ElectraNet SA
electricity transmission network

Application Notice

Proposed New Large Network Assets

Lower Flinders Region of South Australia

ElectraNet SA
7 October 2003

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1.0 EXECUTIVE SUMMARY

1.1 Background

ElectraNet SA has identified projected limitations in the electricity transmission network supplying the Lower Flinders region of South Australia: specifically, the area around Port Pirie. However, it is important to note that limitations in the Lower Flinders transmission system have the potential to directly impact areas as far-reaching as the Eyre Peninsula and far west coast regions of the State under certain prior outage or contingency operating conditions.

Port Pirie, located about 200 kilometres north of Adelaide on the eastern coast of Spencer Gulf, is South Australia's third largest regional centre outside of Adelaide. It is essentially an industrial city, with a population of about 18,000. The surrounding area is used mainly for crop, and to a lesser extent, sheep farming. The growing of wine grapes is becoming increasingly popular in the area, but is still in its infancy.

A ridge of hills that has its southern-most point in the vicinity of Lochiel, some 80 kilometres to the south of Port Pirie, and running northwards approximately parallel to the coast and about 20 kilometres inland, combined with flat land between this range and the coast, inherently creates sites with reasonably windy conditions. As a result, this region has been identified as providing ideal conditions for the establishment of large-scale wind generation facilities by a number of wind-farm proponents, and there are initial proposals to establish installations some 50 kilometres to the south of Port Pirie, near Brinkworth. ElectraNet is presently investigating connection options to connect large scale wind farms in this vicinity.

ElectraNet, as South Australia's Transmission Network Service Provider, has undertaken comprehensive studies to fully assess the implications of the projected limitations mentioned above. In performing those studies, ElectraNet has ensured that due consideration was given to the impact of various wind generation proposals, totalling over 500 MW of installed capacity (with an average output of approximately 160MW assuming the wind-farms have an availability level of 30%), that could potentially be connected into the Lower Flinders transmission network.

Careful consideration of the results of those studies, in conjunction with all relevant information received following ElectraNet's initial consultation with interested parties to identify feasible non-transmission alternatives to address the projected network limitations (via the document titled "Request for Information – Emerging Transmission Network Limitations, Lower Flinders Region of South Australia, Ageing Network Assets" that was published on ElectraNet's website in April 2003), has culminated in ElectraNet's preparation and issue of this Application Notice.

1.2 Projected Network Limitations

The following issues are listed to highlight projected limitations concerning the transmission network that supplies the Lower Flinders area and that have the potential to impact on the Eyre Peninsula and far west coast regions of the State under certain contingency conditions:

- **Projected Non Compliance with the South Australian Electricity Transmission Code (SATC) and the National Electricity Code (NEC) Requirements**

  Electricity demand has grown to the point where the existing network may be unable to supply customer load during a single contingency on the Davenport-Playford 275 kV line during a high load period and coinciding with a time when Playford Power Station is not generating, or an outage of any of the Playford-Baroota, Baroota-Bungama or Playford-Bungama 132 kV lines under high summer demand conditions.

- **Aged Assets at end of Technical and Operating Life**

  Bungama 132 kV substation was built in the early 1950's and uses high maintenance bulk oil and air operated equipment that is at the end of its economic service life. The control cabling within the substation is of the Vulcanised Indian Rubber (VIR) type that has deteriorated with age and is in need of replacement. Considerable upgrading of protection and earthing systems is required to return the substation to what is now regarded as "Good Electricity Supply Industry Practice".

- **Operational Flexibility and System Security**

  Studies have recently identified that following a critical contingency involving the Davenport-Playford 275 kV line under high demand operating conditions, the Brinkworth and Cultana 275/132 kV transformers will become overloaded. To avoid system security violations and wide-spread long term loss of customer load, automatic controls will operate to minimise customer impact and supply-outage duration.

1.3 Nature of Augmentation

ElectraNet ensures that its transmission facilities are designed to provide the specified levels of:

- Supply reliability;
- Security of supply;
- Quality of supply;

in accordance with its obligations under the NEC, the SATC, and Connection Agreements.

The planning criteria encompass the technical requirements of the NEC and the service obligations (C2.2) of the South Australian Transmission Code and are used to establish the adequacy of forecast system performance (with changing load growth and load characteristics) and to determine the need for and timing of system augmentation or re-configuration. System augmentation options are then developed that will satisfy the planning criteria and environmental constraints.

The performance requirements for the transmission network (as defined by the NEC) are stated in chapters 4 and 5 of the NEC. In particular, Clause 5.6.2 and Schedule 5.1 of the NEC describe the need to plan, operate and maintain the network so that it is capable of withstanding a credible contingency event.

Bungama, and Brinkworth are both Category 3 loads under the definitions contained within the South Australian Transmission Code. This requires that the contracted Agreed Maximum Demand (AMD) at each of these connection points must be met during a single contingency outage of either a transmission line or transformer that services these connection points.

Baroota is classified as a Category 1 load under, and under this classification, ElectraNet has no obligation to provide either transformer or line (N-1) capacity, but must endeavour to restore contracted line capacity within 2 days of an interruption, in the case of a line interruption/failure, and to either repair or replace the failed unit within 4 days of the failure, in the case of transformer failure.

NEMMCo, as the National Electricity Market Manager is required to ensure that the National Electricity Market is operated in a secure state. This means that all plant and equipment must be operating within their defined ratings, voltage and frequency must be within tolerance, and the power system must be stable in terms of transient, voltage and oscillatory behaviour, and the power system will return to a secure operating state following the occurrence of a credible contingency event.

While the disconnection of customer load is an acceptable method of achieving a secure system, this is not a practical alternative in the modern world for the relatively frequent single contingency events that can occur, and is contrary to the service standards imposed for Category 3 loads under the SATC. In effect, these NEC and SATC requirements make it necessary to plan and develop the transmission network so that it can support 100% of the anticipated peak load under any single credible contingency event.

The transmission network is planned so that 100% of the peak forecast load at each substation or connection point can be supplied during both normal and first-contingency (N-1) emergency conditions (i.e., following the disconnection of any single generating unit or transmission line). This is consistent with C5.6.2 and S5.1.2.1of the NEC and the limitations under which NEMMCO operates the transmission network to ensure that it remains secure following a credible contingency event.

ElectraNet advises Code Participants in cases where their connection point is inadequate to meet forecast demands under contingency conditions, where this aspect is not addressed via the NEC or the SATC, and seek their advice as to what, if any, remedial action they would wish to have undertaken.

When considered in the context of the codes discussed above, it is clear that the network limitations identified in the Lower Flinders region (summarised in section 3.3 below) are attributable to that part of the transmission network being unable to continue to supply customer loads or maintain a customer's connection in a secure manner or within the SATC service standards following an outage (either planned or forced) of one or more of the items of electrical plant that make up the transmission system. As such, the proposed new large network assets are clearly classified as reliability augmentations, and as a consequence, must minimise the NPV cost to consumers over a reasonable time period.

1.4 Non-network reinforcement options

No alternative non-network solutions were received by ElectraNet following its posting on its website of the document titled "Request for Information – Emerging Transmission Network Limitations, Lower Flinders Region of South Australia, Ageing Network Assets" in April 2003.

ElectraNet has given consideration to Demand Side Management (DSM), generation, and distribution options as means of reinforcing the Lower Flinders transmission network during the course of its investigations, but analysis shows that none of these alternatives, either in isolation or in combination, provide an economic, satisfactory or practical solution for the projected limitations that have been identified.

1.5 Network reinforcement options

ElectraNet's analysis has identified three feasible options for network reinforcement:

Option 1: Establish a single-transformer 160 MV.A 275/132 kV substation at Bungama with 275 kV supply provided by turning the Davenport-Para 275 kV "west" circuit in-and-out of the new substation, and replace the function of the existing 60 MV.A Brinkworth transformer with a 160 MV.A unit.

Option 2: Establish a two-transformer (2x160 MV.A) 275/132 kV substation at Bungama with 275 kV supply provided by turning the Davenport-Para 275 kV "west" circuit in-and-out of the new substation.

Option 3: Establish a new 132 kV substation at Bungama and construct a new dual-circuit 132 kV transmission line from Bungama to Playford to replace the existing under-rated Bungama-Playford lines.

As mentioned, in conjunction with these studies, ElectraNet has carried out initial consultation with Code Participants and Interested Parties to identify feasible non-transmission alternatives to address the emerging network limitations. The closing date for submissions was 30th May 2003. No submissions were received.

Following rigorous assessment, ElectraNet has identified Option 1 as the option that meets the required technical and service standards at the least cost to participants in the National Electricity Market (NEM).

This assessment included the application of the ACCC's Regulatory Test for reliability augmentations (as is the case for the projected limitations in the transmission network supplying the Lower Flinders region of South Australia, where corrective action is specifically required to address service standard obligations) to the three options. This test requires that in order to satisfy the test, an augmentation must *"minimise the net present value of the cost of meeting those standards...having regard to a number of alternative projects, timings, and market development scenarios"*. Applying this test, Option 1 was found to be the least-cost solution for all of the scenarios considered, over the fifteen-year analysis timeframe. Furthermore, sensitivity analysis shows this result to be robust under a range of assumptions.

