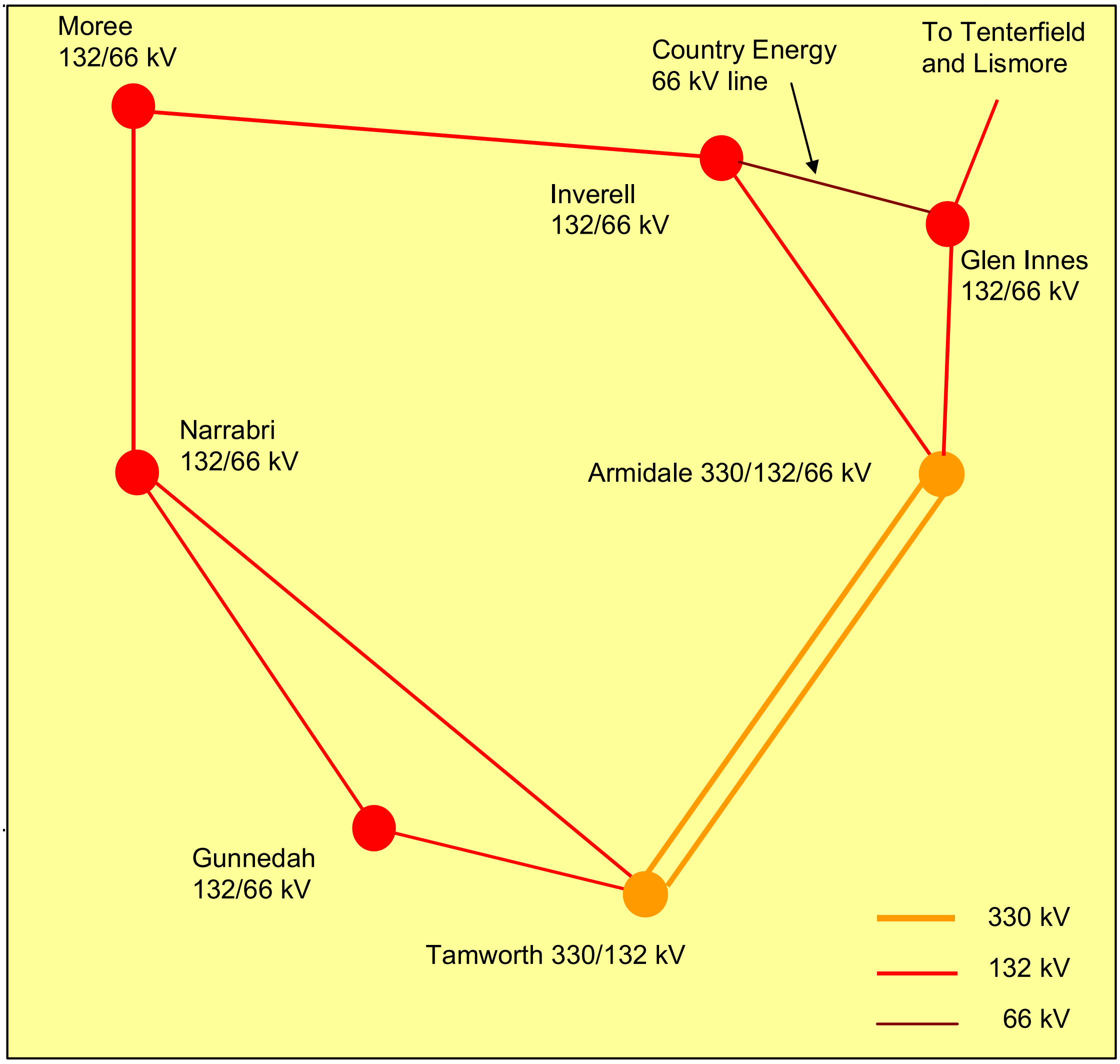
At this stage options to relieve the above constraints include:

- A second 330 kV line to Darlington Point from Wagga. This may involve rebuilding one of the Wagga – Yanco 132 kV lines and the Yanco - Darlington Point 132 kV line;
- Establishment of an interconnection between Darlington Point and Victoria which provides support to the Finley/Deniliquin and Echuca areas;
- Establishment of an additional interconnection between Wagga and Victoria which provides support to the Finley/Deniliquin and Echuca areas;
- Demand management; and
- Development of local generation

5.8.3. Supply to the Glen Innes/Inverell Area

The Inverell area is supplied primarily by a 132 kV line from Armidale. On outage of this line, Inverell is supplied from Tamworth via Narrabri and Moree, a distance of over 400 km. The capacity of the system supplying Inverell is limited by unacceptably low voltages at Inverell on outage of the Armidale – Inverell 132 kV line.

System Supplying the Inverell Area



The 24 MW hydro generator at Copeton dam can provide relief but would only be available when water is being released for irrigation. There is also potential to transfer up to about 12 MW of load from Inverell to Glen Innes, via Country Energy's 66 kV system, if required.

A 66 kV system owned by Country Energy supplies Inverell and areas to the north and west as far as Goondiwindi. The supply to the Goondiwindi area is by a single 66 kV line.

Following detailed joint planning between TransGrid, Powerlink, Ergon and Country Energy, construction of a 132 kV line from Bulli Creek (in Queensland) to Goondiwindi has been identified as the most appropriate way to provide a second supply to the Goondiwindi area and to relieve the constraint on the 132 kV system supplying Inverell.

In the medium term, load growth in the Inverell area is expected to result in the capacity of the 132 kV network being exceeded.

Options to address this constraint include:

- Construction of a 132 kV line between Glen Innes and Inverell (possibly utilising the route of Country Energy's existing 66 kV line), which would improve security of supply to both Inverell and Glen Innes;
- Demand management; and
- Local generation.

5.8.4. Supply to the Gunnedah, Narrabri and Moree Areas

Constraint:

The transmission system supplying the Gunnedah, Narrabri and Moree areas is around 300 km long. Its capacity is limited by both thermal constraints and voltage conditions on outage of critical 132 kV lines. These constraints are expected to emerge within about ten years, the timing being affected by possible developments such as local generation and "spot loads" such as mines.

Options to Relieve Constraint:

The options available to address the constraints include:

- Construction of a 132 kV line from Tamworth to Gunnedah (or possibly from Tamworth to Narrabri if there is development of a "spot" load in the Narrabri area);
- Uprating of 132 kV lines in the area and the installation of additional capacitors;
- Demand management;
- Development of local generation.

At this stage an indicative network option is the construction of a 132 kV line from Tamworth to Gunnedah by around 2009 at an estimated cost of about $7 Million.

One option for constructing the new line is via a redevelopment of the existing Tamworth – Gunnedah 66 kV line.

5.8.5. Supply to the Laurieton/Lake Cathie Area

The coastal strip between Laurieton, Lake Cathie, and Port Macquarie is expected to continue to develop. The capacity of Country Energy's existing 33 kV system south from Port Macquarie and its existing 66 kV system north from Taree are likely to be reached within the next five to ten years.

Options to overcome these limitations include:

- Demand management;
- Local generation;
- Establishing a 132/66 kV or 132/33 kV substation in the area, supplied from the existing Taree – Port Macquarie 132 kV line; and
- Provision of an additional 33 kV line to the Lake Cathie area from Port Macquarie.

Establishment of a 132 kV substation may relieve the loading on the 132/66 kV transformers at Taree, which are expected to be heavily loaded by that stage.

5.8.6. Supply to the Penrith Area

The Penrith area together with parts of the Blue Mountains is supplied from Regentville 330/132 kV substation. The Regentville substation site is very constrained and can only accommodate two 330/132 kV transformers. 132 kV connections to Wallerawang and Sydney West allow some load to be transferred to those 330/132 kV substations if required.

It is presently anticipated that the firm transformer capacity, allowing for load transfers, may be exceeded in around ten years. Options to relieve this constraint include:

- Local generation;
- Demand Management;
- Installation of larger transformers at Regentville; and
- Establishment of a new 330/132kV substation in the area.

5.8.7. Dapto Transformer Capacity Limitations

Constraint

Based on the current load forecast, the firm transformer capacity of this substation is expected to be exceeded by summer 2007/2008. Additional capacitor banks are planned to be installed at either Dapto or Springhill substation to relieve the loading on the transformers.

A substantial local generation project is in the early stages of development. If the generation project were to proceed the peak demand on the Dapto 330/132 kV transformers may increase during periods when the generation is not available. The increase in load on the Dapto 330/132 kV transformers following the generation project may advance the onset of the constraint.

Options to Relieve the Constraint:

The options available to address the transformer capacity limitation in the longer term include:

- Installation of an additional 375 MVA transformer. This would need to implemented in a manner that effectively manages Distributor equipment fault rating limitations;
- Establishment of a new 330/132 kV substation to offload Dapto;
- Installation of additional capacitors;
- Demand management; and
- Development of multi-train local generation.

5.8.8. Supply to Yass Town 66/22 kV Substation

The existing 66 kV supply to Yass Town 66/22 kV Substation originates from Yass 330/132/66 kV Substation. The existing 132/66 kV 30 MVA transformer supplying the 66 kV circuit is approaching the end of its service life. Country Energy has advised that their 66kV and 22kV systems supplied from Yass will not require augmentation in the near future.

Duplication of the 66 kV supply to meet Country Energy's medium term requirements, would complicate the refurbishment of Yass 330/132/66 kV substation and transmission outlets.

When either the existing Yass 132/66kV transformer has reached the end of its effective service life or the Country Energy demand at Yass increases to a point where augmentation of the existing arrangements are necessary then the options available include:

- Replace the existing 132/66kV transformer;
- Establishment of a 132kV switching station adjacent to the Country Energy Yass Town 66/22kV substation with a point of connection for a Country Energy 132/66kV or 132/22kV transformer;
- Demand management;
- Development of local generation.

5.8.9. Yanco 132/33 kV Transformer Capacity Limitations

Constraint

Based on the current load forecast, the firm transformer capacity of this substation is expected to be exceeded by summer 2008/2009.

Options to Relieve the Constraint:

The options available to address the transformer capacity limitation in the longer term include:

- Installation of an additional 132/33 kV transformer;
- Replacement of the existing 45 MVA transformers with larger units;
- Demand management; and
- Development of local generation.

5.8.10. Finley 132/66 kV Transformer Capacity Limitations

Constraint

Finley substation has a single 132/66kV transformer and 66kV connections to Deniliquin and Mulwala.

Based on the current load forecast, the firm transformer capacity of this substation is expected to be exceeded by summer 2008/2009. Capacitor banks have recently been installed to relieve the loading on the transformer capacity.

Depending on the measures taken to relieve the Mulwala system constraints and the Darlington Point/Coleambally/Deniliquin/Finley/Wagga Wagga 132kV system constraints, there may be a need to establish a second 132/66kV transformer to provide a secure supply to the Finley 66kV system well before the Finley 66kV load reaches a point where the firm rating is reached.

Options to Relieve the Constraint:

The options available to address the transformer capacity limitation in the longer term include:

- Installation of an additional transformer to provide a secure supply;
- Demand management; and
- Development of local generation.

5.8.11. Wagga 132/66 kV Substation Transformer Rating Limitations

Constraint

Based on the current load forecast, the firm transformer capacity of this substation is expected to be exceeded in the summer of 2007/2008.

Country Energy has initiated an investigation into the 66kV reticulation system near Wagga Wagga and identified that they may require a separate 66kV supply point as part of their system augmentations.

The two main incoming 132kV circuits to Wagga 132/66kV substation are both rated at less than the existing firm 132/66kV transformer rating. Any increase in the 132/66kV transformer capacity at Wagga 132/66kV substation will also involve augmentation of the connections to Wagga 330/132kV substation.

The Wagga 132/66kV substation operates close to the substation equipment 132kV fault ratings and further augmentations to increase 132/66kV capacity and alleviate 132kV circuit thermal capacity will need to address the substation fault rating limitations.

Options to Relieve the Constraint:

The options available to address the transformer capacity limitation in the longer term include:

- Establishment of Wagga North 132/66kV substation;
- Installation of an additional 132/66 kV transformer at Wagga, or replacement of the existing transformers by larger units;
- 132kV line developments in the area;
- Demand management;

- Development of local generation; and
- Development of a new 132/66 kV substation at Morven.

5.8.12. Supply to Holbrook

Country Energy has indicated that the existing radial 66 kV system supplying Holbrook is approaching the limit of its capacity and the lack of alternative supply to the area poses issues obtaining maintenance outages.

The demand in the area is currently stable or declining and the timing of the need for a new 132/66kV substation in the Morven area remains under review. The timing of a new 132/66kV substation in the area will be subject to load growth in the area and is difficult to predict.

A new 132/66kV substation (should one be established) would reduce the loading on the Wagga 132/66 kV transformers.

5.8.13. Jindera – ANM Line

A proposal is under consideration for the construction of a new 330 kV line between Wagga and Jindera (refer to Section 5.5.1)

One of the options under consideration for the 330 kV line is to use the route of the existing Wagga--ANM 132 kV line. To allow this to happen a third high capacity 132 kV line would be required to supply ANM. The line may be constructed between ANM and Jindera.

The second Jindera to ANM 132 kV line may be required within a five to ten year timeframe to allow the Wagga to Morven (if a Morven substation is established, otherwise the Wagga – ANM) 132 kV line to be reconstructed as a 330 kV line.

Appendix 1 - TransGrid's Network Planning Approach

1. General

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

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

In addition, as a Transmission Network Service Provider (TNSP) under the National Electricity Code TransGrid is obliged to meet the requirements of Schedule 5.1 of the Code. 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 *Code 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 Code 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 Code Participants and interested parties and to apply the ACCC's Regulatory Test to development proposals.

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

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

In meeting these obligations TransGrid's approach to network planning is socially and economically based and is consistent with both the Code and the Regulatory Test. Joint planning with DNSPs, directly supplied industrial customers, generators and interstate TNSPs is carried out to ensure that the most economic options consistent with customer and community requirements are identified and implemented.

TransGrid has traditionally planned the network to achieve supply at least community cost, without being constrained by State borders or ownership considerations. Transmission augmentations have been subjected to a cost-benefit assessment according to NSW State Treasury guidelines since the 1980s. This approach has been carried forward into the National Electricity Market in meeting the requirements of Chapter 5 of the Code.

Jurisdictional Planning Requirements

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

In fulfilling this obligation, TransGrid must recognise specific customer requirements as well as NEMMCO's 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 radial supplies).

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

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

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

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

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

The Network Planning Process

The network planning process is undertaken at three levels:

1. Connection Planning

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

2. Network Planning within the New South Wales Region

The main 500 kV, 330 kV and 220 kV transmission system is developed in response to the overall load growth and generation requirements and may be influenced by interstate interconnection power transfers. Development includes 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, under the National Electricity Code, by the Inter-regional Planning Committee convened by NEMMCO. Network Service Providers may also apply to NEMMCO for interconnection works to be classified as regulated.

The IRPC conducts an annual planning review of the inter-regional networks, and assists NEMMCO in preparing the annual Statement of Opportunities. This document identifies actual and potential constraints on the interconnectors that may be addressed by transmission augmentations, generation developments or demand management developments. A timetable for addressing inter-regional constraints follows from this work. TransGrid's approach to the development of the network since the advent of the NEM is in accordance with rules and guidelines promulgated by the ACCC.

Planning Horizons

Transmission planning is carried out over a short time frame of one to five years and also over a longer-term time frame of five to 15 years. The shorter-term planning supports commitments to network developments with relatively short lead-times. The long-term planning considers options for future major developments and provides a framework for the orderly and economic development of the transmission network.

In this Annual Planning Report the constraints that appear over a longer time frame are considered to be indicative. The timing and capital cost of possible network options to relieve them may change significantly as system conditions evolve.

Identifying Network Constraints and Assessing Possible Solutions

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

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

During the initial planning phase a number of options for addressing the constraint are developed. In accordance with Code requirements, consultation with interested parties is carried out to determine a range of options including network, local generation and DM 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 ACCC's Regulatory Test. In applying the Regulatory Test the cost and benefit factors may include:

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

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

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

Application of Power System Controls and Technology

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

Network control systems 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 removal of circuits for maintenance.

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

2. Planning Criteria

The Code 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;
- Automatic reclosure of overhead transmission lines; and
- Rating of transmission lines and equipment.

In addition to adherence to Code 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.

