



CONSULTATION PAPER

DEVELOPMENT OF

NEW SCONE 66/33/11kV SUBSTATION

(to Address Capacity and Condition Issues in the Upper Hunter Area)

15th October 2007

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EXECUTIVE SUMMARY

This paper has been prepared to provide a basis for EnergyAustralia to consult with registered and interested parties on the possible options for the development of the electricity supply network in the Muswellbrook supply area to address projected limitations of that part of EnergyAustralia's distribution system. EnergyAustralia will conduct an economic analysis of possible options that satisfy regulatory test.

Section 1 of the paper provides a description of the Muswellbrook supply area.

Section 2 presents EnergyAustralia's service standards for the area and describes, in detail, various asset condition and capacity issues in the area that resulted in the need for augmentation of supply to the area.

Section 3 outlines the possible options to address the issues affecting the supply network including options for supply system development. Three feasible augmentation options are described:

Option 1 – A new Scone 33/11kV zone and a new 33kV feeder between Muswellbrook STS and the new Scone zone, consistent with a long term strategy to upgrade the existing 33kV network.

Option 2 – A new Scone 66/11kV zone and extension of the existing 66kV 'Dartbrook' feeder to the new Scone zone, consistent with a long term strategy to convert to a 66kV network

Option 3 – A new hybrid 66/33kV and 66/11kV Scone STS/zone and extension of the existing 66kV 'Dartbrook' feeder to the new Scone zone, consistent with a long term strategy to convert to a hybrid a 66kV and 33kV network

Section 4 presents the results of a preliminary application of the regulatory test and the options are ranked.

Section 5 concludes that, while results of a preliminary application of the regulatory test suggest that Strategy 3: conversion to a hybrid 66/33kV network will produce a marginally leaser cost outcome; it is not possible to determine definitely a preferred strategy based purely on least cost.

Therefore, on the basis that

- (a) there is marginal difference between the net present cost for each strategy;
- (b) the choice to supply Scone at 66kV will not lock EnergyAustralia into an area strategy;

and subject to comments received during the consultation period, EnergyAustralia favours construction of Scone zone as a 66/33/11kV substation and extension the 66kV 'Dartbrook' feeder, which is the first stage of Strategy 3: 'Hybrid 66/33kV Network' as this strategy provides significant strategic advantages.

1. INTRODUCTION

1.1. Purpose and Scope

This paper has been prepared to provide a basis for EnergyAustralia to participate with and consult registered and interested parties so as to identify possible options to address projected limitations of the electricity supply network in the Muswellbrook Network Area, in particular, to consult on possible options for addressing the immediate issues on the 33kV network and on the configuration of a substation to replace the existing Scone zone.

It includes:

- a discussion of supply system limitations identified by EnergyAustralia that have led to the necessity of identifying possible options for augmentation of the distribution network in the area;
- a discussion of the service standard that has been adopted for planning purposes;
- a description of possible options which have currently been identified for development of the electricity supply in the area; and
- a detailed preliminary cost effectiveness analysis of each of these options, carried out in accordance with the requirements of the regulatory test.

1.2. Background

1.2.1. Introduction

The existing Scone zone substation is located within the Muswellbrook network area and is supplied from Muswellbrook subtransmission substation (STS) via an open 33kV ring. The conductor ratings of the feeders that comprise the 33kV ring are exceeded during contingencies in peak summer periods now and Scone zone is expected to exceed its 1% risk level in summer 2007/08. There are also condition and operational issues at Scone zone that need to be addressed.

Muswellbrook 132/33kV STS requires retirement as soon as practicable due to the age and condition of the equipment. It is the only source which provides 33kV supply to the northern part of the upper Hunter region. The preferred long term strategy for the area is to convert the network currently supplied at 33kV from Muswellbrook STS to 66kV operation to allow it to be supplied from Mitchell Line 66/11kV STS, which is in proximity to Muswellbrook STS, however, the long term strategy for the Upper Hunter area is still under consideration.

1.2.2. Supply Arrangements

Muswellbrook 132/33kV STS supplies Scone, Aberdeen, Muswellbrook, Moonan & Rouchel zone substations and Muswellbrook mine. Glenbawn Hydro generator is also connected to this 33kV system (Figure II). Scone and Aberdeen zones are supplied from Muswellbrook STS via an open 33kV ring. Scone zone is supplied on one leg of the ring (feeder 5), while Aberdeen, Rouchel, Moonan zones and Glenbawn generator are on the other (feeder 7). Muswellbrook zone and Muswellbrook mine are each supplied directly from Muswellbrook STS. This system supplies a large geographical area representing the northern part of the Upper Hunter Region (Figure I).

Mitchell Line 132/66kV STS is located approximately 6.5km from Muswellbrook STS. Both Muswellbrook and Mitchell Line STS are supplied at 132kV from TransGrid's Mitchell Line 330/132kV bulk supply point (BSP).

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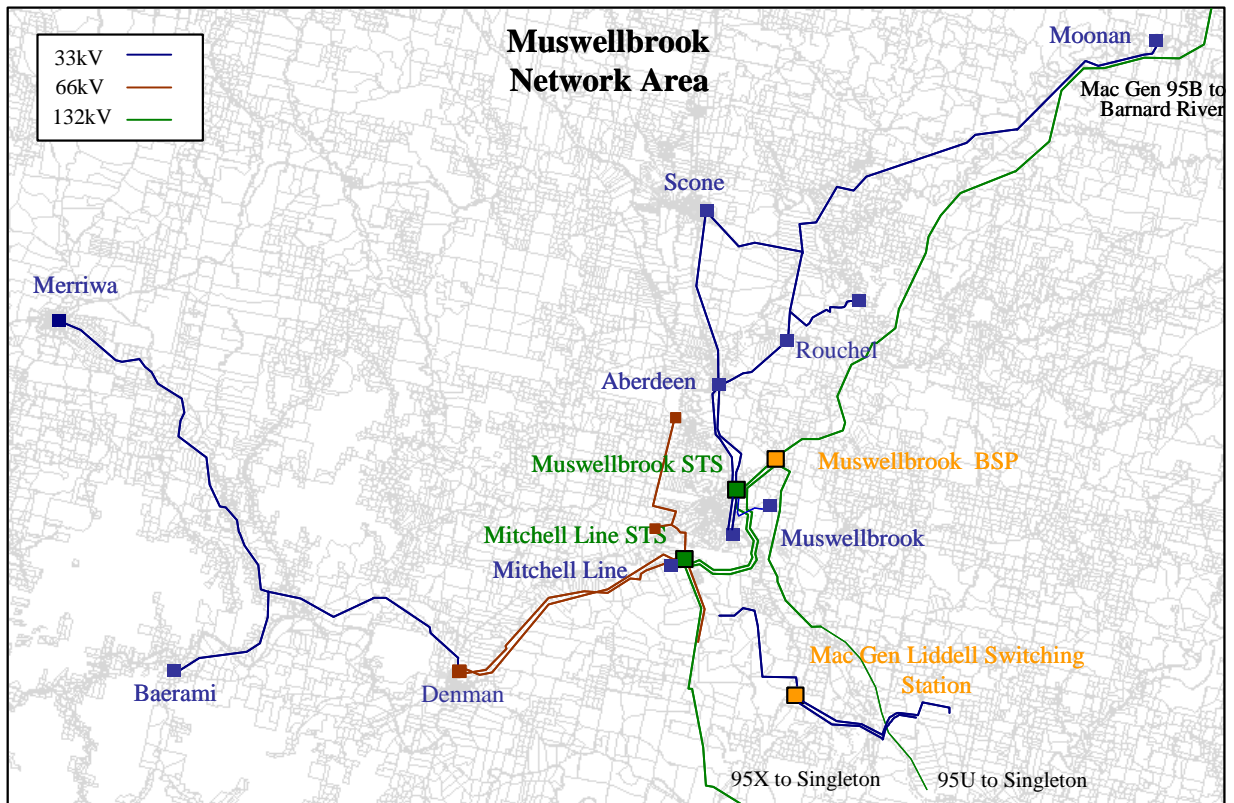


Figure I: A geographic map depicting the Upper Hunter area.

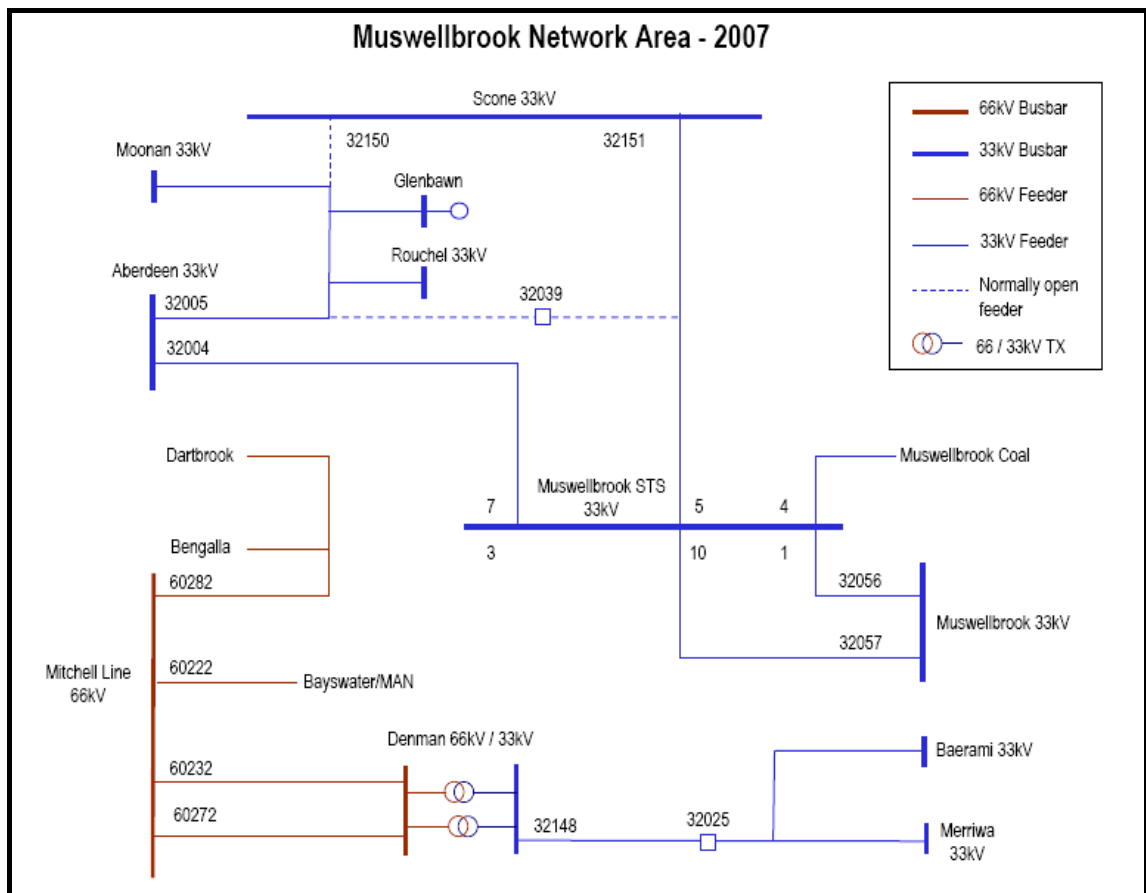


Figure II: Schematic depicting the normal supply arrangement to upper Hunter area.

