Final Report

Proposed New Large Network Asset - Brisbane CBD Area

Joint Report by ENERGEX Limited & Powerlink Queensland
20 February 2004

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DOCUMENT PURPOSE

For the benefit of those not familiar with the National Electricity Code (NEC) and the National Electricity Market (NEM), ENERGEX and Powerlink offer the following clarifications on the purpose and intent of this document:

1. The document is produced in accordance with the NEC, which requires ENERGEX and Powerlink, as part of forward planning, to identify foreseeable FUTURE supply requirements in its network, well in advance of them becoming an operational problem.

2. The NEC requires ENERGEX and Powerlink to identify, evaluate and compare both network and non-network solutions to determine which can overcome the future supply requirements at the lowest cost to electricity consumers. This document contains the results of this evaluation in accordance with NEC requirements.

3. The purpose of this document is to advise that a final recommended solution has been determined, in time for it to be implemented to address future supply requirements.

What the document does NOT mean:

A. It does NOT mean that the lights are about to go out. The identified supply requirements are expected to arise some years into the future, assuming that demand for electricity continues to grow. There is enough time between now and then to implement a solution.

B. It does NOT mean that ENERGEX and Powerlink have been surprised, or that anything is “out of the ordinary”. On the contrary, it is part of the normal, routine planning processes in the NEM.

1 EXECUTIVE SUMMARY

Electricity demand in the Brisbane CBD Area is continuing to grow strongly in line with Queensland's economic and population growth. This area includes the Central Business District and inner suburbs including Kelvin Grove, Windsor, Fortitude Valley, Spring Hill, New Farm, East Brisbane, West End and Milton.

Primary electricity supply to the Brisbane CBD Area is provided by five 110kV circuits which have adequate capacity for the existing needs of the CBD Area. The five 110kV circuits provide supply into the local 33kV and 11kV networks which transfer electricity to customers throughout the Brisbane CBD Area.

ENERGEX Limited (ENERGEX) and Powerlink Queensland (Powerlink) have identified that steps must now be taken to ensure a reliable electricity supply to the Brisbane CBD Area in 2005 and 2006, and to position Brisbane for anticipated growth in the longer term. Augmentations proposed in this document will prevent supply interruptions during single network contingencies, including outages of the 110kV network supplying the CBD Area and outages in the 33kV supply network. Such action is necessary for ENERGEX and Powerlink to comply with their respective obligations regarding reliability of electricity supply.

In June and July 2003, ENERGEX and Powerlink carried out consultation with interested parties to identify feasible non-network alternatives to address future CBD Area supply requirements. Responses were received from three parties and follow-up discussions were held.

No feasible non-network options were identified that would have sufficient capacity on their own to address the supply requirements identified in 2005 and 2006. ENERGEX is, however, investigating the feasibility of future energy efficiency and other demand side initiatives in the Brisbane CBD Area to defer subsequent network developments. These initiatives have been considered in the analysis of solutions.

ENERGEX and Powerlink carried out comprehensive system analysis to identify network options to provide sufficient transformer and line capacity to meet the CBD Area requirements in 2005, 2006 and beyond. After technical and cost assessments, the following feasible options were analysed in detail to compare the Net Present Value (NPV) of the costs to market participants, in accordance with the ACCC Regulatory Test:

Option 1	New supply to the CBD Area at 275kV + related works. Upgrade to equipment at key CBD substations
Option 2	New supply to the CBD Area at 110kV + related works. Upgrade to equipment at key CBD substations
Option 3	New supply to the CBD Area at 33kV + related works. Upgrade to equipment at key CBD substations

The ACCC Regulatory Test requires that for reliability augmentations (as is the case for the Brisbane CBD Area), the recommended option be the option with the lowest Net Present Value (NPV) cost compared with alternative options. To allow comparison of options on an equivalent basis, the economic analysis was carried out over fifteen years, and included consideration of anticipated/modelled projects that are expected to be required to meet forecast growth in electricity demand in the Brisbane CBD Area. Market development scenarios and other analytical techniques were used to check the sensitivity of the outcome to changes in these assumptions.

Consequently, an Application Notice was published in December 2003 containing a draft recommendation to implement *Option 2 – New Supply to the CBD Area at 110kV + Related Works* to address the future supply requirements in the Brisbane CBD Area.