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

Main Transmission Network

Power flows on the main transmission network are subject to overall state load patterns and the dispatch of generation within the NEM, including interstate export and import of power. NEMMCO applies operational constraints on generator dispatch to maintain power flows within the capability of regional networks. These constraints are based on the ability of the networks to sustain credible contingency events that are defined in the Code. 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 within 15 minutes.

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

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

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

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

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

Although TransGrid performs much of its transmission line maintenance using live line techniques, provision must be made for outages of line and terminal equipment in accordance with TransGrid's asset management plan.

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

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

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

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

Relationship with Inter-Regional Planning

Under the provisions of the Code, NEMMCO may recommend the creation of a Region 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 Code currently does not require NEMMCO, in making such a recommendation, to consider either the size of the price difference that is likely to occur, or the consequences to load connection points if there should be a network contingency.

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

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

Networks Supplied from the Main Transmission Network

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

Supply to Major Load Areas and Sensitive Loads

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

Load Area	Indicative Peak Load
The NSW north, supplied from the Hunter Valley, Newcastle and over QNI	900 MW
Newcastle area	2300 MW (this includes aluminium smelters with a load greater than 1000 MW)
Greater Sydney	6200 MW
Western Area	500 MW
South Coast	600 MW
South and South West	1400 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'.

Urban and Suburban Areas

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

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

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

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

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

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

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

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

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 outage.

Non Urban Areas

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

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

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

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

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

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

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

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

Transformer Augmentation

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

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

Consideration of Low Probability Events

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

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

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

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

In TransGrid's network appropriate facilities and mechanisms are frequently 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.

3. Protection Requirements

Basic protection requirements are included in the National Electricity Code. The Code 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 Code and determined by stability considerations as well as the characteristics of modern power system equipment. Where special protection facilities or equipment are required for high-speed fault clearance they are justified on either a Code compliance or a benefit/cost basis.

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

4. Transient Stability

In accordance with the Code transient stability is assessed on the basis of the first angular swing following a solid two phase-to-ground fault on one circuit at the most critical location that is cleared by the faster of the two protections with intertrips available.

Historically, the incidence of particular types of faults on the NSW main transmission system has been:

Fault Type	Frequency of Occurrence
Single-phase-to-ground	75%
Two-phase and two-phase-to-ground	11%
Three-phase	4%
Uncertain	10%

The two phase-to-ground criterion has been adopted as:

- Two-phase-to-ground faults are reasonably common; and
- It is a compromise between the more frequent but less onerous single-phase faults and the less frequent but more onerous three-phase faults.

Recognition of the potential impact of a three-phase fault 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 thoroughly tested international system dynamic analysis software.

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

5. Steady State Stability

The requirements for control of steady state stability are included in the Code. 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 staged system tests.

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

6. Line and Equipment Thermal Ratings

Line thermal ratings have traditionally been based on a fixed continuous rating and a fixed short time rating. Recently, probabilistic-based line ratings, which are dependent on the likelihood of coincident adverse weather conditions and unfavourable loading levels, have been developed. This approach has been applied to selected lines whose design temperature is 85 degrees Celsius or less. For these lines a sustained emergency rating and a short-time emergency rating have been developed. Typically the short-time rating is based on a load duration of 15 minutes, although the duration can be adjusted to suit the particular load pattern to which the line is expected to be exposed. The duration and level of loading must take into account any requirements for re-dispatch of generation or load control.

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

TransGrid owns a single 330 kV cable and this cable is rated according to manufacturer's recommendations that have been checked against an appropriate thermal model of the cable.

7. Reactive Support and Voltage Stability

It is necessary to maintain voltage stability, with voltages within acceptable levels, following the loss of a generator or any single transmission circuit at times of peak system loading. A reactive power margin is maintained over the point of voltage instability in accordance with Code requirements. The system voltage profile is set during generator dispatch to minimise the need for post-contingency reactive power support.

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

TransGrid has traditionally assumed that all on-line generators can provide reactive power support within their rated capability.

Reactive power plant is installed to support planned power flows, 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. This usually includes the ability to withstand the outage of two circuits in succession or both circuits of a double circuit line under reasonably probable patterns of power transfer across the main network.

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

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

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

- In general it has proven prudent and economic to limit the voltage change between the pre and post-contingency steady-state 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; 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 bank sizes of reactive plant the requirements of the Code are considered.

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

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

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

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

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

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

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

9. Short-circuit Rating Requirements

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

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

Where necessary the maximum possible short-circuit duty on individual substation components is calculated in order to establish the adequacy of the equipment. These calculations are based on:

- 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;
- Maximum fault contribution from interstate interconnections is assumed;
- 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; and
- Generators are modelled as a constant voltage behind sub-transient reactance.

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;
- The physical location of “incoming” and “outgoing” circuits;
- Maintenance requirements;
- Operating requirements; and

- Transformer arrangements.

TransGrid has applied, or has in hand, the following arrangements:

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

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 be secure although loss of load may eventuate.

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

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

11. Autoreclosure

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

Slow speed three-pole reclosure is applied to most overhead circuits. On the remaining overhead circuits, under special circumstances, high-speed single-pole autoreclosing may be applied. For public safety reasons reclosure is not applied to underground cables

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

12. Power System Control and Communication

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

- Automatic excitation control on generators;
- Power system stabilisers;
- 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; and
- Control of reactive output from SVCs.

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

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

- Protection signalling; and
- Load monitors.

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

13. Scenario Planning

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

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

Appendix 2 - Basis of the 2003 NSW Load Forecast

The information contained in this appendix provides an overview of the load characteristics in NSW followed by a discussion of the underlying process used by TransGrid in compiling its load forecasts, including the treatment of distributed generation and major industrial loads, our modelling methodology and the assumptions underpinning the various forecast scenarios. Detailed tables of TransGrid's load forecast for NSW and individual supply point forecasts are in Appendix 3.

A2.1 NSW Load Characteristics

Electricity demand is influenced by a number of factors and can vary substantially over different times of the day, days of the week, and months of the year. Nevertheless, there are some clear patterns in the nature of electricity consumption over time that can be identified and taken into account in the load forecasting process.

A2.1.1 Load Profiles

Figures A2.1 and A2.2 show half-hourly electrical demands during the week of peak demand in the most recent winter and summer periods. The diagrams reveal the variation in demand between weekdays and weekends as well as a distinctly different daily load pattern for winter and summer periods.

Winter daily maximum demands occur consistently in the evening around 6:00-6:30pm. Extreme winter loads are closely associated with the extent of domestic space heating in use at the time of peak demand. In summer, the load tends to rise throughout the morning as the temperature increases and usually reaches its maximum sometime between 10am and 4pm. Extreme summer maximums tend to be driven by air-conditioning loads.

Also shown are the temperature trends on the days in question, revealing the strong correlation between daily maximum demand and temperature. As would be expected, higher winter demands are associated with colder temperatures and vice versa in summer.

Figure A2.1: Week of NSW Peak Demand Winter 2002: (16 - 22 June 2002)

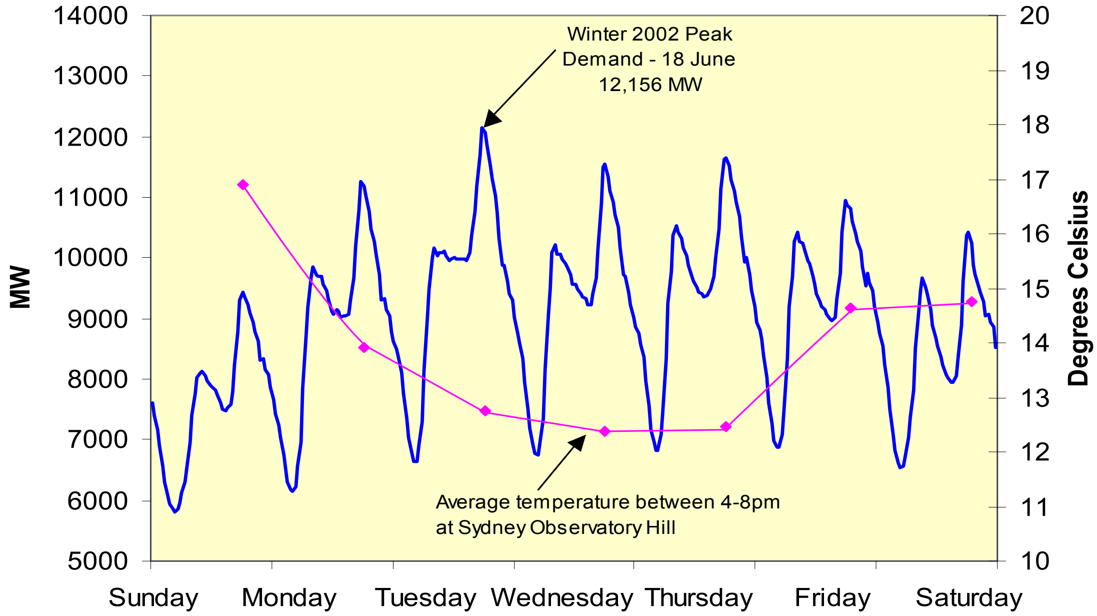


Figure A2.2: Week of NSW Peak Demand Summer 2003: (26 January - 1 February 2003)

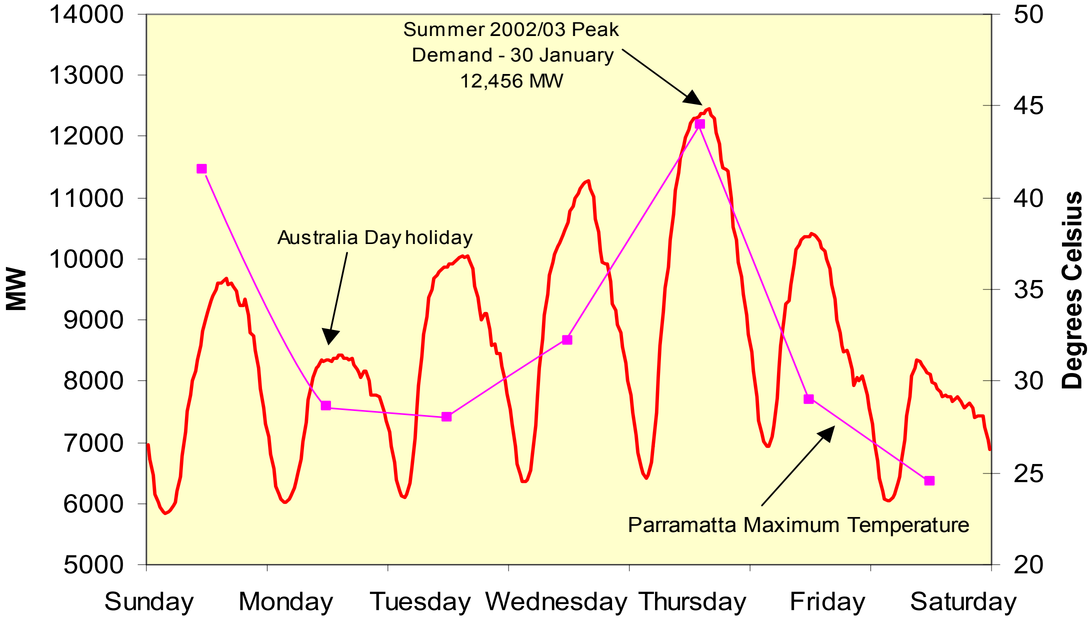
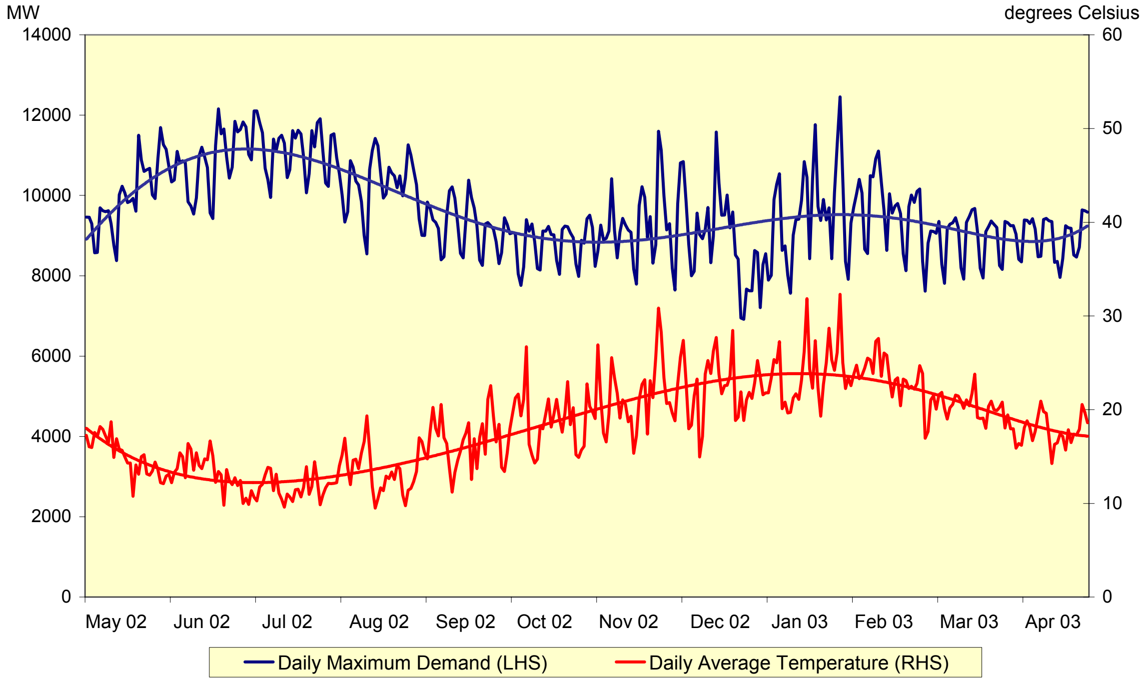


Figure A2.3 shows daily temperature and maximum demands from May 2002 through to April 2003. This graph clearly highlights the response of demand to temperature, but also highlights the less volatile nature of winter peak loads and temperatures compared to summer. The traditional Christmas holiday period is partly responsible for the greater variance in summer daily maximum demands with end-use electricity consumption falling well below levels experienced during non-holiday periods. Volatility in temperatures ("spikes") during summer, particularly spikes in temperature significantly higher than the average, are also more typical and longer, than winter "cold spikes".

Figure A2.3: Daily Average Temperature and Maximum Demand – May 2002 to April 2003



A2.1.2 Growth of Air-Conditioning Loads

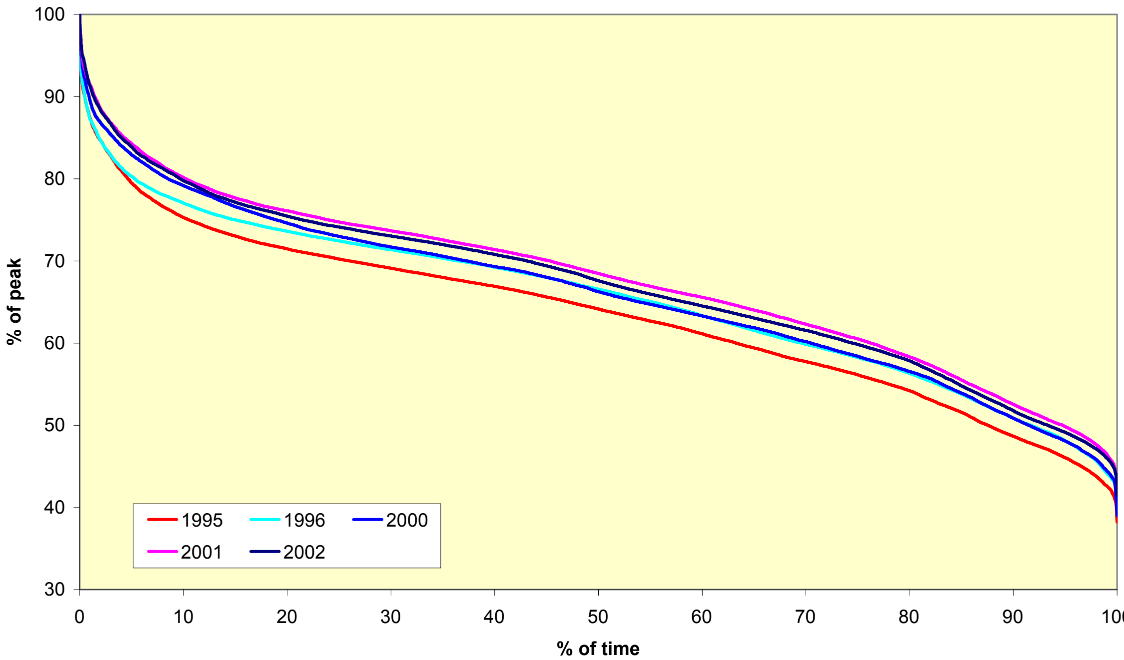
The increase in both the sensitivity of summer loads to temperature and the trend rate of growth in summer peak demand is widely believed to be associated with an increase in the installation of air-conditioning, mainly in the residential and commercial sectors in New South Wales. Continued growth in the air-conditioning market is expected for a number of years and will thus continue to be a driving force behind summer peak demand growth. It is therefore expected that the sensitivity of summer peak demand to temperature will also continue to increase. This has implications for the forecast rate of change for both active and reactive power demands on the electricity supply system.