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1.2.3. Subtransmission Substations

Muswellbrook Subtransmission Substation

Muswellbrook 132/33kV STS supplies Aberdeen, Moonan, Muswellbrook, Rouchel, and Scone zone substations, as well as Glenbawn Dam Hydro Station and Muswellbrook Coal and is the only source of 33kV supply to the northern part of upper Hunter area. It is equipped with one 60MVA and two 20MVA 132/33kV transformers and has a firm capacity of 45.4MVA in both summer and winter, limited by the transformers.

Mitchell Line Subtransmission Substation

Mitchell Line 132/66kV STS provides supply to Denman zone, which in turn supplies Merriwa and Baerami zones; as well as radial supplies to Dartbrook, Bengala and Bayswater coal mines. It is equipped with two 120MVA transformers. Currently the firm rating is limited to 120MVA limited by the nameplate rating of the transformers; however, the transformers are scheduled to be tested and it is expected that a cyclic rating of approximately 140MVA will be achieved.

1.2.4. Overhead Feeder Network

132kV Network

The supply to the Upper Hunter area is from TransGrid's 330/132kV BSP located at Sandy Creek, just north of Muswellbrook Township. Muswellbrook STS is supplied via feeders 95H and 95F and Mitchell Line STS is supplied from feeders 95F, 95M and 95X. A reactor is installed on feeder 95H at Muswellbrook STS to reduce fault levels, caused close proximity of the STS to the BSP.

The remaining feeder 95U, which directly supplies Singleton STS and feeder 953 and interconnects the Upper and Lower Hunter 132kV networks via Redbank PS and Rothbury ZS is outside the scope of this document.

66kV Network

The 66kV supply in upper Hunter area is provided by Mitchell Line STS. Mitchell Line STS also supplies Bayswater Coal Mine via a 66kV overhead feeder, and Bengalla and Dartbrook mines via another 66kV overhead feeder. The 66kV 'Dartbrook' feeder from Mitchell Line STS supplying Bengalla and Dartbrook mines comes within 4.5km of the existing Aberdeen zone substation.

33kV Network

The 33kV overhead network from Muswellbrook STS has individual line route lengths up to 57km from the STS to zone substations. Scone and Aberdeen zone substations are supplied via a 33kV overhead feeder ring which is normally operated open due to the limitations of the protection scheme on this network. Moonan and Rouchel zone substations and the Glenbawn Dam Hydro Station are also connected through radial connections to this network. Muswellbrook zone and Muswellbrook mine are each supplied directly from Muswellbrook STS.

1.2.5. Zone Substations

Scone Zone Substation

Scone 33/11kV zone substation is supplied from Muswellbrook STS via an open 33kV overhead feeder ring, which maintains the zone substation on a separate supply from other substations.

Scone 33/11kV zone substation is equipped with two 12.5MVA 33/11kV transformers operated in parallel and has a firm capacity of 14.2MVA in summer and 15.3MVA in winter limited by the secondary conductors.

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Aberdeen Zone Substation

Aberdeen 33/11kV zone substation is supplied from Muswellbrook STS via an open 33kV overhead feeder ring. Aberdeen zone substation also has 33kV connections with Moonan, Rouchel and Scone zone substations as well as Glenbawn Dam Hydro Station. Aberdeen 33/11kV zone substation is equipped with two 5MVA transformers operated in parallel.

Muswellbrook Zone Substation

Muswellbrook 33/11kV zone substation is supplied from Muswellbrook STS via two 33kV overhead feeders. Muswellbrook zone substation is equipped with two 22MVA transformers.

Customer Load Control (CLC) for the load supplied from Muswellbrook STS to is controlled by the one AF Plant at this substation. The AF Signal (492Hz) is injected back through the 33kV bus and onto the 33kV network where it propagates to each zone.

Moonan Zone Substation

Moonan 33/11kV zone is radially connected to the Scone-Aberdeen 33kV overhead feeder ring and is equipped with two 3MVA transformers.

Rouchel Zone Substation

Rouchel 33/11kV zone substation is supplied from Muswellbrook STS. Rouchel zone substation is equipped with a single 5MVA transformer. An 11kV pole top regulator controls voltage regulation on the feeder due to the zone transformer operating with fixed taps.

2. IDENTIFICATION OF NEED FOR AUGMENTATION

2.1. Applied Service Standard

The Minister for Energy and Utilities imposed design, reliability and performance licence condition on distribution network service providers on 1 August 2005. The specific requirements are outlined in Schedule 1 of the Licence Condition.

A summary of the service standards applicable to the issues affecting the upper Hunter network supplied by Muswellbrook STS is described below.

2.1.1. Applicable to all Network Elements

The minimum requirement for any network element is that, with all elements in service, the loading does not exceed the cyclic rating of any element. The requirements described in the following sections are additional to this requirement.

2.1.2. Subtransmission Substations

EnergyAustralia generally applies a deterministic N-1 security standard to subtransmission substations, which means that following a credible contingency of any one network element, loading will not exceed the sustained emergency capacity of the remaining system elements. Under Schedule 1 of the Licence Conditions, all subtransmission substations are to comply with a deterministic N-1 security standard by 30 June 2012.

The upper voltage level on the underground 132kV system is restricted to 1.05 per unit. Marginally higher voltages may be possible in some areas with overhead connection. The lower voltage limit is determined by the requirement during first contingency outages for: transformers in subtransmission substations to maintain regulation; and voltage levels on the 132kV system should not fall below 90% of their nominal voltage (0.9 pu).

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2.1.3. Zone Substations

Under Schedule 1 of the Licence Conditions, a 1% risk based criteria is applied for first contingency (N-1) outages of zone substations supplying greater than 5MVA of load. This means that the chance in any season is less than 1% that, following a credible outage of any one network element, loading will exceed the sustained emergency capacity of the remaining system elements. In terms of reliability standards as defined by the Rules, this constitutes a slight reduction in security from an 'N-1' reliability criterion for zone substations. By 2019, EnergyAustralia are required to move to a deterministic (N-1) security standard for Zone Substations.

The voltage regulation range of the 33kV and 66kV system is determined by the requirement for zone transformers: to maintain regulation under normal system conditions; and be less than 4% below their set voltage level (allowing for Line Drop Compensation) during first contingency outages. For 11kV networks, voltage drops of up to 5% are regarded as satisfactory. Higher voltage drops are permissible provided that the network connection provided to low voltage customers is within the limits specified in Australian Standard AS2926.

2.1.4. 66kV and 33kV Network

Under Schedule 1 of the Licence Conditions, an N-1 deterministic criteria is applied to sub-transmission feeders carrying greater than 5MVA of load. This means that for first contingency outages, the loading on each element is not to exceed the cyclic rating of that element.

The voltage regulation range of the 33kV and 66kV system is determined by the requirement for zone transformers: to maintain regulation under normal system conditions; and be less than 4% below their set voltage level (allowing for LDC) during first contingency outages.

2.2. Description of Network Issues

2.2.1. Subtransmission Substations

Muswellbrook Subtransmission Substation

Muswellbrook STS has a firm capacity of 45.4MVA, limited by the transformer ratings. The load currently exceeds the firm capacity of the STS during peak summer periods.

Muswellbrook STS was commissioned in 1959 and originally formed part of the now decommissioned Muswellbrook Power station. There are many significant asset condition issues and are such that the STS requires retirement as soon as practicable.

The 132kV circuit breakers are at the end of their serviceable life and a project has been initiated to replace them with scheduled completion by March 2008. An investigation has been initiated to determine a strategy for managing the issues at Muswellbrook until its retirement.

Mitchell Line Subtransmission Substation

Mitchell Line STS has a firm capacity of 120MVA in both summer and winter. Peak loads of 44.7MVA and 44.9MVA were recorded in summer 2005/2006 and winter 2006 respectively. The peak load for Mitchell Line STS is not forecast to exceed the firm capacity for the foreseeable future. Land is owned adjacent to the zone, which may be utilised for the installation of a third transformer if required in the future.

Mitchell Line STS was commissioned in 1983 and currently has no major condition issues.

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2.2.2. Overhead Feeder Network

132kV Network

Feeders 95F and 95M are constructed as a composite line (both circuits on common poles). To achieve adequate clearances, maintenance on one circuit requires both lines to be taken out of service. This outage has significant impact on system voltages, and produces unacceptable voltage regulation (i.e. voltages less than 0.9pu) at Mitchell Line and Singleton STS, Rothbury zone and Redback power station.

66kV Network

At present, one radial feeder from Mitchell Line STS supplies two mines, Dartbrook and Bengalla, which creates an isolation problem as well as potentially affecting reliability of supply. Access on mine sites can also be difficult. There is sufficient capacity in the 66kV feeders to supply anticipated future demand including a temporary supply to new Scone and Aberdeen zone substations required as part of the preferred strategy.