1.6 Recommendation

With due consideration for all available information, this Application Notice proposes to implement Option 1 to address the projected network limitations in the Lower Flinders region of South Australia. The proposed new large network assets involve:

- The disconnection of the existing 60 MV.A transformer at Brinkworth substation, and the installation in the spare transformer bay adjacent to it of a 160 MV.A unit to replace the function of the existing transformer.
- The establishment of a single-transformer 160 MV.A 275/132 kV substation adjacent to the existing 132 kV switchyard at Bungama, with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation. (The existing 132 kV switchyard would subsequently be dismantled and removed.)

The Brinkworth transformer replacement must be commissioned as soon as possible, but no later than November 2004. The new 275/132 kV connection point at Bungama is to be commissioned by November 2005.

The total cost of these new assets is estimated to be $30.6M.

ElectraNet invites submissions from Code Participants and interested parties on this Application Notice.

Submissions close on Monday 24th November 2003.

2.0 INTRODUCTION

ElectraNet has identified projected limitations in the electricity transmission network supplying the Lower Flinders region of South Australia. The analysis supporting these findings, including due consideration of the impact of potential large-scale wind generation in the area, has culminated in the preparation and issue of this Application Notice.

Accordingly, this Application Notice proposes the installation of the following network assets to address those limitations:

- The establishment of a single-transformer 160 MV.A 275/132 kV substation at Bungama, about 10 kilometres east of Port Pirie in the State's mid-north, and providing 275 kV supply by diverting the existing Para-Davenport 275 kV "west" circuit in-and-out of the new substation.
- The replacement at Brinkworth substation, about 60 kilometres to the south-east of Bungama, of the service provided by an existing 60 MV.A 275/132 kV transformer with a 160 MV.A unit.

The recommendations in this Application Notice are based on:

- Identification of a projected network limitation in the Lower Flinders region of South Australia during worst case single network contingencies from late 2003 onwards;
- The initial consultation undertaken by ElectraNet to identify potential non-transmission solutions to address these emerging network limitations,
- An analysis of feasible options in accordance with the ACCC's Regulatory Test, and;
- The assessment that major network augmentation is required as soon as possible after 2003 to maintain a reliable supply to customers.

The recommended augmentation option must satisfy the regulatory test promulgated by the ACCC. An augmentation satisfies this test if... *"in the event that the augmentation is proposed in order to meet an objectively measurable service standard linked to the technical requirements of schedule 5.1 of the Code, the augmentation minimises the net present value of the cost of meeting those standards"*. In the case of the Lower Flinders transmission system, the augmentation is needed to meet the service standards outlined in the SATC in addition to the technical standards of the NEC, clearly making the Lower Flinders augmentation a "reliability augmentation".

3.0 PROJECTED NETWORK LIMITATIONS

3.1 Network Limitations

Primary supply to the Lower Flinders region of South Australia is provided by four ElectraNet SA connection points; Brinkworth, Bungama Rural, Bungama Industrial and Port Pirie (combined), and Baroota.

Because of their design and age the two Playford to Bungama 132 kV lines are a source of power flow limitations on the Lower Flinders transmission network. These two lines were the first long distance high-voltage transmission lines built in South Australia, and as a result construction and quality assurance practices were under development and not at the levels now achievable. As a consequence, many of the spans on these lines were not constructed to meet the original clearance requirements. Recent investigations have shown that this situation has worsened as the lines have deteriorated with age.

The two Playford-Bungama 132 kV lines were constructed to British design criteria that were later found to be inappropriate for Australian climatic conditions. As a result, the actual ratings achieved by these lines are considerably lower than those originally anticipated and will not be adequate to meet forecast loading conditions under all practical operating conditions. In addition, the lines are now over 50 years of age and nearing the end of their physical life.

Work undertaken on the Playford-Bungama and Playford-Baroota-Bungama lines has addressed high priority sections of line and mechanical strength issues only with a view to minimising the risk of mechanical failure and public contact with the lines. A substantive rebuild of these lines is required if these lines are to continue to be serviceable into the future.

The age, physical condition, and electrical standards to which Bungama 132 kV substation was built are also factors that need to be taken into consideration.

Bungama 132 kV substation was built in the early 1950's and uses old bulk oil and air-operated equipment which is at the end of its service life. The control cabling within the substation is of the Vulcanised Indian Rubber type that has deteriorated with age and is in need of replacement. Protection systems within the substation require upgrading to bring them up to what is now regarded as "Good Electricity Supply Industry Practice" and there is also a need to refurbish the substation earthing system.

3.2 Capability During Single Contingencies

There is a range of technical factors that influence network capability, including line and equipment thermal ratings, protection requirements, transient stability, reactive support, generation and load patterns, and voltage stability. In addition, appropriate allowance must also be made to include sufficient capability in the system to allow for unexpected outages or failures of plant and to permit equipment to be maintained in accordance with accepted asset maintenance practices.

In light of these requirements, the following single contingencies on the Lower Flinders 132 kV transmission network are of particular concern:

- For an outage of the Davenport-Playford 275 kV line under high demand operating conditions, ElectraNet has installed automatic controls that are required to operate in order to maintain system security in the NEM, and that will result in significant disconnection of customer load in the region of Bungama and disruption to network operation in the event of such an outage, in order to avoid overloading plant and potential voltage collapse. Studies undertaken recently show that the existing 275/132 kV 60 MVA transformer at Brinkworth substation is not able to support the entire load in the Lower

Flinders region following such a critical contingency, indicating that there is insufficient 275/132 kV capacity in the Lower Flinders region.

- An outage of the Playford-Baroota 132 kV line under typical summer operating conditions will overload the thermal rating of the Playford-Bungama 132 kV line.
- Alternatively, an outage of the Playford-Bungama 132 kV line under typical summer operating conditions will overload the thermal ratings of the Playford-Baroota and Baroota-Bungama 132 kV lines.

With consideration for these single contingencies, and based on the most recent forecast loads supplied by ETSA Utilities, Code compliant 132 kV voltage levels and operation within transmission line rating limits will not be achievable during the summer of 2003/04, indicating that some form of additional reinforcement of the system is urgently required.

3.3 Load Forecasts and Assumptions

Electricity demand in the mid-north of South Australia as a whole is currently growing at approximately 2.3% per annum. However, the load in the Lower Flinders region is predominantly due to a single, relatively constant industrial load. Load growth in such cases is dominated by the expansion plans of the individual customer involved. ETSA Utilities (South Australia's Distribution Network Service Provider, or DNSP) has surveyed that customer and advises that no significant load increase (more than 5 MW) is anticipated by that customer for 2002/03 and beyond. Demand forecasts issued by ETSA Utilities for the connection points supplying the Lower Flinders region suggest that load growth will settle to a rate of about 2.1% per annum in the medium term.

A load growth overview and supporting assumptions were provided in Section 3.2 of the public document titled "Request for Information – Emerging Transmission Network Limitations, Lower Flinders Region of South Australia, Ageing Network Assets" that was published on ElectraNet's website in April 2003.

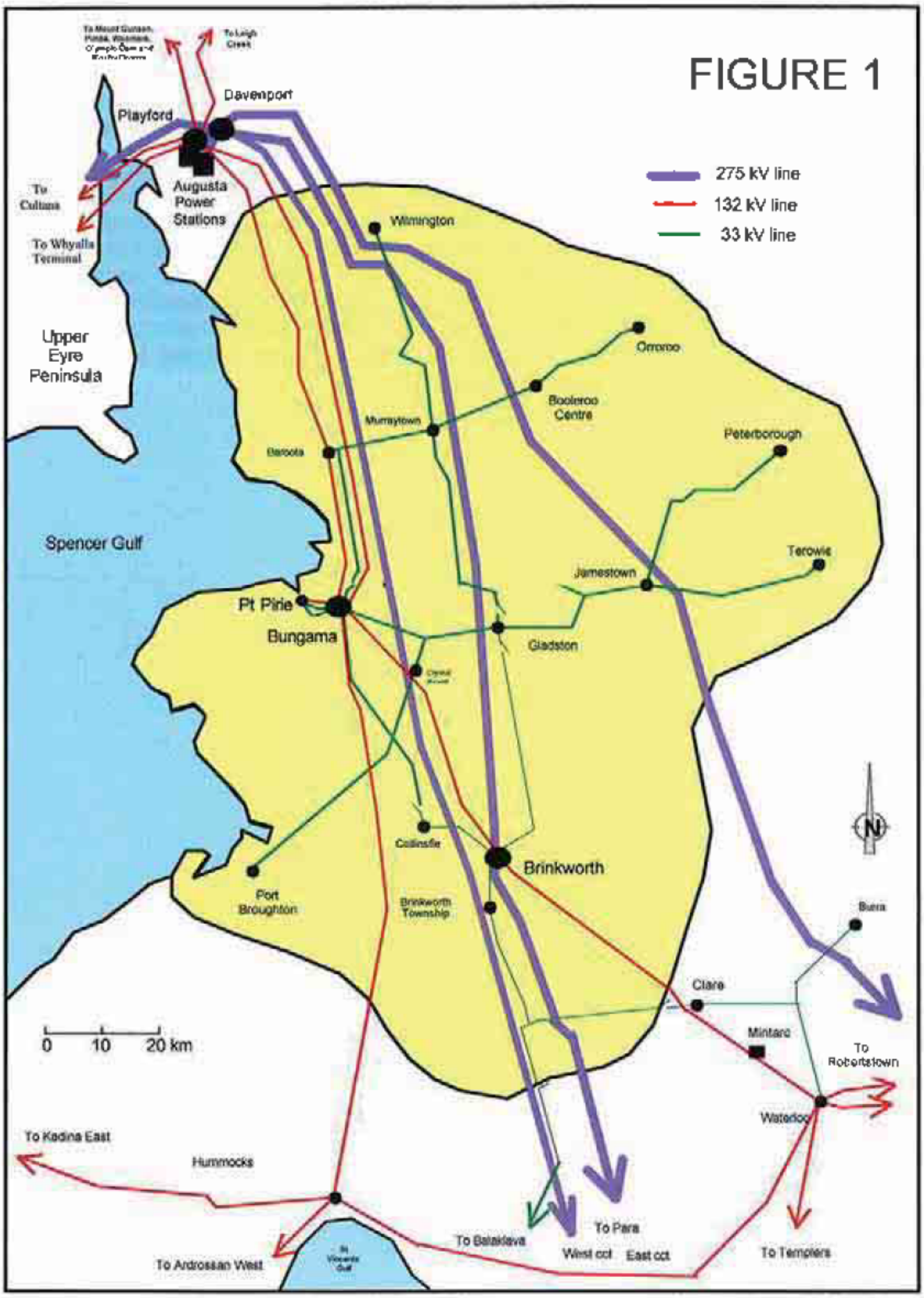
A proposal by SAMAG Limited, a subsidiary of Sydney-based PIMA Mining NL, to establish a large-scale magnesium ore smelter approximately 12 kilometres north of Bungama, would have substantial impact on the electrical load in the area. However, given the ongoing uncertainty surrounding the SAMAG proposal (now spanning some years), and considering that ElectraNet has only limited time in which to implement a solution once a Code violation has been identified on its transmission network, ElectraNet has opted to assume that the SAMAG proposal has been indefinitely postponed in its analysis of the Lower Flinders transmission system. However, it should be noted that due consideration has been given to the SAMAG proposal to ensure that any augmentation that is implemented does not unduly inhibit the development should it eventuate in the future.