A2.1.3 Load Duration

Load duration curves provide further information on the characteristics of electricity use. In general, the steeper the peak of the curve the higher is the peak demand in that year compared to the demand at other times of the year. This is for the most part caused by extreme weather conditions (either hot or cold), which result in spikes in demand on particular days.

On a calendar year basis, Figure A.2.4 shows that there is little difference in the load duration curves for 2001 and 2002. Over a longer time horizon, however, there appears to be some evidence that the load duration curve for NSW is gradually becoming flatter. For example, loads that were 90 per cent or more of the peak load occurred for 1.4 per cent of the year in 2002 compared to 0.5 per cent in 1995. This is likely to reflect a number of factors, including the convergence of summer and winter demand levels. It may also partially reflect increased use of electrical appliances and machinery resulting in an increase in underlying electricity demand, i.e. the demand for non-temperature sensitive load. However the relevant weather conditions at various times of the year, and from one year to the next, can make it difficult to determine the true extent of these factors.

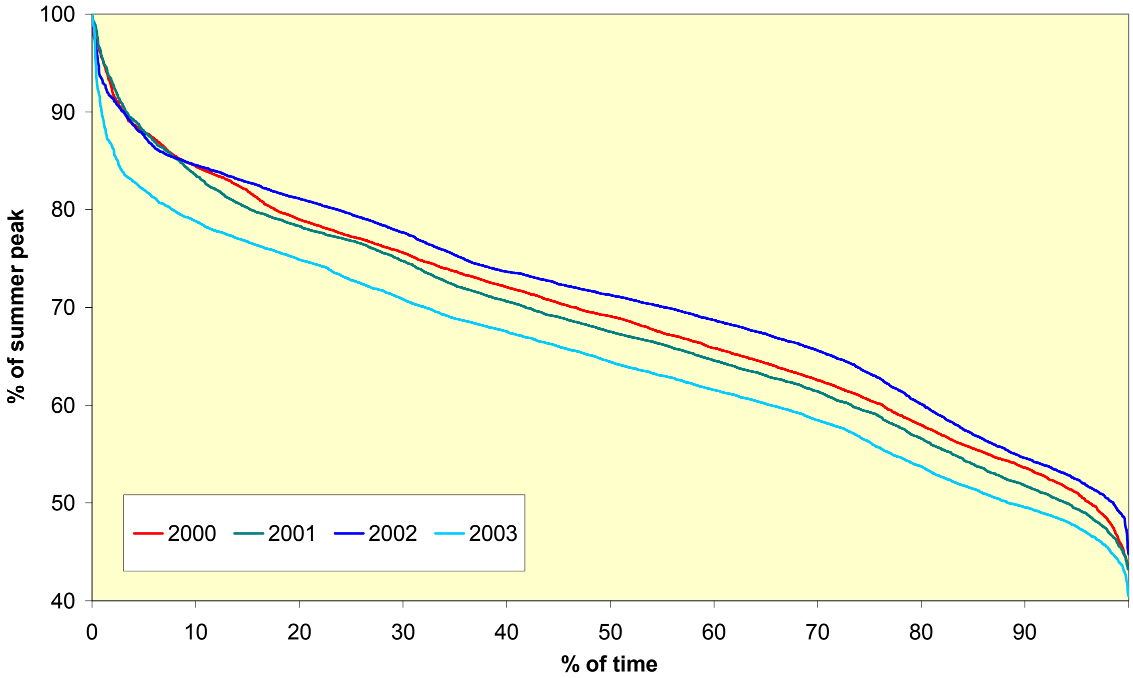
Figure A2.4: NSW Load Duration Curves



An instructive view of the changing dynamics of the NSW load can be better gained by looking at the load duration curves for summer and winter as shown in Figures A2.5 and A2.6.

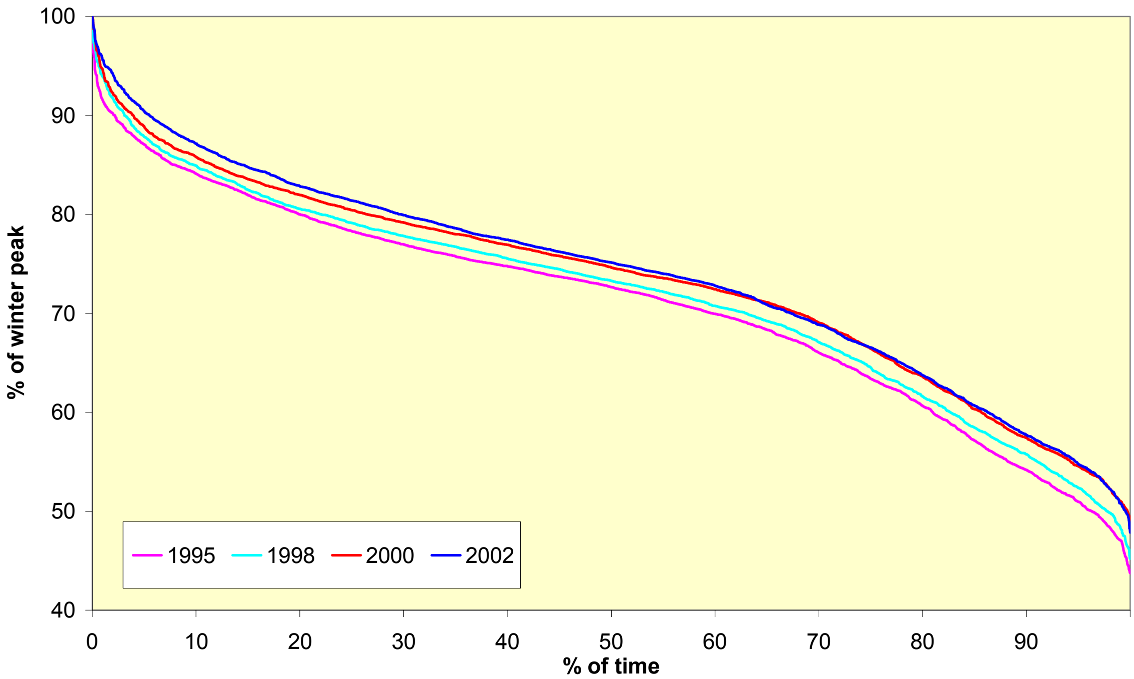
The shape of the summer load duration curve is becoming increasingly dependent on the prevailing temperature conditions during the season. For example, as shown in Figure A2.5, the load duration curve for summer 2002, a relatively mild summer, is considerably flatter than in other recent years. Figure A2.5 also highlights the influence of higher sensitivity of summer demand to temperature with the load duration curves tending to become steeper over time. This trend is likely to continue as the penetration of air-conditioning increases.

Figure A2.5: NSW Summer Load Duration Curves



In contrast the winter load duration curve appears to have been getting flatter in recent years, most likely due to milder winter weather. Combined with the generally lower variability in temperatures during winter, the load duration curve from one year to the next is therefore a lot more stable than during summer.

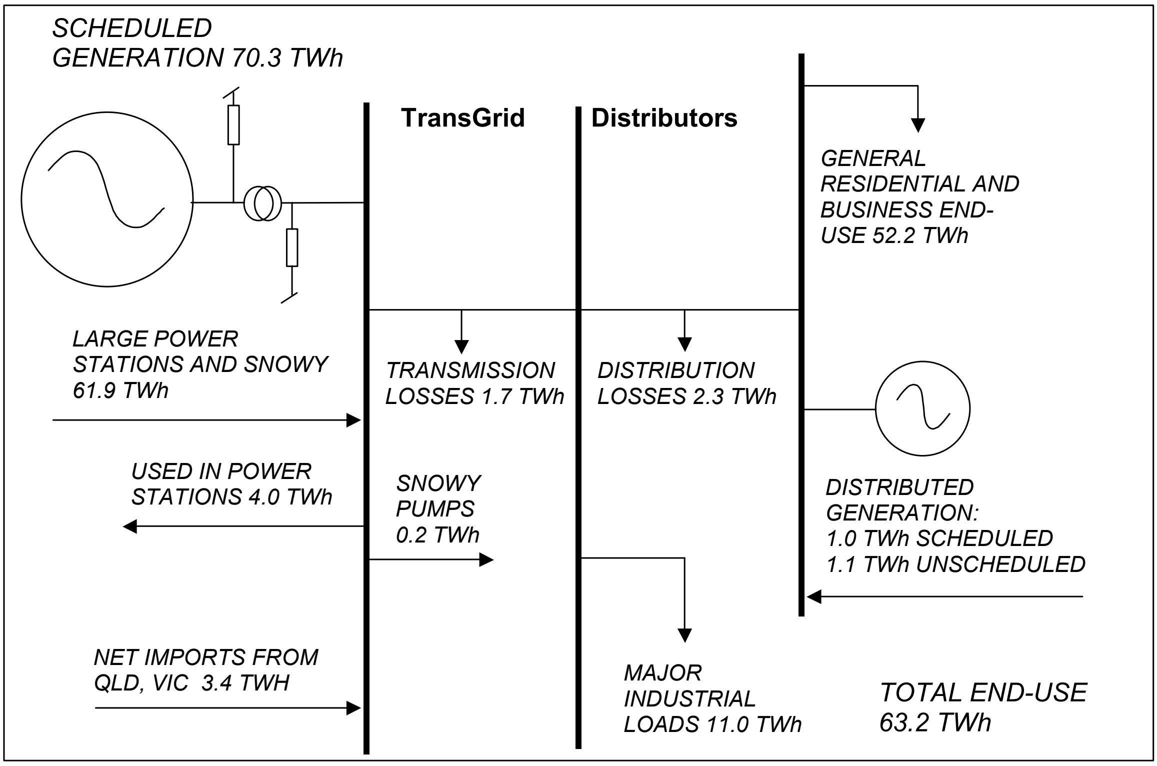
Figure A2.6: NSW Winter Load Duration Curves



A2.2 2003 NSW Load Forecast Process

Energy forecasts for NSW have been prepared for a number of different measures: end-use consumption; TransGrid system supplied; energy sent out; and energy generated. The various measures differ in the context of where in the electrical production and distribution system the load is being measured. Peak demand has traditionally been measured in NSW at the terminals of Scheduled generators. The NSW electrical network is depicted in Figure A2.7 and shows the impact that forecasts of distributed generation, major industrial loads and network losses could have on the overall forecast of energy supplied to the transmission network by the major generators owned by Delta, Eraring and Macquarie Generation; Snowy; and interregional interchange.

Figure A2.7: NSW Electricity Supply and Demand 2001-02



A2.2.1 Environmental Policies

Specific environmental policies that have the potential to impact on load forecasts have been considered. Some of these policies – in particular MRET – will have the effect of replacing existing non-renewable remote generation with cogeneration or renewable embedded generation (see below). Other impacts are considered either to be captured by historical efficiency trends in the data or else be too small to make a material difference to overall load growth.

A2.2.2 Embedded Generation

Although future increases in renewable energy drive the forecasts of embedded generation, the important distinction for load forecasting purposes is between scheduled and non-scheduled embedded generation. Non-scheduled embedded generators supply some end-use demand without increasing the load on the transmission system; whereas the output of scheduled embedded generators also needs to be added to the total generation bid into the NEM. Existing sources of embedded generation are disclosed in a recent survey of distributors by NEMMCO and future aggregated increases are set out in the NIEIR report, "Projections of Cogeneration and Embedded Generation in NEM Regions"[3]. Projected increases are based on this report. In the 2002 APR, the average projected increase between 2004 and 2012 in embedded generation in NSW (other than from the Sithe cogeneration facility at Smithfield) was 320 GWh per annum; however the NIEIR report projects increases of only 65 GWh a year over the same period. To the extent that the forecasts of embedded generation are less than were projected in 2002, the load forecasts at the generated, sent out and TransGrid supplied level are that much greater.

Sensitivity analysis was used to investigate the impact on the load forecast if 30 per cent of the MRET targets by 2010 are supplied by sources of embedded generation in NSW (rather than most of the MRET target for NSW being met by sources outside of the Region). Under these circumstances, there is an assumed catch-up in embedded renewable energy projects in NSW, which occurs from 2007 onwards. The outcome would be a reduced energy requirement from scheduled generators in NSW of the order of 1200 GWh in 2010 and reductions in peak demand (as generated) of about 50 MW.

A2.2.3 Major Industrial Loads

For forecasting purposes it is convenient to consider separately major industrial loads since these types of loads tend to be invariant to short term fluctuations in economic or weather conditions. These loads are therefore excluded from the econometric modelling phase of the forecasting process discussed in the following section and then added back in at a later stage.

Major industrial loads currently include the Tomago and Kurri Kurri aluminium smelters, BHP steel in Newcastle and Port Kembla, and the paper mills near Albury and Tumut. These loads currently account for around 12 per cent of demand and 17 per cent of Energy Sent Out.

A small number of large new industrial projects continue to be promoted in NSW. Any such project individually could have a significant impact on load growth in the region. However, there is currently no certainty that any will commence operation within the next 10 years. Accordingly, the projections of major industrial loads for NSW, which include accommodation for some increase in aluminium smelting capacity and one small steel project, are similar to those included in the 2002 APR. However, there have been some changes to the timing of these increases in light of actual expansion plans that have been revised.

A2.2.4 Demand Side Response

Customers in the NEM may have an ability to curtail load in the event of high prices. The load forecasts have not been reduced to account for instances where this may occur at times of peak demand.

Significant resources are being made available over the next five years by TransGrid and Energy Australia to support energy efficiency and demand reduction. However, it is not possible at this time to quantify any departure from existing trends in demand side response. The load forecasts will therefore continue for the present to implicitly assume historical increases in demand side response. Therefore, additional demand side initiatives in the future may reduce the current implied generation requirement.

A2.2.4.1 The Demand Management and Planning Project

The NSW Government, TransGrid and Energy Australia have an important responsibility to deliver a reliable supply of electricity to the people of NSW, while promoting opportunities to change the way energy is consumed. The 330 kV augmentation of supply to Sydney demonstrates a balanced approach to dealing with these competing responsibilities. TransGrid, Energy Australia and Planning NSW have established the Demand Management and Planning Project to enable conditions of consent for two significant metropolitan infrastructure projects to be met. The project will investigate and identify the significant potential for reducing the demand for electricity for all classes of consumers in the inner Sydney area.

The primary objective of the project is to provide robust, practical and accurate information on the electricity demand reduction opportunities in Sydney that may defer or replace the need for further developments to the local electricity supply infrastructure.

Additional objectives include:

[3] Refer to NEMMCO's forthcoming *Statement of Opportunities 2003.*

- Supporting the implementation of specific demonstration projects to improve the quality and reliability of this information;
- Investigating and identifying barriers and opportunities for further work that could enhance the potential for demand management, including issues within the NEM or other institutional or regulatory factors; and
- Specifically investigating and reporting on the opportunities for State and local planning, and development approval processes that contribute to or hinder demand management opportunities.

To these ends, a Stakeholder Reference Group has been established that includes representatives from various organisations, agencies and bodies covering relevant areas of expertise, including architecture, the property industry, energy management, engineering, the community sector, government departments, businesses, non-government organisations and cogeneration associations.

A2.2.5 Network Losses

Network losses have the potential to affect the relativity between the loads forecast at different levels in the system (e.g. between the energy sent out by generators and the energy supplied by TransGrid). Projections are based on historical average observations.