33kV Network

The 33kV conductor ratings of the Scone-Aberdeen overhead feeder ring are presently exceeded during contingency events, and are forecast to be exceeded in the normal state in summer 2010/2011. The 33kV network also experiences poor voltage regulation for contingencies.

The limiting section of the two 33kV feeders, numbered feeder 5 and 7, supplying the Scone-Aberdeen ring is the section from Musellbrook STS, which has a rating of 342A (at 33kV).

The worst case failure scenario is for failure of feeder 5, which requires Scone zone substation to be supplied via the longer path around the feeder ring. Air break switches installed on feeder 7 allow it to be sectionalised, providing a relatively shorter path of supply. A circuit breaker is presently being installed on Feeder 7 to provide fault discrimination along the feeder length.

The reliability of this network is affected by lightning, due to long radial feeders that do not have overhead earth wire (OHEW) installed, and by bush fires. The protection reclose function is disabled during bushfire season. All circuits are timber pole construction.

2.2.3. Zone substations

Scone Zone Substation

Scone 33/11kV zone substation was originally commissioned in 1965 at 11kV, with some sections of 11kV bus and a regulator. It was later expanded to its current configuration in approximately 1975. Scone zone has a firm capacity of 14.2MVA in summer and 15.3MVA in winter. Summer load is forecast that the Summer 1% risk level of 15.7MVA will be exceeded in summer 2007/2008.

Recent investigations indicate that a number of the 33kV outdoor circuit breakers are approaching the end of their serviceable life and are recommended to be replaced within the next five years. The 11kV outdoor circuit breakers are an outdoor cabinet style that has been identified as a risk due to the low clearances to ground. These circuit breakers are on a replacement program with replacement recommended within the next five years. The control and protection equipment is obsolete and is recommended to be replaced within the next five years in conjunction with the switchgear.

Due to clearance issues, maintenance of the 11kV busbar requires an outage of the whole substation switchyard. In addition, the layout of the substation is not conducive to ease of maintenance.

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The zone substation is in the vicinity of Scott Memorial Hospital as well as a number of residential swimming pools, which could present possible earthing issues.

Aberdeen Zone Substation

Aberdeen zone substation has a firm capacity of 8.3MVA in summer and 9.2MVA in winter limited by the 11kV switchgear. The load exceeded its summer firm capacity in summer 2005/2006 although it remained below the 1% risk condition. Capacitors were recently installed at the zone substation (3MVAR) and the substation is forecast to maintain the load below the firm capacity until 2017.

Aberdeen zone substation was commissioned in 1951 and is not designed to current EA standards. There are several conditions issues that need to be addressed, in particular, the 11kV bulk-oil switchgears is recommended for replacement within the next five years.

There is no available land adjacent to the zone substation.

Muswellbrook Zone Substation

Muswellbrook zone substation has a firm capacity of 22.9MVA in both summer and winter limited by the 11kV switchgear. Muswellbrook zone substation load has exceeded its summer firm capacity although it is not forecast to exceed the 1% risk condition until summer 2011/2012. Load transfers of approximately 2MVA, including the new Rutherford Rd Muswellbrook Shopping Centre, from Muswellbrook zone to Mitchell Line zone substation are anticipated by the end of 2007 and are included in the current load forecast.

Muswellbrook zone substation was commissioned in 1974. Several 33kV outdoor circuit breakers require replacement within the next five years, with the remaining circuit breakers to be replaced within the following five years. There is only one set of 110V protection batteries.

Moonan Zone Substation

There are no capacity issues at Moonan zone substation within the immediate forecast period.

Moonan zone substation was constructed in 1966 at 11kV with some sections of 11kV bus and a regulator. It was later upgraded to form a 33/11kV zone, which was commissioned in 1986. It underwent a major refurbishment in 2002/2003 and the substation is generally in good condition. Condition reports indicate that the transformers require replacement within the next ten years.

Rouchel Zone Substation

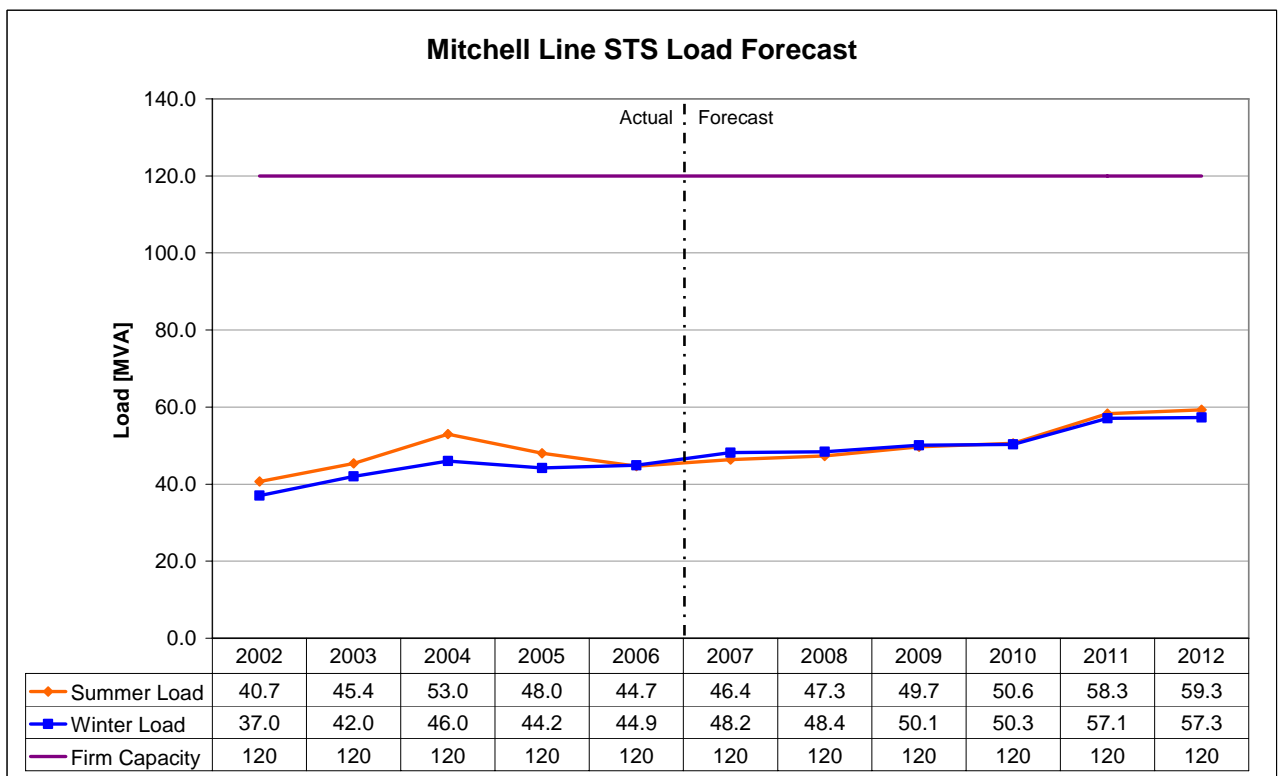
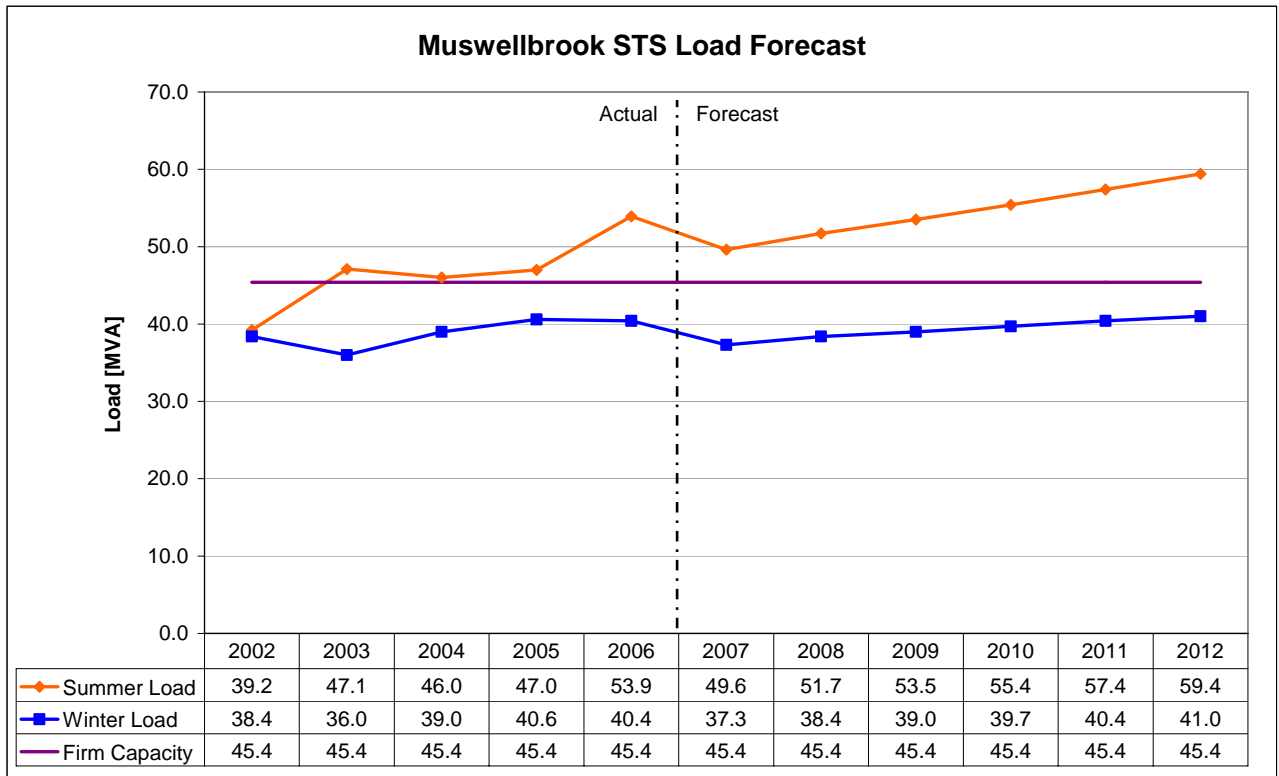
There are no capacity issues at Rouchel zone substation within the immediate forecast period.