Option 2 was the least cost option over the period of analysis, and comprises the following works:

By late 2005:

- Re-arrange the existing Belmont to Newstead 110kV double circuit line to connect it into Murarrie substation and retension the existing line between Murarrie and Newstead;
- Establish an expanded 110kV switching station at the existing Newstead site and install two 110kV underground cables from Newstead to McLachlan Street;
- Establish a 110kV busbar at the existing McLachlan Street 33/11kV Substation and install two 60 MVA 110/11kV transformers; and
- Extend the 110kV busbar and reconfigure the 110kV network at the existing Charlotte Street Substation.

By late 2006:

- Partially relocate existing 110kV lines between Belmont and Murarrie, and establish a teed 110kV underground connection to the existing Charlotte Street Substation;
- Establish Ann Street Substation on existing site with 2 x 60 MVA 110/11kV transformers;
- Install 2 x 60 MVA 110/11kV transformers at the existing Wellington Road 33/11kV Substation; and
- Construct a double circuit 275kV line between the existing Belmont and Murarrie Substations with one 275/110kV 375MVA transformer at Murarrie – to be achieved through partial rebuild/relocation of existing 110kV lines.

The total estimated capital cost of these works is $178.5M. Construction of the recommended augmentations is expected to begin from Quarter 2 2004. This will allow the works to be commissioned progressively from late 2005 to late 2006.

No submissions were received in response to the Application Notice. The draft recommendation has therefore been adopted without change as the final recommendation and immediate steps will now be taken to implement these works.

2 INTRODUCTION

Electricity demand in the Brisbane CBD Area is continuing to grow strongly in line with Queensland's economic and population growth. This area incorporates the Brisbane Central Business District and surrounding suburbs including Kelvin Grove, Windsor, Fortitude Valley, Spring Hill, New Farm, East Brisbane, West End and Milton. There will need to be ongoing investment over the next ten years in major electricity infrastructure supplying the Brisbane CBD Area. As part of their commitment to maintaining a reliable supply to customers, ENERGEX and Powerlink have determined that steps are now required to meet CBD Area electricity supply requirements in 2005 and 2006.

Where a network service provider such as ENERGEX or Powerlink proposes to establish a new large network asset to address future supply requirements, it is required to issue an Application Notice under Clause 5.6.6 of the National Electricity Code (Code). The Code then requires consideration of any submissions received in response to the Application Notice, and preparation of a Final Report.

This Final Report must contain information regarding:

- the reasons the augmentation is required, including, if relevant, why it is considered a 'reliability augmentation' as defined in the Code;
- feasible options available to address the future supply requirements, including any proposed non-network alternatives that meet the requirements;
- a detailed description of the proposed new large network asset;
- the technical details of the recommended solution, including the timetable for implementation and commissioning date;
- why the solution satisfies the Regulatory Test prescribed by the Australian Competition and Consumer Commission (ACCC); and
- a summary of submissions received from interested parties and the applicant's response to each submission.

This final recommendation is based on:

- the assessment that action is now required to maintain a reliable electricity supply in the Brisbane CBD Area during single network contingencies from late 2005 onwards, and under network intact conditions thereafter;
- the consultation undertaken by ENERGEX and Powerlink to identify potential solutions to address these future supply requirements;
- the interrelationship between the forecast supply requirements in the Brisbane CBD Area in 2005 and 2006 and the future supply needs of the suburbs surrounding this area;
- the analysis of feasible options in accordance with the Regulatory Test prescribed by the ACCC; and
- the publication of an Application Notice containing a draft recommendation to address the future supply requirements to allow comment by interested parties.

The recommended solution maximises the net economic benefits to participants in the National Electricity Market. These economic benefits arise from maintaining a reliable power supply at the least cost to the market and therefore to end-use customers.

3 REASONS AUGMENTATION IS REQUIRED

3.1 Supply to the Brisbane CBD Area

Electricity is transferred from power stations to the Brisbane metropolitan area via Powerlink's 275kV transmission network. Bulk supply for the CBD Area[1] is provided from 275kV substations located at South Pine[2], Rocklea and Belmont. There is currently no 275kV supply substation in the CBD Area.

Five 110kV circuits transfer the bulk supply from the 275/110kV substations to the CBD Area, namely:

(i) A double circuit overhead line/underground cable from Upper Kedron (mainly supplied from South Pine Substation) into the CBD Area via Ashgrove West Substation;

(ii) A single circuit overhead line/underground cable from Rocklea Substation into the CBD Area via West End Substation; and

(iii) A double circuit overhead line/underground cable from Belmont Substation into the CBD Area through Newstead and Victoria Park[3] Substations.