A2.2.6 Economic and Demographic Scenarios

TransGrid's forecasts of NSW energy and peak demand are dependent upon economic scenarios that provide future values for the input variables for the models. TransGrid has prepared its load forecast on the basis of three different economic scenarios, prepared by NIEIR[4] on behalf of NEMMCO. Table A2.1 shows the projected growth in Gross State Product for each scenario.

Table A2.1: Projected NSW GSP growth by scenario (per cent)

	High	Medium	Low
2002/03		1.9	
2003/04	3.8	2.7	2.2
2004/05	4.5	3.4	2.5
2005/06	4.3	3.5	2.1
2006/07	3.4	2.3	1.4
2007/08	3.5	2.9	1.7
2008/09	4.3	3.3	2.2
2009/10	3.8	2.9	2.0
2010/11	4.3	2.9	2.2
2011/12	4.2	2.7	1.9
2012/13	3.5	2.5	1.8
Average growth rate	**3.8**	**2.8**	**2.0**

In a separate attachment prepared for NSW, NIEIR also provided forecasts of NSW resident population; real electricity and natural gas prices; and the 'all groups' Sydney CPI over the forecast period. Table A2.2 shows the forecast compound growth rate of each variable to 2012-13.

[4] NIEIR, *The Economic Outlook for the NEM States to 2012/13*, Report for NEMMCO, Committee Version, April 2003 (forthcoming in the 2003 Statement of Opportunities).

Table A2.2 Economic Scenario Forecasts

	Average Annual Percentage Change 2002-03 to 2012-13		
	High	Medium	Low
NSW Resident Population	1.2	1.0	0.8
All Groups Sydney CPI	1.8	2.6	4.0
Real Electricity Prices	1.7	1.4	1.0
Real Natural Gas Pries	1.2	0.7	0.2

A2.3 Development of the Modelled NSW Load Forecast

The required time horizon of the forecast and the availability of historical data largely determine the modelling strategy used to derive the NSW load forecast. The adopted methodology uses a sequence of econometric models in which the variables to be forecast are explained by scenarios for key economic, weather and other explanatory variables.

The NSW load forecast is developed in a three-stage process. In the first stage, forecasts of end-use electricity consumption are developed using an aggregate econometric model. This model takes into account the long run impact of changes in electricity and natural gas prices, real income and population; as well as the short run impact of temperature and seasonal variables. The long run economic and demographic variables are modelled under high, medium and low growth scenarios, however, no attempt is made to forecast future weather conditions. Rather, temperature is modelled at its long-run average value. At this stage, the forecasts implicitly assume that current demand side initiatives that improve end-use efficiency are continued into the future.

In the second stage, forecast energy generated by the major power stations is derived from the energy that is necessary to supply the forecast end-use electricity consumption, taking account of changes in major industrial loads, distributed generation and network losses. Forecast increases in non-scheduled distributed generation result in lower growth in energy generated at the major power stations, compared with energy consumed by end-users.

NSW summer and winter peak demand forecasts are derived in the third stage of load forecast development. peak demands are derived from models that relate standard weather peak electrical demand to average electrical demand (or total energy).

The following two sections summarise the models of per capita electricity consumption and maximum demand used by TransGrid to derive the annual energy forecasts and summer and winter peak demand forecasts. Detailed descriptions of the models are available from TransGrid on request.

A2.3.1 Per Capita Electricity Consumption

The starting point for the econometric modelling process considers electricity consumption as occurring in distinct short and long run stages. In the short run, consumption is constrained by the number and average efficiency of various installed electrical appliances. Consumption in the short run is therefore determined by the intensity of use of existing appliances. However, in the long run, behaviour will be more flexible, since the stock of electrical appliances may be partially updated and expanded with more efficient models. An important contribution to the expansion of the stock of electrical appliances derives from additions to the housing stock.

The data used for electricity consumption are derived from yearly distributor sales data from the Electricity Supply Association of Australia[5], minus major industrial loads. These data are converted to a monthly series and adjusted to the same seasonal pattern as energy supplied by TransGrid to distributors. This derived energy measure is expressed on a per capita basis.

The short and long run stages of electricity consumption are modelled by a single partial adjustment model. In this model, long run changes in electricity consumption per capita are related to changes in the real electricity price, the relative price of natural gas, Gross State Product per capita and the real

[5] ESAA, *Electricity Australia 2002*, Sydney

mortgage interest rate. However, because of the partial adjustment mechanism, deviations from the predicted long run consumption path occur, both due to seasonal effects (including temperature effects) and also because of the time taken to adjust to the new long run consumption path.

The estimated per capita energy consumption relationship is then used in conjunction with forecasts of population growth, distributed generation, major industrial loads and network losses to derive forecasts that are dependent on various given economic scenarios.

Average long run elasticities for the last five years have been derived from the long run parameter estimates of the energy model and are shown in Table A2.3. The value alongside each variable should be interpreted as the proportional change in end-use electricity consumption resulting from an increase in the variable in question. For example, a one per cent increase in real income will result in an increase in electricity consumption of 0.91 per cent. The adjustment of consumption to the new level may take more than one year.

Table A2.3: Long-Run Elasticities

Elasticity of demand with respect to:	
Electricity price	-0.06
Natural gas price	0.06
Real income	0.91
Interest rates	0.05

A2.3.2 Peak Demand

Actual peak demand reached in any particular season is highly dependent on the temperature prevailing on the day of the peak. The trend rate of growth from one year to the next may only be observed on the basis of measures of demand that have been adjusted for the effects of temperature variation. Accordingly, both summer and winter peak demands are first subjected to a temperature adjustment process prior to modelling the adjusted series. The methodology for deriving Standard Weather Peak Demand (SWPD) involves regressing actual daily maximum demand against temperature. This results in an estimate of the sensitivity of peak demands to changes in temperature, that is, the degree to which demand changes in response to a one degree increase or decrease in temperature.

The temperature adjustment process requires the collection of daily maximum demands for all weekdays for the summer and winter periods. For winter this period covers 11 weeks commencing on the last Monday in May and ending in the first or second week of August. In summer, the period from the first Monday in December through to the end of February is selected. The modelled relationship between maximum demand and temperature is estimated on observations from Monday through to Thursday excluding holiday periods[6]. The reasons for limiting the sample are twofold, actual peak demands are observed to occur on these days and, because demands tend to be lower at any given temperature on Fridays and weekends, the estimated models more accurately predict actual peak demands.

To capture the influence of temperature on daily maximum demand, composite temperature variables are constructed which take into account temperature on the current day as well as one day lagged temperature in summer and two day lagged temperatures in winter[7]. Lagged temperature variables are

[6] In summer, 'business as usual' demand conditions do not re-emerge following the Christmas – New Year period until mid way through January. A period from 24 December through to early January, such that the sample begins again on the second Monday in January, is therefore excluded from the analysis. The Australia Day public holiday in January and the Queen's birthday public holiday in June are also excluded.

[7] In winter the daily maximum demand occurs consistently around 6:00-6:30pm while in summer the time of peak is less well defined. For this reason, the contemporaneous temperature variable used in winter is the average temperature between 4-8pm while in summer the average of the daily maximum and minimum is used. The lagged temperature observations used for both winter and summer are averages of the daily maximum and minimum temperature. The contemporaneous and lagged temperature values are combined into one weighted average value.

included in the analysis to account for changing weather patterns. The relative intensity and duration of a period of hot or cold weather can result in different demand responses. This may partly be due to the thermal properties of buildings but may also reflect a psychological phenomenon whereby people perceive a series of hot or cold days differently to just one or two days.

A regression equation is estimated for each year in the sample. A single year's observations, however, are usually too few to yield robust statistical results. This has been addressed by pooling data from three consecutive years. In particular this has the advantage of providing a larger range of temperature observations than would necessarily be available in a single year. 'Dummy variables' for the two preceding years enable the influence of the current year to be isolated. The temperature adjusted peak demand for the latest year is then calculated as the prediction from this model at three standard reference temperatures as shown in Table A2.4. These temperatures are derived as the 10th, 50th and 90th percentiles of the coldest (hottest) annual temperature in winter (summer), when observed at Sydney Observatory Hill (Parramatta) since 1957, where temperature is the weighted average of the contemporaneous and lagged temperature observations.

Table A2.4: Winter and Summer Standard Reference Temperatures

	Winter Temperature (°C)	Summer Temperature (°C)
10th percentile	9.5	32.0
50th Percentile	10.4	29.4
90th Percentile	11.4	27.2

The estimated coefficient on the temperature variable is defined as a temperature sensitivity. The temperature sensitivities thus derived for both winter and summer are shown in Table A2.5.

Table A2.5: Estimated Temperature Sensitivities

Season Ending:	Winter Temperature Sensitivity (MW/°C)	Summer Temperature Sensitivity (MW/°C)
1994	-254.5	145.6
1995	-251.1	149.1
1996	-243.5	146.2
1997	-236.7	170.2
1998	-249.7	184.2
1999	-266.6	205.9
2000	-284.8	230.8
2001	-264.6	275.1
2002	-272.0	290.6
2003	-	308.0

Once SWPD series have been derived, the second stage of the process is to model the relationship between SWPD and average demand. Winter peak demand is modelled on the basis of the estimated relationship between winter SWPD in MW and winter average demand (energy in MWh for the period June-August divided by the number of hours in the period). The forecasts are produced using a component of the energy forecasts described above for various economic growth scenarios and on the basis of high, average and low probability weather conditions using the three winter reference temperatures. This produces forecasts of SWPD at the 10 th, 50 th and 90 th percentiles of the probability distribution.

Summer peak demand is modelled and forecast on a similar basis to winter peak demand, using summer SWPD (MW), summer reference temperatures and summer average demand (energy in MWh for the period December-February divided by the number of hours in the period). A feature of the summer forecasting model is that it incorporates an additional trend variable from 1997 to account for the recent and expected future growth in air-conditioning loads.

A2.4 Changes to Load Forecasting Methodology for 2003

Some changes to TransGrid's load forecasting methodology were made in 2003. These changes, which are discussed below, mean that forecasts in previous Annual Planning Reports may not be strictly comparable.

A2.4.1. Measures of System Demand

In order to ensure as much consistency as possible with the material analysed and published by NEMMCO in the SOO, it has been decided to use system demand data supplied directly from NEMMCO's Energy Management System (EMS) for the period since the commencement of the NEM as the basis of the peak demand forecasts, rather than TransGrid recorded data or "Total Demand" from NEMMCO's market system. The EMS data averages four-second measurements of actual Region demand over every half-hour trading period, whereas the 'Total Demand' measure is an average of six figures within each half-hour that individually incorporate the actual demand at the start of a five minute interval and an estimated forecast error. The different averaging methods generally result in actual EMS measures being higher than Total Demand. The adoption of the EMS data since December 1998 has therefore resulted in some upward revisions to the standard weather peak demands compared to those published last year.

A2.4.2. Measures of Temperature

In previous years, temperature observations from the Sydney (Observatory Hill) weather station were used as the basis for the analysis of the relationship between peak demand and temperature for both winter and summer. Periodically during summer, significantly higher temperatures occur in Parramatta compared to Sydney. Because of this, the Parramatta temperature provides a better explanation of movements in NSW daily maximum demands. Therefore, in 2003, TransGrid has moved to the use of temperature observations from the Parramatta North weather station for summer temperature correction while maintaining Sydney as the focal point for winter. However, the winter temperature observations have also changed from a daily average measure to a 4 - 8 p.m. average. This is more closely aligned to the time of daily maximum demands during winter.

A2.4.3 Summer Peak Demand Forecasts

Slight changes have been made to the process for preparing summer peak demand forecasts compared to last year. Previously, actual demands from 1975 onward were used as the basis for forecasting both summer and winter peak demand. In 2003, TransGrid has shortened the historical period on which it prepares its summer forecast to 1992 onward. TransGrid considers that the underlying factors driving summer demand during the 1990s and into the future are significantly different from those during the 1970s and '80s. Therefore the use of a shorter historical period produces forecasts of summer peak demand that are more consistent with the growth in this series in recent years.

A2.4.4 Effect of Changes

The combined effect of the changes to the historical daily peak demand series and revised temperature variables used in the temperature correction of peak demand has been to increase the base on which the peak demand forecasts are made by approximately 200 MW in winter and 300 MW in summer. For example, the 50% PoE temperature-corrected actual for winter 2001 published in the 2002 SOO was 11 832 MW. The equivalent figure is now 12 014 MW. Similarly, the summer 50% PoE temperature-corrected actual for summer 2001-02 was 11 272 MW compared with the latest estimate of 11 556 MW.

This increase in the level of the historical temperature corrected actual series explains some of the increase in the forecast level of summer and winter peak demand in the 2003 forecasts compared to the 2002 forecasts.

The peak demand forecasts have also been influenced by changes to the energy forecasts. TransGrid peak demand forecasts are based on an estimated long-run relationship with the level of average demand during the winter and summer months. Higher monthly energy forecasts have therefore resulted in higher average demands and hence higher peak demand forecasts. The factor which primarily contributed to this result is the substantial downward revision to the amount of non-scheduled embedded generation which is expected to be operating in NSW over the forecast period.

Higher actual growth in energy so far this financial year compared to what was expected in the 2002 forecasts has also lifted the base upon which the forecasts have been made.

Changes to the economic scenarios have had minor effects on the forecasts with economic growth only slightly lower on average over the forecast period. TransGrid also requested NEMMCO to provide, as part of the economic scenarios, forecasts of real electricity and natural gas prices, whereas in 2002 these were separately sourced. The 2002 forecasts were for a decline in real prices, while the 2003 forecasts are for increasing real prices. While the estimated price elasticity of demand is relatively small, this change does have a small downward effect on the forecasts.

A2.5 2002 Forecast Evaluation

Table A2.6 compares TransGrid's 2002 forecasts with actual outcomes. The Actual winter and summer peak demands have been temperature corrected to the relevant 10%, 50% and 90% PoE temperatures for comparison with the respective high medium and low economic scenario forecasts.

As noted earlier, since the 2002 forecasts were produced, TransGrid has updated the system demand data it uses to prepare its load forecasts. The analysis and numbers presented below have been prepared using the same methods and data as was used when the 2002 forecasts were produced.

The peak demand figures are 'Total Demand' as published in NEMMCO's market systems and differ from the peak demands reported elsewhere in this report. Similarly, the temperature corrected peak demands differ from those calculated using the new data series supplied by NEMMCO presented in Appendix 3.

Table A2.6: 2002 Forecasts and Actuals

	Actual	Temperature Corrected Actual	High Forecast	Medium Forecast	Low Forecast
2001-02 Energy Sent Out (GWh)	**66,283**			66,240*	
2002 Winter Peak Demand (MW)	**12,074**				
10% PoE		*12,420*	12,480	12,250	12,020
50% PoE		*12,150*	12,230	12,000	11,770
90% PoE		*11,950*	12,040	11,810	11,590
2002/03 Summer Peak Demand (MW)	**12,331**				
10% PoE		*12,210*	12,590	12,430	12,260
50% PoE		*11,530*	11,860	11,710	11,550
90% PoE		*10,990*	11,290	11,140	11,000

* The forecast of energy sent out for 2001/02 was based on actual data up to March 2002.

In June 2002, Energy Sent Out was forecast to be 66,240 GWh in 2001/02, comparing favourably with the actual outcome of 66,283 GWh.

On a temperature corrected basis, winter peak demands exceed the medium forecast by 140-180 MW for the three reference temperatures. The summer temperature corrected demands on the other hand were below the medium forecast by 150-220 MW. On this basis, the 2002 winter peak demand seems to have been slightly under forecast while the summer 2002-03 forecasts were too high.

The 2002 results also show actual summer peak demand exceeding the 10% PoE temperature corrected actual demand. This is a believable outcome given that the temperature recorded at Parramatta on the day of peak demand reached its second-highest level ever. The revised temperature correction methodology adopted for the 2003 forecasts also indicates that peak demand in summer 2003 was consistent with close to a 10% summer (refer to Appendix 3). The results for winter indicate that actual peak demand in 2002 was consistent with below average (50% PoE) temperature conditions.

A2.6 Supply Point Forecasts

Comparisons of the modelled approach to forecasting NSW peak load may be made with the sum of distributors' forecasts (see Appendix 3).