Rouchel zone substation was commissioned in 1985. The transformer is recommended for replacement within the next ten years, there is no oil containment and limited SCADA, but in general the substation is in reasonable condition.

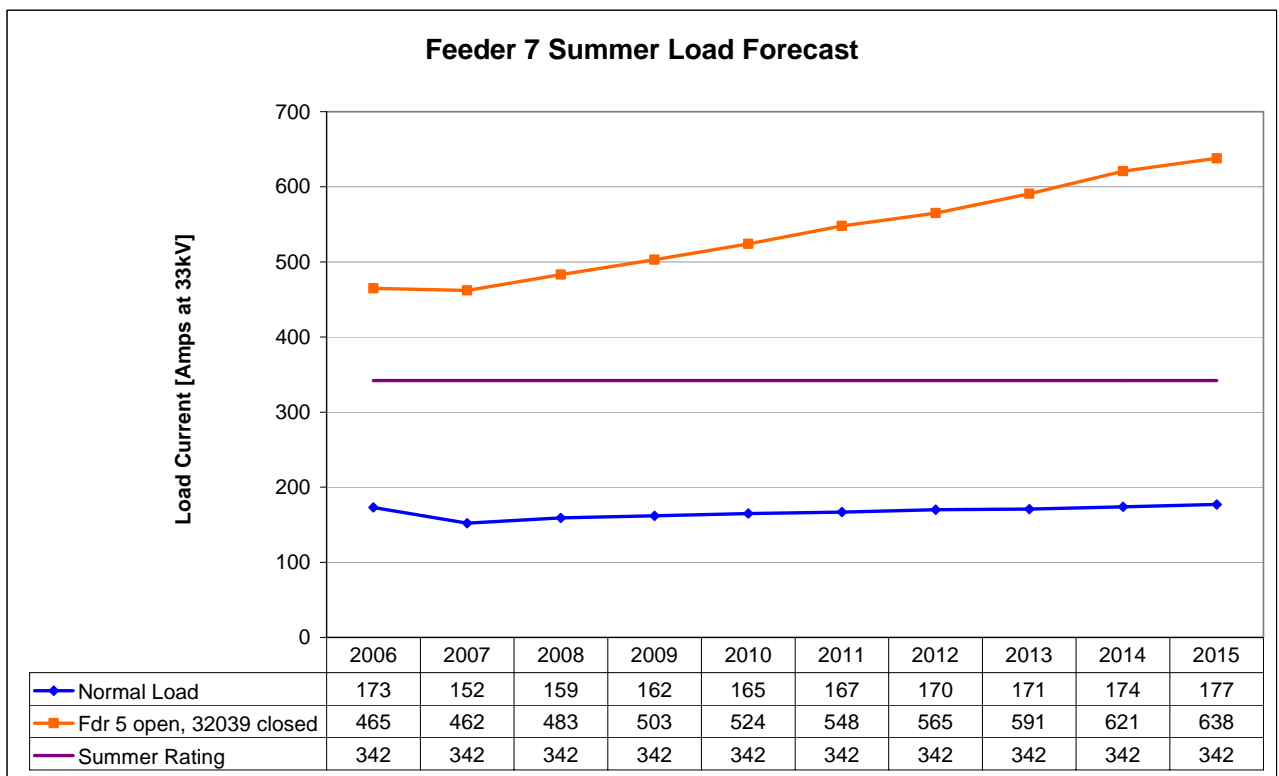
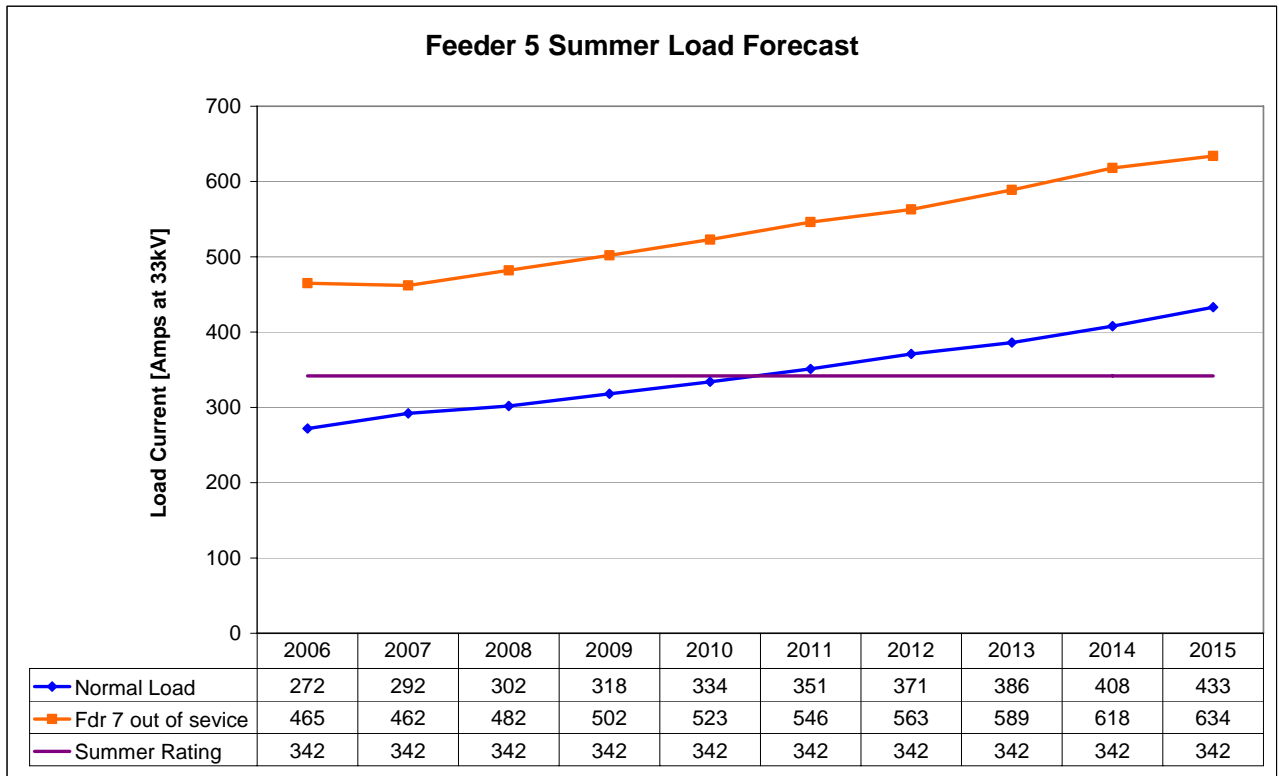
2.3. Load Forecast

Load forecasts for Muswellbrook STS, Mitchell Line STS, the 33kV feeders 5 and 7 and for Scone Aberdeen and Muswellbrook zone substations, are provided in the following figures. The forecast includes committed spot loads and general load growth. The forecast is based on actual loads for summer 2005/2006 and winter 2006. Please note in the load forecast as given below, the year 2006 indicates summer 2005/2006 and winter 2006.