3.4 Projected Network Limitations - Summary

The projected network limitations for the Lower Flinders region 132 kV network are summarised below for clarity:

- The two Playford-Bungama 132 kV transmission lines were constructed in the early 1950's to British design criteria and practices that were subsequently found to be inappropriate under Australian environmental conditions, and consequently are no longer adequately rated under some operating conditions for their short-term forecast duty. The lines are generally in poor mechanical condition due to their age and service life. Recent investigation shows that this situation has deteriorated as the lines have aged.

- Bungama 132 kV substation was built in the early 1950's and uses high maintenance bulk oil and air-operated equipment that is also at the end of its economic and physical service life. The control cabling within the substation is of the Vulcanised Indian Rubber type that has deteriorated with age and is in need of replacement. Considerable upgrading of protection and earthing systems is required to bring the substation up to what is now regarded as "Good Electricity Supply Industry Practice".
- Studies using recently supplied load data have revealed to ElectraNet SA that a single contingency on the 275 kV Davenport-Playford circuit at Port Augusta, although physically remote from the Lower Flinders region, has the potential to overload the Lower Flinders 132 kV network and could ultimately bad to voltage collapse, under certain loading conditions. Since the existing 275/132 kV 60 MVA transformer at Brinkworth is not able to support the entire load in the Bungama region under this single contingency condition, it is evident that there is inadequate 275/132 kV capacity being injected into the Lower Flinders region to support the existing loads.



LOWER FLINDERS REGION OF SOUTH AUSTRALIA

ELECTRICITY NETWORK

4.0 OPTIONS CONSIDERED

4.1 Consultation Summary

The 2003 Annual Planning Review[1] identified that action would be required in the relatively short term to address an impending network limitation related to supply to the Lower Flinders region of South Australia.

In April 2003 ElectraNet issued a consultation paper providing more detailed information on the projected network limitations in the Lower Flinders region of South Australia. This paper sought information from Code Participants and interested parties regarding potential solutions to address the anticipated network limitations.

The closing date for submissions was 30th May 2003. ElectraNet received no submissions to this paper.

4.2 Non-Transmission Options Identified

4.2.1 Existing and New Generation

A single 90 MW gas turbine powered generator is located at Mintaro, about 45 kilometres south east of Brinkworth on the Brinkworth-Waterloo 132 kV line. Two coal-fired power stations, one comprising four 60 MW generators, and the other, two 250 MW generators, are situated at Port Augusta, approximately 80 kilometres to the north of Bungama at the top of Spencer Gulf. The generators are privately owned, and dispatch is market driven.

NEM data indicates that the two 250 MW generators at Port Augusta are being operated as base-load plant, while the remaining generators at Port Augusta and the single generator at Mintaro are dispatched on an opportunity basis, typically when the electricity pool price is at higher levels. The generators at Port Augusta contribute to the supply of the Lower Flinders connection points via the 132 kV network that connects into Bungama and Brinkworth substations. However, these circuits are out of service following the operation of the emergency controls needed to prevent voltage collapse and transformer overloads under some single contingency events. Additionally, these generators are unable to reduce the loading in the Playford-Bungama 132 kV circuits for contingencies that result in overloads on these circuits.

Consideration was given to speculative proposals for large-scale gas fired generating plant in the vicinity of Port Pirie. However, the size of the units is such that they could only be technically connected to the 275 kV system and because of this would not impact on the 132 kV supply requirements.

No other generation alternatives that could address the identified network limitations were received in response to the initial 'Request for Information' document.

There is the potential for the establishment of large-scale wind generation facilities along the range of hills parallel to the coast to the south of Port Pirie. While, as discussed in the 'Request for Information' document, any form of generation into the Bungama 132 kV network will have marginal impact on the projected limitations identified, it should be kept in mind by solution providers that, by their nature, wind-farms are granted special dispensation for market access, and are subject to unscheduled dispatch. The impact of these proposals has been taken into account in the scenarios presented in Section 6 of this document.

1 Published in June 2003.

4.2.2 Demand Side Management

ElectraNet obtains electricity demand forecasts over a ten-year horizon from ETSA Utilities, South Australia's principal electricity distributor and the sole electricity distributor in the Lower Flinders area. ETSA Utilities confirms that these forecasts take into account demand management programmes in-place or proposed that may reduce the forecast demand at transmission connection points. No information was obtained from other Code Participants or Interested Parties regarding other initiatives as a result of the consultation process undertaken so far.

4.2.3 Embedded Generation

As with demand side management programmes, ETSA Utilities electricity demand forecasts take account of embedded[2] generation, either in-place, proposed, or likely to occur, that may similarly reduce the forecast demand at transmission connection points. Again, no information about initiatives was obtained from any other party during the consultation process.

4.3 Transmission Options Identified

In addition to the consultation process to identify possible non-transmission solutions, ElectraNet carried out studies to determine the most appropriate transmission network solution to address the projected limitations. Three feasible options were identified, details of which are contained in the next section.

2 An embedded generator connects directly to the low voltage distribution network. Output from such generators therefore reduces the expected energy that the transmission grid is required to deliver. Embedded generators may also reduce the demand the transmission grid is required to deliver, depending on their mode of operation.

5.0 FEASIBLE SOLUTIONS

This section provides an overview of the feasible options identified, with a full summary of the financial analysis contained in Appendix 2. In each of the options, analysis has identified that a capacitor bank will be required at Hummocks to provide voltage support in the area. However, the timing of the installation of the capacitor bank for each of the options is dependent on the accompanying transformer and/or line reinforcement, and therefore varies between options. This has been taken into account in the accompanying financial analyses (refer Appendix 2).

Option 1 - 275 kV augmentation at Bungama substation and at Brinkworth substation[3]		
Date reqd.	Proposed Augmentation	Total capital cost
November 2004	Replace the existing 60 MV.A Brinkworth transformer with a 160 MV.A unit.	$30.6M
November 2005	Establish a single-transformer 160 MV.A 275/132 kV substation at Bungama with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation.	

Option 1 proposes that a new 1x160 MV.A 275/132 kV substation be established adjacent the existing site at Bungama, and that the existing 60 MV.A transformer at Brinkworth would be disconnected and a new 160 MV.A transformer installed in the vacant transformer bay at Brinkworth substation.

At Bungama...

The layout of the new 132 kV section would be functionally identical to that of the existing substation at Bungama, except that the 132 kV lines from Playford would be replaced by supply from the proposed single 275/132 kV transformer. The existing 132 kV switchyard would be dismantled and removed. The 275 kV injection would be provided by diverting the existing Davenport-Para "west circuit" 275 kV transmission line in-and-out of the new substation. The route length of this new section of line is approximately 7 kilometres. Additional 132 kV structures would be required to facilitate the connection of existing 132 kV lines to the new substation. The Playford-Bungama and Playford-Baroota 132 kV lines would be removed from service while the existing Bungama-Baroota 132 kV line, which is adequately rated to support the Baroota connection point Agreed Maximum Demand (AMD) for some years into the future, would be retained. Contingency supply would be obtained from Brinkworth substation in the event of a 275/132 kV transformer outage at Bungama.

At Brinkworth...

The existing 60 MV.A transformer at Brinkworth would be replaced with a 160 MV.A transformer. The 60 MV.A transformer, that is approaching the end of its technical and economic life, would be disconnected and retired from service (but left in situ), and the new 160 MV.A transformer would be installed in the substation's vacant transformer bay.

3 The timing of the augmentation is based on the electricity demand forecast as published in the initial consultation paper issued by ElectraNet in April 2003. The financial analysis evaluates possible variations to the timings for different load growth forecasts using the market development scenarios in section 6.0.

