EnergyAustralia™

DEVELOPMENT OF ELECTRICITY SUPPLY TO EAST MAITLAND/THORNTON/TARRO

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EXECUTIVE SUMMARY

This paper has been prepared to identify options for the development of the electricity supply network in the East Maitland to Tarro area which will analysed in accordance with ACCC's regulatory test.

Section 1 provides a description of the East Maitland to Tarro supply area.

Section 2 describes in detail the objectively measurable service standard (planning criterion) against which the need and effectiveness of augmentation options are to be assessed.

Section 3 describes in detail the nature of the growing load in the area, the limitations affecting the transmission network in the area and the need for augmentation of supply to the area.

In Section 4 three feasible augmentation strategies are described.

Strategy 1 comprises:

- Construct a 132/33kV STS at Beresfield;
- Replace the circuit breakers, switchroom and transformers at Tarro Zone;
- Construct a new zone substation at Thornton with 2x33/11kV 33MVA transformers;
- Replace the switchroom and transformers at East Maitland Zone;
- Install capacitors at East Maitland and Tarro zone substations; and
- Construct/relocate the 33kV feeders in the area.

Strategy 2 comprises:

- Construct a new zone substation at Thornton with 2x132/11kV 37MVA transformers;
- Rebuild East Maitland as a 132kV substation with 2x37MVA transformers;
- Rebuild Tarro as a 132kV substation with 2x37MVA transformers and capacitors;
- Install a regulator station on the Gresford feeder; and
- Construct new 132kV feeders in the area.

Strategy 3 comprises:

- Install 2x132/66kV 120MVA transformers and additional 66kV feeder bays at Kurri STS
- Replace the circuit breakers, switchroom and transformers at Tarro Zone;
- Construct a new zone substation at Thornton with 2x66/11kV 33MVA transformers;
- Replace the circuit breakers, switchroom and transformers at East Maitland Zone;
- Construct a 66/33kV substation on the Gresford feeder;
- Install capacitors at East Maitland and Tarro zone substations; and
- Construct/rebuild feeders in the area at 66kV.

In Section 5 the results of a preliminary application of the regulatory test are presented. The main conclusions are that the most cost effective option is Strategy 1.

1. INTRODUCTION

1.1. Purpose and Scope

This paper includes:

- a discussion of supply system limitations identified by EnergyAustralia that have lead to the necessity for replacement and augmentation of the distribution network in the area;
- a discussion of the service standard that has been adopted for planning purposes;
- descriptions of options for development of the electricity supply in the area; and
- details of a cost effectiveness analysis of each of these options that has been carried out in accordance with the requirements of the ACCC's regulatory test.

This paper was prepared in June 2004 following commencement of construction of Beresfield substation. It uses load forecasts and other information available at the time of project authorisation in October 2003.

1.2. Background

1.2.1. Introduction

A number of issues exist for the supply network to the East Maitland/Thornton/Tarro area west of Newcastle. These include the need to address significant existing capacity limitations as well as providing sufficient future capacity to supply future load growth.

This area is serviced by two zone substations, one at East Maitland and one at Tarro and lies between two 132/33kV subtransmission substations, Kurri & Tomago. Load at both zone substations is currently exceeding firm capacity. In 2003, the load at Kurri STS was 29.7MVA above firm capacity in summer and is expected to exceed it's Winter firm rating in 2005. Tomago STS is expected to exceed it's firm rating in the summer of 2004/05 and the winter of 2008.

The key constraint driver is the increase in commercial load, the operation of air conditioning systems during peak summer periods and ongoing residential & industrial developments. Load is forecast to grow at approximately 5 % p.a. and summer loads are approximately 21% higher than winter loads.

There is a need for an additional 53 MVA of zone substation capacity and an additional 140MVA of sub-transmission capacity for year 2010 loads. This situation applies to East Maitland and Tarro substations with Tarro having limited opportunity for improvements in capacity or load transfer.

A detailed planning study has been carried out to help determine a preferred supply strategy for the short and longer term. The study has attempted to ensure any immediate supply developments are compatible with the preferred longer-term augmentation strategy.

The study identified 22 options as being feasible and that would fit the long-term supply requirements for the area. There was an analysis of the options to form a list of strategies (38 strategies), each strategy consisted of a set of individual options which addressed the key issues and as many other issues as possible and also satisfy as many constraints as possible.

These strategies have been taken into further analysis that included technical, environmental and financial issues and three primary strategies were identified that would meet the short and long term supply requirements for the area.

The three strategies are:

- Construct a new Beresfield 132/33 subtransmission substation (STS) and associated works.
- Build 132/11kV Zones for East Maitland, Thornton and Tarro.
- Upgrade 66kV capacity from Kurri STS for East Maitland, Thornton and Tarro.

Due to the high growth rates there is a need to undertake works in the short term while still encompassing the long-term outcomes.

1.2.2. Supply Arrangements

Kurri and Tomago are 132/33kV sub-transmission substations that supply an area generally north and west of Newcastle via a series of 33/11kV zone substations. Because of the interrelated nature of the areas served by these two stations, a strategic decision has been taken to consider solutions to the emerging issues in these areas jointly.

Kurri supplies the majority of the Maitland and Cessnock local government areas including the main centres of Maitland, East Maitland, Cessnock, Pokolbin, Kurri, Branxton and Rutherford. Key issues include residential development around Maitland and growth in tourism and wine processing in the Cessnock area.

Tomago supplies the majority of the Port Stephens local government area, including the main centres of Tarro, Raymond Terrace, Medowie, Williamtown, Tanilba Bay and Nelson Bay. Key issues are substantial residential development at Nelson Bay, Medowie and Raymond Terrace and commercial / light industrial development around Williamtown and Tomago.

Peak demands at Kurri STS are heavily biased toward summer, while demands at Tomago are similar in both summer and winter. At East Maitland zone substation , both summer and winter demands are significant, however summer growth rates are substantially higher than winter rates and summer will continue to be the critical period. Tarro is strongly summer peaking.

1.2.3. Capability of the Existing Network

In the near term, several initiatives have been committed to in order to manage risks. These include load transfers from Branxton and Cessnock to Rothbury and moving Branxton to Singleton 66kV (relieving Kurri STS), and reconnecting Kooragang to Waratah STS (relieving Tomago STS). At zone level they include load transfers from East Maitland to Rutherford, and from Tarro to a temporary Thornton zone.

1.2.3.1. Kurri 132/33kV Sub-transmission Substation

Kurri 132/33kV Sub-transmission Substation supplies the majority of the Maitland and Cessnock Local Government areas. This is a very large supply area extending from Wollombi in the south to Martin’s Creek in the north and includes the main centres of Maitland, East Maitland, Cessnock, Pokolbin, Kurri, Branxton and Rutherford.
Over the last ten years the area has been one of the fastest growing in NSW and continues experiencing significant residential expansion particularly around Ashtonfield and Thornton and also to the west of Maitland. Very significant load increases have also been occurring in the Cessnock Vineyard district as a result of increasing tourism and wine processing activities in this area.

An overall diversified demand growth of around 2.3% in Winter and 4.3% in Summer has been estimated. High growth areas such as Thornton have been projected to have summer demand growth of 5.4%. Kurri has a firm transformer rating of 120MVA and installed capacity of 180MVA (3 x 60MVA). The effective firm capacity (EFC) is 136MVA limited by 1200A 33kV transformer secondary bay equipment. The substation has an existing normal peak loading of 165MVA in summer and 130MVA in winter. Forecast loads are shown in Appendix C.