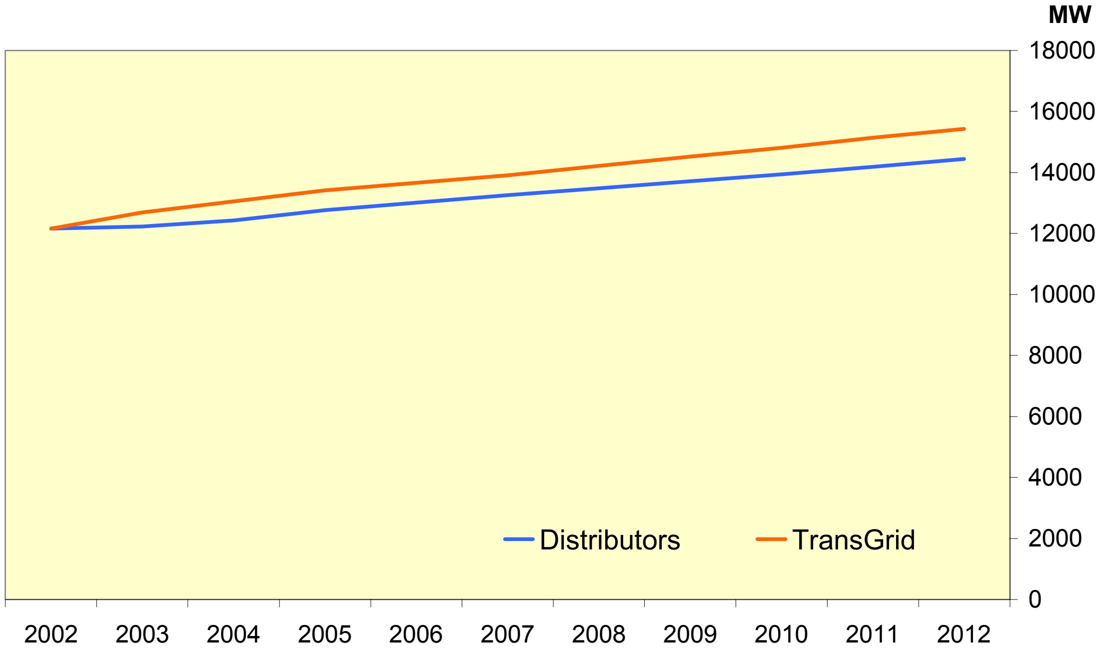
The distributors' forecasts cannot be directly compared with the TransGrid modelled forecasts because they are provided on an undiversified basis. Due to differing weather conditions across the state at any point in time, the maximum load conditions at each supply point in NSW will not necessarily coincide with each other. An aggregation of undiversified supply point forecasts will therefore tend to overstate peak demand for NSW as a whole, when measured at the bulk supply point. A second complicating factor is that TransGrid's forecasts are not made at the supply point level. Instead, TransGrid's forecasts are produced on a generator terminal basis. At the generator terminal, energy produced is greater than that which is received at the bulk supply points due to the effects of transmission losses and the inclusion of energy used in the generation of electricity itself which is not sent out into the main transmission network.

To facilitate the comparison of the supply point forecasts with the TransGrid modelled forecasts, actual peak demands at each supply point for Winter 2002 and Summer 2003 have been sourced from market interval metering data. The raw sum of the supply point actuals was then compared with the NSW coincident peak demand and scaled such that the two values were equal. The aggregated supply point forecasts were then scaled up by the same factor. This scaling factor reflects the net effect of diversity between supply points, generator auxiliaries and transmission losses and is assumed to remain the same over the forecast period.

Figures A2.8 and A2.9 provide a comparison of TransGrid's modelled 50% PoE peak demand forecasts for NSW with this aggregation of bulk supply point forecasts. The first value is the actual NSW coincident peak demand in winter 2002 (12 156 MW) and summer 2003 (12 456 MW).

The comparison of winter forecasts reveals lower expected growth rates in the distributor forecasts. As shown in the Figure A2.8, TransGrid's forecast is based on the premise that the actual outcome for 2002 was below a 50% PoE result and, therefore, the 50% PoE forecast for 2003 shows a decisive increase over the actual 2002 demand. The distributor forecasts on the other hand show a very flat transition between the 2002 actual and the 2003 forecast.

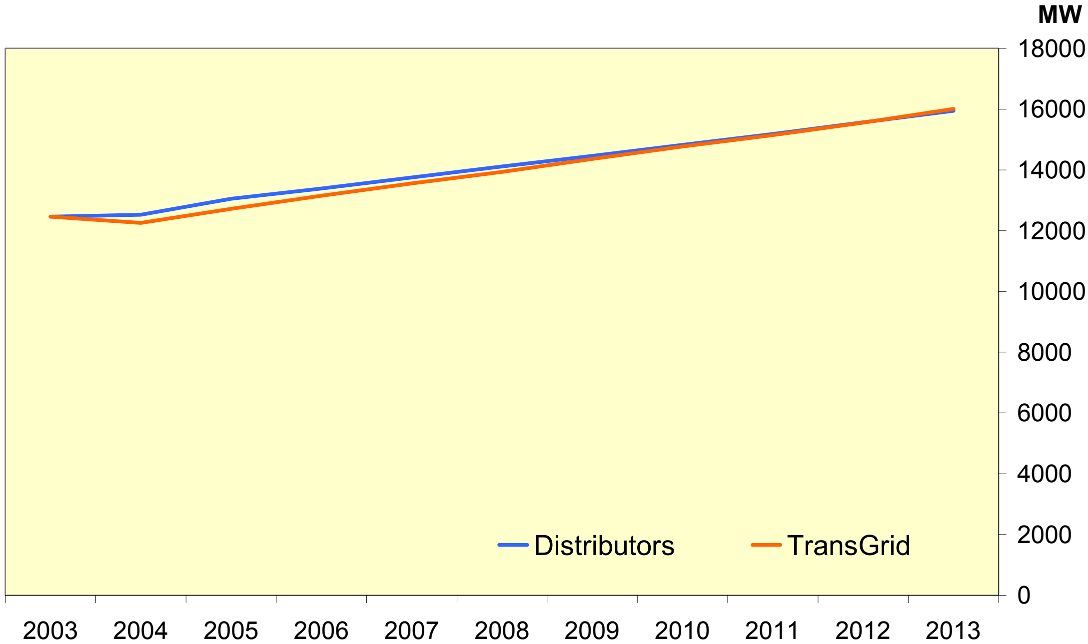
Figure A2.8: Aggregate NSW Load Forecasts – Winter Peak Demand



The distributor forecasts for summer, shown in Figure A2.9, also show a slightly lower forecast rate of growth when compared to TransGrid's forecast. Again the distributor forecasts show a relatively flat transition between 2003 and 2004 while TransGrid's forecast initially shows a step down. This reflects TransGrid's view that peak demand in summer 2003 was above a 50% PoE result.

Part of the discrepancy between TransGrid and the Distributors in the first forecast year, for both summer and winter, may reflect the timing of the production of the respective forecasts. TransGrid's forecasts were completed in June 2003 and therefore take into account the most up to date information. The distributor forecasts on the other hand were prepared at various times between June 2002 and May 2003.

Figure A2.9: Aggregate NSW Load Forecast – Summer Peak Demand



Appendix 3 - 2003 NSW Load Forecasts: Detailed Information

This Appendix presents detailed tables of the 2002 NSW load forecasts to 2012-13. The first set of tables presents the NSW Energy forecasts in GWh and Peak Demand forecasts in MW as modelled by TransGrid. Details of the methodology and assumptions underlying TransGrid's forecasts are detailed in Appendix 2.

TransGrid's load forecasts are followed by supply point forecasts of winter and summer Peak Demand in MW and MVar for each of the five Distributors connected to the TransGrid transmission network: Energy Australia; Integral Energy; Country Energy; Actew-AGL; and Australian Inland Energy[8]. These forecasts are based on the most recent information supplied to TransGrid by Distributors. Major industrial loads that TransGrid isolates in its forecasting process have been extracted from the Distributor forecasts and summarised in a separate table. Where the information provided by Distributors does not cover the entire forecast period, TransGrid has derived the forecasts using similar growth patterns to that reflected in the latter years of the Distributors' forecasts.

The supply point forecasts do not represent coincident maximum demands but rather the expected maximum demand in MW and MVar at each individual supply point during the respective summer and winter periods over the forecast period. Where embedded generation exists within the Distribution network, the forecasts are on the basis that this generation is not operating at the time of peak demand.

[8] Whole of network forecasts for NSW distributors are also available in their submissions to IPART as part of the revenue determination process.

TransGrid Modelled Load Forecasts

Table A3.1: NSW Energy Forecast on a Sent Out Basis

ACTUAL:	ENERGY GENERATED *GWh*		ENERGY SENT OUT *GWh*		TRANSGRID SYSTEM SUPPLIED *GWh*		END-USE CONSUMPTION *GWh*	
1992/93	54 551		51 985		50 259		49 439	
1993/94	56 531		53 947		52 300		50 639	
1994/95	58 091		55 700		54 016		51 920	
1995/96	59 885		57 339		55 311		53 698	
1996/97	61 260		58 556		56 601		53 669	
1997/98	63 894		60 212		57 398		58 713	
1998/99	65 420		62 566		59 236		59 544	
1999/00	67 569		63 655		61 128		60 949	
2000/01	69 353		65 834		63 030		62 897	
2001/02	70 289		66 283		63 337		63 190	*
2002/03	72 240	*	68 360	*	65 380	*	65 180	*
Average increase	*1 769*		*1 637*		*1 512*		*1 574*	
Average growth rate	*2.9%*		*2.8%*		*2.7%*		*2.8%*	

PROJECTIONS:	ENERGY GENERATED			ENERGY SENT OUT			TRANSGRID SYSTEM SUPPLIED			END-USE CONSUMPTION		
	HIGH	***MEDIUM***	***LOW***	***HIGH***	***MEDIUM***	***LOW***	***HIGH***	***MEDIUM***	***LOW***	***HIGH***	***MEDIUM***	***LOW***
	GWh	*GWh*	*GWh*	*GWh*	*GWh*	*GWh*	*GWh*	*GWh*	*GWh*	*GWh*	*GWh*	*GWh*
2003/04	75 600	75 370	75 130	71 410	71 190	70 960	68 130	67 920	67 700	67 890	67 690	67 480
2004/05	78 430	77 650	77 220	74 070	73 340	72 930	70 730	70 010	69 620	70 520	69 840	69 460
2005/06	80 830	79 450	78 700	76 340	75 030	74 330	72 700	71 430	70 740	72 740	71 520	70 860
2006/07	83 420	81 300	79 940	78 780	76 790	75 500	75 000	73 050	71 800	75 140	73 270	72 080
2007/08	86 040	83 170	81 250	81 260	78 550	76 740	77 410	74 770	73 000	77 470	74 940	73 250
2008/09	88 520	85 090	82 500	83 600	80 360	77 920	79 690	76 530	74 150	79 680	76 660	74 380
2009/10	91 110	86 890	83 640	86 050	82 060	78 990	82 070	78 190	75 200	82 010	78 290	75 430
2010/11	93 710	88 780	84 800	88 500	83 850	80 090	84 460	79 930	76 260	84 360	80 020	76 520
2011/12	96 840	90 930	86 320	91 450	85 880	81 520	87 340	81 910	77 660	87 140	81 940	77 880
2012/13	99 710	92 670	87 440	94 170	87 520	82 580	89 980	83 500	78 700	89 740	83 540	78 940
Average increase	*2 750*	*2 040*	*1 520*	*2 580*	*1 920*	*1 420*	*2 460*	*1 810*	*1 330*	*2 460*	*1 840*	*1 380*
Average growth rate	*3.3%*	*2.5%*	*1.9%*	*3.3%*	*2.5%*	*1.9%*	*3.2%*	*2.5%*	*1.9%*	*3.3%*	*2.5%*	*1.9%*

* Estimated prior to full year data availability.

TransGrid Modelled Load Forecasts

Table A3.2: NSW Winter Peak Demand (as generated)*

	ACTUAL MW	TEMPERATURE CORRECTED (10%) MW	TEMPERATURE CORRECTED (50%) MW	TEMPERATURE CORRECTED (90%) MW
1992	9 792	9 924	9,729	9 435
1993	9 578	10 148	9 922	9 699
1994	9 610	10 277	10 043	9 812
1995	10 613	10 628	10 397	10 169
1996	10 564	10 716	10 492	10 270
1997	10 401	10 940	10 722	10 507
1998	11 156	11 323	11 093	10 866
1999	11 324	11 728	11 483	11 240
2000	11 900	12 220	11 958	11 699
2001	11 760	12 258	12 014	11 773
2002	12 156	12 646	12 396	12 148
Average increase	*236*	*272*	*267*	*271*
Average growth rate	*2.3*	*2.5*	*2.5*	*2.6*

PROJECTIONS:	10% PROBABILITY OF EXCEEDANCE			50% PROBABILITY OF EXCEEDANCE			90% PROBABILITY OF EXCEEDANCE		
	HIGH	MEDIUM	LOW	HIGH	MEDIUM	LOW	HIGH	MEDIUM	LOW
	MW	*MW*	*MW*	*MW*	*MW*	*MW*	*MW*	*MW*	*MW*
2003	12 930	12 940	12 890	12 710	12 690	12 670	12 390	12 440	12 350
2004	13 350	13 300	13 220	13 130	13 040	13 000	12 800	12 800	12 670
2005	13 800	13 660	13 540	13 580	13 400	13 320	13 240	13 150	12 990
2006	14 170	13 910	13 730	13 940	13 660	13 510	13 610	13 400	13 170
2007	14 540	14 180	13 900	14 320	13 920	13 670	13 980	13 660	13 330
2008	14 960	14 490	14 110	14 730	14 230	13 890	14 390	13 970	13 540
2009	15 380	14 800	14 320	15 150	14 530	14 090	14 810	14 270	13 740
2010	15 780	15 090	14 500	15 550	14 820	14 270	15 200	14 560	13 920
2011	16 250	15 420	14 720	16 020	15 160	14 490	15 680	14 890	14 140
2012	16 710	15 720	14 920	16 480	15 450	14 690	16 130	15 190	14 340
2013	17 170	16 010	15 110	16 940	15 750	14 880	16 590	15 480	14 540
Average increase	*410*	*310*	*220*	*410*	*300*	*230*	*400*	*300*	*220*
Average growth rate	*2.8*	*2.2*	*1.6*	*2.9*	*2.2*	*1.7*	*2.9*	*2.2*	*1.6*

* To estimate peak demands measured on a sent out basis, divide the numbers in this table by 1.056.

TransGrid Modelled Load Forecasts

Table A3.3: NSW Summer Peak Demand (as generated)*

	ACTUAL *MW*	TEMPERATURE CORRECTED (10%) *MW*	TEMPERATURE CORRECTED (50%) *MW*	TEMPERATURE CORRECTED (90%) *MW*
1992-93	8 727	8 827	8 417	8 070
1993-94	8 667	9 024	8 646	8 325
1994-95	9 003	9 290	8 902	8 574
1995-96	8 879	9 411	9 031	8 710
1996-97	8 961	9 857	9 414	9 040
1997-98	9 966	10 349	9 870	9 464
1998-99	10 220	10 823	10 287	9 834
1999-00	10 662	11 294	10 694	10 186
2000-01	11 572	12 055	11 339	10 734
2001-02	10 990	12 312	11 556	10 917
2002-03	12 456	12 634	11 834	11 156
Average increase	*373*	*381*	*342*	*309*
Average growth rate	*3.8*	*3.7*	*3.5*	*3.3*

PROJECTIONS:	10% PROBABILITY OF EXCEEDANCE			50% PROBABILITY OF EXCEEDANCE			90% PROBABILITY OF EXCEEDANCE		
	HIGH *MW*	MEDIUM *MW*	LOW *MW*	HIGH *MW*	MEDIUM *MW*	LOW *MW*	HIGH *MW*	MEDIUM *MW*	LOW *MW*
2003-04	13 150	13 140	13 130	12 270	12 250	12 250	11 510	11 500	11 490
2004-05	13 710	13 680	13 660	12 760	12 720	12 710	11 950	11 910	11 900
2005-06	14 240	14 160	14 120	13 220	13 150	13 110	12 360	12 290	12 250
2006-07	14 780	14 630	14 540	13 710	13 560	13 470	12 800	12 650	12 560
2007-08	15 310	15 060	14 920	14 200	13 950	13 810	13 260	13 000	12 870
2008-09	15 860	15 520	15 300	14 720	14 370	14 150	13 750	13 410	13 190
2009-10	16 420	15 960	15 650	15 240	14 780	14 470	14 240	13 790	13 470
2010-11	16 910	16 360	15 960	15 710	15 160	14 760	14 690	14 140	13 740
2011-12	17 450	16 810	16 310	16 220	15 580	15 090	15 180	14 540	14 050
2012-13	18 030	17 270	16 680	16 790	16 040	15 450	15 750	15 000	14 410
Average increase	*540*	*460*	*400*	*500*	*420*	*360*	*460*	*380*	*330*
Average growth rate	*3.6*	*3.2*	*2.8*	*3.6*	*3.1*	*2.7*	*3.5*	*3.0*	*2.6*

* To estimate peak demands measured on a sent out basis, divide the numbers in this table by 1.060.

