1 Introduction

1.1 Project Outline

TransGrid is proposing to construct a 330 kilovolt (kV) transmission line in Far North NSW (as shown in **Figure 1-1**). The proposed line would be approximately 205 kilometres (km) long and located between the existing Dumaresq Switching Station (near Bonshaw) and Lismore. The need for this additional connection has been driven by forecasted growth in the peak demand for electricity in Far North NSW (also referred to as the Far North Coast). This demand is rising at a rate higher than the NSW average, with summer demand in the region reaching a record high in 2009. By 2031, the Far North NSW region's population is forecast to grow by more than 60,000 people[1], placing further demand on the capacity of the electricity production and transmission network.

The reliability of supply is presently, and expected to be, limited if all elements of the network are not in service. There are a number of scenarios where elements of the network may not be in service and this could significantly affect the supply of electricity to the region impacting a large number of customers, resulting in overloading of lines and/or low voltage levels. In the period to summer 2016/17, the worst case contingency event could result in up to 61MW of customer load being interrupted. This would be the equivalent of up to 18,000 households being affected by supply interruptions (**Chapter 2 Project Need and Alternatives**).

If all elements of the network are in service, they are presently capable of adequately supplying the Far North NSW, however, upgrades and additions to the existing network are required to ensure reliability of electricity supply. To meet the increasing demand, TransGrid plans to invest $227 million in infrastructure to augment the capacity of the electricity network in Far North NSW.

In defining the final route of the proposed Dumaresq to Lismore 330kV transmission line or 'Far North NSW Project' (hereafter referred to as 'the Project'), a Feasibility Study, Constraints Report and a series of route and environmental investigations has been completed. This work has resulted in the production of this Environmental Assessment (EA) in line with Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 The Proponent

The Proponent is TransGrid, a State Owned Corporation and the owner, operator and manager of the NSW high voltage network connecting generators, distributors and major end users in NSW and the ACT. They are responsible for the safe, efficient and reliable transmission of electricity from power generators to electricity distributors such as Essential Energy. Electricity distributors provide power to homes, businesses and industry across NSW.

The principle objectives and functions of TransGrid are outlined in the *Energy Services Corporations Act 1995 No. 95* (NSW). Under section 6C of this Act, the principle functions of an energy transmission operator are:

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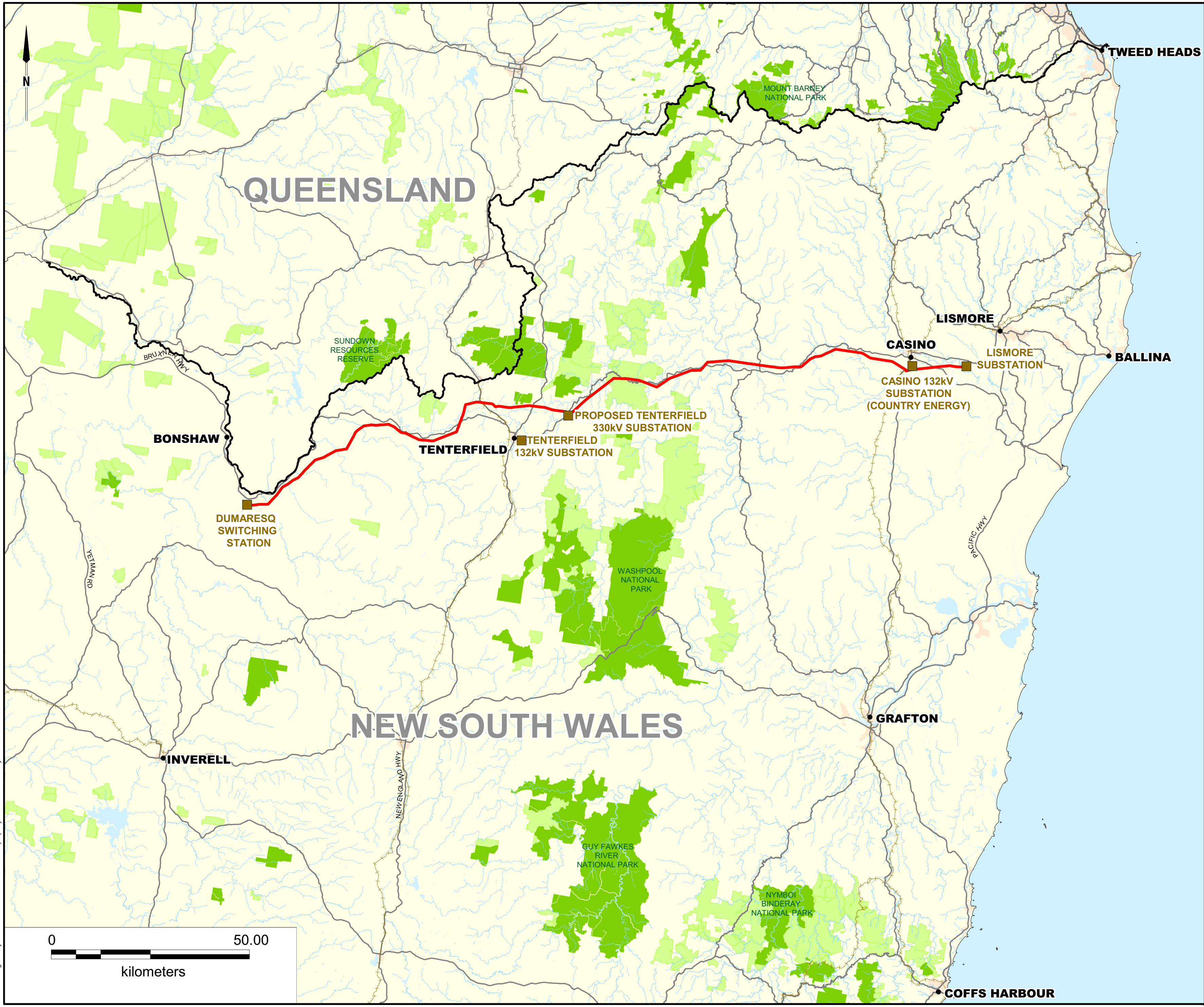
[1] December 2006, The Department of Planning's 2006-2031 Far North Coast Regional Strategy, Page 4 states: overall population of 289 000 by 2031. This represents an additional 60 400 people or a 26% increase for the period 2006–31. http://www.planning.nsw.gov.au/PlansforAction/Regionalplanning/FarNorthCoast/tabid/189/Default.aspx

(a) to establish, maintain and operate facilities for the transmission of electricity and other forms of energy, and

(b) to provide services for the transmission of electricity and other forms of energy in accordance with the relevant regulatory regime.

The principal objectives of an energy transmission operator are outlined in section 6B of this Act and include:

- to protect the environment by conducting its operations in compliance with the principles of ecologically sustainable development contained in section 6 (2) of the *Protection of the Environment Administration Act 1991* (NSW);
- to operate efficient, safe and reliable facilities for the transmission of electricity and other forms of energy; and
- to promote effective access to those transmission facilities.



Legend

- Proposed 330kV Alignment
- Substation / Switching Station
- Roads
- Railways
- National Parks
- State Forests

Map compiled using MapInfo StreetPro Data. © 2010 MapInfo Australia Pty Ltd, URS Australia and PSMA Australia Ltd. URS Australia, MapInfo Australia or PSMA Australia do not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that these companies shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

Datum: GDA94, Projection: UTM Grid: MGA Zone 56

Drawn: AO	Approved: WM	Date: 17/11/2010
Job No: **43177662**	File: 43177662.104.wor	

Client

TransGrid

Project

FAR NORTH NSW (DUMARESQ - LISMORE 330kV TRANSMISSION LINE) PROJECT

Title

PROJECT LOCATION

Figure: 1-1

URS

1.3 Project Components

The Project comprises:

- Construction of a 205km, 330kV transmission line, which includes;
  - a new 96km 330kV transmission line and 60m easement through greenfield areas from Dumaresq Switching Station to the proposed location of the new Tenterfield 330/132kV Substation (Tenterfield 330kV Substation);
  - a new 109km 330kV transmission line between Tenterfield 330kV Substation and Lismore Substation. Between the Tenterfield 330kV Substation and Casino (95km), the 330kV transmission line would replace the existing 132kV transmission line and the existing 45 metre (m) easement would be extended to 60m. Between Casino and Lismore Substation (14km), the new 330kV transmission line would run adjacent to the existing 132kV transmission line (which would remain operational on completion of construction). The existing 45m easement would be extended to 90m for this section;
  - removal of 95km of the existing 132kV transmission line between the proposed Tenterfield 330kV Substation and structure 395 to the south of Casino;
- upgrades to the Lismore Substation and Dumaresq Switching Station (within the existing sub/switching station footprints);
- establishment of a new 330/132kV substation approximately 14km north east of Tenterfield to maintain the existing 132kV connection to the Tenterfield 132kV Substation;
- establishment and upgrade of access tracks both within the easement and outside the easement for the purposes of transmission line construction and operational maintenance;
- replacement and restringing of the existing earthwire between the new Tenterfield 330kV Substation and existing Tenterfield 132kV Substation with optical ground wire (OPGW); and
- construction of a site storage facility with sufficient room for storage of crossarms, insulators, fittings and an area for welding/fabricating and storage of waste materials and other ancillary sites as required.

1.4 Terms and Definitions

Table 1-1 provides a summary of the terms used throughout this EA along with a description of the areas and activities to which they refer. The areas referred to in **Table 1-1** are shown in **Chapter 3 Location of Works** and specific project components more fully described in **Chapter 4 Project Description**.