No interconnections for load transfer presently exist on the 33kV network. The 66kV network does provide interconnections to Singleton STS allowing transfer of Branxton Zone Substation (approx 10MVA) to Singleton if required. Arranging this transfer presently requires complex manual field switching which can take considerable period of time to complete. Under these transfer conditions reliability and security is reduced for Branxton due to the long 66kV interconnections, which pass through a storm prone region. However due to the very high loading at Kurri it is intended to supply Branxton from Singleton as a permanent arrangement to provide necessary immediate load relief.

In the event of a single transformer or associated equipment failure at Kurri STS it is likely that over 30MVA of load shedding would be required under present peak load conditions. Ongoing load shedding or restriction is likely to be required over an extended period of time until appropriate equipment repairs can be effected.

It is apparent that existing loading at Kurri is presently loaded to well above firm rating and loading is forecast to grow rapidly. This is a system constraint and represents a major supply issue which requires addressing in the short as well as the medium to long term.

1.2.3.2. Tomago 132/33kV Sub-Transmission Substation

Tomago 132/33kV Sub-Transmission Substation supplies the majority of the Port Stephens Local Government Area. This is a very large supply area extending from Seaham in the west to Nelson Bay and includes the main centres of Tarro, Raymond Terrace, Medowie, Williamtown, Tanilba Bay and Nelson Bay. Port Stephens is one of the fastest growing Local Government Areas in NSW and is experiencing significant residential expansion at Nelson Bay, Medowie and Raymond Terrace and commercial/light industrial load development around Williamtown and Tomago.

Based on current spatial load projections an overall diversified demand growth of around 5% in summer and 2.7% in winter has been estimated. Developing areas such as Nelson Bay have been projected to have summer demand growth of up to 5.5%. Ongoing large load increases are anticipated at Williamtown RAAF Base as part of an expansion program.

Tomago has a firm transformer rating of 120MVA and installed capacity of 180MVA (3x60MVA). The effective firm capacity (EFC) is 136MVA limited by 1200A 33kV transformer secondary bay equipment. The substation has an existing normal peak loading of 105MVA in winter and 128MVA in summer. The base summer and winter load forecast for Tomago are provided in the appendix D. Loading on Tomago is expected to exceed the substation effective firm capacity in 2005.

Apparent losses on the 33kV network are calculated to increase markedly over the next ten years making a significant contribution to demand on Tomago Substation. No suitable interconnections exist on the 33kV network to allow any load transfer from Tomago. However, Tomago can be used to provide load support for Waratah STS. Under peak load conditions this transfer could load Tomago over the full rating of 180MVA after 2003.

1.2.3.3. East Maitland Zone Substation

East Maitland is loaded well above it's firm capacity and loading is presently above a 1% level of risk.
Short term measures to improve capacity have already been undertaken at East Maitland which include improving transformer cooling and providing for 11kV load transfers.

The estimated costs of further incremental upgrades are indicated below

Table 1 – East Maitland

Description	Cost ($M)
11kV Switchroom	2.00
Capacitors	0.7
Transformers 3x19 MVA	1.5

There is limited space at East Maitland and expansion of the existing switchroom would be difficult.

1.2.3.4. Tarro Zone Substation

Tarro Zone Substation loaded well above it's firm capacity and loading has presently above a 1% level of risk.

The limiting equipment is the 1954 vintage 11kV switchgear. There is room to build a new switchroom to allow replacement of the 11kV switchgear. Replacement of the 11kV switchgear would allow the firm capacity to be increased from 22.9MVA to 25MVA (transformers limit). In the longer term the rating could be further increased by uprating transformers to 33MVA units.

The estimated costs of incremental upgrades are indicated below.

Table 2 – Tarro Zone

Description	Cost ($M)
11kV Switchroom (2000A panel)	2.00
Capacitors	0.7
33MVA Transformers	1.5

If Tarro remains as a 33/11kV substation the design issues are simplified greatly.

The main issue for the distribution is the supply to the Thornton area from Tarro substation and the high growth in the Thornton area..

Further, the distribution between the East Maitland and Tarro substations is limited in operational use by the use of different off-peak load control frequencies and the distance between the substations limits transfers with this effecting the Ashtonfield, Metford and Thornton areas.

The distribution limitations will be further escalated by the high growth rates in a short period.

1.2.4. Tarro and East Maitland Supply Strategy

The main issues in the Tarro to East Maitland area are:

- Overloading on 33kV sub-transmission feeders and substation feeder bays.
- Depressed 33kV voltages at East Maitland, Gresford, Martins Creek & Wallalong.
- Overloading of Kurri STS to 165MVA , firm 120MVA.
- East Maitland loaded to 34.1MVA, 124% of firm capacity (13.7MVA each transformer).
- Tarro loaded to 34.0 MVA, 148% of firm capacity.
- High summer growth rates for the area (East Maitland 10.3% 99-01, Tarro 10.7% 99-01).
- Forecast shortfall in zone substation capacity of 53.5MVA for year 2010 for the East Maitland – Tarro area.
- Aged assets for equipment at Tarro, 1954 vintage & East Maitland 1966 vintage..
- 11kV Distribution loading existing & future
- 11kV limited interconnection
- Future overloading of Tomago STS.

1.2.5. National Electricity Code Requirements

Most of the EnergyAustralia network within the area, including Tarro and East Maitland zone substations are classified as distribution system assets by the National Electricity Code (the Code). Tomago and Kurri sub-transmission substations are however Transmission assets. The area is however crossed by a number of EnergyAustralia's transmission lines.

The proposed regional strategy addresses both transmission and distribution constraints and includes both transmission and distribution augmentations. Clause 5.6.2 (e) and (f) of the Code requires, 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 Code Participants of these limitations and consult with affected Code 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, which would be a new small network asset. The Code planning and consultation processes for transmission assets differ slightly from distribution assets and are contained in Clause 5.6.6.

The proposed development strategy for the Tarro/East Maitland area involves expenditure in excess of $10 million which is regarded by the Code as a large network asset. Furthermore likely strategies involve the construction of a new sub-transmission substation, connected to the transmission network. This substation will become a new transmission exit point.

At the present time the zone substations at East Maitland & Tarro and the transmission substation at Kurri are loaded to above their firm capacity. Loading at Kurri is approaching the point where loading will exceed substation rating under normal operating conditions. System augmentation is required to maintain existing standards of service and would thus be considered a reliability driven augmentation. EnergyAustralia will use a least cost test to examine a range of options which will meet the objectives of replacing aging infrastructure and providing for increased long term future capacity.

2. IDENTIFICATION OF NEED FOR AUGMENTATION

2.1. Code Requirements

With respect to augmentations Clause 5.6.2 (e) of the National Electricity Code indicates

"where .. analysis indicates that any relevant technical limits of the transmission and distribution systems will be exceeded, either in normal conditions or following the contingencies specified in schedule 5.1 , the Network Service Provider must notify any affected Code Participants of these limitations and advise those Code Participants of the expected time required to allow the appropriate corrective network augmentation or non-network alternatives, or modifications to connection facilities to be undertaken"

Furthermore clause 5.6.2 (g) states

> *"Distribution Network Service providers must carry out an economic cost effectiveness analysis of possible options to identify options that pass the regulatory test…"*

For transmission augmentations Clause 5.6.6 (b) (5) and 5.6.6 (h) (3) require analysis and recommendations as to why the applicant considers that a new large network asset satisfies the regulatory test and whether the new asset is a reliability augmentation.