In turn, the five 110kV circuits listed above provide supply into the local ENERGEX 33kV and 11kV networks that transfer electricity to customers throughout the Brisbane CBD Area.

The 33kV network also plays a significant role in maintaining a reliable power supply to the CBD Area. 33kV feeders from Doboy 110/33kV Substation[4] to Wellington Road 33/11kV Substation[5] supply part of the CBD Area electricity requirements. Other parts of the 33kV network can provide backup for outages in the 110kV network.

3.2 Future CBD Area Supply Requirements

ENERGEX and Powerlink have identified that steps must now be taken to maintain a reliable power supply to the Brisbane CBD Area from late 2005 onwards, and to position Brisbane for future growth.

Planning studies show that the thermal capacity of some lines and transformers in the Brisbane CBD Area will be exceeded under contingency conditions from the summer of 2005/06 onwards. Action is required to avoid future overloads when all network elements are in service ("network intact") and when a single network element is out of service ("N-1 conditions"). Analysis to support these conclusions, including load forecasts and relevant assumptions, was published in an earlier consultation document entitled "Request for Information – Emerging Network Limitations – Supply to Brisbane CBD and Surrounding Suburbs"[6].

[1] The Brisbane CBD Area includes the Brisbane Central Business District (CBD) and surrounding inner city suburbs including Spring Hill, Fortitude Valley, Milton, Kelvin Grove, Newstead, New Farm, Herston, Bowen Hills, Newmarket, Wilston, Windsor, West End, Highgate Hill, South Brisbane, Woolloongabba, Kangaroo Point and East Brisbane.
[2] Located in the suburb of Brendale.
[3] Located in the suburb of Fortitude Valley.
[4] Located in the suburb of Murarrie.
[5] Located in the suburb of East Brisbane.
[6] Published 23 June 2003. Copies available from ENERGEX or Powerlink.

The following critical contingencies have been identified. Action is required to ensure full supply can be maintained if these outages occur during times of peak electricity demand:

(i) Outages on the 110kV network supplying the Brisbane CBD Area by late 2005; and

(ii) Outages at key CBD Area 110/33kV and 33/11kV substations:

  (a) Outages at Victoria Park 110/33kV Substation by late 2005;

  (b) Outages at McLachlan Street 33/11kV Substation by late 2005; and

  (c) Outages at Astor Terrace 33/11kV Substation by late 2006.

Further information about these and other forecast supply requirements[7] is contained in the 'Request for Information' document. It should be noted that one of the future requirements listed in the 'Request for Information' document is now not expected to occur. ENERGEX and Powerlink have reviewed the operation of the Brisbane CBD Area electricity supply system, and identified that a thermal overload on the Rocklea to West End 110kV cable for network intact conditions during the 2005/06 summer can be avoided through line re-arrangements[8].

ENERGEX and Powerlink have statutory obligations to ensure their networks have sufficient capacity to provide network services to customers[9]. Capacity is required to be provided to the Brisbane CBD Area such that the forecast peak demand can be supplied with the most critical element out of service, ie. N-1. If no action is taken, interruptions to customer supply will need to occur in the Brisbane CBD Area from late 2005 onwards during single network contingencies to prevent network equipment being overloaded. ENERGEX and Powerlink therefore consider action to address the emerging network requirements in the Brisbane CBD Area to be a "reliability augmentation", as defined in the National Electricity Code[10].

The reasons outlined above demonstrate the need to augment the existing electricity network supplying the Brisbane CBD Area prior to summer 2005/06.

[7] Some network requirements that arise beyond 2006 were also identified in the 'Request for Information'. Other longer-term requirements have been considered in the economic analysis of options (refer option discussion in section 5) to ensure the impact of short-term works on future network development is properly considered and assessed.

[8] Line re-arrangements allow customer load to be supplied from different parts of the network. Load transfers through network reconfiguration, either manual or automatic, are a standard operational tool used by electricity distribution network owners to manage their systems efficiently.