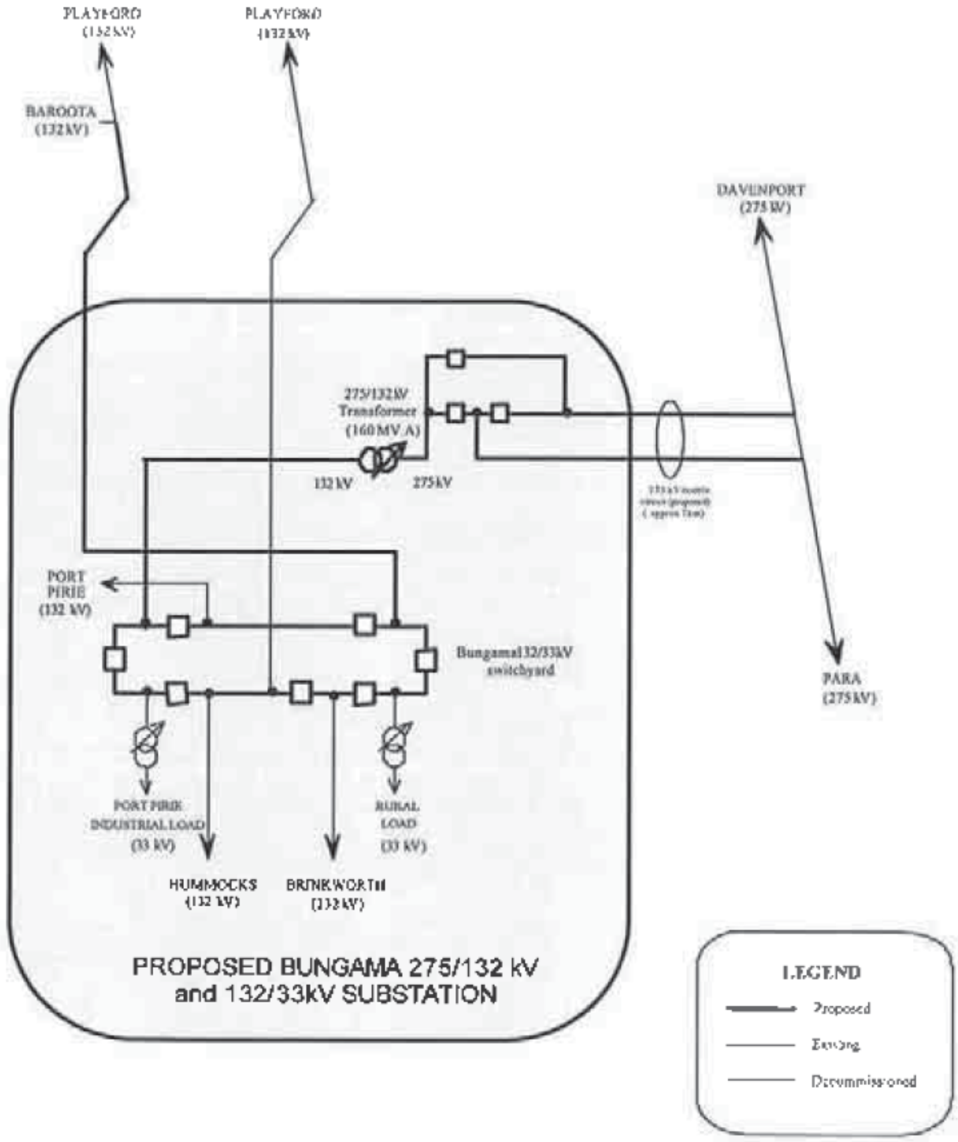
This development option provides for increased security of supply to the Lower Flinders region by providing diversity of supply from two independent high-capacity sources. This arrangement provides for greater security and operational flexibility during construction and thereafter.

Planning studies show that this option will not materially impact other transmission networks within the NEM.

Option 1

1x160 MVA 275/132kV transformer at Bungama and 1x160 MVA 275/132kV transformer at Brinkworth

(Only the Bungama portion of the proposed work has been represented in the following diagram since the work at Brinkworth simply involves the replacement of the existing transformer.)



Option 2 - 275 kV augmentation at Bungama substation[4]		
Date reqd.	Proposed Augmentation	Capital cost
November 2004	Establish a two-transformer (2x160 MV.A) 275/132 kV substation at Bungama with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation.	$31.2M

Option 2 involves essentially the same modifications at Bungama as those proposed for Option 1 above, except that two 160 MV.A 275/132 kV transformers would be installed at the new Bungama substation instead of a single 160 MV.A unit. In this option, the 60 MV.A 275/132 kV transformer at Brinkworth, that as mentioned is approaching the end of its technical and economic life, would be disconnected and retired from service (but left in situ).

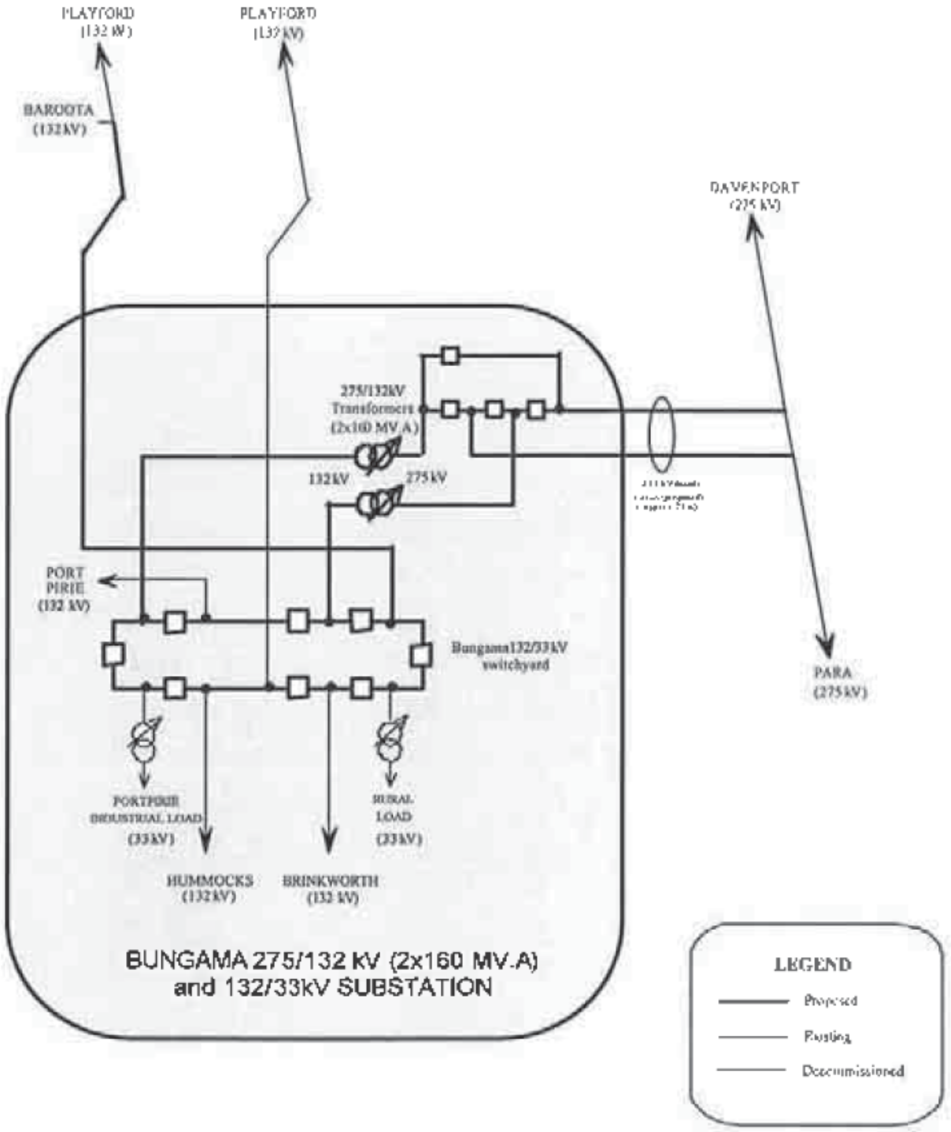
Planning studies show that this option will not materially impact dher transmission networks within the NEM.

4 The timing of the augmentation is based on the electricity demand forecast as published in the initial consultation paper issued by ElectraNet in April 2003. The financial analysis evaluates possible variations to the timings for different load growth forecasts using the market development scenarios in section 6.0.

Option 2

2x160 MVA 275/132kV transformers at Bungama

(Only the Bungama portion of the work proposed for this option has been represented in the following diagram since the work at Brinkworth simply involves disconnecting the existing transformer.)



Option 3 - 132 kV augmentation between Playford substation and Bungama substation[5]		
Date reqd.	Proposed Augmentation	Capital cost
November 2004	Establish a new 132 kV substation at Bungama and construct a new dual-circuit 132 kV transmission line from Bungama to Playford to replace the existing under-rated Bungama-Playford lines.	$40.3M

The proposed works for Option 3 involves the establishment of a new 132 kV substation adjacent the existing site at Bungama. The layout of the new 132 kV section would be functionally identical to that of the existing substation at Bungama. The existing 132 kV switchyard would be dismantled and removed. It is proposed that the two existing 132 kV lines between Playford and Bungama would be replaced by a double circuit 132 kV transmission line. This dual circuit would be constructed using 373 ACSR conductor and would be designed to operate at a conductor temperature of 80°C. The existing 60 MV.A transformer at Brinkworth would be disconnected and retired from service (but left in situ), its function replaced with a new 160 MV.A unit to prevent overloads in the event of a contingency on the Playford-Davenport 275 kV line. The new 160 MV.A transformer would be installed in the substation's vacant transformer bay.