These requirements, and the ACCC's regulatory test indicate that if the augmentation is required to maintain standards of service within a region limb (a) of the test should be used. That is, the option that passes the regulatory test is the one that minimises the cost of meeting an objectively measurable service standard linked to the technical requirements of Schedule 5.1 of the Code.

In this case the need to provide for general load growth is the primary driver of the proposed project. At the present time the zone substations at East Maitland & Tarro and the transmission substation at Kurri are loaded to above their firm capacity. Loading at Kurri is approaching the point where loading will exceed substation rating under normal operating conditions. System augmentation is required to maintain existing standards of service and would thus be considered a reliability driven augmentation.

2.2. Objectively Measurable Service Standard

EnergyAustralia applies a risk based service standard to their suburban zone substations. This means that

1. With all zone transformers or sub-transmission feeders network elements in service, the loading on each element is not to exceed the continuous rating of that element.

2. The chance in any season is less than 1% that following outage of any one network element, loading will exceed the sustained emergency capacity of remaining system elements.

In terms of reliability standards as defined by the Code, this constitutes a slight reduction in reliability from an "N-1" reliability criterion (as described in S5.1.2.2 (b) (4)).

A deterministic (N-1) criteria is used for subtransmission substations.

2.3. Consideration of Demand Management

EnergyAustralia has investigated demand side options in the East Maitland, Thornton and Tarro areas.

The investigation found that the absolute volume of DM required is large. The value available for DM is moderate at best. Based on the findings and EnergyAustralia's experience with other investigations, it is considered highly unlikely that sufficient effective DM options would be identified in an investigation to enable a cost-effective deferral of any part of this investment strategy.

Based on this analysis it is considered unreasonable to expect that it would be cost-effective to postpone the expansion by implementing demand management strategies. The investigation recommended that no further specific investigation of demand management options be pursued with respect to the proposed Beresfield STS and Thornton Zone Substation Projects.

3. LOAD FORECASTS

3.1. Basis of Demand Forecasts

The development of efficient network development plans requires long term forecasting of demand. Whilst historical load information is used in the forecasting process, it is necessary to also consider the impact of factors such as weather and changing customer needs.

The Tarro to East Maitland load forecasts are based on regression analysis of historical peak demands to establish the underlying trend growth, and projected forwards from a stating point of the most recent actual demand, corrected for both temperature and humidity. Corrections are then applied to this base forecast to account for changing customer needs, as reflected in applications for supply and known new developments.

Changes in demand predicted by the above process are then cross-checked against expected growth arising from high level forecasts of population, office space and infrastructure.

The forecasts represent the median expectation of actual peak demand. Annual variations in demand arising from unpredictable factors such as weather can result in actual demand deviating from the forecast value by 5% in either direction.

3.2. Tarro to East Maitland Load Forecasts

Increases in electricity consumption are expected to occur due to a combination of factors:

- Significant growth in population due to the attractiveness of the area and continuing land releases. It is estimated that net increases in the number of dwellings in the region will result in additional demand on the existing infrastructure.
- Redevelopment of existing homes and increased household energy consumption resulting from improved living standards and amenities.
- Continuing commercial and industrial development associated with population growth.

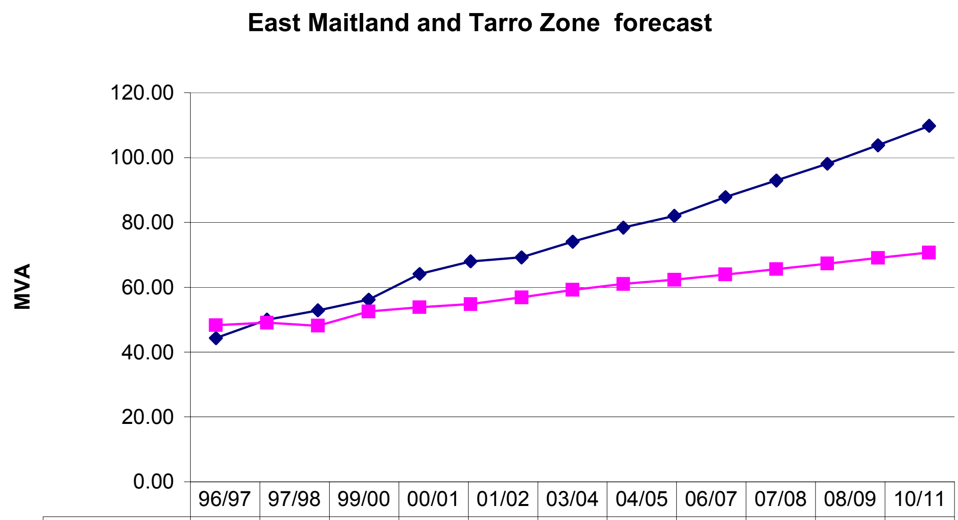
The load in the region is envisaged to grow steadily and Energy Australia's most recent forecasts for the area, up to 2011 are shown in Table 3 below and shown in Figure 1. The figures up to 2003 are actual measured values and beyond this date have been extrapolated. Forecasts for the individual zone substations are included in Appendix A and B.

Table 3 - Forecast of Summer Maximum Demands for East Maitland and Tarro Substations

Summer	Total Demand (2 substations)	Network Firm Capacity
	MVA	MVA
96/97	44.30	47.90
97/98	49.99	47.90
98/99	52.88	47.90
99/00	56.16	47.90
00/01	64.08	47.90
01/02	68.00	50.30
02/03	69.20	50.30
03/04	74.10	50.30
04/05	78.40	50.30
05/06	82.00	50.30
06/07	87.80	50.30
07/08	92.90	50.30
08/09	98.10	50.30
09/10	103.80	50.30
10/11	109.80	50.30
11/12	116.10	50.30

Actual values are shown up to 2003/4

Figure 1 Zone Substation Forecast Maximum Demands



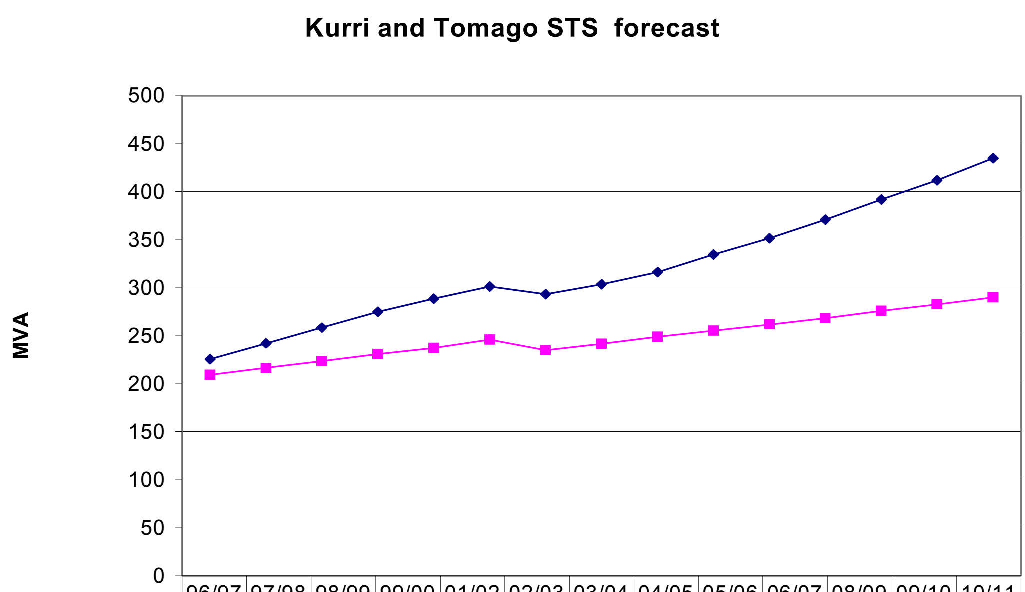
	96/97	97/98	99/00	00/01	01/02	03/04	04/05	06/07	07/08	08/09	10/11
Summer	44.30	49.99	56.16	64.08	68.00	74.10	78.40	87.80	92.90	98.10	109.80
Winter	48.3	49.1	52.5	53.9	54.8	59.2	61.0	63.9	65.6	67.3	70.7