Table 1-1 Summary of Key Terms and Definitions

Terminology used in this EA	Definition
The Project	The Dumaresq to Lismore 330kV Transmission Line otherwise known as the Far North NSW Project comprising all components as further described in Section 1.3, i.e. the 205km 330kV alignment, upgrades at the Lismore Substation and Dumaresq Switching Station, establishment of a new substation north-east of Tenterfield, access tracks to and within the proposed easement and the earthwire replacement works and ancillary facilities. Also referred to as the proposed Project.
Study Area	The area in which environmental studies have been undertaken to assist in determining the route, scale and location of the Project components. The study area comprises a western and eastern component as defined below.
Study Area West	The area between and including Dumaresq Switching Station and the proposed Tenterfield 330kV Substation in which environmental studies have been undertaken to assist in determining the route, scale and location of the Project components. There is no existing transmission line within this study area.
Study Area East	The area between Tenterfield 330kV Substation and Lismore Substation (and including Lismore Substation) in which environmental studies have been undertaken to assist in determining the route, scale and location of the Project components. This area includes the existing 132kV easement and adjacent areas to allow expansion to a 60m easement (90m from south of Casino to Lismore Substation) and access tracks.
Preferred Corridor	The corridor identified in September 2009, following initial consultation and environmental studies, within which an alignment would be identified. The corridor width varies between 500m and 1.6km.
Alignment	Refers to the proposed route of the transmission line (also referred to as the centreline) and the associated easement.
Alignment West	Refers to the identified 60m easement and centreline between and including Dumaresq Switching Station and the proposed Tenterfield 330kV Substation. Within this area there is no existing transmission line.
Alignment East	Refers to the proposed 60m easement between Tenterfield 330kV Substation and Lismore Substation (and including Lismore Substation). Between Tenterfield 330kV Substation and Casino, the existing 132kV transmission line would be dismantled and a 330kV line built in its place; and the existing 45m easement would be widened to 60m. Between structure 395 south of Casino and Lismore (14km), the new 330kV line would run adjacent to the existing 132kV line and the easement would be widened to 90m for this section.
Access Tracks	Refers to establishment of on-easement and off-easement access tracks for the purposes of transmission line construction and operational maintenance.
Easement	Refers to a ‘right of way’ along the transmission line route to enable TransGrid to access the line for inspection and maintenance purposes. The easement rights would also enable TransGrid to control any activity that may pose a risk to the line or to public safety.
Existing 132kV easement	The existing 45m wide easement or ‘right of way’ between Lismore Substation and Tenterfield 132kV Substation.

Terminology used in this EA	Definition
The 330kV easement	The proposed easement or 'right of way' associated with the proposed 330kV transmission line between Dumaresq Switching Station and Lismore Substation.
Structures	Refers to all of the proposed structures, both angle positions and intermediate structures (see below). Alignment East contains 253 structures and Alignment West 281 structures. However, these figures may change as a result of the detailed design.
Angle Position (AP)	Angle positions represent the locations where the direction of the proposed transmission line changes. The majority of the angle positions would be 'tension supporting structures', i.e. rectangular or square based steel lattice towers. There are a total of approximately 70 Angle Positions proposed for the Project.
Intermediate structures	Structures along which the conductors would be strung. Used principally in locations where the transmission line runs in a straight line. These suspension structures would mainly be twin pole H-frame structures. However, wide spans may require 'tension supporting structures' such as steel lattice towers.
Transmission line	Refers to the physical wires (conductors) and the pole and tower structures along the alignment.

1.5 Environmental Assessment Process

1.5.1 Environmental Assessment Scope

As a Major Project, the proposal is subject to the provisions of Part 3A of the EP&A Act and, accordingly, it will be subject to assessment by the Director-General of the Department of Planning (DoP) and determination by the Minister for Planning.

On 11 September 2009, the Executive Director of DoP, as delegate for the Director-General of DoP, issued Environmental Assessment Requirements pursuant to section 75F(2) of the EP&A Act. The Director-General's Requirements (DGRs) are provided in **Appendix A-1** and a table cross referencing the DGRs and where they are addressed in this EA can be found in **Appendix A-2**.

The DGRs identified both general requirements and key issues to be addressed in the EA. The key issues comprised:

- strategic planning and project justification;
- land use planning impacts;
- ecological impacts;
- human amenity impacts (noise and vibration, air
- quality and traffic impacts);
- heritage impacts;
- hazard and risk;
- noise impacts;
- visual amenity;
- construction related impacts (noise, water quality, weed management, soil and erosion); and
- traffic and transport.

These key issues were addressed through targeted investigations, which were conducted by appropriate specialists, and described in separate reports. The project team also identified other issues that could be considered important in the context of the Project and completed assessments accordingly. Where the reports containing the findings of these investigations are very detailed and/or expansive (i.e. Consultation, Surface Water and Hydrology, Biodiversity, Heritage, Visual Amenity and Hazard and Risk), they are presented in **Volume 2: Appendices,** and summaries are provided in the relevant chapters of this main report. In other instances the whole assessment forms the relevant Chapter of **Volume 1** of this EA (the Main Report). The outcomes of these investigations were used as source materials for this EA.

1.5.2 Environmental Assessment Preparation and Exhibition

The objectives of this EA are to:

- comply with the requirements of the EP&A Act, as formalised in the Director-General's Environmental Assessment Requirements;
- provide the Minister for Planning with sufficient information to determine the Project; and
- inform the community about the Project.

The EA will be placed on exhibition for public review for a minimum period of 30 days in accordance with Section 75H of the EP&A Act.

1.5.3 Decisions and Assessments

Subsequent to exhibition of the EA, copies of all submissions or a report of all issues raised will be provided to TransGrid and relevant Government authorities. TransGrid will review the submissions and consider and respond to the issues raised.

The Director-General will prepare an assessment report for the Project, which will take into account comments from relevant Government authorities as well as other stakeholders and the community. The assessment report will be provided to the Minister for Planning who will determine whether to grant Project Approval and, if so, may impose a number of conditions upon that approval.

1.6 Document Structure

This EA document is comprised of three volumes. The contents of Volumes 1, 2 and 3 are outlined below:

Volume 1	*Executive Summary*	This summarises the key issues and findings detailed in the other parts of the Environmental Assessment.
	Introduction	**Chapter 1** provides an outline of the Project, briefly outlines the environmental impact assessment process, and introduces the various terms used throughout the EA.
	Project Need, Alternatives & Justification	**Chapter 2** details the project need and development alternatives.
	Location of Works	**Chapter 3** details the location of the proposed works and current land use.

Project Description	**Chapter 4** provides an overview of the project and the proposed activities.
Statutory Planning	**Chapter 5** includes a discussion of the relevant controlling Commonwealth and State legislation, and identifies the licences and approvals required to enable the Project to proceed.
Consultation	**Chapter 6** summarises the issues raised during consultation with the statutory authorities, other relevant authorities, and the local community. The issues raised during the consultation process are addressed in the subsequent specialist chapters of the EA.
Environmental Assessment	**Chapters 7-18** provide an overview of the existing environment, an assessment of the likely impacts of the Project and the identification of appropriate mitigation measures to safeguard the environment.
Draft Statement of Commitments	**Chapter 19** outlines TransGrid's commitments to proposed environmental management and mitigation measures to safeguard against, minimise or offset any potential impacts.
Project Evaluation & Justification	**Chapter 20** addresses the principles of Ecologically Sustainable Development (ESD), identifies the potential cumulative impacts and residual risk of the Project, and provides a justification for why the Project should proceed.

Volume 2 Contains the DGRs for assessment of the Project, a compliance table indicating within which section of the EA each DGR is addressed, together with relevant TransGrid policies and procedures referred to throughout the EA, and the separate specialist reports. Specialist reports on Project Feasibility, Emerging Transmission Network Limitation, Constraints Identification, Consultation, Surface Water and Hydrology, Biodiversity, Heritage, Visual, and Hazard and Risk are included. .

Volume 3 Provides the mapping referred to throughout the EA. Aerial and topographic map series in A3 format are provided.

2 Project Needs and Alternatives

2.1 Introduction

The objective of this Chapter is to outline the need for the proposed Project, examine alternatives to meet that need, and identify the preferred option for the Project given the constraints and opportunities faced by the proponent. These issues are required to be addressed in this EA by the Director General's Requirements (DGRs).

To achieve this, the Chapter is structured as follows:

- Discussion of the Project need, i.e. what are the drivers for the development?
- Review of the strategic planning process undertaken by the proponent to lead to the proposed Project.
- Analysis of the identified reasonable and feasible options to demonstrate why the proposed Project is the preferred option.

2.2 Project Need

2.2.1 Far North Region Supply Arrangements

Local Supply Structure

TransGrid is the Transmission Network Service Provider (TNSP) in NSW. It is responsible for electricity supply planning and the reliable transmission of bulk electricity generated at major power stations in NSW and other states to the regional distribution networks across NSW. TransGrid's transmission network comprises of 500kV, 330kV, 220kV and 132kV transmission lines, underground cables and associated substations and switching stations.

The local Distribution Network Service Providers (DNSPs) control the regional networks and are responsible for electricity supply to domestic, commercial and industrial customers. Essential Energy (formerly Country Energy) is the responsible DNSP for the Far North NSW region, and operates 132kV lines as well as 66kV, 33kV, 22kV and 11kV lines with associated substations and local distribution lines in the region.

In the event that demand for electricity in the Far North NSW region grows, Essential Energy would require more electricity to be transmitted to its substations from the main transmission network to enable the delivery of reliable supply to its customers. If sufficient electricity cannot be delivered to the local network through the main transmission network (either due to inadequate overall transmission capacity or due to outages from equipment failure) then widespread supply interruptions (blackouts) are likely to occur, potentially damaging transmission infrastructure as well as household items. These impacts would have the potential to affect a number of Essential Energy's existing and future customers.