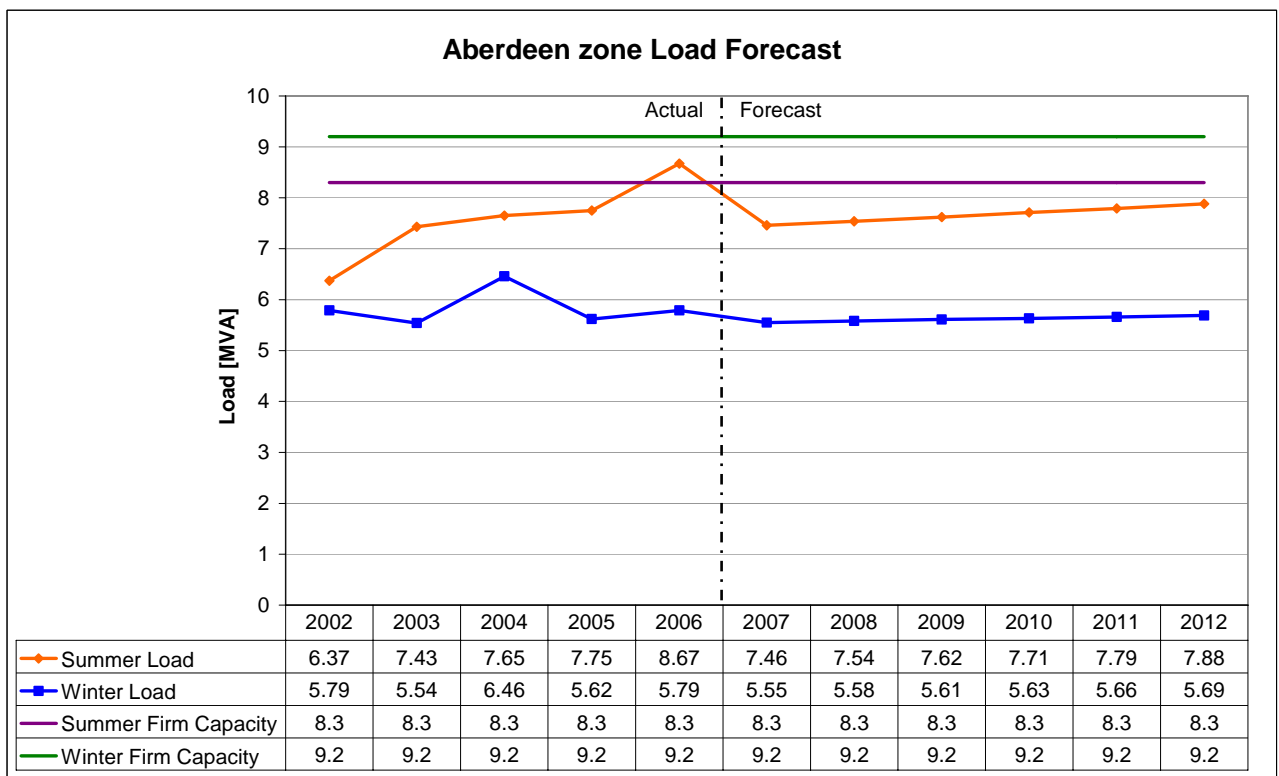
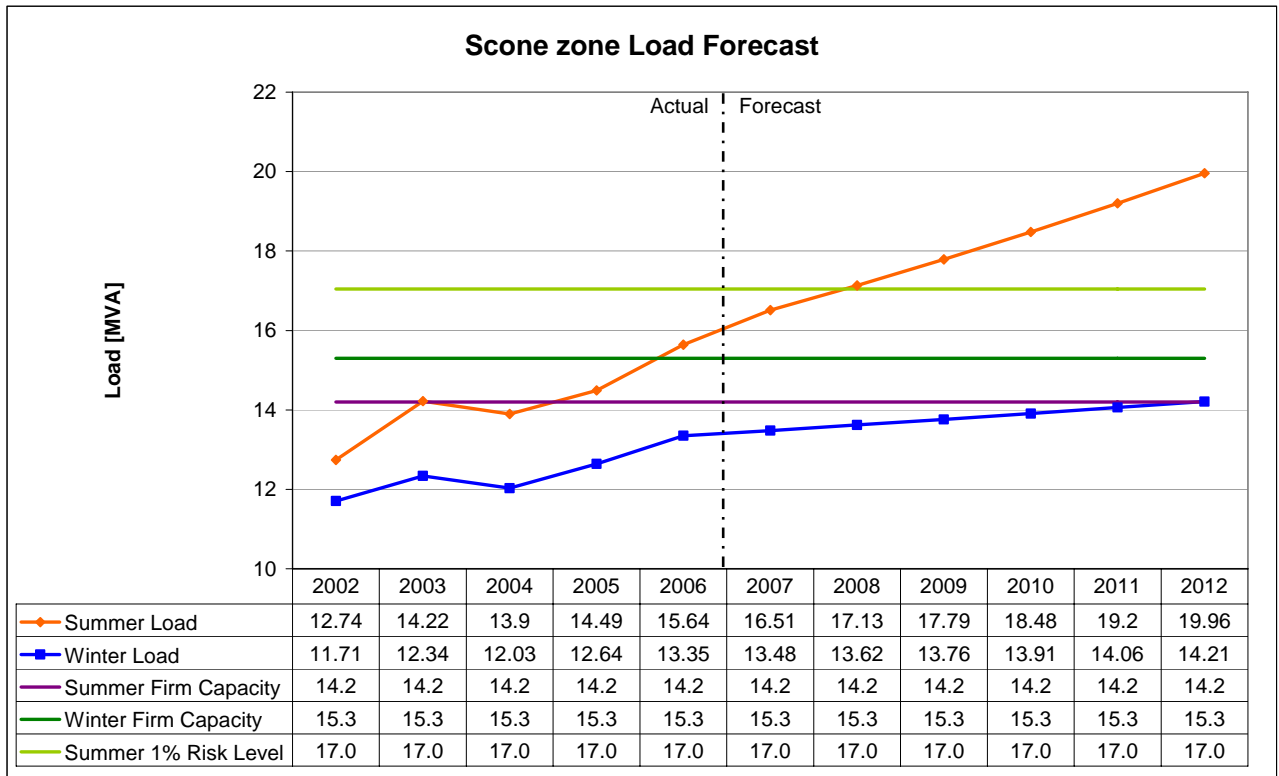
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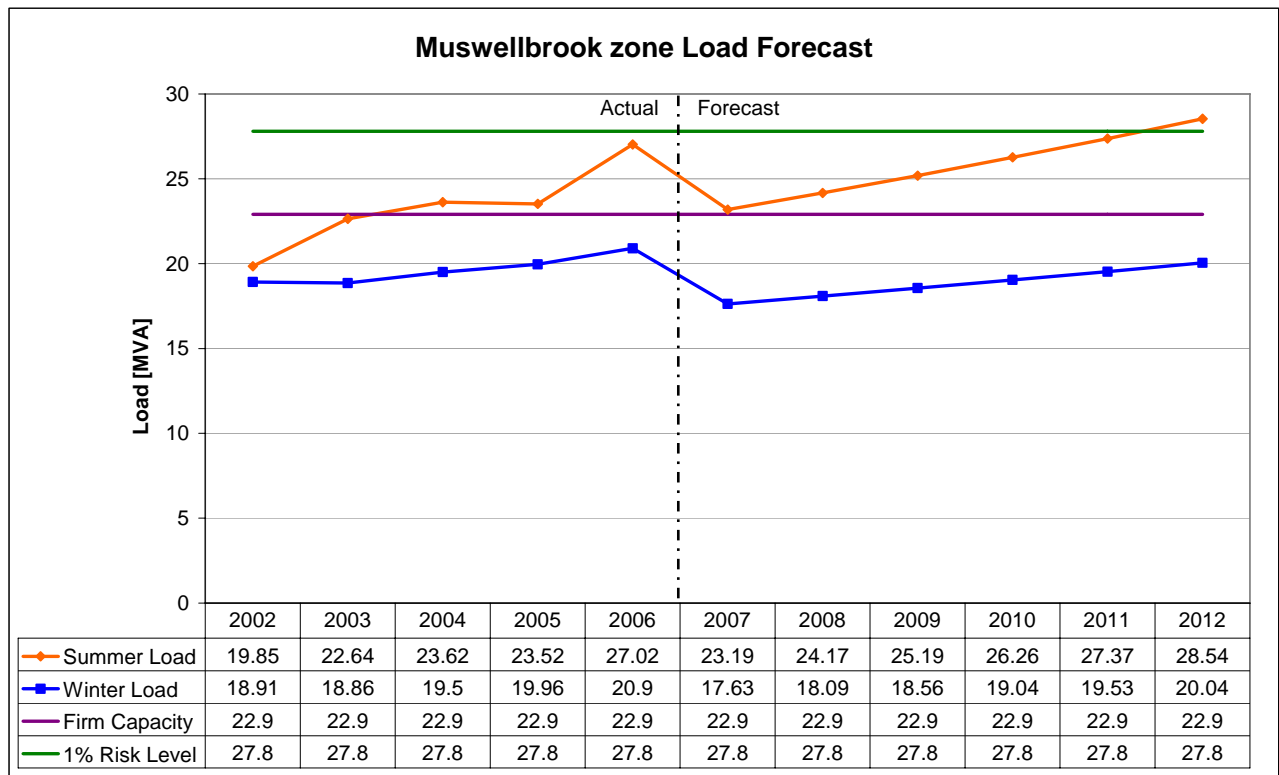
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2.4. Consideration of Demand Side Management and Local Generation

A review of demand management opportunities in the Muswellbrook supply area was carried out in September 2007. The review indicated that, under the preferred strategy, demand reductions would not enable any reduction in costs, since the primary driver is the need to replace Muswellbrook STS. Alternate strategies might become more economic, if accompanied by significant demand reductions. However, the cost differential between these options is relatively small and the demand reduction required would be very large. There is also a need resolve a number of other equipment condition and operational issues in this area as soon as practicable. On balance, it is not considered reasonable to expect that demand management would cost effectively defer the proposed investment for a new Scone zone substation.

2.5. National Electricity Rules Requirements

Muswellbrook STS and Mitchell Line STS, and the network they supply are classified as distribution system assets by the National Electricity Rules (the Rules).

The Rules (clauses 5.6.2(e) and (f)) require that, where analysis indicates that any relevant technical limits of a distribution system will be exceeded, that the Distribution Network Service Provider must notify any affected Registered Participants of these limitations and of the expected time for corrective action and consult with affected Participants and interested parties on the possible options to address the projected limitations of the relevant distribution system. A Network Service Provider does not need to consult on a network option that would be a small network asset, or for options that do not augment the system.

Each of the options considered under Section 3 includes a replacement and an augmentation component. The augmentation components of these options are considered new large distribution network assets as they involve expenditure in excess of \$10 million. They were therefore the subject of consultation in accordance with clause 5.6.2(f) of the Rules.

The new capacity provided by the proposed augmentation has been necessitated by the need to meet the service standards described in Section 2 and has therefore been treated as a reliability driven augmentation for the purposes of the Regulatory Test. Consequently, EnergyAustralia has

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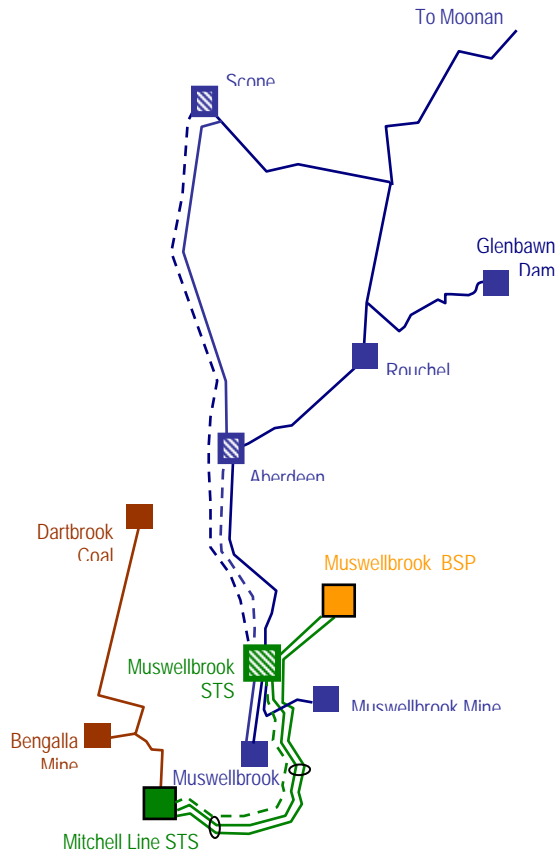
used a least cost test to examine the options identified to address projected system limitations by providing increased long term future capacity. It should be noted that, while this consultation paper was primarily written for the augmentation component of these works, the economic analysis has considered the total project costs.