The daily load profile identifies that large commercial customers in East Maitland and light industrial customers in Tarro dominate the electrical demand during the day. The increasing use of air-conditioning is also a major constraint driver for both areas.

3.3. Kurri and Tomago STS Load Forecasts

The base summer and winter load forecast for Kurri and associated apparent network losses are provided in the graph below.

Figure 2 STS Forecast Maximum Demands



	96/97	97/98	98/99	99/00	01/02	02/03	03/04	04/05	05/06	06/07	08/09	09/10	10/11
Summer	226	242	258	275	301	293	304	316	334	351	392	412	435
Winter	209	216	224	231	246	235	242	249	255	262	276	283	290

The reduction in load in 2002/3 is a result of load transfers from Tomago and Kurri to adjacent substations. Apparent losses on the 33kV network are calculated to increase markedly over the next ten years making a very significant contribution to future demand on Kurri Substation.

4. OPTIONS

The development strategy for the East Maitland/Tarro area comprises a number of stages which can be progressively implemented.

There is an immediate need to identify the preferred option to:

- To provide firm zone substation supply capacity of at least 100MVA to cater for the year 2010. This is 50MVA above the existing firm capacity.
- To address the distribution limitations around Thornton and Metford.
- To provide load relief for the Zone substations of East Maitland & Tarro.
- To alleviate both voltage and load problems on the 33kV networks from Kurri and Tomago sub-transmission systems.
- To provide load relief for Kurri STS and Tomago STS.

EnergyAustralia has developed three network options. With all the strategies the construction of a zone substation at Thornton is needed, the only difference is the primary voltage. In simple terms the higher the voltage the larger the substation.

The location chosen for this substation is reasonably well isolated from residential areas and with well designed landscaping would have a low visual impact

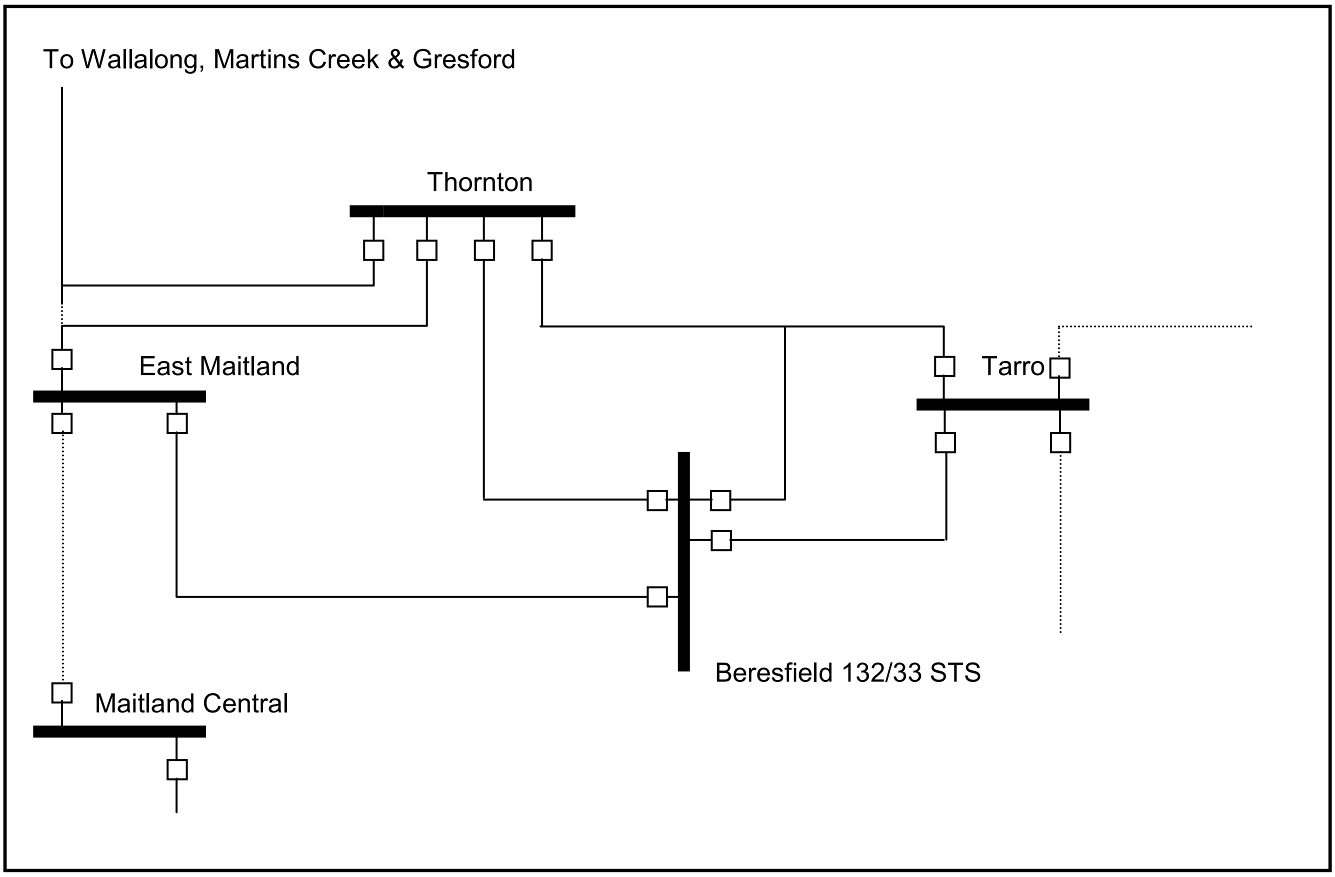
Tarro and East Maitland zone substations will require various degrees of construction dependant on the final strategy, and as mentioned above the higher the primary the larger the substation.

The three strategies proposed are described in the following sections.

4.1. Strategy 1 - Beresfield 132/33 STS and Thornton 33/11 Zone.

The strategy proposes the construction of a 132/33kV substation on land owned by Energy Australia off Weakleys Drive, Beresfield, together with the construction of a 33/11kv zone substation at Thornton and staged redevelopment of Tarro and East Maitland zone substations..