Energy Australia Supply Point Load Forecasts

Summer Peak Load Forecasts by Substation[9]

	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Beaconsfield West	413.0	39.0	416.0	40.0	420.0	41.0	441.0	43.0	449.0	44.0	460.0	45.0	472.0	47.0	484.0	48.0	496.0	49.0	508.3	50.0
Haymarket	527.0	90.0	539.0	94.0	547.0	97.0	550.0	101.0	565.0	105.0	576.0	109.0	588.0	114.0	600.0	118.0	612.0	122.0	624.2	126.1
Sydney East	678.0	234.0	698.0	242.0	717.0	250.0	743.0	258.0	768.0	265.0	791.0	273.0	815.0	282.0	839.0	290.0	860.0	297.0	881.5	304.2
Sydney North	866.0	229.0	919.0	237.0	943.0	245.0	981.0	254.0	989.0	263.0	1014.0	272.0	1039.0	281.0	1065.0	291.0	1092.0	299.0	1119.7	307.2
Sydney South	1171.0	176.0	1183.0	182.0	1220.0	189.0	1231.0	195.0	1262.0	202.0	1300.0	209.0	1339.0	216.0	1379.0	224.0	1413.0	232.0	1447.8	240.3
Munmorah	117.8	37.9	99.1	39.8	103.9	29.1	113.2	34.9	116.0	23.1	124.0	26.0	130.0	32.0	140.0	38.0	152.0	41.0	165.0	44.2
Vales Point	123.0	42.8	130.6	43.6	135.0	36.8	149.0	50.8	152.0	43.2	156.0	48.0	160.0	52.0	165.0	55.0	179.0	58.0	194.2	61.2
Tuggerah	154.8	95	181.5	108.3	191	148	221.8	170.5	234.2	128	250	135	262	140	280	150	304	163	330.1	177.1
Newcastle[10]	648.3	309.4	673.2	320.7	695.4	338.7	721.6	358.2	785.4	395.7	815.2	408.1	844.9	420.7	874.7	433.2	904.5	445.7	935.2	458.6
Muswellbrook	104.7	80.9	128.7	57.4	144.5	67.5	150.9	72.4	152.4	73.5	160.9	77.9	166.2	87.6	171.7	98.0	176.6	106.4	181.6	115.5
Liddell	30.2	17.1	30.2	17.1	29.7	16.8	35.2	20.0	35.1	19.9	32.1	18.2	32.1	18.2	32.1	18.2	32.1	18.2	32.1	18.2

Winter Peak Load Forecasts by Substation

	2003		2004		2005		2006		2007		2008		2009		2010		2011		2012	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Beaconsfield West	527.0	269.0	396.0	56.0	405.0	40.0	413.0	28.0	422.0	10.0	429.0	5.0	437.0	19.0	446.0	35.0	456.0	45.0	466.2	57.9
Haymarket			401.0	49.0	409.0	57.0	418.0	67.0	426.0	55.0	432.0	56.0	440.0	63.0	450.0	68.0	462.0	70.0	474.3	72.1
Sydney East	789.0	62.0	794.0	81.0	802.0	95.0	812.0	87.0	844.0	67.0	856.0	58.0	868.0	48.0	872.0	38.0	884.0	30.0	896.2	23.7
Sydney North	966.0	372.0	856.0	342.0	882.0	350.0	907.0	344.0	932.0	341.0	946.0	335.0	958.0	330.0	972.0	325.0	984.0	320.0	996.1	315.1
Sydney South	1311.0	86.0	1213.0	68.0	1246.0	15.0	1246.0	56.0	1263.0	66.0	1278.0	74.0	1295.0	84.0	1310.0	94.0	1325.0	105.0	1340.2	117.3
Munmorah	117.3	9.4	126.8	10.4	131.3	11.3	135.7	12.2	134.0	13.1	137.2	14.0	140.4	14.9	143.7	16.0	147.2	17.0	150.8	18.1
Vales Point	114.2	15.2	128.8	19.4	131.6	20.0	134.2	20.6	139.2	26.2	141.6	27.0	141.8	27.8	146.2	28.8	148.8	29.8	151.4	30.8
Tuggerah	158.6	88	183.1	120	188.8	127	194.2	134	182.5	135	187.7	141	193.4	149	199.2	157	205.4	166	211.8	87.6
Newcastle[7]	616.6	210.0	635.8	214.7	648.3	206.0	660.2	216.7	675.2	228.0	689.5	228.3	705.6	237.4	725.5	246.8	745.4	256.3	765.8	266.1
Muswellbrook	59.2	48.9	73.7	49.5	98.3	29.0	114.7	37.5	117.2	37.8	120.9	39.9	122.1	41.5	122.3	40.8	125.4	41.7	128.6	42.7
Liddell	30.2	17.1	30.2	17.1	30.2	17.1	29.7	16.8	35.2	20.0	35.1	19.9	32.1	18.2	32.1	18.2	32.1	18.2	32.1	18.2

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[9] Energy Australia forecasts have not been updated since the 2002 Annual Planning Report. An additional year has been added by TransGrid.

[10] No inclusion has been made for the supply to Taree or Port Macquarie. These are either fully or partially supplied from Newcastle normally but have already been included in the forecast elsewhere. It is also assumed that Eraring is normally supplied from Tuggerah not from Newcastle via Awaba.

Integral Energy Supply Point Load Forecasts

Summer Peak Load Forecasts by Substation[11]

	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Dapto	436.1	137.4	446.3	139.6	456.8	143.8	464.4	146.8	470.5	149.2	476.4	151.6	482.2	153.9	488.2	156.3	494.1	158.7	500.0	161.1
Ingleburn	157.7	59.5	163.2	63.7	168.8	68.0	174.4	72.2	179.9	76.5	185.5	80.7	191.0	84.9	196.6	89.2	202.1	93.4	207.7	97.7
Liverpool	403.0	103.0	426.0	113.0	452.0	123.0	475.0	132.0	501.0	143.0	519.0	150.0	535.0	156.0	549.0	162.0	562.0	167.0	575.0	172.0
Marulan	57.2	10.3	58.4	10.5	59.8	10.8	61.1	11.0	62.3	11.2	63.4	11.4	64.4	11.6	65.4	11.8	66.4	12.0	67.4	12.2
Mt Piper	36.4	18.5	36.7	18.6	36.9	18.7	37.2	18.9	37.4	19.0	37.7	19.1	38.0	19.2	38.2	19.4	38.5	19.5	38.8	19.6
Regentville	435.5	183.0	484.0	205.0	498.5	210.2	365.1	168.5	374.2	170.2	383.6	172.0	393.2	173.9	403.0	175.9	413.1	177.9	423.4	180.0
Sydney North	39.0	17.4	40.0	17.0	32.0	13.0	33.0	14.0	34.0	15.0	35.0	15.3	36.0	15.6	37.0	15.9	38.0	16.2	39.0	16.6
Sydney West	1448.7	588.3	1485.0	596.8	1467.8	605.1	1222.0	624.0	1252.0	649.0	1283.0	675.0	1315.0	702.0	1348.0	730.0	1382.0	759.0	1417.0	790.0
Vineyard	206.0	106.8	224.0	116.1	304.9	144.3	322.9	153.6	340.8	162.8	358.8	172.1	376.7	181.3	394.7	190.6	412.6	199.8	430.6	209.1
Outer west relief							420.0	50.0	431.0	52.0	441.0	54.0	452.0	56.0	464.0	58.0	475.0	61.0	487.0	63.0
Wallerawang	70.7	22.5	71.5	22.7	72.3	23.0	73.1	23.2	74.0	23.5	74.8	23.7	75.6	24.0	76.4	24.2	77.2	24.5	77.9	24.8

Winter Peak Load Forecast by Substation

	2003		2004		2005		2006		2007		2008		2009		2010		2011		2012	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Dapto	508.4	105.3	467.6	76.6	475.8	78.8	483.8	81.0	491.5	83.1	499.1	85.2	506.6	87.2	514.2	89.3	521.8	91.3	529.5	93.4
Ingleburn	155.0	70.6	158.0	72.0	162.0	73.0	165.0	74.0	168.0	75.0	171.0	76.0	174.0	77.0	177.0	78.0	180.0	79.0	183.0	80.0
Liverpool	357.0	23.0	372.0	26.0	385.0	29.0	398.0	33.0	412.0	36.0	425.0	39.0	438.1	42.0	449.0	45.0	459.6	48.0	470.3	52.0
Marulan	71.6	3.4	73.2	3.5	74.8	3.6	76.4	3.6	78.0	3.7	79.6	3.8	81.2	3.9	82.8	3.9	84.3	4.0	86.0	4.1
Mt Piper	38.5	17.5	38.6	17.6	38.8	17.7	39.0	17.8	39.2	17.8	39.4	17.9	39.5	18.0	39.7	18.1	39.9	18.1	40.1	18.2
Regentville	354.9	101.1	394.4	113.2	406.2	116.1	415.5	119.1	300.9	71.3	308.4	72.1	316.1	72.9	324.1	73.7	332.2	74.5	340.5	75.4
Sydney North	39.0	17.4	40.0	17.0	40.0	17.0	32.0	13.0	33.0	13.0	34.0	14.0	35.0	14.0	36.0	15.0	37.0	15.0	38.0	16.0
Sydney West	1321.8	339.8	1354.8	344.7	1339.1	349.5	1323.6	346.9	1121.7	224.4	1149.7	231.1	1178.5	238.0	1207.9	245.2	1238.1	252.5	1269.1	260.1
Vineyard	196.0	52.0	205.0	54.0	212.0	56.0	264.0	72.0	277.2	76.3	291.1	80.9	305.6	85.8	320.9	90.9	336.9	96.4	353.8	102.1
Outer west relief									360.0	182.0	369.0	187.5	378.2	193.1	387.7	198.9	397.4	204.8	407.3	211.0
Wallerawang	83.5	27.1	84.7	27.5	85.7	27.8	86.8	28.2	87.8	28.5	88.9	28.9	89.9	29.2	91.0	29.5	92.0	29.9	93.1	30.2

[11] Integral Energy has provided TransGrid with a load forecast for summer and winter covering the 10 year planning horizon. This spatial forecast was developed from the bottom up, and aggregated together at TransGrid substations supplying Integral Energy. Both TransGrid and Integral Energy have identified increasing volatility of summer loads due to the expanding increase in air-conditioning, particularly in residential growth areas, as a major variable in preparing load forecasts. Different procedures for dealing with these volatile peaks have been adopted by the two organisations, and this appears to be primarily driven by project lead times and risk exposure. The forecast loads shown in the above tables do not take into account the embedded generation within these networks. During hot summers it is expected that these loads could be exceeded by up to 10%. In accordance with clause 5.6 of the code, TransGrid has modified Integral Energy's load forecast resulting in higher summer maximum demands being forecast for Regentville, Vineyard, Ingleburn and Sydney West load areas, which supply residential growth areas.

Country Energy (North) Supply Point Load Forecasts

Summer Peak Load Forecasts by Substation[12]

	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Armidale 66kV	28.0	10.2	28.8	10.4	29.6	10.7	30.3	11.0	31.1	11.3	31.9	11.6	32.6	11.8	33.4	12.1	34.2	12.4	35.0	12.7
Bulahdelah					7.0	3.0	7.0	3.0	7.0	3.0	8.0	3.0	8.0	3.0	8.0	3.0	9.0	4.0	9.0	4.0
Coffs Harbour 66kV	61.8	24.4	63.7	25.2	53.6	21.2	55.2	21.8	56.8	22.5	58.5	23.1	60.3	23.8	62.1	24.5	64.0	25.3	65.9	26.0
Dorrigo 132 kV	3.9	1.0	3.9	1.0	4.0	1.0	4.0	1.9	4.0	1.9	4.1	1.9	5.0	1.9	5.0	1.9	5.0	1.9	5.0	1.9
Glen Innes 66kV	20.4	8.0	16.7	6.6	17.0	6.7	17.3	6.9	17.6	7.0	18.0	7.1	18.3	7.2	18.6	7.4	19.0	7.5	19.3	7.6
Gunnedah 66kV	23.6	9.0	24.0	9.0	24.4	9.0	24.8	9.0	25.2	9.0	25.6	9.0	26.0	10.0	26.4	10.0	26.8	10.0	27.2	10.0
Inverell 66kV	35.7	13.0	24.4	8.9	24.9	9.0	25.4	9.2	25.9	9.4	26.4	9.6	27.0	9.8	27.5	10.0	28.0	10.2	28.6	10.4
Kempsey 66kV	2.0	1.0	2.0	1.0	2.0	1.0	2.0	1.0	2.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0
Kempsey 33kV	26.4	12.0	27.0	12.3	27.6	12.6	28.2	12.8	28.8	13.1	29.4	13.4	30.0	13.7	30.6	13.9	31.2	14.2	31.8	14.5
Koolkhan 66kV	48.8	17.7	50.0	18.1	51.2	18.6	52.4	19.0	53.6	19.5	54.8	19.9	56.0	20.3	57.2	20.8	58.4	21.2	59.6	21.6
Lismore 132 kV	144.9	57.3	150.0	59.3	155.2	61.3	160.7	63.5	166.3	65.7	172.1	68.0	178.1	70.4	184.4	72.9	190.8	75.4	197.5	78.1
Moree 66kV	30.5	12.1	31.0	12.3	31.5	12.4	32.0	12.6	32.5	12.8	33.0	13.0	33.5	13.2	34.0	13.4	34.5	13.6	35.0	13.8
Nambucca	27.7	10.9	28.4	11.2	19.1	7.5	19.6	7.7	20.0	7.9	20.5	8.1	21.1	8.3	21.6	8.5	22.1	8.7	22.7	9.0
Narrabri 66kV	40.0	13.1	40.7	13.4	41.4	13.6	42.1	13.8	42.8	14.1	43.5	14.3	44.3	14.5	45.0	14.8	45.8	15.0	46.6	15.3
Port Macquarie 33kV	51.8	22.0	53.6	22.8	55.4	23.6	57.4	24.4	59.4	25.3	61.5	26.2	63.6	27.1	65.8	28.0	68.1	29.0	70.5	30.0
Raleigh					10.0	3.3	10.3	3.4	10.6	3.5	10.9	3.6	11.3	3.7	11.6	3.8	11.9	3.9	12.3	4.0
Sawtell					12.0	3.9	12.4	4.1	12.7	4.2	13.1	4.3	13.5	4.4	13.9	4.6	14.3	4.7	14.8	4.9
Stroud 33kV	30.4	13.0	31.0	13.2	24.6	10.5	25.2	10.7	25.8	11.0	26.4	11.2	26.0	11.1	26.6	11.3	27.2	11.6	27.8	11.8
Tamworth 66kV	89.4	32.4	91.5	33.2	93.6	34.0	95.7	34.7	97.8	35.5	99.9	36.3	102.0	37.0	104.1	37.8	106.2	38.5	108.3	39.3
Taree 66kV	53.4	23.5	55.3	24.4	57.2	25.2	59.2	26.1	61.3	27.0	63.4	28.0	65.6	28.9	67.9	30.0	70.3	31.0	72.8	32.1
Taree 33kV	22.4	8.9	22.9	9.0	23.3	9.2	23.8	9.4	24.3	9.6	24.8	9.8	25.3	10.0	25.8	10.2	26.3	10.4	26.8	10.6
Tenterfield 22kV	4.8	1.9	4.9	1.9	4.9	2.0	5.0	2.0	5.0	2.0	5.1	2.0	5.1	2.0	5.2	2.1	5.2	2.1	5.3	2.1

[12] Country Energy has indicated that these forecasts do not take account of intermittent non-scheduled generation that may be operating at the time of peak demand.