3. OPTIONS

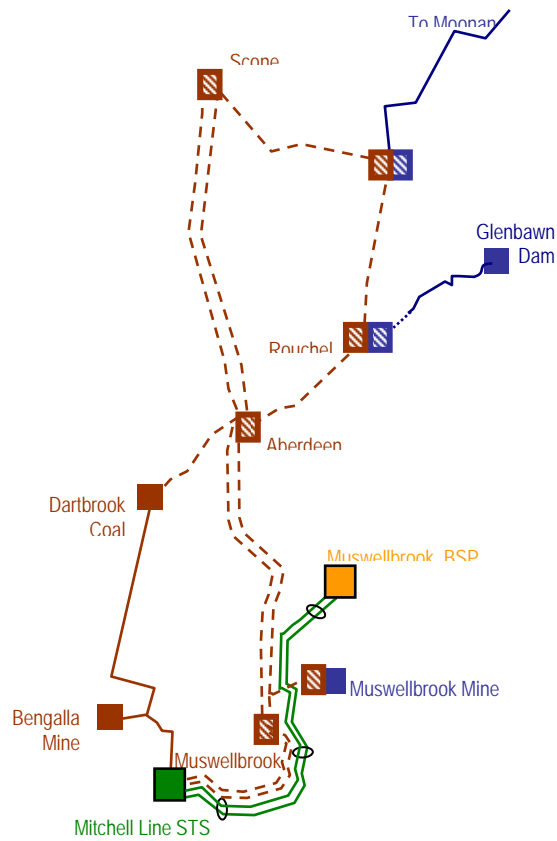
The purpose of this consultation paper is to consult on a proposed project to construct a new Scone zone with associated connections, to replace the existing zone and address existing capacity issues on the 33kV network. The configuration of the new Scone substation will depend on the long term strategy for the Upper Hunter area. Three technically feasible strategies have been considered: Upgrade the existing 33kV infrastructure; Convert the area to 66kV; or a partial conversion to 66kV resulting in a hybrid 66/33kV system. The following sections provide details of each strategy and the corresponding configuration for Scone. The scope and costs are based on initial planning studies and typical unit costs, and may vary as the strategy investigation proceeds. The analysis includes expected capital expenditure until 2024.

Site investigations were completed in March 2007. The preferred location for the proposed Scone zone is a Greenfield site on the New England Hwy. This site is preferred on a least cost basis and is common to all strategies.

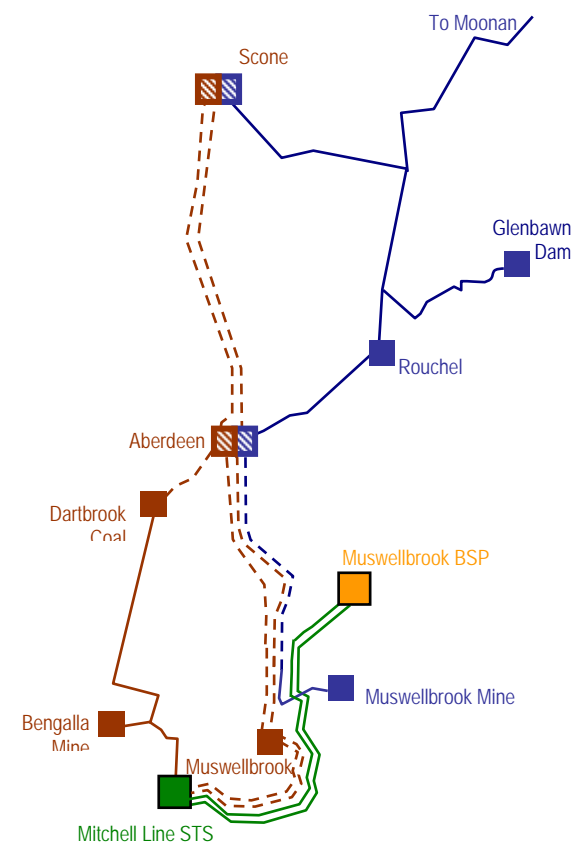
Strategy 1: Upgrade 33kV Network



Strategy 2: Conversion to 66kV Network



Strategy 3: 66/33kV Hybrid Network



KEY		
33kV		New feeder
66kV		New substation
132kV		

NOTE: Not all network shown for clarity

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3.1. Strategy 1: Upgrade 33kV Network

This strategy involves a combination of works to increase the capacity of the existing 33kV system and replacement works to resolve the aged asset and condition issues. An additional 33kV feeder from Muswellbrook STS to Scone is required to resolve the 33kV capacity issues and to improve the voltage on the network. A replacement Muswellbrook 132/33kV substation will enable the existing Muswellbrook STS to be retired. Similarly, Scone and Aberdeen zones will be replaced to resolve the condition issues at these zones and to provide additional capacity.

Under this strategy Scone will be configured as a 33/11kV outdoor/indoor substation with two 33MVA transformers. Connections will be to the existing 33kV network and to the new 33kV feeder from Muswellbrook STS when it is completed.

Table 1: Scope of works and approximate timing and costs for upgrading the existing 33kV network (Strategy 1)

Project	Approximate Cost (\$m)	Indicative Completion
1) New 33kV feeder from Muswellbrook STS to Scone zone	14.7	2009
2) New 33/11kV Scone zone	17.5	2009
3) New Muswellbrook 132/33kV STS	31.2	2009
4) New Aberdeen 33kV zone	14.0	2010
5) Decommission Muswellbrook 132/33kV STS	0.2	2010
6) Upgrade 33kV feeder 5 Muswellbrook STS to Aberdeen Tee	2.9	2011
7) Construct additional feeder between Muswellbrook STS/BSP	7.5	2011
8) Upgrade Muswellbrook zone	5.2	2011
TOTAL	93.2	

} First stage

The estimated capital cost for the first stage of this strategy is \$32.2m, which includes a new Scone zone and a new 33kV feeder from Muswellbrook STS to the new Scone zone. The total net present cost (NPC) of this strategy is \$80.6m, which includes operating and maintenance costs.

3.1.1. Advantages/Disadvantages

This strategy avoids the need to expand Mitchell Line STS for the foreseeable future; however, it requires maintenance of two STS which will be in close proximity to each other.

Under the current forecast, additional augmentation is required in approximately 2030, as the system will begin to experience voltage regulation issues. In addition, this strategy has limited capability to supply potential new mining or private generation developments.

3.2. Strategy 2: Conversion to 66kV Network

This strategy involves conversion of the majority of the network and zone substations currently supplied from Muswellbrook STS to 66kV operation to allow them to be transferred to Mitchell Line STS, avoiding the need to construct a new Muswellbrook STS. The existing 66kV 'Dartbrook' feeder is located within a few kilometres of Aberdeen zone and can be extended to provide supply to the new Scone and Aberdeen zones.

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Under this strategy Scone will be configured as a 66/11kV outdoor/indoor substation with two 33MVA transformers. The initial 66kV connection will be formed by extending the existing 'Dartbrook' 66kV feeder to Scone. Further 66kV connection will be provided by converting the existing 33kV network to 66kV operation. In order to provide back-up supply, the existing Scone zone will be maintained until a second 66kV is available for supply to the new 66/11kV Scone zone.

Table 2: Scope of works and approximate timing and costs for conversion to a 66kV network (Strategy 2)

Project	Approximate Cost (\$m)	Indicative Completion
1) Extend 66kV "Dartbrook" Feeder to Scone zone	10.4	2009
2) New Scone 66/11kV zone	17.8	2009
3) New Aberdeen 66/11kV zone	14.8	2010
4) Rebuild / construct feeders between Muswellbrook STS/BSP to provide two 132kV feeders to Mitchell Line STS, and two 66kV feeders from Mitchell Line STS to Scone-Aberdeen	13.3	2010
5) Upgrade Feeder 5 to 66kV from Muswellbrook STS to Aberdeen	4.9	2011
6) Upgrade Feeder 7 to 66kV from Muswellbrook STS to Aberdeen	3.9	2011
7) Muswellbrook zone 66kV Conversion & 11kV Upgrade	15.1	2011
8) Upgrade feeders 5 and 7 to 66kV between Aberdeen and Scone	16.5	2012
9) New Rouchel 66/33/11kV zone	9.1	2012
10) Muswellbrook Coal 66/33kV Step-down	3.1	2012
11) Moonan 66/33kV Step-down	3.1	2012
12) Decommission Muswellbrook 132/33kV STS	0.2	2013
13) Mitchell Line 132/66kV Third Transformer	8.5	2023
TOTAL	120.7	

} First stage

The estimated capital cost for the first stage of this strategy is \$28.2m, which includes a new Scone zone and extension of the 66kV 'Dartbrook' feeder to the new Scone zone. The total net present cost (NPC) of this strategy is \$90.4m, which includes operational and maintenance costs.

3.2.1. Advantages/Disadvantages

Conversion to 66kV resolves the voltage issues at Scone zone when supplying at 33kV during contingencies and will provide greater capabilities to provide supply to future mining and private generation developments than provided by the 33kV strategy.

The primary disadvantages of this strategy are that it involves extensive feeder work to rebuild the existing network at 66kV; and it requires conversion of all the existing zones to 66kV supply. While Scone and Aberdeen are due for replacement, and so relatively economical to convert to 66kV

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operation, condition reports indicate that Rouchel, Muswellbrook and Moonan zones are in reasonable condition.

In addition, EnergyAustralia has obligations to provide 33kV connection to Glenbawn Dam and Muswellbrook Mine, which are also currently supplied out of Muswellbrook STS. Consequently, the scope of works includes a hybrid 66/33/11kV Rouchel zone to supply Glenbawn Dam and a 66/33kV step-down station to supply Muswellbrook mine.

The route to Moonan is approximately 34 km long. Rather than convert this feeder to 66kV, a step-down transformer will also be installed near the Moonan-tee to supply Moonan zone at 33kV.

3.3. Strategy 3: 66/33kV Hybrid Network

Rather than converting the whole network to 66kV as in Strategy 2, Scone and Aberdeen zone will be installed as a 66/33/11kV hybrid zone substations and will provide 33kV supply to Moonan and Rouchel zones, Glenbawn Dam and Muswellbrook Mine. Muswellbrook zone will be converted to 66kV. This will allow the existing network supplied from Muswellbrook STS to be transferred to Mitchell Line STS, enabling Muswellbrook STS to be retired without requiring a new STS.