Local Supply Network

The Far North NSW region comprises the Ballina, Bellingen (part), Byron, Clarence Valley, Coffs Harbour, Kyogle, Lismore and Richmond Valley local government areas. The region has a population of approximately 280,000 people. Its electrical load is characterised primarily by rural loads, with urban residential and commercial/light industrial loads in the scattered main population centres.

TransGrid's existing 330kV and 132kV transmission line network for northern NSW is illustrated in **Figure 2-1**. The Far North NSW region is circled. TransGrid's network in the region has expanded in the past 30 years, with progressively higher voltages being introduced as demand load in the region has grown. As part of this expansion, 330kV lines were constructed in the 1980s and 1990s. In support of this, both TransGrid and Essential Energy have also installed a number of capacitor banks at substations within the area to assist in managing voltage levels when all network elements are in service and/or during outage conditions.

In addition to TransGrid's transmission network, there is also a privately-owned transmission link, Directlink, which was established in 2000. Directlink is a Direct Current (DC) link connecting Essential Energy's 110kV network in the Tweed Shire and Essential Energy's 132kV network at Mullumbimby. It is now a regulated asset and is able to supply electricity into the region through three parallel 'dc links' from the Queensland transmission network via the Tweed Shire network. The availability of Directlink is a key factor as it determines the amount of load that can be relied upon to be supplied from Queensland.

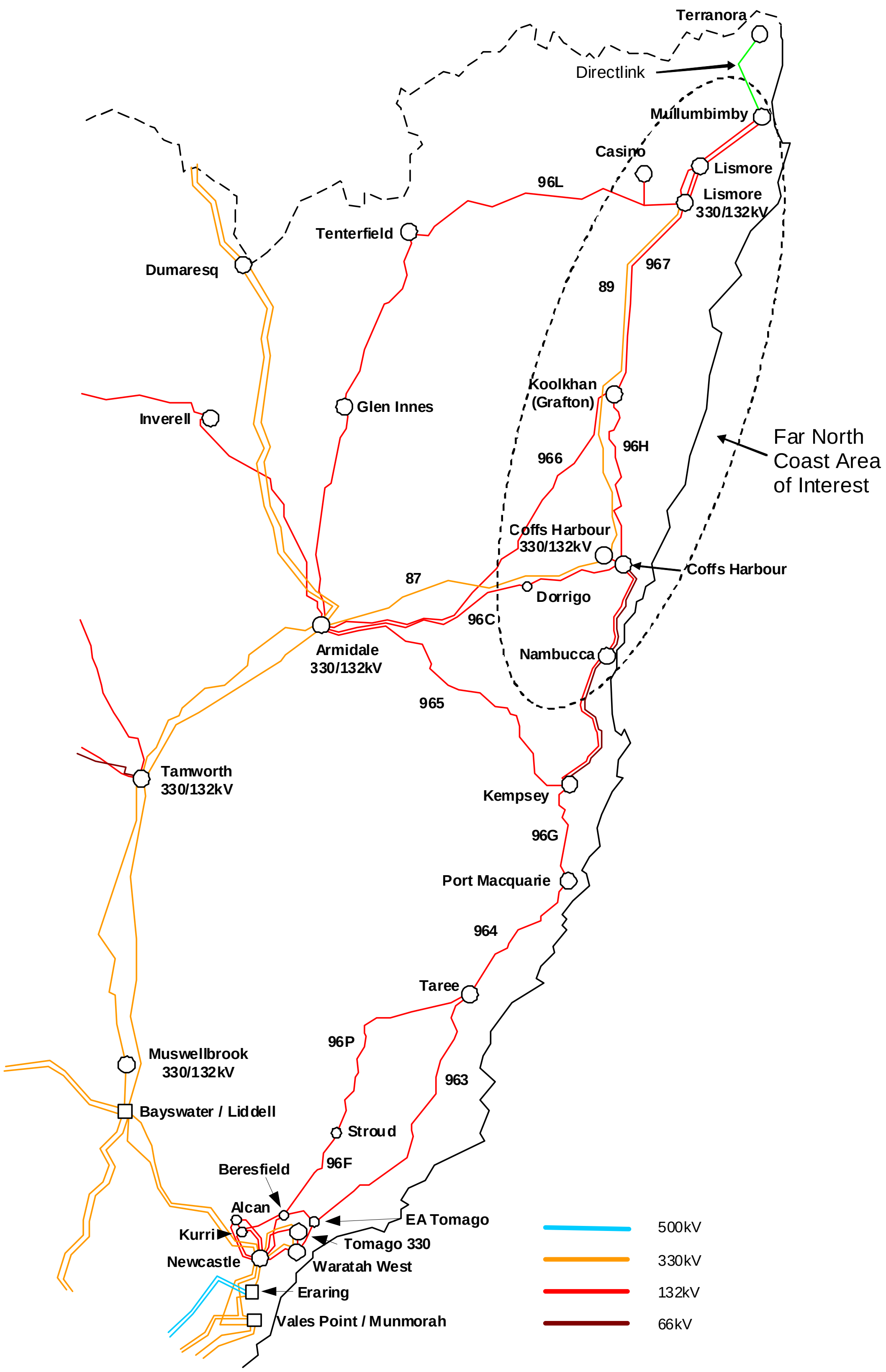
2.2.2 Electricity Supply Obligations

Under the requirements of the National Electricity Rules (NER), TNSPs and DNSPs are required to provide a safe, sufficient and reliable electricity supply of suitable quality in the most cost-effective manner.

The key obligation in this context is the provision of a reliable supply. As detailed in the Transmission Network Design and Reliability Standard for NSW – Dec 2010[1], TransGrid is required to plan and develop its transmission network on a 'n-1' basis, i.e. there will be no inadvertent loss of load following an outage of any single circuit (a transmission line or a cable) or a transformer, during periods of forecast high load (letter from department of Industry & Investment December 2010).

[1] Industry and Investment, NSW

Figure 2-1 Transmission System Supplying the NSW Far North Coast (Far North NSW) Region



The supply obligations required of TransGrid are underpinned by the mandatory licence conditions introduced by the NSW Government in 2005 for NSW DNSPs[2]. For Essential Energy, these licence conditions also specify 'n-1, 1 minute'[3] reliability standards for sub-transmission lines and substations supplying loads greater than or equal to 15 Mega Volt Ampere (MVA) in urban and non-urban areas.

Hence TransGrid is not only required to meet its own obligations in the management of its transmission network, but also to ensure that its transmission network provides a commensurate level of reliability in supplying Essential Energy to ensure that it meets its own licence conditions.

In accordance with these obligations, the two companies have agreed the network performance requirements for reliability to be applied in network planning and management for Far North NSW.

2.2.3 Electricity Demand Projections

Historical electricity demands show a general increase year on year. **Figures 2-2** and **2-3** show actual and forecast electricity demand in the region. Actual demand is affected by weather conditions on the day that they occurred and as a result the historical demands can deviate from the underlying growth trend.

Rising demand is fuelled by a number of different causes including:

- rising population in the region;
- expanding agricultural, industrial, commercial and tourism ventures;
- increasing use of electrical appliances both in domestic and business environments, e.g. reverse cycle air conditioning, computer equipment, mobile technologies etc;
- generally improved living standards and amenities, reflecting the population's higher expectations for a comfortable lifestyle wherever they may choose to live and work; and
- more community facilities and services.

[2] *Design, Reliability and Performance Licence Conditions imposed on Distribution Network Service Providers*, (Macdonald, 2007)
[3] The ability to supply the whole load following the outage of a critical network component, but allowing for a short interruption (up to one minute) while automatic control schemes operate.