Figure 3. - Beresfield 132/33 STS – 33kV Circuit



This strategy is based on the following work:

1. Improve capacity at Tarro by installing a new switchroom to improve the firm capacity to 31.92MVA.
2. Relocate feeder 860 along Raymond Terrace Rd with underbuilt 11kV for new feeder to free up the existing route between Thornton zone site and Tarro for 33kV feeders in 2004.
3. Construct a permanent Thornton 33/11kV substation in 2005 with two 33kV 33MVA transformers.
4. Construct 132/33kV STS at Beresfield in 2005 and complete the 33kV feeder arrangement.
5. Install capacitors at East Maitland in 2005.
6. Replace the 11kV switchgear, transformer secondaries at East Maitland and install 3x19 MVA transformers.

The construction of overhead mains is a significant component of all the strategies, strategy one will use 33kV wood or concrete pole construction that will generally use existing 11kV routes that will be re-constructed to carry the 11kV and 33kV mains on a single pole.

This type of construction will only have a small increase in the visual impact of the existing lines, as it is very similar to the existing construction. Strategy one offers the least impact for these substations as the existing primary voltage is the same and with that the existing accommodation is generally adequate.

The relocation of a section of 66kV feeder 860 along Raymond Terrace Rd will free up its present route between Tarro and Thornton for 33kV mains but the relocation would require an amount of tree clearing along Raymond Terrace Rd.

Advantages: -

- Improves firm capacity to 38 MVA at East Maitland.
- Construction of Beresfield & Thornton allows for additional capacity in area of high growth.
- Construction at 33kV allows easy connection of the Gresford feeder.
- Removes load from Kurri STS and 33kV system.
- Removes load from Tomago STS and 33kV system.
- Improves firm capacity to 33 MVA at Tarro and removes aged assets.
- Improves 33kV feeder arrangement.
- Improves 132kV feeder arrangement for Kurri/Tomago/Taree/Stroud.
- Flexible arrangement.

Disadvantages: -

- Capacitors are needed at Tarro and East Maitland to reduce 33kV feeder loads.

4.2. Strategy 2 – 132/11kV Zones East Maitland, Thornton & Tarro

This option would require the establishment of new 132/11kV zones at East Maitland, Thornton & Tarro supplied by a new 132kV feeder interconnecting the Kurri and Tomago substations.

This option would reduce loading at Kurri and Tomago STS and the existing 33kV Sub-transmission network. and increase 132kV network capacity.

The 132kV feeder would be constructed to supply the proposed Thornton Zone and would provide for the supply of East Maitland and Tarro Zones in later years.

The major difficulty with this strategy would be the future conversion of both East Maitland and Tarro to 132kV zones as space is very limited at the existing sites and the installation of a 132kV busbar would be difficult.
With the limited space at East Maitland a new site would have to be considered. This would add cost for the purchase of land and the added cost of re-arranging the distribution network in the area

The Tarro site is also small, however land may be purchased next to this site. Maintaining supply during such large conversion works would be difficult. The use of transportable substations would be needed to maintain supply during such works if the existing site could be used..

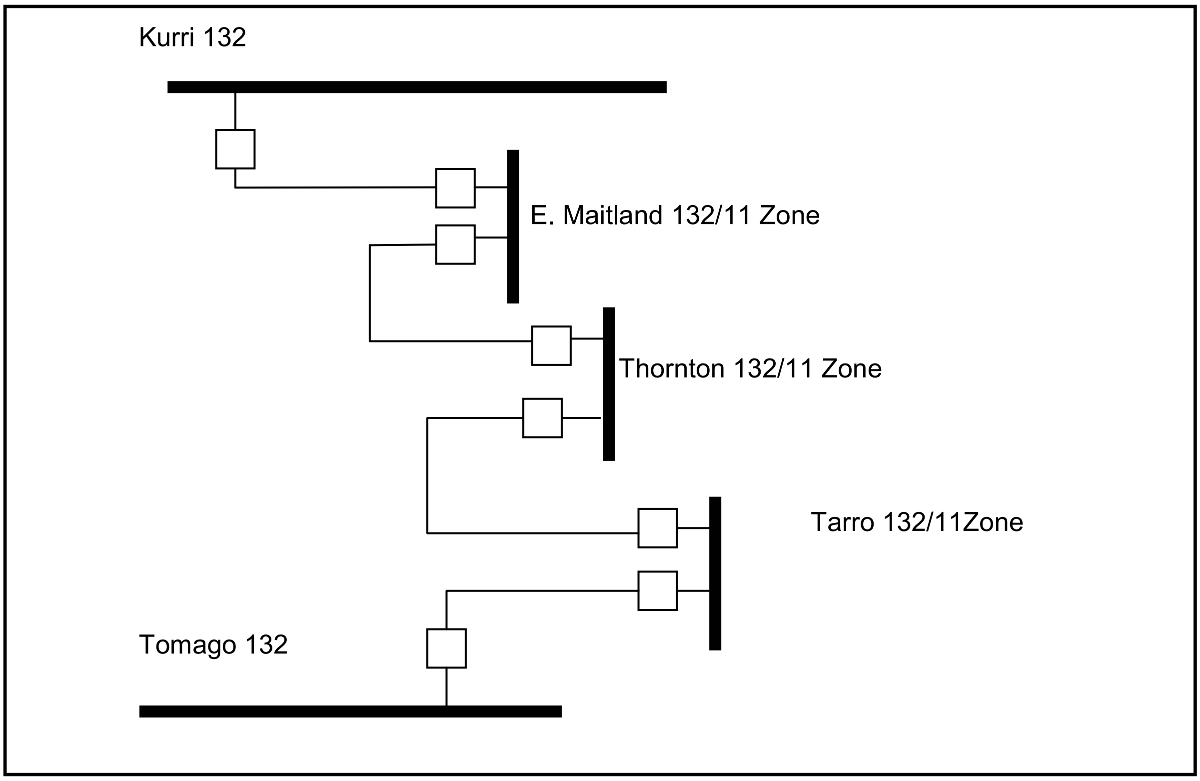
The 33kV feeder No 3 would be connected to the existing East Maitland – Central Maitland 33kV line to maintain two feeders to Central Maitland. The 33kV feeder north to Wallalong, Martins Creek and Gresford zone substations would need to be connected to this section. A 33kV 5/7 MVA regulator would be needed to maintain voltage levels for these three substations, this would be required in year 2005. This supply will have limitations and a new spot load may cause the need to improve the supply by a 132/33kV substation in the future.

Based on the current loadings the following table details the reduction in loading at Kurri and Tomago.

Table 4 - STS Loading for Area (Zone Peak Loads)

Substation	**Kurri**	**Tomago**
Thornton	12	
East Maitland	34.4	
Tarro		22.8
TOTAL	46.4MVA	22.8MVA

Figure 4. - 132kV Circuit



Strategy two has a similar distance of overhead mains construction to strategy 1, but the construction is at 132kV and would require existing lines be re-constructed. The construction will need to use larger concrete single pole construction with horizontal post insulators and an overhead earth wire.

Constructions of this type will have a higher degree of visual impact and may also raise community concern in regard to the proximity to residential areas in the East Maitland and Thornton areas.