Because of the age and condition of the existing Playford-to-Bungama 132 kV transmission lines, these assets cannot effectively be refurbished. A complete rebuild of the assets to modern-day standards is necessary. The most cost-effective way of doing this would be to demolish the Playford-Bungama 132 kV line and rebuild it as a double-circuit line. The Playford-Baroota section of the other line would then be removed from service, while the Bungama-Baroota section of that same line would be retained to provide supply to Baroota which, as mentioned previously, is a Category 1 load. The cost of this additional work has been allowed for in the subsequent analysis of this option.

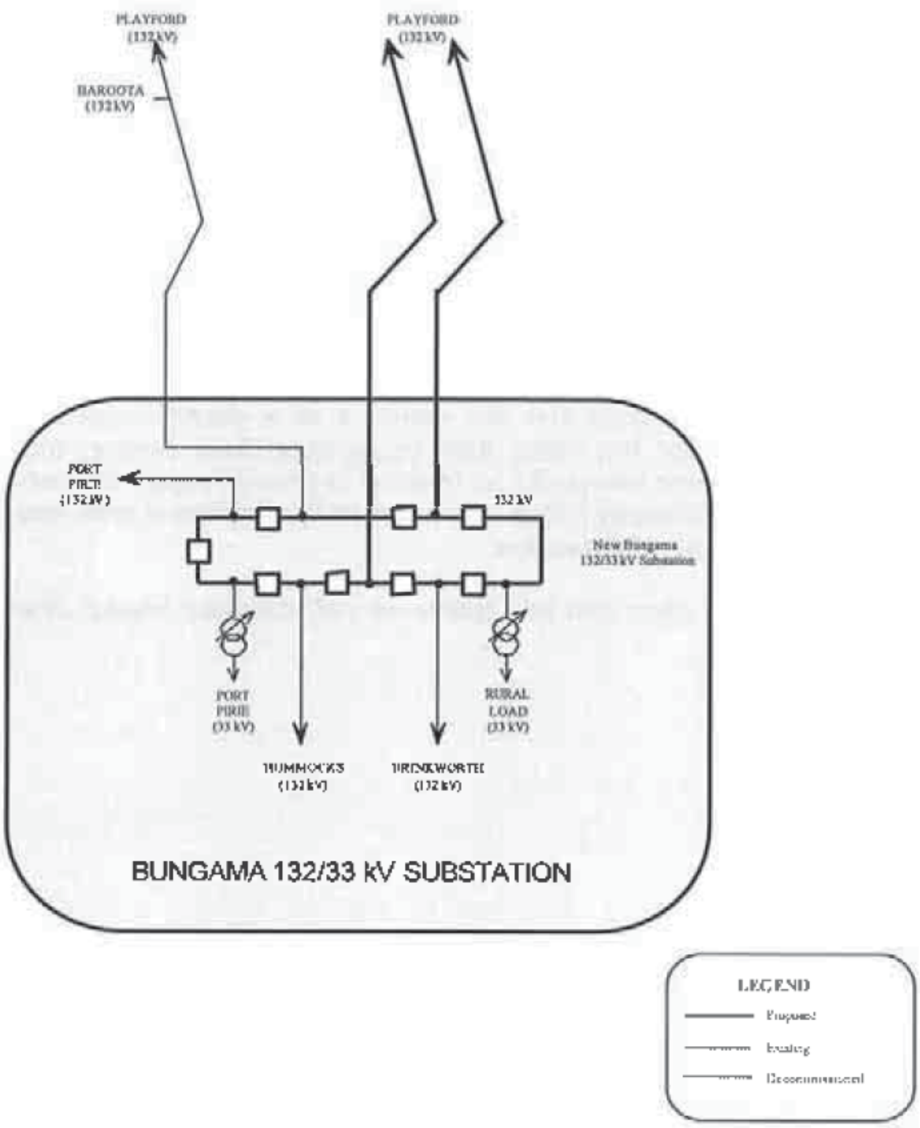
Planning studies show that this option will not materially impact other transmission networks within the NEM.

5 The timing of the augmentation is based on the electricity demand forecast as published in the initial consultation paper issued by ElectraNet in April 2003. The financial analysis evaluates possible variations to the timings for different load growth forecasts using the m arket development scenarios in section 6.0.

Option 3

New 132 kV substation at Bungama, dual circuit 132 kV line from Bungama to Playford, and 1x160 MV.A 275/132kV transformer at Brinkworth

(Only the Bungama portion of the work proposed for this option has been represented in the following diagram since the work at Brinkworth simply involves the replacement of the existing transformer.)



6.0 MARKET DEVELOPMENT SCENARIOS

6.1 Context for Evaluation of Options

All feasible solutions to the identified network limitations must be viewed in the context of wider developments in the NEM:

- Commonwealth legislation has been in effect since 1 January 2001 to encourage increased generation from renewable resources. ElectraNet has considered both proposed and potential levels of wind generation to connect to the Lower Flinders 132 kV transmission network when formulating relevant market development scenarios.

- NEMMCO's Statement of Opportunities (SOO) issued in July 2003 contained information on existing and committed generation developments in South Australia, an extract from which follows:

  "Victoria and South Australia: The analysis of supply and demand in Victoria and South Australia indicates that while reserves for the winter will be adequate until 2011, summer reserves fall below the minimum requirement in the coming summer. The reserve deficit is forecast to be 69 MW in summer 2003/04, and in summer 2008/09, the demand exceeds the supply side capacity."

  The proposed large network augmentation does not inhibit the dispatch of existing and proposed new generation.

6.2 Assumed Market Development Scenarios

The ACCC Regulatory Test requires that options to address a network limitation be assessed against a number of plausible market development scenarios. These scenarios need to take account of:

- the existing system;
- future network developments;
- variations in load growth;
- committed generation and demand side developments;
- potential generation and demand side developments.

The Regulatory Test also requires sensitivity analysis with respect to key input variables, including capital and operating costs, the discount rate and the commissioning date.

The purpose of utilising this approach is to test the robustness of the NPV analysis of the options being evaluated under a range of plausible scenarios.

The NEC requires ElectraNet as a TNSP to analyse the expected future operation of its transmission network taking into account any Market Network Service Provider (MNSP) options (refer Clause 5.6.2 (a) of the NEC). However, as this is an intra-regional development, there is by definition no feasible MNSP development (refer Clause 2.5.2 (a) of the NEC).

6.2.1 Existing Network and Future Transmission Developments

When formulating the market development scenarios, existing network behaviour and the impact of the three proposed transmission augmentations identified in this document were taken into account. Also considered were the impact of proposed large-scale wind farm developments in the vicinity of Brinkworth substation, and the possibility of private generation at the proposed SAMAG site, just north of Port Pirie. More-detailed discussion concerning the impact of additional generation into the Bungama transmission network can be found in section 4.2.1 of this document. Other planned transmission augmentations are independent of the identified limitations to supply the Lower Flinders region of South Australia, and were therefore not included within the scenarios.

6.2.2 Variations in Load Growth

ElectraNet's planning studies rely on annual electricity demand forecasts provided by ETSA Utilities. These forecasts span a ten-year horizon and take into account demand management and embedded generation programmes, in-place, proposed, and anticipated, that may reduce the forecast demand at transmission connection points. ETSA Utilities confirms that the forecasts are representative of electricity usage during hot summer conditions.

The analysis of ElectraNet's transmission system in the Lower Flinders region of the State for the 10-year period from 2003 has been based on the *medium* growth forecast provided by ETSA Utilities, as this represents the most likely load growth scenario. The results of this analysis have then enabled ElectraNet to identify and assess what potential limitations may occur in meeting system reliability and security standards in accordance with the NEC and the SATC.

However, ETSA Utilities also provides two other load forecasts - high and low - to provide an *indication* of the effects of possible changes to the level of economic activity within the State. This information and the basis of the forecasts are contained in the 2003 Annual Planning Review.

Market development scenarios have been developed to consider sensitivity to variations in load growth. The scenarios used in the analysis in this report are outlined in 6.2.5.

As mentioned in Section 3.3, given the ongoing uncertainty surrounding a SAMAG proposal to establish a large-scale magnesium ore smelter approximately 12 kilometres north of Bungama, ElectraNet has assumed that this proposal has been indefinitely postponed in its analysis of the Lower Flinders transmission system.

6.2.3 Existing and Committed Generation

As outlined in the 'Request for Information' document, the network limitations are not sensitive to the level of generation at existing and committed power sources. Therefore no scenarios have been developed for differing levels of output by existing power stations.

While the limitations are sensitive to the presence of generation at Playford Power Station, all scenarios used in the Regulatory Test analysis assume 0 MW output at Playford. This represents the 'best-case' scenario, as any generation at Playford exacerbates the network limitations.

6.2.4 Potential Generation Developments

As discussed in Section 1 of this document, a number of wind-farm proponents have shown significant interest in establishing initial installations, and have forwarded conceptual plans to ElectraNet for consideration. Following assessment of the potential wind-farm developments, ElectraNet estimates that up to 160 MW of new wind generation (over 500 MW of installed capacity, equating to an average of about 160 MW of available wind generation capacity if it is assumed that the wind-farms have an availability level of 30%) could potentially be established in the area around Brinkworth, and has incorporated this scenario in its planning for the reinforcement of the Lower Flinders transmission system.