Figure 2-2 Actual and Forecast Winter Max Demands

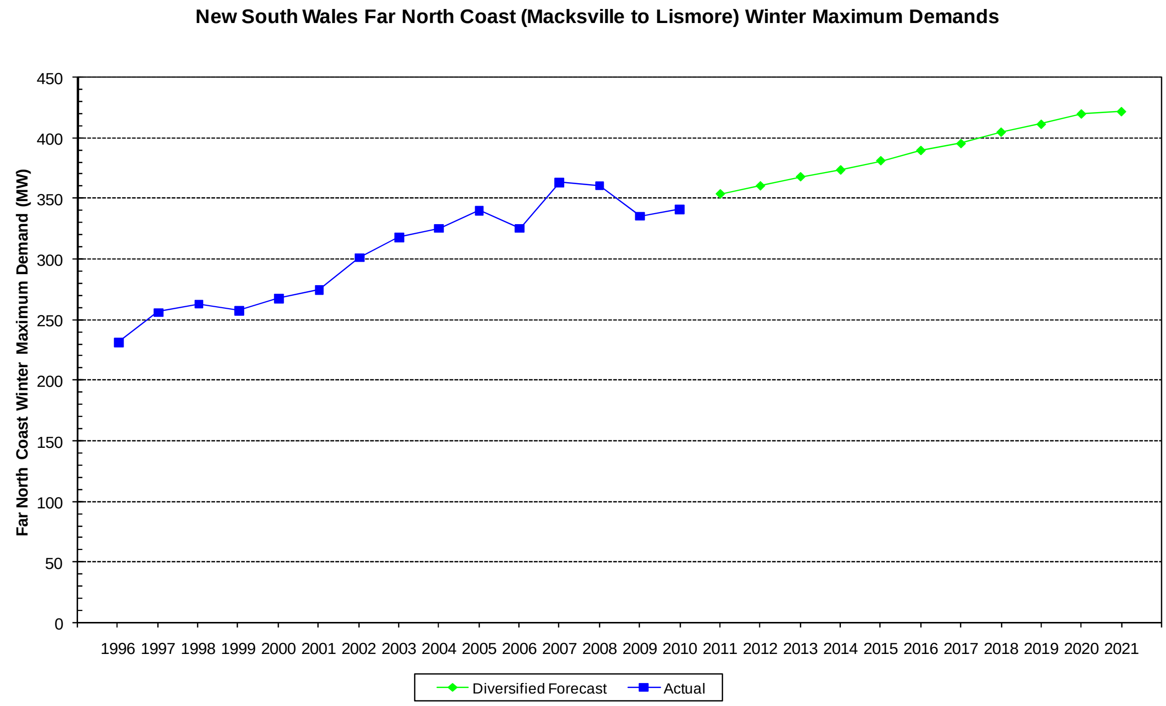
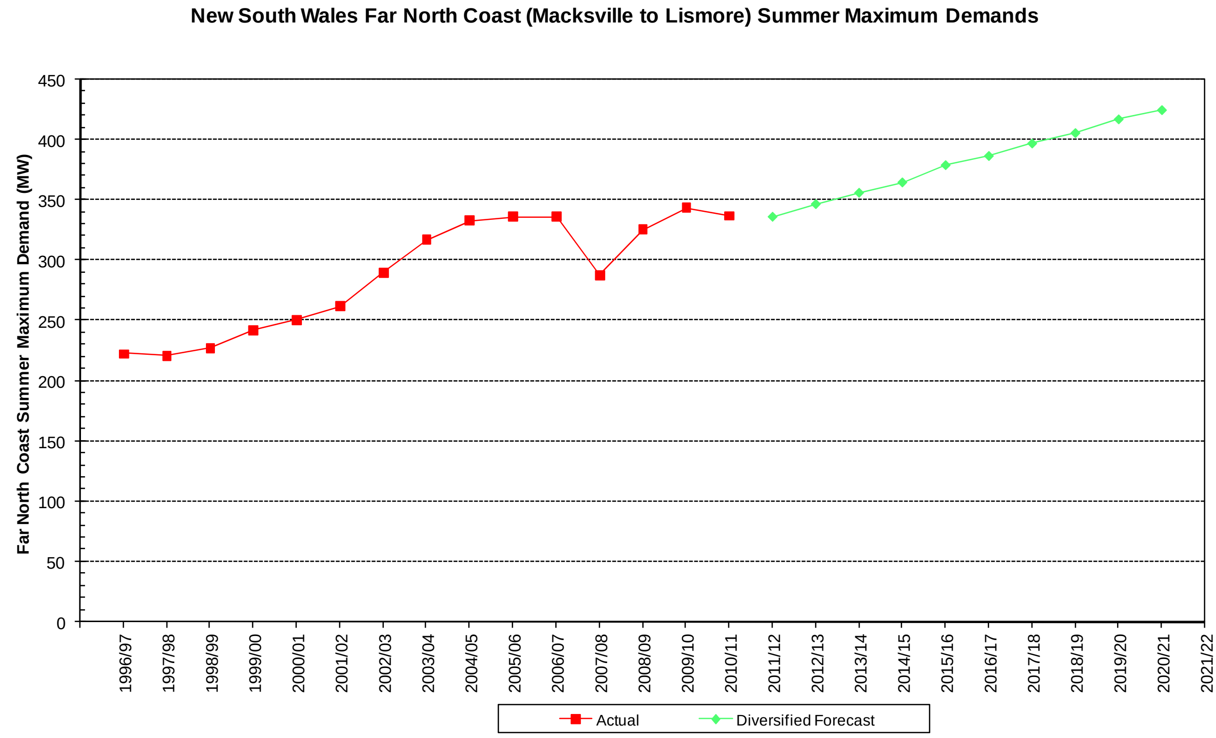


Figure 2-3 Actual and Forecast Summer Max Demands



There are also a number of factors that can, and do, reduce electricity demand from the supply network, potentially influencing the slope of the demand curves. These include:

- increasing efficiency of new appliances and equipment due to technological improvement;
- energy conservation by individual households and enterprises;
- use of local electricity generation options, to produce electricity close to demand, e.g. on a customer's premises; and
- substituting other forms of energy for electricity.

Given TransGrid's and Essential Energy's obligations to meet customer needs for supply of electricity, the two companies work closely to identify potential requirements for future improvement in the electricity supply network.

Growth forecasts are provided in **Figures 2-2** and **2-3**[4], with the forecast maximum winter and summer electricity demand curves for Far North NSW up to 2021. These curves indicate that, notwithstanding measures that mitigate demand, overall electricity demand in the region is forecast to continue to increase. The forecast increase for the region, as shown by the demand curves, is approximately 25% for the 10 years between 2012 and 2021.

The forecast annual load growth is much less than the capacity of one link of Directlink (approximately 55 MW delivered). Consequently, the availability of Directlink is the more important consideration.

As part of the normal planning process, forecasts of maximum demand are updated each year. Each forecast incorporates information that has become available since the previous forecast was produced. Consequently, there can be variations in the forecasts from year to year. For example, the most recent forecasts (provided in this section) differ from those published a number of years ago in the regulatory consultation documents. While this latest forecast is slightly lower than that published in the Final Report, it confirms the ongoing need for augmentation of the network.

2.2.4 Transmission Network Limitations

General Considerations

All high voltage transmission networks have limits to the amount of electricity they can carry. Once these limits are approached, the network is unable to supply electricity reliably to match demand, resulting either in restrictions on use or interruptions to supply.

Key limiting factors include:

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[4] Figures 2-2 and 2-3 show actual and forecast summer and winter maximum demands. The actual maximum demands reflect the particular conditions (temperature and day-type) on the days that they occurred. As those conditions are not necessarily the long term average conditions, care should be taken when interpreting the pattern of actual demands.

The forecast figures are the diversified forecast maximum demands for the area. The maximum demands at the individual 330 kV and 132 kV substations supplying the area do not necessarily occur at the same time. This is referred to as "diversity" between those individual maximum demands. The overall forecast maximum demands for the area have been derived from the forecasts for the individual substations allowing for diversity between them.

The actual maximum demands have been derived from TransGrid meters at the individual substations. The forecast figures are derived from the most recent summer and winter forecast maximum demands (published in TransGrid's 2011 Annual Planning Report) adjusted for recent information on the probable effect of weather on the summer 2010/11 maximum demand.

- voltage drop limit - the voltage level at the receiving end (far end) of the transmission line that the voltage must remain above in order to avoid damaging consumers' equipment;
- conductor clearance limit – where conductors sag too close to the ground or other objects near the line;
- conductor annealing limit - where conductors reach temperatures that could cause the metal to permanently weaken and stretch; and
- substation power limit - a limit on the amount of power that can be delivered through a substation without equipment being overloaded.

Far North NSW

As noted in **Section 2.2.1** above, the electricity supply network in the region has developed over time to match increasing electricity demand. Some of the more recent developments have been undertaken to address identified limitations in the transmission network and hence defer investment in the proposed Project.

In particular, these developments include:

- installation of capacitor banks at various substations by both TransGrid and Essential Energy to support voltage levels both in normal operation and during outage conditions;
- installation of a Static VAr Compensator (SVC) at Lismore Substation in 1999 to provide rapid control of voltage levels during outage conditions;
- uprating of the Armidale-Koolkhan 132kV transmission line in 2006; and
- uprating of the 96C Armidale-Coffs Harbour 132kV transmission line.

As a result of these works, analysis of the electricity supply to Far North NSW by the two companies has concluded that if all elements of the 330kV and 132kV network are in service, they are presently capable of adequately maintaining electricity supply to the Far North NSW region at all times within a ten year planning horizon.

However, the reliability of this supply is presently, and is expected to be, limited by a number of single contingency (n-1) events, identified as follows:

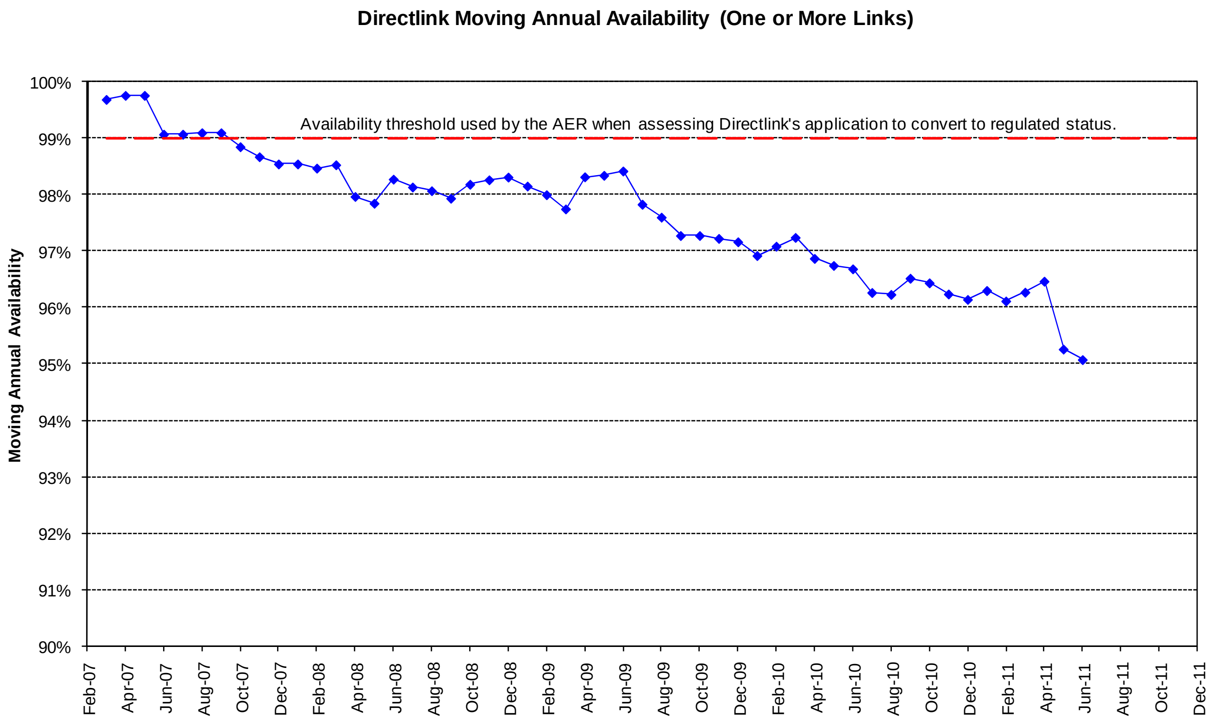
- If the 330kV line between Armidale and Coffs Harbour 330kV Substations were to be out of service during periods of moderate to high electricity demand, the 96C Armidale-Coffs Harbour 132kV line may be overloaded. Under these circumstances, voltages in parts of TransGrid's 132kV transmission network, and in Essential Energy's sub-transmission and distribution networks, particularly in the Lismore area, may not be able to be controlled to adequate levels.
- If the 89 Coffs Harbour-Lismore 330kV line is out of service at times of high demand, the 967 Koolkhan-Lismore 132kV and the 96H Coffs-Koolkhan 132kV lines may be overloaded and low voltages may occur at Lismore.

Analysis by TransGrid and Essential Energy suggests that these limitations could be managed via southward power flows on Directlink to the extent that the transmission system in Queensland and Directlink can accommodate them. However, historical and ongoing operating experience has shown that

Directlink[5] is unable to reliably supply electricity through all three DC links. As a result, for planning purposes, TransGrid considers that a maximum of one of the three links could be relied upon to be available if needed.

Figure 2-4 shows the moving annual availability[6] of one or more links of Directlink as well as the availability benchmark used by the Australian Energy Regulator when Directlink converted to regulated status.

Figure 2-4 Availability of One or More Links of Directlink



The network limitations and the associated timeframes are summarised in **Table 2-1**. Due to the deteriorating availability of Directlink, this table considers two cases; where one link of Directlink is available and where no links are available.

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[5] The reliability issues with Directlink, and the consequent reduced level of load that can be relied upon to be supplied from Queensland, is a major factor contributing to the urgency of the Dumaresq – Lismore 330kV transmission line Project.

At the time that the regulatory consultation was undertaken, TransGrid noted that the availability of Directlink was below the benchmark set by the Australian Energy Regulator during Directlink's conversion to regulated status and concluded that a maximum of one link may be able to be relied upon. Since that time, the availability of Directlink has continued to deteriorate making it less likely that even one link can be relied upon. As shown in Table 2.1, with no links of Directlink available, network limitations arise in 2012/13.

[6] This figure shows monthly values of the average availability over the preceding year. Annual availability figures have been used as these "smooth out" much of the variability that can occur over shorter timeframes. The availability data have been derived from information provided in AEMO reports of generation dispatch.

Table 2-1 Onset of Network Limitations

Constraint	Impact	Year of Onset
Outage of 87 Armidale-Coffs Harbour 330kV line.	Overloading of the 96C Armidale–Coffs Harbour 132kV line. Unacceptably low voltages at Lismore.	2012/13, with no DC links of Directlink available. Around 2016/17 with one DC link of Directlink available.
Outage of the 89 Coffs Harbour–Lismore 330kV line.	Overloading of the 967 Lismore-Koolkhan 132kV line. Unacceptably low voltages at Lismore.	2012/13, with no DC links of Directlink available.

TransGrid has assessed the level of support required to maintain the security of the network in Far North NSW in the event of these single contingency events occurring. This work has shown the worst case scenario to be if the 87 Armidale-Coffs Harbour 330kV line is out of service during times of high demand in summer. The support level required would be dependent on the magnitude and direction of power flows on the Queensland / New South Wales Interconnector (QNI). In the period to summer 2016/17 the support level required could be up to 61MW.

2.2.5 Project Need

The previous sections show that the continuing increasing demand for electricity in the Far North NSW region is pushing the supply network to its limits in terms of safe and reliable operation.

Under normal operations, with all elements of the network in service, the network is presently capable of adequately supplying Far North NSW at all times, within a ten year planning horizon. This has only been possible as a result of the ongoing augmentation of the transmission and distribution networks undertaken by TransGrid and Essential Energy respectively, through the installation of capacitors and uprating of existing lines.

However, there are a number of single contingency events that could significantly affect the supply of electricity to the region, resulting in overloading of lines and/or low voltage levels. These in turn could cause equipment failure and widespread supply failure, impacting large numbers of customers. TransGrid has calculated that in the period to summer 2016/17, the worst case contingency event could result in up to 61MW of customer load being interrupted. At the average NSW household population of 2.5 people per household[7], this would be the equivalent of up to 18,000 households being affected by supply interruptions.

Clearly this is a significant and unacceptable imposition on customers. It would also mean that both companies would fail to meet their respective obligations to the NSW Government to manage their electricity transmission on an ‘n-1’ basis – i.e. to be no inadvertent loss of load following an outage of a single circuit (a line or a cable) or a transformer, during periods of forecast high load.

Given these significant potential impacts, TransGrid and Essential Energy have investigated the options to address the network limitations in the Far North NSW region. They have concluded, as a result of these investigations, that the preferred option to address these potential impacts is the proposed Project – the construction of a new 330kV transmission line between Dumaresq Switching Station and Lismore Substation, via a new 330kV/132kV substation at Tenterfield. The process by which options were identified and analysed, and the basis for the selection of the preferred option, are presented in **Section 2.4** and **Section 2.5** below.

[7] New South Wales Household and Dwelling Projections 2006 to 2036 – 2008 release, NSW Department of Planning

2.3 Project Planning Process

Under the NER, any proposals for network investments by transmission and distribution businesses in the National Electricity Market are subject to a consultation process which includes application of an economic cost-benefit test. In this case, the test was the Australian Energy Regulator's Regulatory Test[8].

2.3.1 Initial Assessment

With their interlinked responsibilities in the region, TransGrid and Essential Energy work in partnership to manage the strategic planning process for the Far North NSW region. This process is undertaken to identify and monitor emerging limitations in the transmission network supplying Far North NSW. The limitations affecting the transmission network supplying the Far North NSW region have been recognised for a number of years, as shown in previous published descriptions in TransGrid's Annual Planning Statements (APS) for 1999 to 2001 and Annual Planning Reports (APRs) for 2002 to 2010, with the APRs in 2008 and 2009 including a summary of the proposed Project.

Building on the work in the early APSs and APRs, in August 2003 the two companies published a paper "Emerging Transmission Network Limitations on the New South Wales Far North Coast[9]" that detailed the likely future limitations of the supply network in the region and to seek information about potential solutions to the network constraints that may be provided by parties other than TransGrid and Essential Energy.

The paper noted that possible options could include increasing the network capacity or reduce loading on critical network elements (either by reducing electrical load at critical times or generating electricity downstream of the critical network elements). The paper also noted that, in parallel, the two companies were developing their own possible options to relieve the identified network constraints. The full paper is included as **Appendix B-1.**

No responses relating to new development proposals were received from other parties in response to the paper.

2.3.2 Regulatory Consultation

As no feasible alternatives to the work being undertaken were identified from that initial assessment, the two companies commenced the regulatory consultation process in April 2008 (including application of the Regulatory Test) for the proposed Project to address the network limitations for supply to Far North NSW as required by the NER. This consisted of a two part consultation process that assessed the feasible options and identified the preferred option.

Consultation commenced with the publication of an Application Notice on the Australian Energy Market Operator's (AEMO, previously known as the National Electricity Market Management Company) website on 28 April 2008. In response, submissions were received from proponents of non-network options, and discussions were entered into with those parties to determine whether such options were potentially viable within acceptable timeframes.

[8] The Australian Energy Regulator published the Regulatory Test pursuant to the National Electricity Rules (as they stood at that time). The purpose of the Regulatory Test was to identify the most cost effective option to meet the reliability obligations placed upon TransGrid and Country Energy (now Essential Energy).

[9] TransGrid & Country Energy, Aug 2003

Progressing through the second stage of the regulatory consultation process, in March 2009 TransGrid and Essential Energy published a further report, Final Report – Development of the Electricity Supply to Far North NSW[10], which is included in **Appendix B-4**. The conclusion of that report, which included application of the Regulatory Test to all known reasonable options, was that the preferred actions were for TransGrid to:

- proceed with construction of the proposed Project; and
- continue discussions with the proponents of non-network developments to determine whether implementation of one or more of those developments was feasible and would be cost-effective in deferring the date by which the proposed Project was to be completed.

2.3.3 Request for Proposals

Following the second stage, in May 2010 TransGrid issued a Request for Proposals (RfP) seeking network support in Far North NSW. The RfP closed on 13 July 2010. The purpose in issuing the RfP was to:

- assess whether the previously-identified non-network development options were economically and technically viable to overcome the network limitations and allow the proposed Project to be deferred; and
- seek immediate network support options for managing the network limitations, given that the availability of Directlink had deteriorated further and that the proposed Project had been delayed from its original timeline.