Under this strategy Scone will be configured as a 66/11kV outdoor/indoor substation with two 33MVA transformers. The initial 66kV connection will be formed by extending the existing 'Dartbrook' 66kV feeder to Scone. Further 66kV connection will be provided by converting the existing 33kV network to 66kV operation.

Table 3: Scope of works and approximate timing and costs for a hybrid 66/33kV system with both Scone and Aberdeen as hybrid substations (Strategy 3)

Project	Approximate Cost (\$m)	Indicative Completion
1) Extend 66kV "Dartbrook" Feeder to Scone zone	10.4	2009
2) New Scone 66/33/11kV zone	21.0	2009
3) New Aberdeen 66/33/11kV zone	20.9	2010
4) Rebuild / construct feeders between Muswellbrook STS/BSP to provide two 132kV feeders to Mitchell Line STS and two 66kV feeders from Mitchell Line STS to Scone-Aberdeen	13.3	2010
5) Muswellbrook zone 66kV Conversion and 11kV Upgrade	15.1	2011
6) Upgrade feeder 7 to 66kV between Muswellbrook STS and Aberdeen	3.9	2011
7) Upgrade feeder 5 to 66kV between Muswellbrook STS and Aberdeen	4.6	2011
8) Upgrade feeder 5 to 66kV between Aberdeen and Scone	6.7	2012
9) Decommission Muswellbrook STS	0.2	2013
10) Mitchell Line 132/66kV Third Transformer	8.5	2023
TOTAL	104.5	

} First stage

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The estimated capital cost for the first stage of this strategy is \$31.4m, which includes a new Scone zone and extension of the 66kV 'Dartbrook' feeder to the new Scone zone. The total net present cost (NPC) of this strategy is \$80.5m, which includes operational and maintenance costs.

3.3.1. Advantages/Disadvantages

This strategy provides the same benefits as the 66kV strategy in terms of reduced system losses, improved voltage levels, greater flexibility and improved reliability; however, it avoids replacement of assets with no condition or capacity issues.

Completion of the new Scone and associated extension of the 'Dartbrook' feeder resolves the immediate 33kV capacity and will also reduce load on Muswellbrook STS by transferring supply of Scone to Mitchell Line STS, reducing our risk exposure in the event of a failure at Muswellbrook STS. In this initial configuration, Scone zone can provide limited backup supply during contingencies; protection issues prevent Scone from providing backup for feeder 7 to supply to Rouchel and Moonan zones. This arrangement also improves the voltage regulation at Scone; the normal supply is at 66kV and so will result in less voltage drop along the line; and the backup supply is provided through a step-up from 66kV to 33kV (followed by a step down from 66/11kV), which provides a greater tapping range.

3.4. Preferred Option

The net present cost of a full conversion to 66kV (Strategy 2) is approximately 10% higher than the least cost strategy; however, there is no clear economic advantage between upgrading the existing 33kV network (Strategy 1) and a 66/33kV hybrid system (Strategy 3). While all strategies have been compiled to address the key network issues, a hybrid network strategy (Strategy 3) provides significant strategic advantages over an upgrade of the existing 33kV network (Strategy 1). These include:

- improved flexibility and capacity to manage supply to mining and private generator developments in the region;
- removal of the need to operate and maintain Muswellbrook STS;
- improved voltage regulation; and
- removal of a large quantity of aged / aging overhead woodpole 33kV feeders from the network.

In addition, it is relatively simple to transfer from a 66kV to a 33kV system; since the clearances at 66kV are greater than those at 33kV and the 66kV feeders and switchgear may often be operated at 33kV. The converse is a more complicated process as the substation and feeders would need to be rebuilt to increase clearances, and it is unlikely that the 33kV gear would be suitable for operation at 66kV. Both scenarios would require the transformers to be exchanged.

On the basis that

- (a) there is marginal difference between the lowest net present cost for each strategy;
- (b) the choice to supply Scone at 66kV will not lock EnergyAustralia into an area strategy;

the preferred option is to construct Scone as a 66/33/11kV substation and extend the 66kV 'Dartbrook' feeder, which is the first stage of Strategy 3: 'Hybrid 66/33kV Network' as this strategy provides significant strategic advantages as listed above. The capital cost to construct the new Scone 66/33/11kV hybrid substation and the 66kV 'Dartbrook' overhead line required to provide the initial supply to this substation is estimated \$31.4 million.

4. APPLICATION OF THE REGULATORY TEST

A preliminary economic analysis has been carried out in accordance with the regulatory test promulgated by the ACCC under clause 5.6.5A of the National Electricity Rules. As indicated in section 4, the “reliability limb” of the test was applied. It involves the comparison of options on an economic basis by carrying out NPC analysis for each of the three options. The option which satisfies the regulatory test is the one that minimises the present value of the costs of meeting relevant service standards discussed in section 2.

EnergyAustralia has included a range of parameters in comparison of options such as change in load growth and variations in material costs. In summary, the three options presented are technically and economically comparable, given due consideration to all capital and operating costs that are able to be defined and quantified.

4.1. Base Case Analysis

The options considered are ranked by cost considering 8.5% discount rate as the base case in the following table. Detailed analysis is provided in APPENDIX A – ECONOMIC ANALYSIS OF BASE CASE.

Table 4: Comparison of costs under the base case

Description	Cost* (\$m)	NPC* (\$m)
Strategy 1: Upgrade 33kV Network	93.2	80.6
Strategy 2: Conversion to 66kV Network	120.7	90.4
Strategy 3: Hybrid 66/33kV Network	104.5	80.5

* Total capital Cost and NPC calculation considering long term requirements for each option.

The net present cost of a full conversion to 66kV (Strategy 2) is approximately 10% higher than the least cost strategy; however, there is no clear economic advantage between upgrading the existing 33kV network (Strategy 1) and a 66/33kV hybrid system (Strategy 3).

4.2. Sensitivity Analysis

Sensitivity Analysis was carried out to consider the impact of different discount factors, growth rates and for variations in feeder, substation and material costs and to consider possible development scenarios of the Upper Hunter area. The base case and the range over which sensitivity checks were conducted are shown in Table 5.

Table 5: Sensitivity analysis conducted

Parameter	Base Case Value	Cases Considered
<u>Discount Rate</u>		
Real Discount Rate	8.5%	7% and 10%
<u>Asset Costs</u>		
Material costs	100%	±25%
Substation costs	100%	±10%
Feeder Costs	100%	75%, 90% and 110% of feeder per unit costs.
<u>Load Growth</u>		
General growth rate	As per 2005/06 forecast	Increment/Decrement the forecast growth rate by 1%
Mining or embedded generation development	None	Assumed development within 5km of Scone.
<u>Licence Conditions</u>		
Affect of possible amendment to the licence conditions	2005 DEUS Licence Conditions	Incorporates possible amendments; in particular 1% risk on overhead lines

The sensitivity analysis did not produce a definitive economic preference between a 33kV upgrade (Strategy 1) and a 66/33kV hybrid network (Strategy 3); however the results indicate that Strategy 3 is likely to produce a marginally lower cost result for the majority of sensitivity scenarios that were considered.

4.2.1. Variation of Discount Rate

The impact of a change in the discount rate is shown in Table 6.

Table 6: Change in the discount rate	NPC (\$m)		
	Real Discount Rate	8.50%	7.00%
Strategy 1: Upgrade 33kV Network	80.6	81.6	79.6
Strategy 2: Conversion to 66kV Network	90.4	93.5	87.6
Strategy 3: 66/33kV Hybrid Network	80.5	82.7	78.3

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4.2.2. Variation of Asset Costs

Material Cost

The impact of a $\pm 25\%$ variation of material cost was considered. Based on recent trends, a 25% decrease is considered unlikely, however is included for completeness. Results are shown in Table 7.

Table 7: Variation in material costs	25% Increase		25% Decrease	
Scenario	Cost (\$m)	NPC (\$m)	Cost (\$m)	Cost (\$m)
Strategy 1: Upgrade 33kV Network	103.2	90.2	83.1	71.1
Strategy 2: Conversion to 66kV Network	134.0	100.9	107.3	79.9
Strategy 3: 66/33kV Hybrid Network	115.4	89.4	93.7	71.5

Substation Costs

The impact of a general $\pm 10\%$ variation in substation cost was considered. Results are shown in Table 8.

Table 8: Variation of substation costs	10% Increase		10% Decrease	
Scenario	Cost (\$m)	NPC (\$m)	Cost (\$m)	Cost (\$m)
Strategy 1: Upgrade 33kV Network	99.9	87.1	86.4	74.2
Strategy 2: Conversion to 66kV Network	127.8	96.0	113.5	84.8
Strategy 3: 66/33kV Hybrid Network	111.1	85.8	98.0	75.1

Feeder Costs

The feeder estimates are calculated on a unit cost per kilometre basis utilising typical feeder costs for overhead line in the Upper Hunter region, which are typically through open paddock and so have minimal clearing requirements. The impact of a general $\pm 10\%$ variation in feeder cost was considered. In addition, a recently completed project to construct a new 66kV line at Denman achieved a feeder unit cost near the lower limit of the error range used to estimate the feeder costs. To reflect the possibility that a similar per unit rate is achieved for the feeder work for these strategies, which will traverse similar terrain to the Denman feeder, a 25% decrease in the feeder per unit rate is also considered. The results are shown in Table 9.

Table 9: Variation of feeder costs	10% Increase		10% Decrease		25% Decrease	
Scenario	Cost (\$m)	NPC (\$m)	Cost (\$m)	NPC (\$m)	Cost (\$m)	NPC (\$m)
Strategy 1: Upgrade 33kV Network	94.9	82.2	91.4	79.0	88.9	76.6
Strategy 2: Conversion to 66kV Network	125.0	93.9	116.4	86.9	109.9	81.7
Strategy 3: 66/33kV Hybrid Network	107.8	83.2	101.3	77.7	96.3	73.6

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4.2.3. Variation of Load Growth

General growth rate

The impact of a variation in the general load growth rate for the Upper Hunter was considered, calculated by changing the growth rate by $\pm 1\%$ i.e. a 1% increment in the growth rate is an additional 1% growth in each year. The main impact is a change in the timing of the third transformer at Mitchell Line STS in Strategies 1 and 3, and the timing of the need to upgrade feeder 5 in Strategy 2. Results are shown in Table 10.