The most likely means of connection into the existing system for the wind-farm proposals tabled to-date will be at the higher voltage levels; either via the 132 kV and/or 275 kV networks. Irrespective of the voltage of connection, the most likely connection point into the existing transmission network, assuming medium to large scale generation, would be Brinkworth substation. Referring again to the discussion provided in section 6.2.3 above, the identified shortcomings in the existing system are relatively insensitive to the level of generation into the Lower Flinders 132 kV system. However, the overall market benefit of any proposed transmission network development option will be influenced by the level of generation provided by wind-farms connecting into Brinkworth due to the impact on transmission system losses. With this in mind, alternative market development scenarios have been developed to reflect varying levels of generation attributable to the potential wind-farms.

The analysis was conducted using assumed average wind-farm generation levels into Brinkworth of 80 MW and 160 MW, in the absence of more firm information from prospective proponents at these early stages of enquiry. However, ElectraNet considers that conducting studies at these levels of assumed generation will provide sufficient indication of the effects on system losses of the presence of generation at Brinkworth.

For completeness, scenarios involving no wind generation were also included. These scenarios have been included to reflect the existing situation in the absence of wind generation, but also serve to represent sustained periods of low wind should the wind farms eventuate.

6.2.5 Market Development Scenarios

Nine market development scenarios have been developed to simulate the impact of variations in load growth while incorporating the assumptions outlined above:

Scenario A	Low load growth forecast No wind generation into Brinkworth
Scenario B	Medium load growth forecast No wind generation into Brinkworth
Scenario C	High load growth forecast No wind generation into Brinkworth
Scenario D	Low load growth forecast 80 MW wind generation into Brinkworth
Scenario E	Medium load growth forecast 80 MW wind generation into Brinkworth
Scenario F	High load growth forecast 80 MW wind generation into Brinkworth
Scenario G	Low load growth forecast 160 MW wind generation into Brinkworth
Scenario H	Medium load growth forecast 160 MW wind generation into Brinkworth
Scenario I	High load growth forecast 160 MW wind generation into Brinkworth

7.0 FORMAT AND INPUTS TO ANALYSIS

7.1 Regulatory Test Requirements

The requirements for the comparison of options to address an identified network limitation are contained in the Regulatory Test promulgated by the Australian Competition and Consumer Commission (ACCC).

The Regulatory Test requires that the recommended option be the option that "maximises the net present value of the market benefit having regard to a number of alternative projects, timings, and market development scenarios... An augmentation satisfies the test if ... in the event that the *augmentation* is proposed to meet an objectively measurable service standard linked to the technical requirements of schedule 5.1 of the Code – the *augmentation* minimises the net present value of the cost of meeting those standards ... having regard to a number of alternative projects, timings and market development scenarios." To satisfy the Regulatory Test, a proposed augmentation must achieve a greater market benefit or a lower cost *in most, but not necessarily all*, credible scenarios.

The Regulatory Test contains guidelines for the methodology to be used to calculate the NPV of the market benefit and cost. For example, where an augmentation is required to satisfy minimum network performance requirements (i.e. a reliability augmentation), the methodology published by the ACCC defines "cost" as the total net cost to all those who produce, distribute and consume electricity in the NEM. That is, the option with the lowest net present value cost maximises the market benefit.

Information to be considered includes the *'efficient operating costs of competitively supplying energy to meet forecast demand'* and the cost of complying with existing and anticipated laws. However, the Regulatory Test specifically excludes indirect costs, and costs that cannot be measured as a cost in terms of financial transactions in the electricity market.

7.2 Inputs to Analysis

A solution to address projected network limitations in the Lower Flinders region of South Australia as outlined in this document is required to satisfy reliability requirements linked to Schedule 5.1 of the National Electricity Code, ElectraNet's service obligations under the South Australian Transmission Code, and the requirements of the Electricity Act SA 1996[6].

According to the ACCC Regulatory Test, this means that the costs of all options must be compared, and the least cost solution is considered to satisfy the Regulatory Test. The results of this evaluation, carried out using a cash flow model to determine the NPV of the various options, are shown in section 8.0.

Cost inputs to the NPV analysis are described below.

7.2.1 Cost of Transmission Augmentations

The cost to implement each of the three feasible transmission augmentations outlined in section 5.0 of this document have been estimated by ElectraNet. Sensitivity studies have been carried out using variations in the capital cost estimates of plus and minus 15% (see section 8.3).

6 Refer section 3.0.

The financial analysis considers all foreseeable cost impacts of the proposed network augmentations to market participants as defined by regulatory processes. The estimated saving in the cost of network losses for each option has been included based on the assumption of typical load factor and an average cost of losses of $30/MW.h. Sensitivity studies have also been carried out on the assumed cost of losses (see section 8.3).

While the financial analysis assumed that a solution had to be implemented by November 2004 to overcome the identified network limitations, the NPV analysis contains, where necessary, subsequent augmentations required to address long-term supply reliability requirements. The sensitivity of the timing of these subsequent works to load growth and generation development scenarios (and therefore the incidence of the capability expenditure) has been taken into account in the financial analysis.

8.0 FINANCIAL ANALYSIS

8.1 Description of Financial Analysis Approach

The economic analysis undertaken considered the NPV of net market benefits of the three options over the fifteen-year period from 2003/04 to 2018/19. A full summary of the results of this analysis is contained in Appendix 2.

8.2 Net Present Value Analysis

Financial analysis was carried out to calculate and compare the NPV of the costs to market participants of each of the options under the range of assumed market development scenarios.

A fifteen-year analysis period was selected for the financial analysis. ElectraNet has elected to use this period as a balance between the National Electricity Code requirement that TNSPs use a minimum planning horizon of ten years, combined with the view expressed by the Inter-regional Planning Committee (IRPC) that a planning horizon beyond ten years better reflects the long-term nature of transmission infrastructure investments.

A discount rate of 10% was selected as a relevant commercial discount rate, and sensitivity analysis was conducted to test the robustness of this assumption.

Capital and operating costs for items that are common to all options were not included in the analysis. These common costs include the capital and operating costs of other future transmission works, where these costs are independent of the identified network limitations. As such, they have no impact on the relative ranking of options resulting from the analysis. Where the timing of common works is affected by the proposed options, the cost of the other works proposed has been included in the NPV analysis.

It should also be noted that supporting studies are based on the medium load growth forecast supplied by the DNSP, unless stated otherwise. This level of growth is considered to represent the most likely development scenario, with the high and low load growth options less likely to occur.

Under the Regulatory Test, it is the ranking of the options that is important, rather than the actual net present value results. This is because the Regulatory Test requires the recommended option to have the lowest net present value cost under most (but not necessarily all) plausible scenarios.

The following table summarises the results of the economic analysis provided in Appendix 2. It shows the Net Present Cost of implementing each of the three options and the NPV of the three alternatives for firstly, no wind generation, then followed by what is expected to be the 'typical' level of generation provided by the wind farms (about 80 MW), and finally, for large scale wind generation (160 MW). For each of the scenarios considered, the best-ranked option is highlighted.

Discount rate 10%		Option 1 Establish a 1x160 MV.A 275/132kV substation at Bungama and replace the existing Brinkworth 60 MV.A transformer with a 160 MV.A unit		Option 2 Establish a 2x160 MV.A 275/132kV substation at Bungama		Option 3 Establish a new 132 kV substation at Bungama and new dual-circuit 132kV line from Playford to Bungama	
		Net Present Cost ($M)	Rank	Net Present Cost ($M)	Rank	Net Present Cost ($M)	Rank
No wind generation into Brinkworth	Scenario A (low load growth)	$22.46	1	$22.67	2	$30.06	3
	Scenario B (medium load growth)	$22.09	1	$22.23	2	$29.74	3
	Scenario C (high load growth)	$21.69	1	$21.74	2	$29.40	3
80MW wind generation into Brinkworth	Scenario D (low load growth)	$22.51	1	$22.73	2	$30.11	3
	Scenario E (medium load growth)	$22.44	1	$22.61	2	$30.04	3
	Scenario F (high load growth)	$23.01	1	$23.21	2	$30.53	3
160MW wind generation into Brinkworth	Scenario G (low load growth)	$22.52	1	$22.73	2	$30.11	3
	Scenario H (medium load growth)	$22.43	1	$22.60	2	$30.03	3
	Scenario I (high load growth)	$22.14	1	$22.24	2	$29.78	3

8.3 Sensitivity Analysis

In addition to examining the impact of market development scenarios, the sensitivity of the option-ranking to three other critical parameters was also examined. The following table shows the parameters that were investigated, the range over which each of the parameters was varied, and the resulting NPV and ranking of each of the three options under the stated conditions. The analysis was conducted using medium load growth and an assumed average wind-farm generation level into Brinkworth of 80 MW, as discussed previously.