Advantages: -

- Improves firm capacity to 65 MVA at East Maitland.
- Construction of Thornton allows for additional capacity in area of high growth.
- Removes load from Kurri STS and 33kV system.
- Removes load from Tomago STS and 33kV system.
- Improves firm capacity to 65 MVA at Tarro and removes aged assets

Disadvantages: -

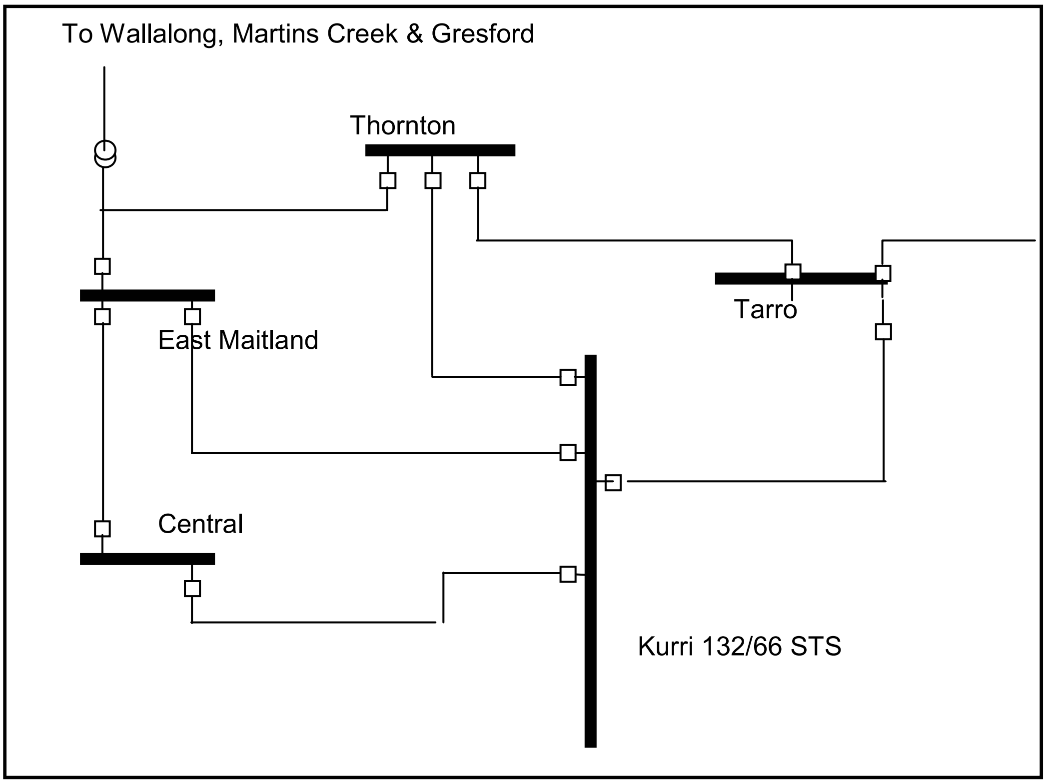
- Limited space at East Maitland for 132kV.
- Higher cost.
- Removes 33kV interconnections to Maitland Central, Raymond Terrace & Mayfield.

4.3. Strategy 3 - 66kV Supply East Maitland, Thornton & Tarro at 66kV from Kurri

This strategy required the upgrade of 66kV capacity from Kurri STS, the construction of a new Thornton 66kV zone substation and the conversion of Tarro, East Maitland and Central Maitland zone substations to 66kV operation.

The following configuration would be able to supply the forecast year 2020 loads, subject to capacity at Kurri 132.

Figure 5. - 66kV Circuit



The connection of Maitland Central at 66kV helps with load reduction at Kurri 132/33 and would improve loadflows for East Maitland.

A 33kV feeder would be connected to the existing East Maitland – Central 33kV line to maintain two feeders to Central and the 33kV feeder north to Wallalong, Martins Creek and Gresford zone substations would need to be supplied by a 66/33kV transformer.

The option would require significant amount of work early in the project life.

Strategy three has the greatest distance of overhead mains construction but a major component is the reconstruction of the existing 66kV feeder 860 to increase its capacity.

The construction would be single pole concrete construction, the visual effect would be less than strategy two but greater than strategy one.

Advantages: -

- Improves firm capacity to 38 MVA at East Maitland.
- Construction of Thornton allows for additional capacity in area of high growth.
- Removes load from Tomago STS and 33kV system.
- Improves firm capacity to 33 MVA at Tarro and removes aged assets

Disadvantages: -

- Major works required at Kurri STS.
- Largest amount of feeder works of all strategies
- Construction at 66kV would require substation for the 33kV Gresford feeder.

5. PRELIMINARY APPLICATION OF THE REGULATORY TEST

A preliminary application of the Regulatory Test, considering network strategies 1, 2 and 3, has been carried out. This analysis incorporates:

- Capital costs.
- Sensitivities to:
    - Discount rate;
    - Demand growth rates;

The unserved energy benefits and losses do not vary materially between options and have thus been excluded from analysis

5.1. Base Case Analysis

The results of the base case economic analysis are summarised in Table 5.

Table 5 Comparison of Options – Base Case

Option	Capital Cost ($M)	PV of Costs ($M)	Effective Annual Cost ($M)
Strategy 1	$ 62.5	$ 44.3	$ 6.34
Strategy 2	$ 64.4	$ 47.2	$ 6.70
Strategy 3	$ 81.0	$ 63.2	$ 8.44

The analysis above clearly indicates the net present value that the lowest cost solution is Strategy 1.

5.2. Sensitivity Analysis

The base case and the range over which sensitivity checks were conducted are shown in Table 6 and 7.

Table 6 - Base Case Values and Range of Values Used in Sensitivity Checks

Parameter	Base Case Value	Sensitivity Checks at
Real Discount Rate	10%	7% and 13%
Demand growth Rates	3.4% (Zone)	1.1% and 5.7%
Capital Costs	100%	120%

Table 7 – Effective Annual Cost ($M)

Sensitivity Case	Strategy 1	Strategy2	Strategy 3
Base Case	$ 6.34	$ 6.70	$ 8.44
Reduced growth rate	$ 6.34	$ 6.38	$ 8.44
Increased growth rate	$ 6.34	$ 6.72	$ 8.44
13% Discount Rate	$ 5.83	$ 6.15	$ 7.94
7% Discount Rate	$ 6.96	$ 7.22	$ 9.02
20% Increase in Capital Costs	$ 7.61	$ 8.0	$ 10.1

Strategy 1 is a lower cost option under all sensitivity checks.

5.3. Conclusion

Strategy 1, a 33kV solution is EnergyAustralia's preferred option. Detailed works associated with this strategy are listed in Table 8.