Table 10: Variation in the general growth rate	1% Increment	1% Decrement
Scenario	NPC (\$m)	NPC (\$m)
Strategy 1: Upgrade 33kV Network	80.8	80.4
Strategy 2: Conversion to 66kV Network	90.9	90.0
Strategy 3: 66/33kV Hybrid Network	81.0	80.0

Large spot load

Mining developments have a large impact on network requirements in the Upper Hunter due to the large demand they place on infrastructure. The current high demand for coal is forecast to continue for the next few years at least, and there are several proposals for new mines or for expansion of existing operations. Enquiries have also been received for the connection of embedded generation in the Scone area ranging in capacity from 20MW to 200MW; including a potential Wind Farm development of up to 50MVA. Given the likely requirements of future developments and the limitations of the existing 33kV network, connections for new mining or embedded generator developments will be made at 66kV.

For developments south of the existing Dartbrook mine, the connection requirements under each strategy will be similar. Developments north of this point will require significantly more feeder work under a 33kV strategy. Table 11 shows the results for connection of a new development located in the vicinity of Scone. It is assumed that if the development is a new load that it will be of sufficient size that the third Mitchell Line STS transformer will be required and installed to coincide with the connection to the new load.

Table 11: Impact of a large development	Spot load (Mine)		Generator	
Scenario	Cost (\$m)	NPC (\$m)	Cost (\$m)	NPC (\$m)
Strategy 1: Upgrade 33kV Network	103.6	86.1	103.6	86.1
Strategy 2: Conversion to 66kV Network	123.6	93.8	123.6	92.0
Strategy 3: 66/33kV Hybrid Network	107.5	83.8	107.5	82.0

It is worth noting that under a 66kV or 66kV hybrid strategy, the interconnected 66kV network will permit greater flexibility and reliability of supply for new and existing developments; in particular, for obtaining outages to perform routine maintenance. Also note that the connection cost for a new large development would be customer funded.

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4.2.4. Variations to Licence Conditions

The licence conditions are currently under review; this may alter the timing of projects within each strategy. Of the currently proposed amendments, the most significant impact in the context of the proposed augmentation is a change in the criteria for overhead urban and non-urban subtransmission lines. Under the current conditions, the forecast demand during a contingency event is not to exceed the thermal capacity of the feeder. With the amended rule, the forecast demand during a contingency event may exceed the thermal capacity for up to 1% of the time i.e. a total aggregate time of 88 hours per annum, provided the maximum forecast load would not exceed the thermal capacity by more than 20%.

This rule does not affect the timing of Strategies 1 and 3, which are driven by the need to retire Muswellbrook STS as soon as practicable. It will, however, impact the timing for the upgrade to feeder 5 under Strategy 1. The impact on the strategy costs due the proposed amendment is shown in Table 12.

Table 12: Possible amendment of licence conditions	With amended licence conditions	
	Cost (\$m)	NPC (\$m)
Scenario		
Strategy 1: Upgrade 33kV Network	93.2	79.7
Strategy 2: Conversion to 66kV Network	120.7	90.4
Strategy 3: 66/33kV Hybrid Network	104.5	80.5

5. CONCLUSION

Of the strategies considered, an upgrade of the 33kV network (Strategy 1) and conversion to a hybrid 66/11kV network (Strategy 3) are of comparable cost. While sensitivity analysis suggests that Strategy 3 will produce a marginally better outcome under most sensitivity scenarios, it is not possible to determine definitely a preferred strategy based purely on least cost.

Therefore, on the basis that

- (c) there is marginal difference between the net present cost for each strategy;
- (d) the choice to supply Scone at 66kV will not lock EnergyAustralia into an area strategy;

and subject to comments received during the consultation period, EnergyAustralia favours construction of Scone zone as a 66/33/11kV substation and extension the 66kV 'Dartbrook' feeder, which is the first stage of Strategy 3: 'Hybrid 66/33kV Network' as this strategy provides significant strategic advantages.

6. CONTACT DETAILS

Comments on this consultation, including proposals for alternative options must be in the form of written submissions, which may be in hard copy or suitable electronic format and must be provided by 15th December 2007. Proposals or other enquiries should be directed to the contact listed below:

John Hele

Acting/Manager – Network Investment

GPO Box 4009

Sydney 2001

Email: jhele@energy.com.au

Phone: 02 9269 2862

Fax 02 9269 4696

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7. APPENDIX A – ECONOMIC ANALYSIS OF BASE CASE

Discount Rate = 8.5%

All figures are expressed in 2007/08 real dollars

Strategy 1: Upgrade 33kV Network

Description	Cost (\$m)	NPC (\$m)	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24
1) New 33kV feeder from Muswellbrook STS to Scone zone	14.7	13.6	2.6	9.7	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2) New 33/11kV Scone zone	17.5	16.2	4.3	10.4	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) New Muswellbrook 132/33kV STS	31.2	29.0	7.8	18.6	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) New Aberdeen 33kV zone	14.0	12.0	0.0	3.5	8.3	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5) Decommission Muswellbrook 132/33kV STS	0.2	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6) Upgrade 33kV feeder 5 Muswellbrook STS to Aberdeen Tee	2.9	2.4	0.0	0.0	1.7	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7) Construct additional feeder between Muswellbrook STS/BSP	7.5	6.4	0.0	1.8	4.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8) Upgrade Muswellbrook zone	5.2	4.3	0.0	0.0	3.1	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capital Cost	93.2	-	14.7	44.0	28.1	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Increase in O&M due to New Infrastructure	-	4.0	0.0	0.0	0.2	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Decrease in O&M due to retirement of assets	-	-7.5	0.0	0.0	0.0	-0.8	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
Total Operation and Maintenance	-	-3.5	0.0	0.0	0.2	-0.3	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Total Cost	93.2	80.6	14.7	44.0	28.3	6.1	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6

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Strategy 2: Conversion to 66kV Network

Description	Cost (\$m)	NPC (\$m)	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24
1) Extend 66kV "Dartbrook" Feeder to Scone zone	10.4	9.6	1.9	6.9	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2) New Scone 66/11kV zone	17.8	16.6	4.4	10.6	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) New Aberdeen 66/11kV zone	14.8	12.6	0.0	3.7	8.8	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) Rebuild / construct feeders between Muswellbrook STS/BSP	13.3	11.4	0.0	3.2	8.8	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5) Upgrade Feeder 5 to 66kV from Muswellbrook STS to Aberdeen	4.9	3.7	0.0	0.0	0.0	2.9	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6) Upgrade Feeder 7 to 66kV- Muswellbrook STS – Aberdeen zone	3.9	2.9	0.0	0.0	0.0	2.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7) Muswellbrook zone 66kV Conversion & 11kV Upgrade	15.1	12.0	0.0	0.0	3.8	9.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8) Upgrade to 66kV Feeders 5 & 7 between Aberdeen & Scone	16.5	12.0	0.0	0.0	0.0	4.0	10.9	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9) New Rouchel 66/33/11kV zone	9.1	6.6	0.0	0.0	0.0	2.3	5.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10) Muswellbrook Coal 66/33kV Step-down	3.1	2.2	0.0	0.0	0.0	0.0	1.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11) Moonan 66/33kV Step-down	3.1	2.2	0.0	0.0	0.0	0.0	1.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12) Decommission Muswellbrook 132/33kV STS	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13) Mitchell Line 132/66kV Third Transformer	8.5	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	3.4	0.0
Total Capital Cost	120.7	-	6.3	24.3	25.8	24.1	25.9	5.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	3.4	0.0
Increase in O&M due to New Infrastructure	-	3.8	0.0	0.0	0.1	0.3	0.4	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Decrease in O&M due to retirement of assets	-	-8.0	0.0	0.0	0.0	-0.3	-0.8	-0.9	-1.0	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5
Total Operation and Maintenance	-	-4.2	0.0	0.0	0.1	0.0	-0.4	-0.3	-0.4	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.8
Total Cost	120.7	90.4	6.3	24.3	25.9	24.1	25.5	5.2	-0.2	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	4.2	2.5	-0.8

CONSULTATION PAPER - DEVELOPMENT OF NEW SCONE 66/33/11kV SUBSTATION

Strategy 3: 66/33kV Hybrid Network

Description	Cost (\$m)	NPC (\$m)	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24
1) Extend 66kV "Dartbrook" Feeder to Scone zone	10.4	9.6	1.9	6.9	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2) New Scone 66/33/11kV zone	21.0	19.5	5.2	12.5	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) New Aberdeen 66/33/11kV zone	20.9	17.9	0.0	5.2	12.5	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) Rebuild / construct feeders between Muswellbrook STS/BSP	13.3	11.4	0.0	3.2	8.8	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5) Muswellbrook zone 66kV Conversion and 11kV Upgrade	15.1	12.0	0.0	0.0	3.8	9.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6) Upgrade feeder 7 to 66kV between Muswellbrook STS and Aberdeen	3.9	2.9	0.0	0.0	0.0	2.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7) Upgrade feeder 5 to 66kV between Muswellbrook STS and Aberdeen	4.6	3.5	0.0	0.0	0.0	2.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8) Upgrade feeder 5 to 66kV between Aberdeen and Scone	6.7	4.7	0.0	0.0	0.0	0.0	4.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9) Decommission Muswellbrook STS	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10) Mitchell Line 132/66kV Third Transformer	8.5	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	3.4	0.0
Total Capital Cost	104.5	-	7.1	27.7	29.9	18.7	9.8	2.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	3.4	0.0
Increase in O&M due to New Infrastructure	-	3.8	0.0	0.0	0.1	0.3	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Decrease in O&M due to retirement of assets	-	-7.6	0.0	0.0	0.0	-0.3	-0.8	-0.9	-0.9	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4
Total Operation and Maintenance	-	-3.8	0.0	0.0	0.1	0.0	-0.3	-0.3	-0.3	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Total Cost	104.5	80.5	7.1	27.7	30.1	18.7	9.4	2.4	-0.1	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	4.3	2.6	-0.8