Country Energy (North) Supply Point Load Forecasts

Winter Peak Load Forecasts by Substation[13]

	2003		2004		2005		2006		2007		2008		2009		2010		2011		2012	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Armidale 66kV	40.7	14.8	41.6	15.1	42.5	15.4	43.4	15.8	44.3	16.1	45.2	16.4	46.1	16.7	47.0	17.1	47.9	17.4	48.8	17.7
Bulahdelah							8.0	3.0	8.0	4.0	8.0	4.0	9.0	4.0	9.0	4.0	9.0	4.0	10.0	4.0
Coffs Harbour 66kV	66.0	26.1	68.0	26.9	56.0	22.1	57.7	22.8	59.4	23.5	61.2	24.2	63.1	24.9	64.9	25.7	66.9	26.4	68.9	27.2
Dorrigo 132kV	4.0	1.0	4.0	1.0	4.0	1.6	4.0	1.6	5.3	2.1	5.4	2.1	5.5	2.2	5.0	2.0	5.7	3.0	5.8	3.0
Glen Innes 66kV	22.2	8.8	16.5	6.5	16.8	6.7	17.1	6.8	17.5	6.9	17.8	7.0	18.1	7.2	18.4	7.3	18.7	7.4	19.1	7.5
Gunnedah 66kV	27.4	10.8	27.8	11.0	28.2	11.1	28.6	11.3	29.0	11.5	29.4	11.6	29.8	11.8	30.2	11.9	30.6	12.1	31.0	12.3
Inverell 66kV	50.0	18.1	38.9	14.1	39.7	14.4	40.5	14.7	41.3	15.0	42.2	15.3	43.0	15.6	43.9	15.9	44.7	16.2	45.6	16.6
Kempsey 66kV	2.0	1.0	2.0	1.0	2.0	1.0	2.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0
Kempsey 33kV	35.1	16.0	35.8	16.3	36.5	16.6	37.2	16.9	37.9	17.3	38.6	17.6	39.3	17.9	40.0	18.2	40.7	18.5	41.4	18.9
Koolkhan 66kV	50.4	18.3	51.6	18.7	52.8	19.2	54.0	19.6	55.2	20.0	56.4	20.5	57.6	20.9	58.8	21.3	60.0	21.8	61.2	22.2
Lismore 66kV	148.0	58.5	152.4	60.2	157.0	62.1	161.7	63.9	166.6	65.8	171.6	67.8	176.7	69.8	182.0	71.9	187.5	74.1	193.1	76.3
Moree 66kV	41.1	16.2	41.9	16.6	42.8	16.9	43.6	17.2	44.5	17.6	45.3	17.9	46.2	18.2	47.0	18.6	47.9	18.9	48.7	19.2
Nambucca	30.0	11.9	30.8	12.2	19.5	7.7	20.0	7.9	20.5	8.1	21.0	8.3	21.5	8.5	22.1	8.7	22.6	8.9	23.2	9.2
Narrabri 66kV	47.0	15.4	46.0	15.1	46.8	15.4	47.6	15.6	48.4	15.9	49.2	16.2	50.0	16.4	50.9	16.7	51.8	17.0	52.6	17.3
Port Macquarie 33kV	69.0	29.4	71.1	30.3	73.2	31.2	75.4	32.1	77.7	33.1	80.0	34.1	82.4	35.1	84.9	36.2	87.4	37.2	90.0	38.4
Raleigh					12.0	3.9	12.4	4.1	12.7	4.2	13.1	4.3	13.5	4.4	13.9	4.6	14.3	4.7	14.8	4.9
Sawtell					14.0	4.6	14.4	4.7	14.9	4.9	15.3	5.0	15.8	5.2	16.2	5.3	16.7	5.5	17.2	5.7
Stroud 33kV	33.8	14.4	34.4	14.7	35.0	14.9	27.6	11.8	28.2	12.0	28.8	12.3	28.4	12.1	29.0	12.4	29.6	12.6	30.2	12.9
Tamworth 66kV	89.6	32.5	91.8	33.3	94.0	34.1	96.2	34.9	98.4	35.7	100.6	36.5	102.8	37.3	105.0	38.1	107.2	38.9	109.4	39.7
Taree 66kV	66.8	29.5	68.8	30.3	70.9	31.2	73.0	32.2	75.2	33.2	77.4	34.1	79.8	35.2	82.2	36.2	84.6	37.3	87.2	38.4
Taree 33kV	25.0	9.1	25.4	9.2	25.8	9.3	26.1	9.5	26.5	9.6	26.9	9.8	27.3	9.9	27.7	10.1	28.2	10.2	28.6	10.4
Tenterfield 22kV	5.5	2.2	5.6	2.2	5.6	2.2	5.7	2.2	5.7	2.3	5.8	2.3	5.8	2.3	5.9	2.3	6.0	2.4	6.0	2.4

[13] Country Energy has indicated that these forecasts do not take account of intermittent non-scheduled generation that may be operating at the time of peak demand.

Country Energy (Central) Supply Point Load Forecasts

Summer Peak Load Forecasts by Substation[14]

	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Wellington 330/132kV	148.8	30.2	151.8	30.8	154.8	31.4	157.9	32.1	161.0	32.7	164.3	33.4	167.5	34.0	170.9	34.7	174.3	35.4	177.8	36.1
Wellington 132-66/11kV	7.3	3.1	7.4	3.2	7.6	3.2	7.7	3.3	7.9	3.4	8.0	3.4	8.2	3.5	8.4	3.6	8.5	3.6	8.7	3.7
Beryl 132/66kV	30.8	13.1	32.1	13.7	33.3	14.2	34.7	14.8	36.1	15.4	37.5	16.0	39.0	16.6	40.6	17.3	42.2	18.0	43.9	18.7
Mudgee 132-66/22kV	18.4	7.3	19.1	7.6	19.9	7.9	20.7	8.2	21.5	8.5	22.4	8.8	23.3	9.2	24.2	9.6	25.2	9.9	26.2	10.3
Molong 132/66 kV	4.1	1.9	4.2	1.9	4.2	1.9	4.3	1.9	4.3	2.0	4.4	2.0	4.4	2.0	4.5	2.0	4.5	2.1	4.6	2.1
Manildra 132/11 kV	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0
Orange 132/66kV (132kV Bus)	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6
Orange 132/66kV (66kV Bus)	36.3	16.5	37.3	17.0	38.2	17.4	39.2	17.9	40.2	18.3	41.2	18.8	42.2	19.2	43.3	19.7	44.4	20.2	45.5	20.7
Panorama 132/66kV Sub	57.2	18.8	58.4	19.2	59.5	19.6	60.7	20.0	61.9	20.4	63.2	20.8	64.4	21.2	65.7	21.6	67.0	22.0	68.4	22.5
Wallerawang 330/132/66kV (132kV Bus)	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3
Wallerawang 330/132/66kV (66kV Bus)	4.3	0.9	4.4	0.9	4.4	0.9	4.5	0.9	4.6	0.9	4.7	1.0	4.8	1.0	4.9	1.0	5.0	1.0	5.1	1.0
Parkes 132/66kV (132kV Bus)	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9
Parkes 132/66kV (66kV Bus)	20.8	8.2	21.2	8.4	21.6	8.6	22.1	8.7	22.5	8.9	23.0	9.1	23.4	9.3	23.9	9.4	24.4	9.6	24.9	9.8
Forbes 132/66kV	33.3	17.1	34.0	17.4	34.6	17.7	35.3	18.1	36.0	18.5	36.8	18.8	37.5	19.2	38.2	19.6	39.0	20.0	39.8	20.4
Cowra 132/66kV	28.1	12.0	28.7	12.2	29.2	12.5	29.8	12.7	30.4	13.0	31.0	13.2	31.6	13.5	32.3	13.7	32.9	14.0	33.6	14.3

[14] Country Energy has indicated that these forecasts do not include a number of possible spot loads that may emerge over the forecast period.

Country Energy (Central) Supply Point Load Forecasts

Winter Peak Load Forecasts by Substation[15]

	2003		2004		2005		2006		2007		2008		2009		2010		2011		2012	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Wellington 330/132kV	146.9	29.8	149.8	30.4	152.8	31.0	155.9	31.7	159.0	32.3	162.2	32.9	165.4	33.6	168.7	34.3	172.1	34.9	175.5	35.6
Wellington 132-66/11kV	8.2	3.5	8.3	3.5	8.5	3.6	8.7	3.7	8.8	3.8	9.0	3.8	9.2	3.9	9.4	4.0	9.6	4.1	9.8	4.2
Beryl 132/66kV	32.2	13.7	33.5	14.3	34.9	14.9	36.3	15.4	37.7	16.1	39.2	16.7	40.8	17.4	42.4	18.1	44.1	18.8	45.9	19.5
Mudgee 132-66/22kV	19.8	7.8	20.6	8.1	21.4	8.4	22.2	8.8	23.1	9.1	24.0	9.5	25.0	9.9	26.0	10.3	27.0	10.7	28.1	11.1
Molong 132/66 kV	3.6	1.6	5.1	2.3	5.2	2.4	5.3	2.4	5.4	2.4	5.4	2.5	5.5	2.5	5.6	2.6	5.7	2.6	5.8	2.6
Manildra 132/11 kV	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0	11.0	5.0
Orange 132/66kV (132kV Bus)	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6	75.0	29.6
Orange 132/66kV (66kV Bus)	65.3	29.7	56.1	25.6	57.4	26.2	58.8	26.8	60.2	27.4	61.6	28.1	63.0	28.7	64.5	29.4	66.0	30.1	67.5	30.8
Panorama 132/66kV Sub	76.5	25.1	78.0	25.6	79.6	26.2	81.2	26.7	82.8	27.2	84.5	27.8	86.2	28.3	87.9	28.9	89.6	29.5	91.4	30.0
Wallerawang 330/132/66kV (132kV Bus)	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3	26.0	5.3
Wallerawang 330/132/66kV (66kV Bus)	5.4	1.1	5.5	1.1	5.6	1.1	5.7	1.2	5.9	1.2	6.0	1.2	6.1	1.2	6.2	1.3	6.3	1.3	6.5	1.3
Parkes 132/66kV (132kV Bus)	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9	25.0	9.9
Parkes 132/66kV (66kV Bus)	20.4	8.1	20.8	8.2	21.2	8.4	21.6	8.6	22.1	8.7	22.5	8.9	23.0	9.1	23.4	9.3	23.9	9.4	24.4	9.6
Forbes 132/66kV	28.6	14.6	29.1	14.9	29.7	15.2	30.3	15.5	30.9	15.8	31.5	16.2	32.2	16.5	32.8	16.8	33.5	17.1	34.1	17.5
Cowra 132/66kV	22.4	9.6	22.9	9.8	23.3	9.9	23.8	10.1	24.3	10.3	24.8	10.6	25.3	10.8	25.8	11.0	26.3	11.2	26.8	11.4

[15] Country Energy has indicated that these forecasts do not include a number of possible spot loads that may emerge over the forecast period.

Country Energy (South) and Actew-AGL Supply Point Load Forecasts

Summer Peak Load Forecasts by Substation

	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Albury 132kV	119.1	63.6	124.1	66.3	129.4	69.1	134.8	72.0	140.5	75.1	146.5	78.3	152.7	81.6	159.2	85.1	166.0	88.7	173.0	92.4
Canberra 132kV	417.0	305.0	429.0	314.0	442.0	323.0	454.0	332.0	466.0	341.0	479.0	350.0	493.0	360.0	506.0	370.0	520.0	380.0	534.4	390.3
Coleambally 132kV	13.6	4.9	16.0	5.8	17.5	6.4	19.0	6.9	19.6	7.1	20.2	7.3	20.8	7.5	21.4	7.8	22.1	8.0	22.7	8.3
Darlington Pt 132kV	15.8	6.7	16.4	7.0	17.0	7.2	17.6	7.5	18.2	7.8	18.9	8.0	19.6	8.3	20.3	8.7	21.1	9.0	21.8	9.3
Deniliquin 66kV	56.2	24.0	57.9	24.7	59.7	25.4	61.4	26.2	63.3	27.0	65.2	27.8	67.1	28.6	69.2	29.5	71.2	30.3	73.4	31.3
Finley 66kV	26.6	11.3	27.5	11.7	28.5	12.1	29.5	12.5	30.5	13.0	31.6	13.4	32.7	13.9	33.8	14.4	35.0	14.9	36.2	15.4
Griffith 33kV	61.8	33.4	63.6	34.4	65.5	35.4	67.4	36.4	69.3	37.4	71.3	38.5	73.4	39.6	75.5	40.8	77.7	42.0	80.0	43.2
Murrumburrah 66kV	28.2	14.9	29.0	15.3	29.8	15.7	30.6	16.1	31.4	16.5	32.2	17.0	33.0	17.4	33.8	17.8	34.6	18.2	35.4	18.6
Wagga 66kV	111.6	40.8	113.2	41.4	114.9	42.0	116.6	42.6	118.3	43.2	119.9	43.9	121.6	44.5	123.3	45.1	125.0	45.7	126.6	46.3
Wagga 132kV	20.0	6.6	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8
Yanco 33kV	39.5	18.0	40.7	18.5	41.9	19.1	43.2	19.6	44.5	20.2	45.8	20.8	47.2	21.4	48.6	22.1	50.0	22.8	51.5	23.4
Yass 66kV	12.7	4.2	13.0	4.3	13.4	4.4	13.8	4.5	14.2	4.7	14.5	4.8	15.0	4.9	15.4	5.1	15.8	5.2	16.2	5.3
Tumut	32.4	16.1	32.9	16.3	33.5	16.6	34.0	16.9	34.6	17.2	35.1	17.4	35.7	17.7	36.2	18.0	36.8	18.2	37.3	18.5
Cooma 66kV	30.2	9.9	30.9	10.2	31.7	10.4	32.5	10.7	33.3	10.9	34.1	11.2	35.0	11.5	35.8	11.8	36.7	12.1	37.7	12.4
Cooma 132kV (Bega Valley)	44.2	14.5	46.0	15.1	47.3	15.5	48.6	16.0	49.9	16.4	51.3	16.9	52.8	17.3	54.3	17.8	55.8	18.3	57.3	18.8
Snowy Adit	10.2	3.4	10.3	3.4	10.4	3.4	10.5	3.5	10.6	3.5	10.7	3.5	10.8	3.6	10.9	3.6	11.0	3.6	11.2	3.7
Munyang	7.8	2.6	8.6	2.8	8.9	2.9	9.3	3.0	9.6	3.2	10.0	3.3	10.4	3.4	10.8	3.6	11.3	3.7	11.7	3.9
Queanbeyan	68.8		71.2		73.7		76.4		79.2		82.0		85.0		88.1		91.2	56.0	91.4	56.0
Marulan	33.0	10.8	33.5	11.0	34.2	11.2	34.8	11.4	35.4	11.6	36.0	11.8	36.7	12.1	37.3	12.3	38.0	12.5	38.7	12.7