Following the RfP, TransGrid issued a further document, Supplementary Report – Development of Electricity Supply to the NSW Far North Coast (included in **Appendix B-5**), which detailed the following main outcomes of the RfP process.

- Six responses were received, with options covering local generation, investigation of the potential for demand management in the area, energy storage and assistance in verifying that requested demand reductions are actually received.
- Only one of the six responses received contained sufficient information (details of the amount network support and associated costs) to enable it to be evaluated.
- That option did not offer adequate network support that would allow any further delays to the commissioning of the proposed Project.
- That option could help reduce potential supply interruptions in the region prior to commissioning of the proposed Project, although the amount of network support offered was less than being sought and the support was not offered for summer 2010/11 or summer 2011/12.
- Notwithstanding the above, TransGrid would continue to negotiate with the proponent of that one option to establish a network support contract to help mitigate the risks of supply interruptions prior to the commissioning of the proposed Project.

[10] TransGrid & Country Energy, Mar 2009

2.3.4 Conclusions

The outcome of the RfP process clearly showed that potential non-network development options would be inadequate to fully overcome the risk of potential supply interruptions in the region prior to commissioning of the proposed Project, let alone address the long-term network limitations for which the proposed Project is being developed.

This outcome reinforced TransGrid's previous conclusions in 2009 that the best long-term option for addressing the network limitations in the Far North NSW region would be the development of the proposed Project.

This conclusion was further supported in September 2010 by the Australian Energy Regulator, which confirmed the outcome and final conclusion of the Regulatory Test undertaken by TransGrid[11].

2.4 Project Alternatives

As detailed above, TransGrid and Essential Energy carried out an extensive strategic planning process to identify and assess the potential options for addressing the network limitations in the Far North NSW region.

In accordance with regulatory requirements, this process included a number of consultation stages, seeking third-party proposals for alternative options to the proposed Project, as well as formally completing the Regulatory Test for the preferred option. This analysis led to the conclusion that the proposed Project was the preferred option, and that there were no viable non-network options.

The following sections summarise and analyse the potential options considered.

2.4.1 The Do Nothing Option

In the event that TransGrid and Essential Energy chose not to do anything to strengthen the network (the 'Do Nothing' option), the continuing increasing demand for electricity in the region would place increasing strain on the supply network.

The result of this would be that single contingency events would be more likely, resulting in more frequent interruptions to supply to large numbers of customers in the region. This would have an ongoing and increasing impact on customers, significantly affecting their quality of life and the effective operation of businesses in the region.

As this scenario would be unacceptable to customers in the region, and incompatible with TransGrid's and Essential Energy's regulatory obligations to the NSW Government, it is clear that the 'Do Nothing' option is not feasible.

2.4.2 Demand Management Options

Electricity peak demand, which typically occurs on summer afternoons and winter evenings, is a major driver of investment in new electricity transmission infrastructure. Reducing overall electricity use and shifting electricity use from peak periods to times when the electricity network has spare capacity has multiple benefits.

[11] Pg 21 of "Investigation Report: Compliance with the planning and network development provisions of the National Electricity Rules, TransGrid", AER, Sept 2010

Demand management strategies – namely, activities aimed at improving the efficient use of electricity and/or changing the times that electricity is used (away from peak demand periods) seek to influence the way in which consumers use electricity. If the load reductions achieved through demand management are sufficiently large and appropriately targeted they may relieve network constraints and consequently may be able to defer requirements to build network augmentations.

Demand management has long been accepted by government, business and industry in Australia as a viable alternative to developing and building new electricity generation, transmission and distribution capacity.

For electricity transmission and distribution companies such as TransGrid and Essential Energy, the NERs impose an obligation "*in which generation, energy storage, demand side options and network augmentation options are given due and reasonable consideration*."

This obligation requires that the focus of TransGrid and Essential Energy initiatives should not just be on the network, but also on the delivery of end-user energy services by means of the electricity system as a whole.

Constraints that arise within the distribution network can potentially be addressed by changes in customer behaviour, by changes in equipment used by customers or by installation of small-scale generation at a local level, as well as by enhancement of the distribution network. These options could be devised and implemented by customers or by distributors.

The market-based procedure in the NERs is intended to ensure that all supply and demand side options developed by customers or third parties and by the distributor itself can be developed and evaluated at the same time and in the same manner as network augmentations.

Energy efficiency and demand management programs include:

- improving energy efficiency, through measures such as use of more energy efficient equipment, education and consumer awareness programs; energy audits of businesses and industrial plants, reducing waste, etc;
- conversion of appliances to off-peak use (e.g. hot water systems);
- distributed generation, including standby generation and cogeneration;
- load management, including interruptible loads, direct load control and demand response;
- thermally efficient building designs; and
- fuel substitution, such as using gas for heating systems instead of electricity.

Under the NER, the two companies have to take account of the potential impact of demand management initiatives in preparing forecasts of future electricity requirements. Demand management is therefore an essential part of the network planning process outlined in **Section 2.3** above.

The success of demand management programs in deferring additional transmission infrastructure in any area is dependent on a number of factors, including the rate of population growth, willingness of consumers to modify their patterns of electricity use; and third-party investment in demand management options.

However, as shown in **Section 2.3.3**, there are no feasible, cost effective non-network options that would enable the proposed Project to be deferred.

2.4.3 Small-scale Network Augmentation

As detailed in **Section 2.2.4**, TransGrid and Essential Energy have implemented a number of smaller-scale network augmentation projects (including capacitor bank installations for voltage control and uprating of existing 132kV transmission lines to improve the transmission capacity) that have previously helped manage the identified network limitations and defer the proposed Project.

However, the strategic planning process has concluded that there are no further smaller-scale options available to defer the proposed Project. For example, the "Final Report – Development of the Electricity Supply to Far North NSW"[12] (**Appendix B-4**) examined whether it would be feasible to develop smaller 132kV transmission lines rather than the larger 330kV line.

The report concluded that the forecast demand growth in the region would necessitate an additional 132kV circuit every three years or so – which would not be a reasonable approach given the associated environmental and community impacts of such proliferation of new transmission lines.

2.4.4 New Generation

As noted in **Section 2.3.1**, the 2003 paper, "Emerging Transmission Network Limitations on the New South Wales Far North Coast" (**Appendix B-1**), concluded that possible options for addressing the identified network limitations could include increasing the network capacity or reducing loading on critical network elements (either by reducing electrical load at critical times or generating electricity downstream of the critical network elements (close to where it is used)).

Section 2.4.2 above has examined the possibilities of reducing the electrical load at critical times through demand management options – this Section looks at whether local generation could be established to avoid the proposed Project.

At present, the electricity supplied by TransGrid and Essential Energy is produced by electricity generating companies (in NSW and elsewhere in the NEM) primarily from large-scale coal-fired generators, with an additional mix of hydro-electric plant, gas-fired turbines, and renewable generators (such as wind and solar). These generators are largely located remote from the Far North NSW region, with electricity supplied through the existing transmission network.

However, there are various alternative energy sources that could, in principle, meet local electricity supply needs and avoid the need for the proposed Project.

Examples of such proven generation options include:

- thermal generation, fuelled by coal or gas (such as co- or tri-generation);
- thermal generation using biomass as fuel (e.g. bagasse); or
- renewable generation, such as wind or solar, either as large-scale plant or smaller-scale on customer premises.

However potential options and locations for such local generation are limited by a range of factors, including:

- the need to be installed downstream of the critical network elements to be effective (e.g. installation at Lismore would be much more beneficial than installation around Coffs Harbour for outages of the Coffs Harbour-Lismore line);

[12] TransGrid and Country Energy, Mar 2009

- the need to operate effectively, quickly and reliably at times of high load in both winter and summer (which may mitigate against renewable energy options if generation is constrained by adequate 'fuel' availability);
- the likely need for the installation of additional transmission and connection equipment (e.g. high voltage lines, substations, etc) to safely connect new generation into the existing network.

Based on TransGrid's obligations for providing a reliable electricity supply, it has defined the requirements that local generation would have to achieve. These requirements are that local generators should:

- presently exist or be committed to be in service by the required time[13];
- be sufficiently reliable for TransGrid (and hence Essential Energy) to be able to rely on it to be operating at the critical times (e.g. at times of high demand);
- be located where its output will reduce the loading on the critical part(s) of TransGrid's transmission network; and
- have a proponent willing to enter into a contract ensuring that the generator(s) are operating with the necessary output when required.

There are examples of proposed local generation options that potentially could provide the additional required capacity, but these are currently unable to meet TransGrid's requirements:

- A 30MW reciprocating gas engine proposed for the Casino area (about 20km west of Lismore). At this stage the proposal is not committed and cannot be relied upon to relieve the limitations in the transmission network in Far North NSW;
- Existing bagasse biomass generation plant at Condong and Broadwater. Condong is on the northern side of Directlink and would not reduce the loading on TransGrid's network supplying Far North NSW[14]. For Broadwater, the owner has confirmed that it does not wish to be contractually bound to provide network support to either Essential Energy or TransGrid. Therefore, neither of these plants could be relied upon to relieve the limitations in the transmission network in Far North NSW.

Consequently, TransGrid and Essential Energy sought local generation options as part of the broader request for non-network development options during the regulatory consultation process and via the RfP, as detailed in **Section 2.3**. However, no viable local generation options were identified or proposed during this process.

2.4.5 New Transmission Options

The analysis detailed above shows that the only effective and viable option for addressing the identified network limitations in Far North NSW is a major investment in augmentation of the existing transmission network.