[9] Powerlink's transmission authority includes a responsibility "to ensure as far as technically and economically practicable, that the transmission grid is operated with enough capacity (and if necessary, augmented or extended to provide enough capacity) to provide network services to persons authorised to connect to the grid or take electricity from the grid." (Electricity Act 1994, Section 34.2). The authority also requires Powerlink to plan and develop its network such that the power transfer available through the power system will be adequate to supply the forecast peak demand during the most critical single network element outage. ENERGEX's distribution authority includes a responsibility to "connect and supply electricity to a customer's electrical installation or premises within its distribution area". (Electricity Act 1994, Section 40D). In addition, the connection agreement between ENERGEX and Powerlink includes obligations regarding the reliability of supply as required under Clause 5.1.2.2 of the Code. Capacity is required to be provided to the Brisbane CBD Area such that the forecast peak demand can be supplied with the most critical element out of service, ie. N-1.

[10] A "reliability augmentation" is a network augmentation that is necessitated solely by inability to meet the minimum network performance requirements set out in Schedule 5.1 of the National Electricity Code or in relevant legislation, regulations or any statutory instrument of a participating jurisdiction.

4 RESPONSES TO THE CONSULTATION PROCESS

4.1 Submissions to Application Notice

ENERGEX and Powerlink issued an Application Notice for a Proposed New Large Network Asset on 17 December 2003, which contained a draft recommendation to address future supply requirements in the Brisbane CBD Area. The recommended scope of works, with a total estimated capital cost of $178.5M, was as follows:

By late 2005:

- Re-arrange the existing Belmont to Newstead 110kV double circuit line to connect it into Murarrie substation and retension the existing line between Murarrie and Newstead;
- Establish an expanded 110kV switching station at the existing Newstead site and install two 110kV underground cables from Newstead to McLachlan Street;
- Establish a 110kV busbar at the existing McLachlan Street 33/11kV Substation and install two 60 MVA 110/11kV transformers; and
- Extend the 110kV busbar and reconfigure the 110kV network at the existing Charlotte Street Substation.

By late 2006:

- Partially relocate existing 110kV lines between Belmont and Murarrie, and establish a teed 110kV underground connection to the existing Charlotte Street Substation;
- Establish Ann Street Substation on existing site with 2 x 60 MVA 110/11kV transformers;
- Install 2 x 60 MVA 110/11kV transformers at the existing Wellington Road 33/11kV Substation; and
- Construct a double circuit 275kV line between the existing Belmont and Murarrie Substations with one 275/110kV 375MVA transformer at Murarrie – to be achieved through partial rebuild/relocation of existing 110kV lines.

No submissions were received in response to the Application Notice.

5 OPTIONS CONSIDERED

5.1 Consultation Summary

Each year Powerlink carries out joint planning with electricity distributors such as ENERGEX and publishes an Annual Planning Report in accordance with Code requirements.

The June 2003 Annual Planning Report contained information regarding future supply requirements in the Brisbane CBD Area. It also identified that action would be required to address electricity supply needs in the Murarrie and Trade Coast (Brisbane Port) areas, and that potential solutions to this issue could depend on works to address CBD Area supply requirements.

Also in June 2003, ENERGEX and Powerlink issued a 'Request for Information' document[11] providing more detailed information to National Electricity Code participants and other interested parties on the future supply requirements in the Brisbane CBD Area. This paper was the first step in meeting regulatory requirements related to potential network augmentations. It sought information from Code Participants and interested parties regarding potential solutions, including non-network solutions, to address the anticipated network requirements.

ENERGEX and Powerlink received submissions from the following three (3) parties in response to the 'Request for Information' document:

(i) Envestra/Origin Energy who have the natural gas franchise for the North Brisbane Area;

(ii) ENERGEX Retail Pty Ltd (ERPL) who retails electricity to franchise customers in South East Queensland and to contestable customers throughout the National Electricity Market; and

(iii) Stanwell Corporation, owner of several power stations in Queensland[12].

5.2 Non-Network Options Identified

5.2.1 General

The primary purpose of the 'Request for Information' paper was to identify feasible non-network options to be included in the analysis. Relevant information identified during the consultation is summarised in this section.

5.2.2 Demand Side Management (DSM)

ENERGEX and Powerlink considered the use of DSM initiatives to address the identified CBD supply requirements as part of normal planning practices and in response to submissions received from ERPL and Envestra/Origin.

DSM initiatives involve reducing the amount of power that needs to be supplied through the electricity network. This can be achieved through agreements to interrupt customer electricity supply during peak periods, through energy efficiency initiatives or use of alternative fuel sources such as gas. Local generation can also reduce the demand on the electricity network – this is discussed in section 5.2.3 below.