Table 8 - Preferred Strategy costs and timing

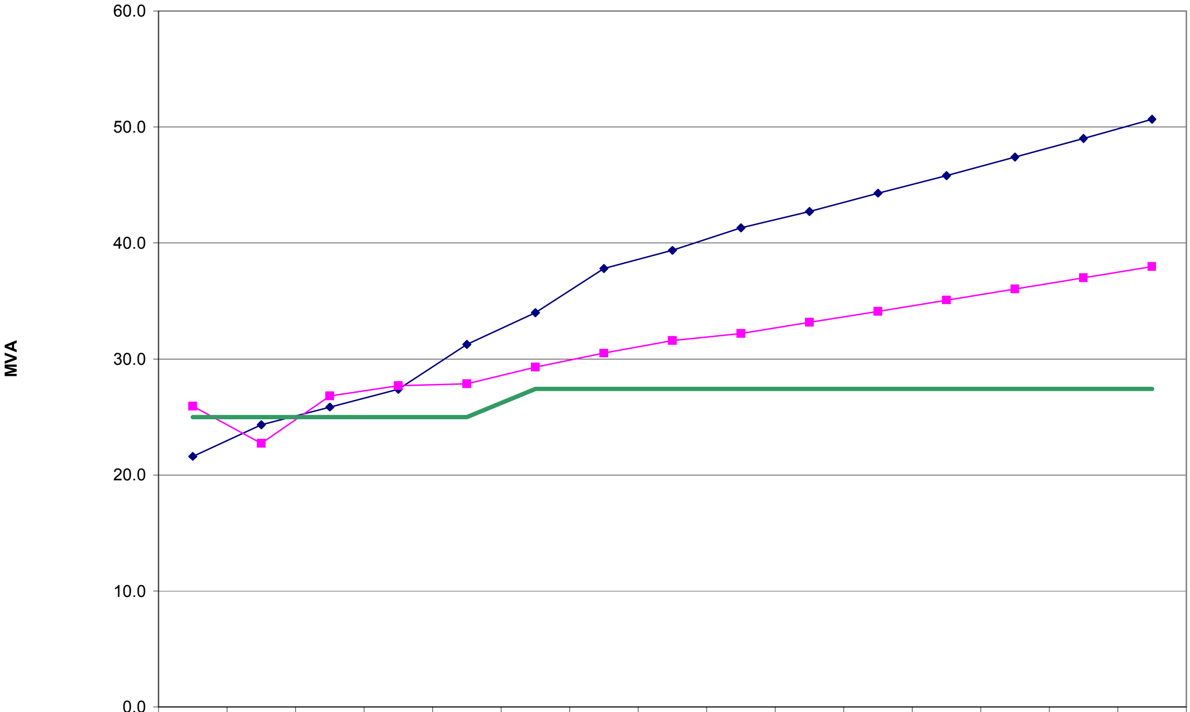
Measure	Cost	Timing
New 132/33kV STS at Beresfield	$20.6m	2004
33kV feeders	$13.5m	2004/7
New zone substation Thornton	$9.2m	2005
Capacitors at East Maitland	$0.7m	2005
Capacitors (12MVAr) at Tarro	$0.7m	2006
Replace Tarro Switchroom	$2m	2007/8
Replace Transformers at Tarro	$0.6	2011
Transformers & switchgear at East Maitland	$3.4m	2011

Key elements of this strategy are the construction of Beresfield and Thornton substations and associated feeder works.

Accordingly EnergyAustralia plan to carry out the following works.

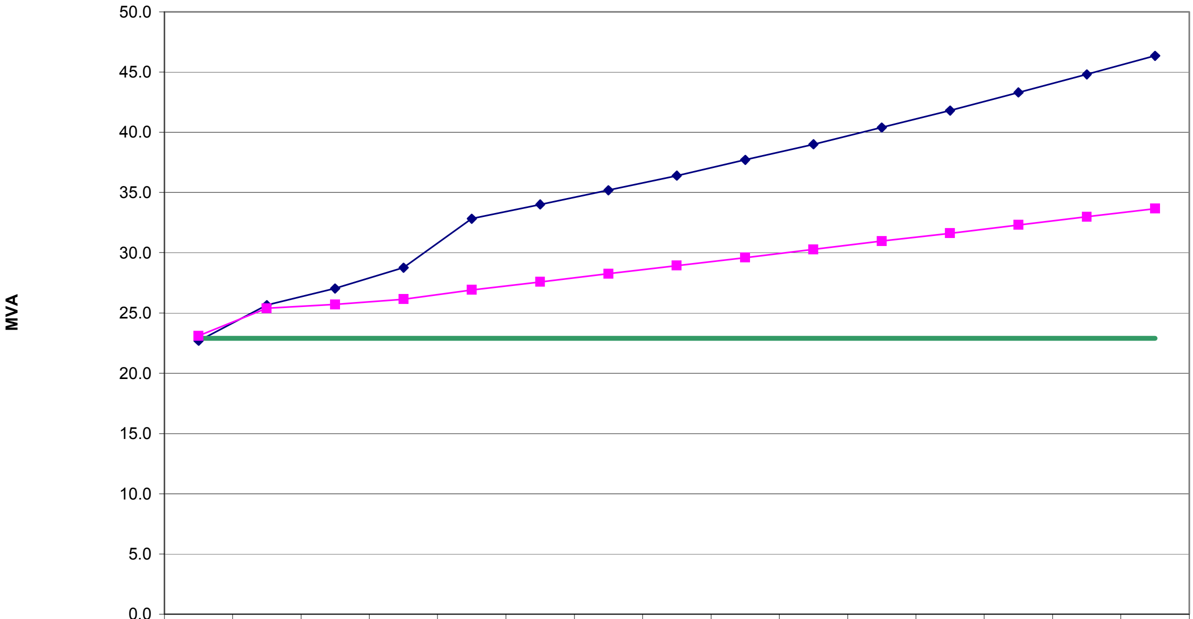
- Construction of a 120MVA firm capacity sub-transmisson substation at Beresfield to be completed in November 2005 ($20.6m).
- Construction of a 33/11kV zone substation at Thornton to be completed in August 2005 ($9.2m).
- 33kV feeder works associated with the above substation works which are to be completed in two stages between 2005 and 2007($13.5m).

APPENDIX A – EAST MAITLAND ZONE FORECAST



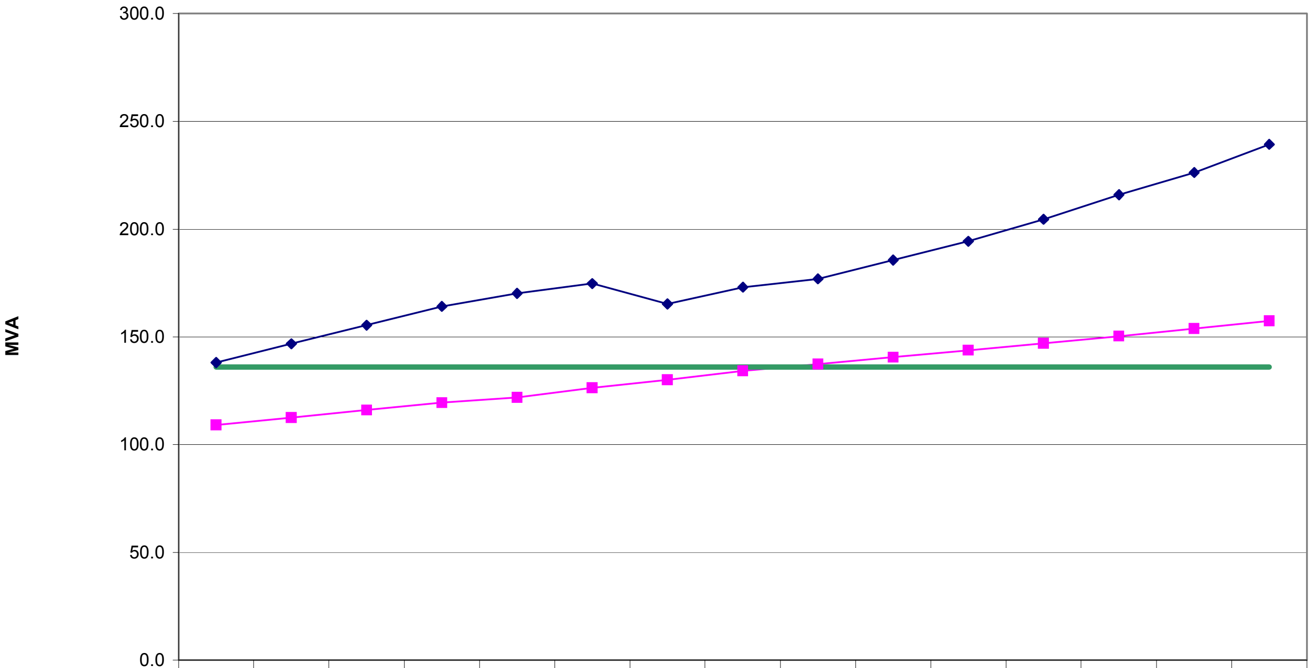
	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Summer	21.6	24.3	25.9	27.4	31.3	34.0	37.8	39.4	41.3	42.7	44.3	45.8	47.4	49.0	50.65
Winter	25.9	22.7	26.8	27.7	27.9	29.3	30.5	31.6	32.2	33.2	34.1	35.1	36.0	37.0	37.98
Firm Rating	25.00	25.00	25.00	25.00	25.00	27.40	27.40	27.40	27.40	27.40	27.40	27.40	27.40	27.40	27.40