Parameter incurring variation (all studies at 10%pa discount rate, DNSP forecast loads and $30/MW.h cost of losses, unless stated otherwise)	Net Present Cost ($M)					
	Option 1 Establish a 1x160 MV.A 275/132kV substation at Bungama and replace the existing Brinkworth 60 MV.A transformer with a 160 MV.A unit	Rank	Option 2 Establish a 2x160 MV.A 275/132kV substation at Bungama	Rank	Option 3 Establish a new 132 kV substation at Bungama and new dual-circuit 132kV line from Playford to Bungama	Rank
Discount Rate (% pa)						
7.5%	**$26.39**	**1**	$26.63	2	$35.18	3
10%	**$22.44**	**1**	$22.61	2	$30.04	3
12.5%	**$19.73**	**1**	$19.91	2	$26.32	3
Cost of losses						
$25/MW.h	**$22.82**	1	$23.03	2	$30.36	3
$30/MW.h	**$22.44**	1	$22.61	2	$30.04	3
$35/MW.h	**$22.56**	1	$22.75	2	$30.14	3
Capital Cost of project						
15% less than estimated cost	**$19.17**	1	$19.33	2	$25.62	3
estimated cost	**$22.44**	1	$22.61	2	$30.04	3
15% more than estimated cost	**$26.21**	1	$26.45	2	$34.89	3

As can be seen in this table, Option 1 is the highest-ranked option under all scenarios. These sensitivity analysis results are consistent with the base case economic analysis, and demonstrate that the outcome is robust in terms of variations in the parameters assessed.

9.0 DISCUSSION OF RESULTS

The following conclusions have been drawn from the analysis presented in this report:

- There is no acceptable 'do-nothing' option. The projected network limitations must be addressed as soon as possible, otherwise it will not be possible to maintain system security and reliability standards during a single contingency on the Playford-Davenport 275 kV transmission line.

- In the first half of 2003 ElectraNet carried out an initial consultation inviting interested parties to propose either network or non-network solutions to the network limitations, with 30th May 2003 as the closing date for submissions. No submissions were received.

- Economic analysis has identified that Option 1 is the least-cost solution over the fifteen-year period of analysis under all of the scenarios considered. On this basis, augmentation comprising the establishment of a single-transformer 160 MV.A 275/132 kV substation at Bungama with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation, and the disconnection of the existing 60 MV.A transformer at Brinkworth and installation adjacent to it in a spare transformer bay a 160 MV.A unit, will satisfy the ACCC Regulatory Test.

- Sensitivity analysis showed that this conclusion was robust when considered against variations in capital cost and other factors outside of the influence of ElectraNet. Option 1 is also the highest-ranked option under all of the applicable market development scenarios.

- The "west" circuit does not incorporate an overhead earth-wire and its recorded performance during lightning storms is significantly poorer than equivalent lines with an overhead earth-wire. In the case of Option 2, this represents an increased risk of outage at Bungama 275/132 kV substation. The recommended development features a second high-capacity supply to Bungama from Brinkworth, and therefore provides superior diversity and reliability of supply to the region.

- Implementation issues significantly favour Option 1, in preference to Option 2, since it will be extremely difficult to maintain supply to the loads supplied out of Bungama substation – notably, the Port Pirie Industrial load - without the need for costly generation support during the installation of the two 275/132 kV transformers proposed in Option 2. In contrast, Option 1 can be staged such that the Brinkworth transformer is initially replaced with a bigger unit, thus providing sufficient additional capacity at Brinkworth to enable it to supply a major portion of the Bungama load as well as its own local load while the required work is then undertaken at Bungama.

- Dynamic stability analysis shows that Option 1 enhances network stability more than the other options considered, indicating that it is more conducive than are the other options to the installation of future generation in the area should this occur.

- In addition to minimisation of the NPV cost, the Regulatory Test requires that a TNSP optimise the timing of any proposed network augmentation that is justified under the Regulatory Test. This project must be implemented as soon as possible in order to meet the reliability standards of the SATC. The construction time for the recommended network solution will require works to commence as early as practically possible (early 2004) to ensure completion within the required timeframe.

10.0 RECOMMENDATION

Based on the conclusions drawn from the analysis, this Application Notice recommends that the following 'new large network assets' be constructed to address the projected transmission network limitations in the Lower Flinders region of South Australia:

- The disconnection of the existing 60 MV.A transformer at Brinkworth substation, and the installation in the spare transformer bay adjacent to it of a 160 MV.A unit to replace the function of the existing transformer.

- The establishment of a single-transformer 160 MV.A 275/132 kV substation adjacent to the existing 132 kV switchyard at Bungama, with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation. (The existing 132 kV switchyard would subsequently be dismantled and removed.)

The Brinkworth transformer replacement, which will improve reliability and security of supply in the region to a significant degree, must be commissioned as soon as possible, but no later than November 2004. The new 275/132 kV connection point at Bungama is required to be commissioned by November 2005.

The total cost of these new assets is estimated to be $30.6M.

Technical details relevant to this proposed new large network assets are contained in Appendix 1. Following the completion of the consultation process (assuming there are no changes required), ElectraNet will proceed immediately to implement the recommendations contained in this Application Notice.

The proposed construction timetable provides for award of equipment and construction contracts and the commencement of on-site construction in early 2004, following satisfactory resolution of Development Approvals, to ensure completion within the required timeframe.

Because of the potential downsizing of a magnesium smelting plant in Queensland, there is the potential that ElectraNet may be able to obtain plant and equipment at discounted prices. This specifically applies to the purchase of the 275/132 kV transformer proposed for Brinkworth (the Brinkworth transformer replacement being the more pressing of the two stages of the recommended option), where it may be possible to purchase an already manufactured 200 MV.A unit at an equivalent or lower price than a new 160 MV.A unit. ElectraNet proposes to pursue this aspect, if available, with a view to minimising the overall capital cost of the project to the NEM.

11.0 CONSULTATION

In accordance with Code requirements, ElectraNet invites submissions from Code Participants and interested parties on this application notice. Submissions are due by Monday 24th November 2003.

Please address submissions to:

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APPENDIX 1

TECHNICAL DETAILS OF PROPOSED NEW LARGE NETWORK ASSETS

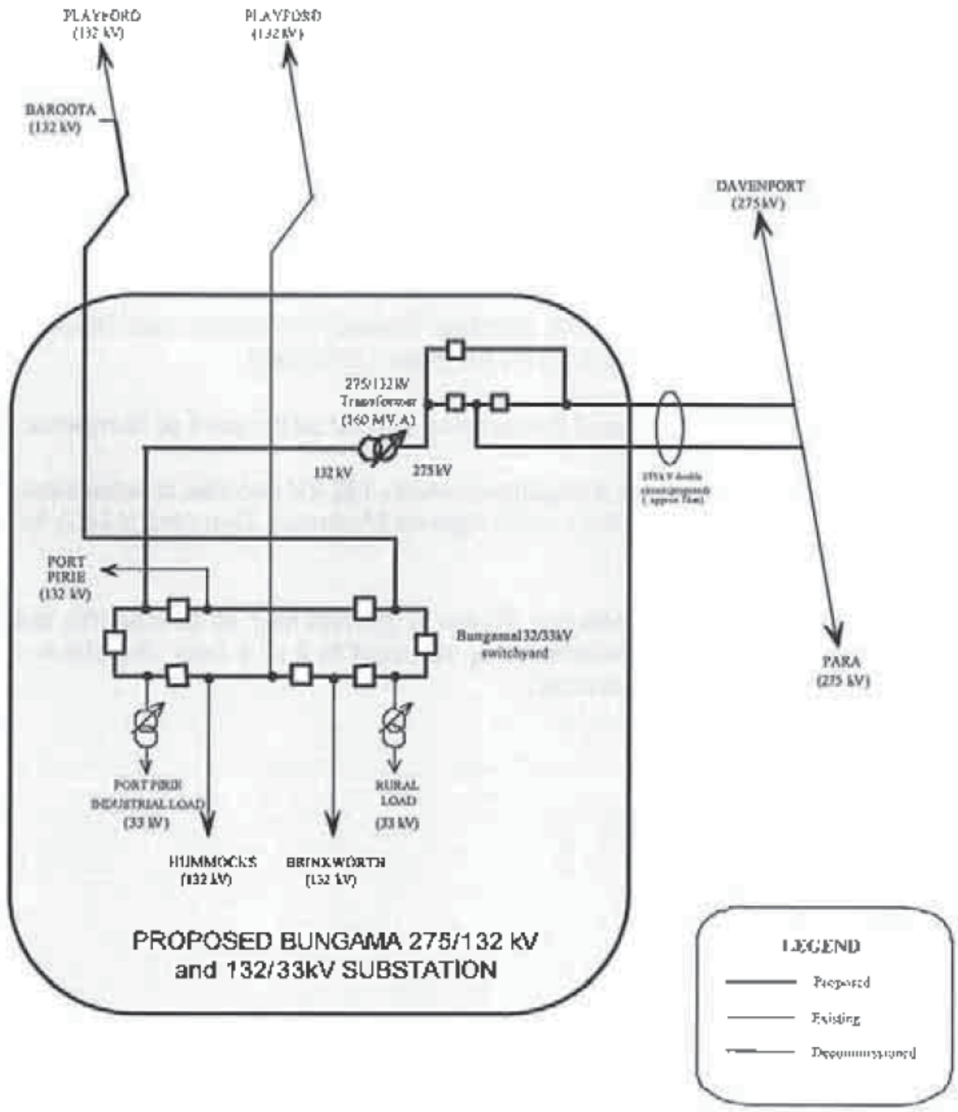
The proposed new large network assets recommended in this Application Notice comprise the following works:

- The establishment of a new 275/132 kV substation containing a single 160 MV.A transformer adjacent the existing site Bungama 132/33 kV substation;
- The construction of a new 132 kV section within the new 275/132 kV substation, with the layout of the new 132 kV section functionally identical to that of the existing, aged substation at Bungama, except that supply presently derived from the Playford-Bungama 132 kV network would instead be replaced by supply from the single 275/132 kV transformer;
- The provision of 275 kV supply to the new Bungama 275/132 kV substation by diverting the existing Davenport-Para 275 kV "west" circuit in-and-out of the substation, and the construction of approximately 7 kilometres of dual-circuit 275 kV line to facilitate the re-routing of this existing line to the new substation;
- The erection of additional 132 kV structures to facilitate the connection of existing 132 kV lines to the new substation;
- The removal from service of the existing Playford-Bungama and Playford-Baroota 132 kV lines (with the easements retained for possible future use);
- The dismantling and removal of the existing 132 kV switchyard at Bungama;
- The retention of the existing Bungama-Baroota 132 kV line that is adequately rated to support the forecast Baroota connection point Agreed Maximum Demand (AMD) for some years into the future;
- The disconnection of the existing 60 MV.A transformer at Brinkworth substation, and the installation in the spare transformer bay adjacent to it of a new 160 MV.A unit to replace the function of the existing transformer.