[13] In assessing whether a generation development is committed, TransGrid uses the criteria applied by AEMO in its statement of Opportunities. Those criteria require that; land has been acquired, all necessary approvals are in place, contracts for construction have been let, financing arrangements are in place and a firm date for construction has been set. It is important to note that a generator being committed does not necessary mean that it will satisfy the other essential requirements.

[14] As Directlink limits the amount of power that can be supplied from the north and there is sufficient capability in the network supplying the Tweed Shire from Queensland to fully utilise the reliably available capacity of Directlink, it makes no difference whether Condong is operating or not.

A number of network augmentation options were identified in the Final Report – Development of the Electricity Supply to Far North NSW[15] (**Appendix B-4**), involving developing additional transmission lines and connections in order to provide sufficient additional transmission network capacity.

These are summarised below, with the two primary options listed first. Both options involve uprating the existing 96C Armidale-Coffs Harbour 132kV line – a separate project that has now been completed. This is the last of the small-scale projects possible to delay the need for a major network augmentation.

Primary Options

- Option 1: Dumaresq-Lismore 330kV line: construction of around 205km of new 330kV transmission line between Dumaresq Switching Station and Lismore 330/132kV Substation, with associated infrastructure; and
- Option 2: Armidale-Lismore 330kV line: construction of around 300km of new 330kV transmission line between Armidale 330/132kV Substation and Lismore 330/132kV Substation, with associated infrastructure.

Both primary options would overcome the network limitations described in **Section 2.2.4** over at least a ten year planning horizon.

Alternative Options

- Armidale-Kempsey Area 330kV line and Kempsey 330/132kV Substation: construction of a new 330kV line between Armidale 330/132kV Substation and a new 330/132kV substation in the Kempsey / Port Macquarie area. Although this option is anticipated to be a later stage in the development of a 330kV network serving the mid-north coast, implementing it as an initial stage of that development would not be technically feasible as it would cause technical impacts elsewhere in the transmission network. Hence this was not considered to be a reasonable option;
- Ebenezer-Lismore 330kV line: construction of a new 330kV line between the Ebenezer area near Ipswich in southeast Queensland and Lismore, with associated infrastructure including a new substation in the Ebenezer area. This option includes future major works that are not considered necessary until well into the future and hence would be unnecessarily bringing forward future investment. The line routing could also be significantly constrained by the presence of National Parks and World Heritage Areas; and
- Armidale-Coffs Harbour-Lismore 330kV line: construction of a new 330kV line between Armidale 330/132kV Substation and Lismore 330kV Substation via Coffs Harbour. This was not considered to be a feasible option as line routing options were likely to be constrained by the presence of National Parks and Conservation Areas, and costs were likely to be significantly greater than for either Option 1 or Option 2.

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[15] TransGrid & Country Energy, March 2009

2.4.6 Conclusion

TransGrid's analysis of the alternative options to major investment in network augmentation has concluded that, although there are potential options, "*there are no known committed or advanced generation or demand management developments that are likely to affect the timing of the onset of the network limitations or the ability of any reasonable option to meet them*."[16]

As a result, TransGrid and Essential Energy have investigated the new transmission options, and concluded that there are two feasible and cost-effective transmission options that could be developed.

- Dumaresq-Lismore 330kV line (Option 1).
- Armidale-Lismore 330kV line (Option 2).

2.5 Preferred Option Analysis

This Section assesses the two feasible and cost-effective transmission options outlined above, and confirms the selection of the preferred option.

It also presents analysis of some of the key design elements of that preferred transmission option, which in turn form the basis of the proposed Project.

2.5.1 Economic Considerations

As part of the development of the transmission line options, and for the purposes of the Regulatory Test, TransGrid and Essential Energy prepared preliminary estimates of the costs for the development of the two options, including capital costs and operational and maintenance (O&M) costs, and cost of complying with laws, regulations and applicable administrative requirements.

The present value of the costs for each option was calculated for a base case of financial and technical assumptions in 2008/09 dollars, as presented in **Table 2-2**.

Table 2-2 Capital Cost Comparison

Option	Capital Costs ($M, 2009)	PV[1] of Costs ($M, 2009)	Rank
Option 1	226.7	108.4	1
Option 2	280.4	134.5	2

[1].Present value – costs compared to a common in $ base 2009

Sensitivity tests of these calculations across a range of reasonable variations (e.g. increased / decreased capital cost; increased / decreased asset life, etc) were carried out, and in all cases Option 1 ranked as the most cost-effective option.

In conclusion, the economic analysis undertaken shows that in broad terms Option 1 is more cost-effective. As a result, Option 1 has been selected as the preferred option for the proposed Project.

[16] pg 24, Final Report – Development of Electricity Supply to the NSW Far North Coast, TransGrid & Country Energy, Mar 2009

2.5.2 Option 1: Preferred Route and Design

Overhead / Underground Line

For the design of the proposed Project, there are essentially two principal sets of technical alternatives, namely:

- Electrical energy may be transmitted either above ground on overhead lines supported by pylons, or by underground cable, and
- The energy may be transmitted either by alternating current (AC), or by direct current (DC). In all cases high voltage (HV) is employed because of the overwhelming efficiency benefits that result from this approach.

AC is the worldwide standard for electrical power grids because of the cost advantages arising from the fact that it is relatively easy to change the voltage of the power. This allows transformers to step up voltage at the generators to very high levels for long-distance transmission (HVAC), and then use additional transformers to step that high voltage back down for local distribution at a reasonable and relatively safe value for use in individual homes and businesses.

High Voltage direct current (HVDC) does provide an alternative to HVAC transmission in some specific situations, particularly when electrical energy has to be transported between two points which are far apart (e.g. some of the connections between Canada and the United States), or where a very long stretch of water has to be crossed (e.g. for the Basslink connection between Victoria and Tasmania). However, because of the need for converter stations to convert the DC power back to AC to allow onward transmission through the existing grid, they are not practical or cost-effective for use in network upgrade such as the proposed Project, where there are intermediate connections such as the substation at Tenterfield. For that reason, HVDC has not been considered further in this assessment.

Long-distance transmission of high voltage alternating current (HVAC) worldwide is primarily based on overhead line technology. UCTE [17] reports that some 99.1% of the extra high voltage electricity (EHV) transmission network is of HVAC overhead line construction, with the remaining 0.9% being underground cable[18], mainly found in urban areas. This is reflected in NSW, where the vast majority of TransGrid's existing HVAC network is overhead line, with some shorter links into major urban areas (such as Sydney CBD) being installed underground.

Although construction of long-distance HVAC underground transmission is technically feasible, primarily offering advantages in minimising visual impacts, there are a number of factors that constrain its practical implementation for the proposed Project, as follows:

- Cost: the installation cost for underground transmission cables can range from 5-10 times the cost of an equivalent overhead line (affected by issues such as easement access, terrain and topography, soil conditions, etc.);

[17] The Union for the Co-ordination of Transmission of Electricity (UCTE) is an association of 33 transmission system operators in 23 continental European countries.

[18] UCTE Statistical Year Book 2006.

- Maintenance: although underground cables may have less outages initially, when outages do occur it can be much more time-consuming to locate, diagnose the problem and repair an underground transmission cable, potentially causing extended outages for customers. The difference in repair times can be weeks or even months, compared to hours or days;
- Installation: the time, effort and impact of underground installation is greater than overhead installation. A single transmission circuit requires three cables, each of which must be installed in an individual conduit within a trench of at least 1.5 meters in depth. The conduits are then encapsulated in thermal concrete and surrounded by special thermal backfill materials. This requires all surface vegetation and obstacles to be cleared, as well as ensuring vehicle access for delivery of the required materials, for the full length of the line. There are also further challenges with crossing watercourses and negotiating steep terrain;
- Capacity constraints: All electricity transmission cables produce heat and therefore have a limit on the amount of power that they can carry. Underground cables cannot dissipate heat as well as overhead lines, given that they are surrounded by soil which has a greater insulating effect than air. Variations in the type of soil surrounding the cable along the route, and differences in the depth of installation can all affect the cable's ability to dissipate heat and hence its operating capacity.

Given the likely benefits of reducing visual impact by underground construction, it would also be technically feasible to construct the transmission line as a mix of overhead and underground cable, with the underground sections designed to avoid visual impacts in potentially sensitive locations. However such an approach would still incur many of the same issues identified above (particularly the cost and reliability / maintenance issues), whilst requiring further electrical infrastructure to be constructed to ensure the safe transition between overhead and underground transmission. It would be much more practical and cost-effective to develop a route that minimizes visual impacts in the first place, and implement other measures (such as pole design, colour schemes, and screening) to mitigate such impacts.

In conclusion, although technically feasible, installation of the proposed Project underground would have significantly greater environmental, economic and social impacts than overhead construction.

Preferred Route – Feasibility

TransGrid started investigating route options for the 'greenfield' section of the proposed Project in 2006, with a feasibility study[19] (**Appendix B-2**) to assess possible routing options for a new 330kV transmission line between Dumaresq Switching Station and Tenterfield. The purpose of the study was to assess whether such a proposal was feasible, and if so, to identify potential route options that could be investigated further.

The study concluded that there were a number of major constraints to a line routing, including steep and rocky terrain, existing habitation, Torrington State Conservation Area, National Parks, State Forests, the NSW/QLD state border, the township of Tenterfield, heritage listed properties, current and former mine sites, the Dumaresq River and minor airstrips. The presence of the Torrington Conservation Area in the centre of the study area, in particular, constrains the potential options to broad corridors either north or south of its boundaries.