Country Energy (South) and Actew-AGL Supply Point Load Forecasts

Winter Peak Load Forecasts by Substation

	2003		2004		2005		2006		2007		2008		2009		2010		2011		2012	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Albury 132kV	92.1	49.2	94.5	50.5	96.9	51.7	99.3	53.1	101.8	54.4	104.4	55.8	107.1	57.2	109.8	58.7	112.7	60.2	115.6	61.7
Canberra 132kV	535.0	248.0	541.0	250.0	546.0	253.0	551.0	255.0	557.0	258.0	562.0	260.0	568.0	263.0	574.0	266.0	580.0	268.0	585.0	271.0
Coleambally 132kV	7.4	2.7	12.6	4.6	15.0	5.4	17.5	6.3	19.0	6.9	20.5	7.5	21.2	7.7	21.8	7.9	22.4	8.1	23.1	8.4
Darlington Pt 132kV	14.0	6.0	14.6	6.2	15.2	6.5	15.9	6.8	16.6	7.1	17.3	7.4	18.0	7.7	18.8	8.0	19.6	8.3	20.4	8.7
Deniliquin 66kV	47.1	20.1	48.1	20.5	49.0	20.9	50.0	21.3	51.0	21.7	52.0	22.2	53.1	22.6	54.1	23.1	55.2	23.5	56.3	24.0
Finley 66kV	23.3	9.9	23.5	10.0	23.7	10.1	23.9	10.2	24.2	10.3	24.4	10.4	24.6	10.5	24.8	10.6	25.0	10.7	25.3	10.8
Griffith 33kV	45.0	24.3	43.4	23.4	44.2	23.9	45.1	24.3	45.9	24.8	46.8	25.3	47.7	25.7	48.6	26.2	49.5	26.7	50.5	27.2
Murrumburrah 66kV	34.2	18.0	35.3	18.6	36.5	19.2	37.6	19.8	38.8	20.4	39.9	21.0	41.0	21.6	42.2	22.2	43.3	22.8	44.5	23.4
Wagga 66kV	97.0	35.5	97.0	35.5	97.1	35.5	97.1	35.5	97.2	35.5	97.3	35.6	97.3	35.6	97.4	35.6	97.4	35.6	97.5	35.6
Wagga 132kV	20.0	6.6	20.0	6.6	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8	45.0	14.8
Yanco 33kV	31.3	14.2	33.8	15.4	36.3	16.5	36.8	16.7	37.4	17.0	37.9	17.2	38.5	17.5	39.1	17.8	39.7	18.0	40.3	18.3
Yass 66kV	14.7	4.8	15.0	4.9	15.3	5.0	15.6	5.1	15.9	5.2	16.2	5.3	16.5	5.4	16.8	5.5	17.2	5.6	17.5	5.8
Tumut	35.4	17.6	36.1	17.9	36.7	18.2	37.3	18.5	37.9	18.8	38.5	19.1	39.1	19.4	39.7	19.7	40.4	20.0	41.0	20.3
Cooma 66kV	35.3	11.6	36.0	11.8	36.7	12.1	37.4	12.3	38.2	12.5	38.9	12.8	39.7	13.1	40.5	13.3	41.3	13.6	42.2	13.9
Cooma 132kV (Bega Valley)	40.7	13.4	41.8	13.7	43.0	14.1	44.2	14.5	45.4	14.9	46.7	15.4	48.0	15.8	49.4	16.2	50.7	16.7	52.2	17.1
Snowy Adit	10.2	3.4	10.3	3.4	10.4	3.4	10.5	3.5	10.6	3.5	10.7	3.5	10.8	3.6	10.9	3.6	11.0	3.6	11.2	3.7
Munyang	30.5	10.0	32.8	10.8	33.1	10.9	33.4	11.0	33.7	11.1	34.1	11.2	34.4	11.3	34.8	11.4	35.1	11.5	35.5	11.7
Queanbeyan	78.0	42.3	80.7	43.8	83.5	45.3	86.4	46.8	89.3	48.3	92.4	50.0	95.6	51.8	98.8	53.6	102.3	55.4	105.8	57.3
Marulan	40.6	13.4	41.4	13.6	42.1	13.8	42.9	14.1	43.6	14.3	44.4	14.6	45.2	14.9	46.0	15.1	46.9	15.4	47.7	15.7

Australian Inland Energy Supply Point Load Forecasts

Summer Peak Load Forecast by Substation

	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Broken Hill	54.3	27.0	54.3	27.0	54.3	27.0	54.3	27.0	54.3	27.0	54.3	27.0	54.3	27.0	54.3	27.0	54.3	27.0	54.3	27.0
Deniliquin	7.5	3.6	7.5	3.6	7.5	3.6	7.5	3.6	7.5	3.6	7.5	3.6	7.5	3.6	7.5	3.6	7.5	3.6	7.5	3.6
Balranald	4.0	1.9	4.0	1.9	4.0	1.9	4.0	1.9	4.0	1.9	4.0	1.9	4.0	1.9	4.0	1.9	4.0	1.9	4.0	1.9

Winter Peak Load Forecast by Substation

	2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Broken Hill	49.8	24.1	49.8	24.1	49.8	24.1	49.8	24.1	49.8	24.1	49.8	24.1	49.8	24.1	49.8	24.1	49.8	24.1	49.8	24.1
Deniliquin	6.0	2.9	6.0	2.9	6.0	2.9	6.0	2.9	6.0	2.9	6.0	2.9	6.0	2.9	6.0	2.9	6.0	2.9	6.0	2.9
Balranald	3.6	1.2	3.7	1.2	3.7	1.2	3.7	1.2	3.7	1.2	3.7	1.2	3.7	1.2	3.7	1.2	3.7	1.2	3.7	1.2

MAJOR INDUSTRIAL LOADS[16]

Summer

	2004 MW	2005 MW	2006 MW	2007 MW	2008 MW	2009 MW	2010 MW	2011 MW	2012 MW	2013 MW
Industrial Loads	1460	1582	1582	1582	1582	1582	1582	1582	1582	1582

Winter

	2003 MW	2004 MW	2005 MW	2006 MW	2007 MW	2008 MW	2009 MW	2010 MW	2011 MW	2012 MW
Industrial Loads	1420	1548	1548	1548	1548	1548	1548	1548	1548	1548

[16] Includes industrial loads that were previously included in the EnergyAustralia and Integral Energy forecast tables

Appendix 4 - Glossary

Term	Explanation/Comments
ACCC	The Australian Competition and Consumer Commission.
Annual Planning Review	The annual planning process covering transmission networks in New South Wales.
Annual Planning Report (APR)	A document that sets out issues and provides information to the Market that is relevant to transmission planning in New South Wales. This document is the APR 2003.
CBD	Central Business District.
Constraint	An inability of a transmission system or distribution system to supply a required amount of electricity to a required standard.
DITM	A NSW Government scheme facilitating the provision of leased telecommunications services.
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.
HVDC	High Voltage Direct Current
IPART	Independent Pricing and Regulatory Tribunal of NSW
IRPC	The Inter-regional Planning Committee that is convened by NEMMCO and has representation from all jurisdictions of the NEM.
Jurisdictional Planning Body (JPB)	The organisation nominated by a relevant Minister as having transmission system planning responsibility in a jurisdiction of the National Electricity Market.
kV	Operating voltage of transmission equipment. One kilovolt is equal to one thousand volts.
Local Generation	A generation or cogeneration facility that is located on the load side of a transmission constraint.
MRET	Mandatory Renewable Energy Target
MVar	A unit of reactive power. One "Mega-var" is equal to 1,000,000 Var.
MW	A unit of active power (rate of energy consumption). One Megawatt is equal to 1000 kilowatts or about 1340 horsepower.
MWh	A unit of energy consumption. One Megawatt hour is the amount of energy consumed in one hour at a rate of one Megawatt.
National Electricity Code (the Code)	The code of conduct for the National Electricity Market that has been approved by participating state governments under the National Electricity Law and is administered by NECA.
NEC (the Code)	The National Electricity Code.
NECA	The National Electricity Code Administrator.
NEM	The National Electricity Market.

Term	Explanation/Comments
NEMMCO	National Electricity Market Management Company. The company that administers and operates the National Electricity Market.
New Small Network Asset	An augmentation of the transmission network that is expected to cost between $1 Million and $10 Million.
New Large Network Asset	An augmentation of the transmission network that is expected to cost more than $10 Million.
Regulatory Test	A test promulgated by the ACCC that is required by the Code to be applied when determining the relative economic merits of options for the relief of transmission constraints.
SEDA	Sustainable Energy Development Authority.
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 5 - Contact Details

For all general enquiries regarding the Annual Planning Report and for making written submissions in respect to the proposed new small network assets described in Section 5.3 contact:

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or

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For enquiries relating to load forecast information contact

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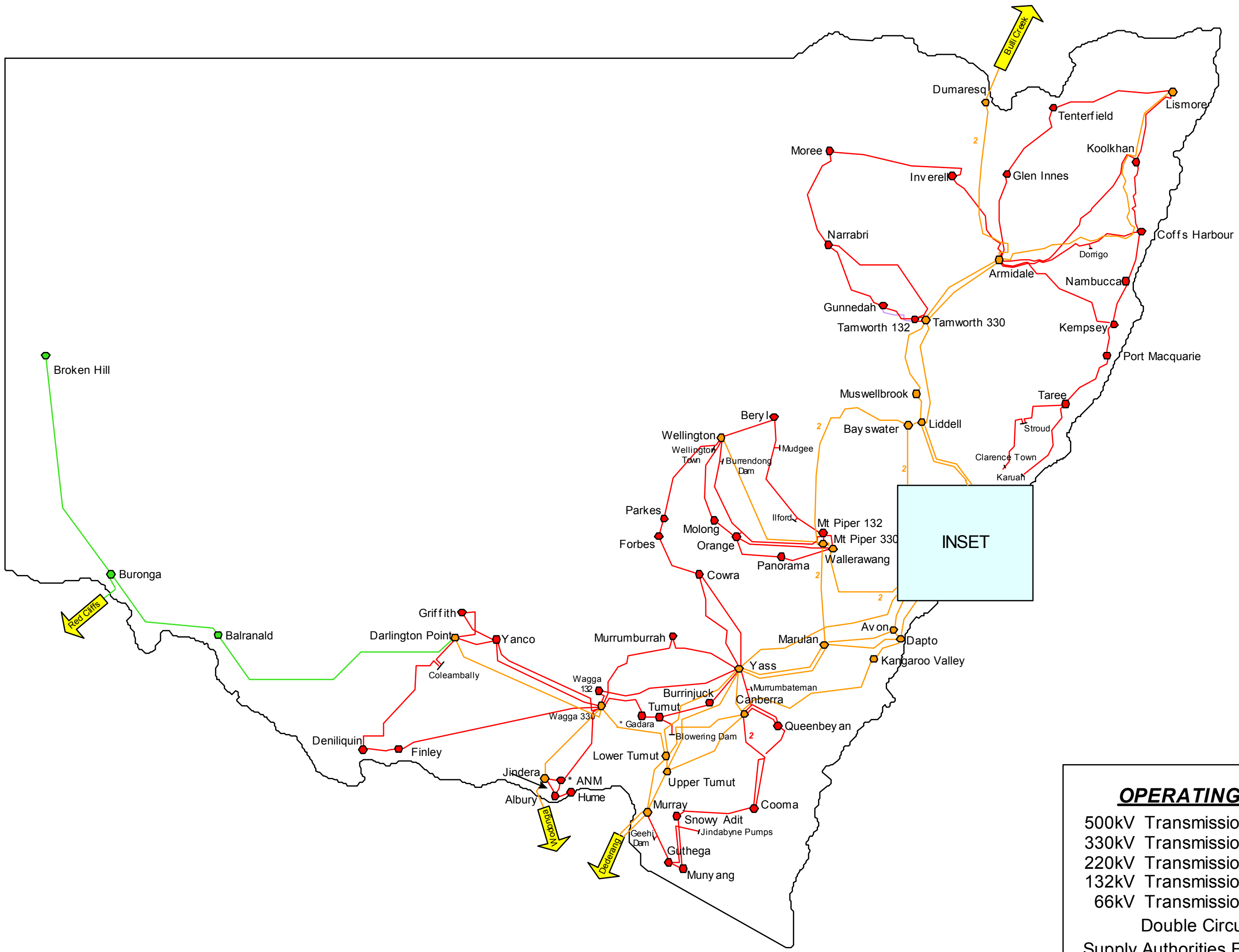
	email:	richard.hickling@transgrid.com.au

Appendix 6 – System Maps

System maps appear on the following two pages.



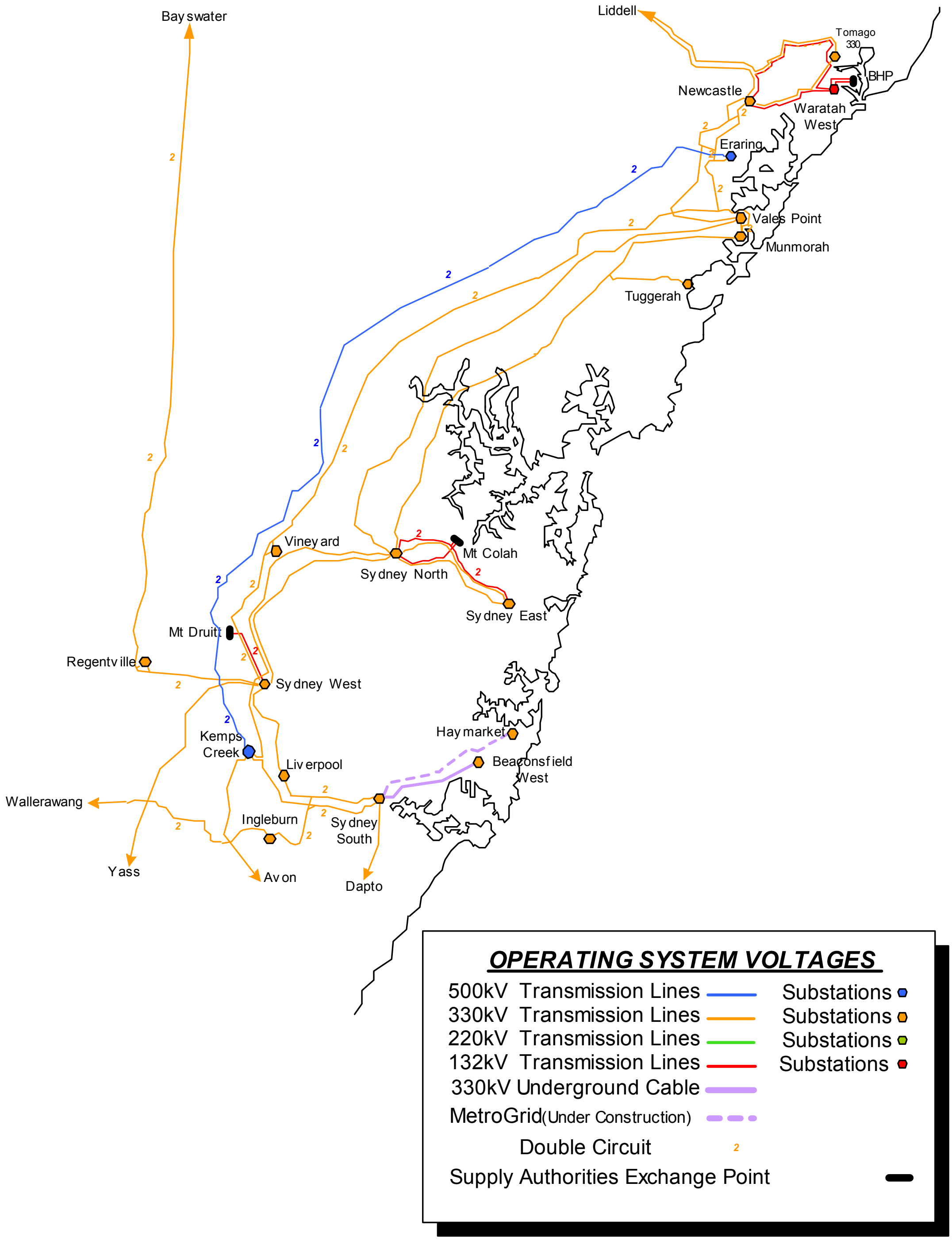
OPERATING SYSTEM VOLTAGES

500kV Transmission Lines — Substations
330kV Transmission Lines — Substations
220kV Transmission Lines — Substations
132kV Transmission Lines — Substations
66kV Transmission Lines
Double Circuit 2
Supply Authorities Exchange Point
Interstate Exchange Point Redcliffs

*** Notes**

ANM (Australian National Mills) &
Gadara(Visy Pulp Mills) are privately owned sites
with TransGrid operating assets.

INSET


Bayswater
Liddell
Tomago 330
BHP
Newcastle
Waratah West
Eraring
Vales Point
Munmorah
Tuggerah
Vineyard
Sydney North
Mt Colah
Sydney East
Mt Druitt
Regentville
Sydney West
Kemps Creek
Haymarket
Beaconsfield West
Liverpool
Wallerawang
Ingleburn
Sydney South
Yass
Avon
Dapto
OPERATING SYSTEM VOLTAGES
500kV Transmission Lines
330kV Transmission Lines
220kV Transmission Lines
132kV Transmission Lines
Substations
Substations
Substations
Substations
330kV Underground Cable
MetroGrid(Under Construction)
Double Circuit
Supply Authorities Exchange Point