Option 1

1x160 MVA 275/132kV transformer at Bungama and 1x160 MVA 275/132kV transformer at Brinkworth

(Only the Bungama portion of the proposed work has been represented in the following diagram since the Brinkworth transformer simply involves the replacement of the existing transformer.)



APPENDIX 2

Financial Analysis Summary – Transmission Use of System (TUOS) Charges

15 Year Analysis Period

Discount rate 10%	Scenario A *Low load Growth, 0MW wind generation*		Scenario B *Medium load Growth, 0MW wind generation*		Scenario C *High load Growth, 0MW wind generation*		Scenario D *Low load Growth, 80MW wind generation*		Scenario E *Medium load Growth, 80MW wind generation*		Scenario F *High load Growth, 80MW wind generation*		Scenario G *Low load Growth, 160MW wind generation*		Scenario H *Medium load Growth, 160MW wind generation*		Scenario I *High load Growth, 160MW wind generation*	
	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank
Option 1. single transformer at Bungama, single transformer at Brinkworth	$22.46	1	$22.09	1	$21.69	1	$22.51	1	$22.44	1	$23.01	1	$22.52	1	$22.43	1	$22.14	1
Option 2: two transformers at Bungama	$22.67	2	$22.23	2	$21.74	2	$22.73	2	$22.61	2	$23.21	2	$22.73	2	$22.60	2	$22.24	2
Option 3: rebuild existing 132kV Playford-Bungama lines, new 132kV substation at Bungama, 160MVA transformer at Brinkworth	$30.06	3	$29.74	3	$29.40	3	$30.11	3	$30.04	3	$30.53	3	$30.11	3	$30.03	3	$29.78	3

Development Options	Scenario A *Low load Growth, 0MW wind generation*	Scenario B *Medium load Growth, 0MW wind generation*	Scenario C *High load Growth, 0MW wind generation*	Scenario D *Low load Growth, 80MW wind generation*	Scenario E *Medium load Growth, 80MW wind generation*	Scenario F *High load Growth, 80MW wind generation*	Scenario G *Low load Growth, 160MW wind generation*	Scenario H *Medium load Growth, 160MW wind generation*	Scenario I *High load Growth, 160MW wind generation*
Option 1									
TF at Bung, TF at Brinkworth	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05
15Mvar capacitor at Hummocks	11/12	09/10	07/08	11/12	09/10	07/08	11/12	09/10	07/08
Option 2									
2 TFs at Bungama	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05
15Mvar capacitor at Hummocks	13/14	11/12	09/10	13/14	11/12	09/10	13/14	11/12	09/10
Option 3									
Rebuild 132 kV line TF at Brin	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05
15Mvar capacitor at Hummocks	06/07	05/06	04/05	06/07	05/06	04/05	06/07	05/06	04/05

Scenario A		Low load Growth, 0MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.103	-0.106	-0.108	-0.112	-0.114	-0.115	-0.119	-0.122	-0.126	-0.128	-0.132	-0.137	-0.140	-0.143
=> NPV of Losses	-$0.88															
Total for Option 1	**$22.46**															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116
==> NPV of TUOS	$0.20															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.112	-0.115	-0.118	-0.121	-0.124	-0.127	-0.128	-0.132	-0.136	-0.140	-0.143	-0.147	-0.152	-0.156	-0.159
=> NPV of Losses	-$0.98															
Total for Option 2	**$22.67**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116
==> NPV of TUOS	$0.20															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.088	-0.091	-0.093	-0.095	-0.098	-0.098	-0.101	-0.104	-0.108	-0.110	-0.113	-0.117	-0.120	-0.122
=> NPV of Losses	-$0.75															
Total for Option 2	**$30.06**															

Scenario B		Medium load Growth, 0MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.104	-0.166	-0.172	-0.177	-0.183	-0.189	-0.194	-0.205	-0.213	-0.224	-0.237	-0.259	-0.276	-0.300
=> NPV of Losses	-$1.36															
Total for Option 1	**$22.09**															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.112	-0.115	-0.185	-0.191	-0.197	-0.204	-0.210	-0.216	-0.228	-0.237	-0.250	-0.264	-0.288	-0.307	-0.334
=> NPV of Losses	-$1.52															
Total for Option 2	**$22.23**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.088	-0.142	-0.147	-0.151	-0.156	-0.161	-0.166	-0.175	-0.182	-0.192	-0.203	-0.221	-0.236	-0.256
=> NPV of Losses	-$1.16															
Total for Option 2	**$29.74**															

Scenario C		High load Growth, 0MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109	0.107	0.106
==> NPV of TUOS	$0.56															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.117	-0.132	-0.150	-0.170	-0.194	-0.222	-0.255	-0.288	-0.335	-0.385	-0.458	-0.549	-0.668	-0.840
=> NPV of Losses	-$1.91															
Total for Option 1	**$21.69**															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.112	-0.130	-0.146	-0.167	-0.189	-0.215	-0.247	-0.283	-0.321	-0.372	-0.428	-0.509	-0.611	-0.743	-0.935
=> NPV of Losses	-$2.12															
Total for Option 2	**$21.74**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.100	-0.112	-0.128	-0.145	-0.165	-0.190	-0.218	-0.246	-0.286	-0.328	-0.391	-0.469	-0.571	-0.718
=> NPV of Losses	-$1.63															
Total for Option 2	**$29.40**															

Scenario D		Low load Growth, 80MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101
=> NPV of Losses	-$0.76															
Total for Option 1	**$22.57**															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116
==> NPV of TUOS	$0.20															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112
=> NPV of Losses	-$0.85															
Total for Option 2	**$22.79**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116
==> NPV of TUOS	$0.20															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086
=> NPV of Losses	-$0.65															
Total for Option 2	**$30.15**															

Scenario E		Medium load Growth, 80MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101
=> NPV of Losses	-$0.76															
Total for Option 1	**$22.69**															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112
=> NPV of Losses	-$0.85															
Total for Option 2	**$22.89**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086
=> NPV of Losses	-$0.65															
Total for Option 2	**$30.25**															

Scenario F		High load Growth, 80MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109	0.107	0.106
==> NPV of TUOS	$0.56															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101
=> NPV of Losses	-$0.76															
Total for Option 1	$22.83															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112
=> NPV of Losses	-$0.85															
Total for Option 2	$23.01															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086
=> NPV of Losses	-$0.65															
Total for Option 2	$30.37															

Scenario G		Low load Growth, 160MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101
=> NPV of Losses	-$0.76															
Total for Option 1	**$22.57**															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116
==> NPV of TUOS	$0.20															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
" Losses $		-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112
=> NPV of Losses	-$0.85															
Total for Option 2	**$22.79**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116
==> NPV of TUOS	$0.20															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086
=> NPV of Losses	-$0.65															
Total for Option 2	**$30.15**															

Scenario H		***Medium load Growth, 160MW wind generation***														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101
=> NPV of Losses	-$0.76															
Total for Option 1	**$22.69**															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112
=> NPV of Losses	-$0.85															
Total for Option 2	**$22.89**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086
=> NPV of Losses	-$0.65															
Total for Option 2	**$30.25**															

Scenario I		High load Growth, 160MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Brinkworth, 1 at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		1.998	3.398	3.352	3.306	3.260	3.214	3.168	3.122	3.076	3.030	2.984	2.938	2.892	2.846	2.800
==> NPV of TUOS	$23.03															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109	0.107	0.106
==> NPV of TUOS	$0.56															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101	-0.101
=> NPV of Losses	-$0.76															
Total for Option 1	**$22.83**															
Option 2		**Two TFs at Bungama**														
2 TFs at Bungama		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.033	3.458	3.411	3.364	3.318	3.271	3.224	3.177	3.130	3.083	3.037	2.990	2.943	2.896	2.849
==> NPV of TUOS	$23.44															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112	-0.112
=> NPV of Losses	-$0.85															
Total for Option 2	**$23.01**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line - TF at Brinkworth		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		2.655	4.515	4.454	4.393	4.332	4.271	4.209	4.148	4.087	4.026	3.965	3.904	3.842	3.781	3.720
==> NPV of TUOS	$30.61															
18 Mvar Capacitor at Hummocks		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
* Losses $		-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086	-0.086
=> NPV of Losses	-$0.65															
Total for Option 2	**$30.37**															