APPENDIX B – TARRO ZONE FORECAST



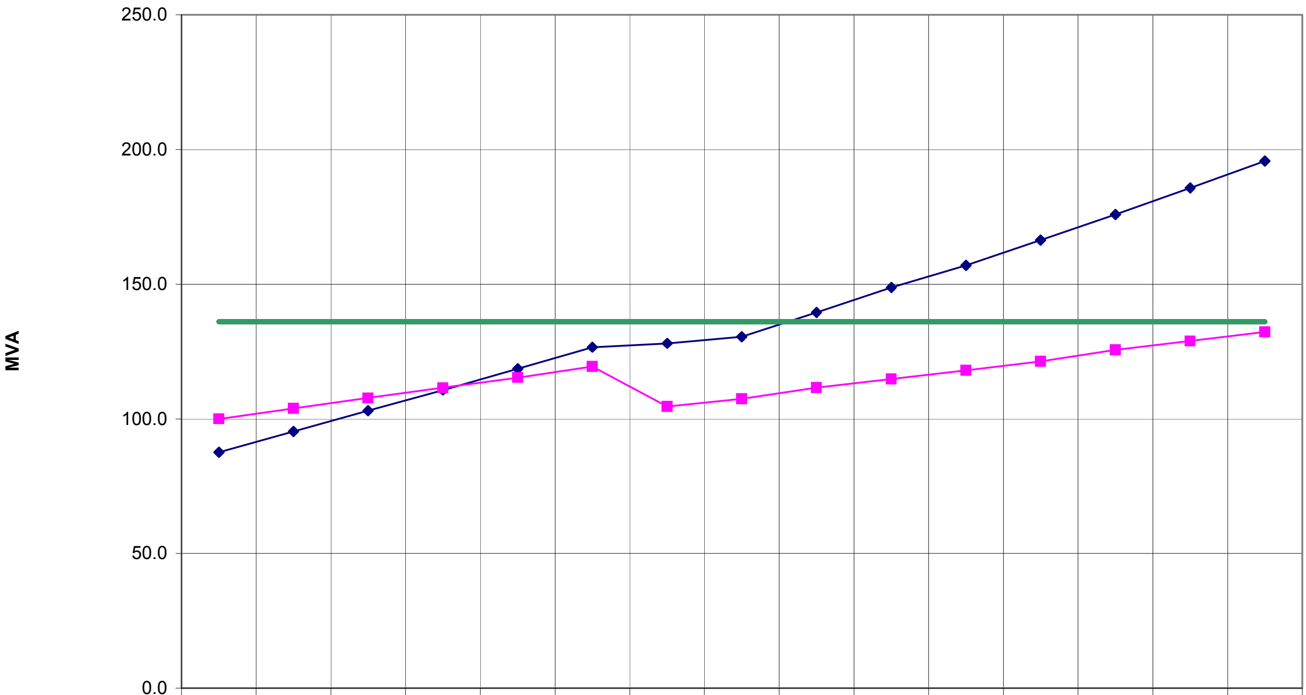
	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Summer	22.7	25.7	27.0	28.8	32.8	34.0	35.2	36.4	37.7	39.0	40.4	41.8	43.3	44.8	46.35
Winter	23.1	25.4	25.7	26.1	26.9	27.6	28.3	28.9	29.6	30.3	31.0	31.6	32.3	33.0	33.66
Firm Rating	22.90	22.90	22.90	22.90	22.90	22.90	22.90	22.90	22.90	22.90	22.90	22.90	22.90	22.90	22.90

APPENDIX C – KURRI STS FORECAST



	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Summer	138.0	146.7	155.4	164.1	170.1	174.7	165.3	173.1	176.9	185.6	194.4	204.6	215.9	226.3	239.3
Winter	109.1	112.5	116.0	119.5	121.9	126.3	130.1	134.2	137.4	140.5	143.8	147.0	150.3	153.8	157.4
Firm Rating	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136

APPENDIX D – TOMAGO STS FORECAST



	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Summer	87.6	95.3	103.0	110.7	118.6	126.6	128.0	130.4	139.5	148.8	157.0	166.3	175.9	185.7	195.7
Winter	99.9	103.8	107.7	111.6	115.3	119.4	104.6	107.4	111.6	114.8	118.0	121.3	125.6	128.9	132.3
Firm Rating	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136

APPENDIX E – PRESENT VALUE OF COSTS

All figures are in $m	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Strategy 1																	
Beresfield	0.5	7.35	8.75	4	0	0	0	0	0	0	0	0	0		0	0	
Thornton		0.8	3.2	4.2	2												
Mains	0.1	0.4	4	3.6	2.7	2.7											
Minor Works	0.495			0.9	0.7	1	1			5.25							
O & M		0.11	0.31	0.46	0.52	0.56	0.58	0.58	0.58	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Total Costs	1.10	8.66	16.26	13.16	5.92	4.26	1.58	0.58	0.58	5.90	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Present Value of Costs	**$44.28**																
Effective Annual Cost	**$6.34**																
Strategy 2																	
East Maitland				4	7.2												
Tarro							4	7.2									
Thornton		12.2															
Mains	0.495	6	8	4													
Minor Works		2.6		0.7	0.7												
O & M		0.25	0.33	0.44	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Total Costs	0.50	21.05	8.33	9.14	8.44	0.54	4.54	7.74	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Present Value of Costs	**$47.61**			These figures are based on 132kV Zone Substations with a 65MVA firm capacity. 37MVA firm substations will increase the EAC significantly.													
Effective Annual Cost	**$6.70**																
Strategy 3																	
East Maitland			6.4	0.75													
Tarro		3.71			0.75				1.2								
Thornton			4	7													
Mains	0.495	15	20	4													
Minor Works			6.9														
O & M		0.15	0.58	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Total Costs	0.495	18.86	37.877	12.468	1.47	0.72	0.72	0.72	1.92	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Present Value of Costs	**$63.22**																
Effective Annual Cost	**$8.44**																