[19] Dumaresq to Tenterfield 330kV Transmission Line Route Feasibility Study, Connell Wagner, Jul 2006

Within these constraints, site investigations and analysis of the study area indicated that the proposed Project would be feasible, with three possible route corridors identified (shown **in Figure 5.1, Appendix B-2**), as summarised in **Table 2-3.**

Table 2-3 Proposed Project: Route Option Comparison

Route		Details
Northern Corridor 1	Route	Runs north-east parallel with the Bruxner Highway, then east in the vicinity of Reedy Creek Road. Rejoins the Highway and runs generally east in parallel to link to the existing Lismore-Tenterfield line at the Tenterfield 132kV Substation or a connection east of this point.
	Constraints	Steep terrain, landing strips, homesteads, Dumaresq River, Tenterfield Creek, Bruxner Highway road corridor.
	Opportunities	Generally good access, extensive areas of cleared or partially cleared land, generally favourable terrain, shortest length.
Northern Corridor 2	Route	Running north-east parallel with the Bruxner Highway, then east in the vicinity of Reedy Creek Road. Continues south-east in proximity to the road before entering the Mole River valley. The route runs parallel with Upper Mole River Road before heading north-east to run parallel with the existing easement for the Glen Innes-Tenterfield line to the Tenterfield 132kV Substation from the south.
	Constraints	Steep terrain, heritage sites, rocky outcrops, landing strips, homesteads, Mole River, Gibraltar Nature Reserve, narrow corridor in some locations.
	Opportunities	Road reserves, Glen Innes-Tenterfield 132kV line easement, grazing lands.
Southern Corridor	Route	Runs south-east / east in a sweep around the bottom of the Conservation Area, across the New England Highway, then parallel to the existing easement for the Glen Innes-Tenterfield line to the Tenterfield 132kV Substation
	Constraints	Longer overall length, steep terrain, landing strips, threatened ecological communities, dense vegetation, Bolivia Hill Nature Reserve.
	Opportunities	Access advantages of the existing Queensland-New South Wales Interconnection 330kV line easement, Glen Innes-Tenterfield 132kV line easement, open grazing lands.

The Southern Corridor is significantly longer than the Northern Corridor routes and was largely identified in case unforeseen constraints subsequently prevented the adoption of one of the Northern Corridor route options.

Preferred Route – Constraints

In 2009 a Constraints Identification and Preferred Corridor Report[20] was produced for the full length of the proposed Project – the 'greenfield' section between Dumaresq and Tenterfield; the section between Tenterfield and Casino which is proposed to use the existing easement for the existing 132kV line; and the section between Casino and Lismore which is proposed to run adjacent with the existing 132kV line. This report is provided in **Appendix B-3**.

Building on the findings of the feasibility study a staged approach was adopted for the constraint analysis. This analysis examined the environmental, social, technical and economic issues related to the Project and its conclusions were used to help finalise the preferred route alignment.

[20] Dumaresq-Lismore 330kV Transmission Line Constraints Identification and Preferred Corridor Report, Sept 2009

The key stages of the work comprised:

- a desktop review of all existing environmental and engineering data relating to the study area;
- a community consultation programme to promote awareness of the proposed Project, and to assist in gathering local knowledge about the study area and about what is important to the local community in regards to corridor selection;
- consultation with relevant government agencies to understand their requirements and recommendations in relation to the study area;
- preliminary field investigations, in particular to identify key land use, ecological, heritage, and visual constraints;
- consolidation of all identified information and constraints into a Geographic Information System (GIS) package to facilitate an objective analysis of all constraints within the study area;
- a constraints analysis workshop to analyse the identified constraints and routing options; and
- identification of a preferred corridor within which an easement could be developed for the proposed Project.

Table 2-4 provides a comparison of the northern corridors option against the southern corridor option.

Table 2-4 Proposed Project: Northern / Southern Corridors Comparison

Northern Corridors	Southern Corridor
Length of corridor options 82-90km – offers shortest length option.	Longest overall option, approximately 105km.
Potential to use easement for Bruxner Highway or for Glenn Innes-Tenterfield 132kV line, reducing need for additional easements.	Potential to use easements for Queensland-New South Wales Interconnection 330kV line and Glenn Innes-Tenterfield 132kV line, reducing need for additional easements.
Generally good access from existing road networks, including Bruxner Highway.	Access less favourable, requiring additional easements / clearing for construction.
Some areas of steep terrain, but potential options with less steep terrain, and minimal rocky outcrops.	Extensive and significant areas of steep terrain, with considerable rocky outcrops.
Extensive areas of cleared or partially cleared land.	Significant areas of densely populated vegetation likely to require clearing.
Smaller number of identified Threatened Ecological Communities (TECs), due to less dense vegetation and use of existing cleared easements.	Larger number of identified TECs within greater areas of denser vegetation.
Only one registered airstrip within 1km of the identified corridors.	Five registered airstrips within 1km of the identified corridors.
Clusters of registered Indigenous and European heritage sites within proximity of the identified corridors.	Clusters of registered Indigenous and European heritage sites within proximity of the identified corridors.

The review of these factors related to the ‘greenfield’ (Alignment West) component of the Project concluded that the northern options were less constrained and had less of an environmental impact than the southern option. Therefore the Southern Corridor option was ruled out at an early stage of the process.

Key issues in the selection of the preferred corridor included topography, access, proximity to residences, severance, vegetation clearing, land use, visual, ecological, and heritage constraints.

The selection of the preferred corridor was identified following the findings of a constraints analysis workshop. The workshop was held in order to consider and analyse the balance and significance of the varying environmental, social, engineering and economic constraints across the study area.

The workshop and the constraints analysis focused on comparing the key route differences between the two Northern Corridor route options. **Table 2-5** summarises the conclusions of this option analysis.

Table 2-5 Preferred Corridor: Option Analysis

Key Area of Route	Key Issues	Preferred Option
Optimum point to cross the Mole River: 2 corridor options	Potential biodiversity constraints from presence of TECs High likelihood of Aboriginal heritage sites	No preferred option without further detailed field investigation, due to no significant difference in constraints
Optimum routing around Tenterfield: 2 options to the north	Likely presence of threatened species and TECs High densities of rural residential dwellings	Most northerly corridor option preferred, as the option closer to Tenterfield had a higher density of landholdings and generally more restrictive ecological constraints

The advantages of the preferred corridor, as detailed in Section 6 of the report **(Appendix B-3**), are identified as follows:

- avoidance of dense clusters of holdings. In a number of locations, the width of the corridor was determined in order to maximise the opportunity for avoiding residential dwellings and small property holdings;
- the corridor location and width maximises the opportunities for paralleling lots and paddocks thereby reducing severance and minimising potential impact on the use of agricultural machinery;
- a corridor width of 500m to 1.6km allows for opportunities at the detailed design stage to position the alignment in order that various environment impacts can be avoided or mitigated;
- avoidance of existing centre-pivot irrigation systems;
- a reasonable level of access from existing sealed roads to the corridor;
- locating the corridor across a limited number of land uses that are predominantly rural agricultural in nature, largely comprising cropping and pasture land. Significant areas of closed forest were avoided;
- maximising opportunities to avoid identified Threatened Ecological Communities as defined in the TSC Act; and
- the avoidance of a number of large identified areas of threatened species habitat. This includes intact native vegetation that represents important habitat for native flora and fauna including threatened species.

The preferred corridor option is shown in Figures 6-1a and 6-1b of **Appendix B-3**.

Transmission Line Structures

With conclusion that an overhead line represents the optimum design in terms of reliability, ease of installation, environmental impact, cost-effectiveness and on-going maintenance, one key element of identifying the preferred corridor was to minimise potential visual impact from the proposed Project on the local communities in the area.

In addition to routing, the design of the support structures for the transmission line can also mitigate visual impacts. With this in mind, TransGrid has identified two options for the supporting structures for the proposed Project:

- Traditional 330kV steel lattice towers: steel lattice towers with a typical tower height ranging from 25m to 37m[21]. They have a heavier construction and are required at Angle Positions (where the loads are much greater) and where other engineering requirements require the use of a more robust support structure; and
- Concrete H-frame pole structures: smaller concrete suspension structures with an average height of approximately 30m. The H-frame poles are considered to have a lesser visual and environmental impact due to smaller structure footprint

A combination of steel lattice towers and H-frame pole structures would be used for the transmission line, as detailed in **Chapter 4 Project Description**, with H-frame poles used wherever possible with the objective of minimising visual impacts.

However, there will always be engineering conditions (such as ground conditions or change of angle in line alignment) which will dictate where steel lattice towers are required.

2.5.3 Conclusions – Preferred Option and Design

In conclusion, the proposed Project represents the preferred option for addressing the network limitations in Far North NSW.

In the absence of feasible non-network solutions, two transmission line options had been identified as viable options to ensure that both TransGrid and Essential Energy meet their obligations for the reliable supply of electricity to the region.

Of these options, initial analysis concluded that the Dumaresq-Lismore 330kV transmission line option (Option 1) is the most cost-effective.

For the specific corridor alignment, the outcome of the Constraints Identification and Preferred Corridor Report, coupled with on-going discussions with property owners, the community and other key stakeholders, identified the preferred alignment that offers the optimum compromise of the identified environmental, social, technical and economic benefits and impacts.

Further details of the location of the preferred alignment for the transmission line and associated works, including access tracks and the proposed Tenterfield 330kV Substation is described in **Chapter 3 Location of Works**.

[21] For the proposed Project, the last two structures leading into Lismore Substation would be double circuit structures, supporting both 330 kV and 132 kV line, and hence would have a height of 46-54m

Within this alignment, analysis of the technical options shows that, although technically feasible, installation of the proposed Project underground would have greater environmental, economic and social impacts than overhead construction with appropriate routing and selection of supporting structures.

Chapter 4 Project Description provides further technical details on the Project components and the construction process.