Several DSM programs already exist in the Brisbane CBD Area. The largest of these is hot water system load management during peak periods. Such existing programs have been included in the demand forecasts used in the planning process, and therefore are already being used to defer augmentations as long as possible.

[11] "Request for Information – Emerging Network Limitations – Supply to Brisbane CBD and Surrounding Suburbs". Available from ENERGEX or Powerlink.

[12] The submission from Stanwell acknowledged receipt of the 'Request for Information' document and advised that Stanwell was not proposing any generation or other developments which could serve as a solution to the CBD Area supply requirements.

The possibility of further DSM initiatives was raised in the submissions from ERPL and Envestra/Origin[13]. Examples of potential initiatives include:

- Replacement of existing electric hot water systems and stoves with gas units;
- Replacement of existing electric hot water systems with solar units;
- Use of gas or solar hot water systems in lieu of electric units in new premises;
- Replacement of traditional electric air-conditioning plants with gas plants;
- Use of ice storage with electric air-conditioning plants; and
- Installation of energy efficient lighting.

The CBD Area load consists of both residential and commercial load, with the highest proportion of electricity demand due to commercial high-rise in the Central Business District.

Some of the above DSM strategies are already being incorporated into new buildings, namely energy efficient lighting, gas stoves and gas or solar hot water systems. This is likely to increase in the future should the draft Sustainable Housing Code (refer section 6.1) be implemented. DSM strategies are discussed when building developers approach ENERGEX to request connection to the electricity distribution network. An estimated demand figure for future new high rise residential or commercial buildings is included in the load forecast, which accounts for any DSM strategies being adopted. Estimates for other new loads are also incorporated in the demand forecast as far as possible.

New programs could also potentially be developed to reduce electricity demand from existing customers. However, to avoid investment in the electricity network, it would be necessary to maintain electricity demand at current levels.

ENERGEX's experience with previous DSM programs is that incremental change in electricity usage is more easily achieved than a step change in demand growth. Behavioural and attitudinal change by customers takes time to occur. For example, existing appliances, such as hot water systems, are generally not replaced until they fail beyond repair. When this occurs, most customers opt for replacement with a similar unit to minimise inconvenience, such as length of time without hot water. Even if they are encouraged to convert to gas or solar, this has only an incremental impact on electricity demand in the short-term. There are similar issues associated with changes to electricity usage in commercial premises, where practical and commercial issues are associated with any significant changes.

If a demand side program is to avoid the need for network investment (ie – be a truly feasible alternative), it is essential that there be certainty that electricity demand can be contained so as not to exceed the capability of the existing electricity network. If this does not occur, forced interruptions to customer power supply could result. Electricity demand in the Brisbane CBD Area and relevant surrounding areas is growing strongly by approximately 40 - 60MW per year[14] due to population growth and new commercial and residential developments. Achieving this volume of demand reduction each year through DSM measures, while ensuring the reliability of supply to the CBD Area is maintained, is not considered achievable within the next three years. ENERGEX and Powerlink have therefore concluded that DSM will not be able to address the CBD Area supply requirements in 2005 or 2006.

However, it is considered that DSM initiatives may defer further network expenditure beyond 2006. To have a significant impact on demand in this timeframe, it is recognised that additional DSM initiatives need to be developed now.

[13] These submissions provided observations/information to be considered in the planning assessment – no specific demand side management solutions capable of addressing the CBD Area supply requirements were put forward. For the information of non-industry readers, a third party may offer to provide grid support to a network owner through implementation of a specific non-network solution. The third party is paid for this service under a contractual arrangement, provided this is justified compared with other alternatives and allowable under the network owner's regulated revenue arrangements.

[14] For the next three years.

For this reason, ENERGEX has started researching the application of such mechanisms in the CBD Area, including the establishment of trial demand side initiatives. The Ministerial Council on Energy also recently announced that it will examine options for a demand-side response pool in the National Electricity Market. These measures are designed to promote greater customer participation in the electricity market. The potential implementation of these measures in the medium to long-term has been taken into account in the analysis in this document through the market development scenarios outlined in section 6.0.

5.2.3 Existing Local Generation

ENERGEX and Powerlink are not aware of any large existing generation facilities in the Brisbane CBD Area. There are numerous small standby generators installed in high rise buildings to provide backup during outages. These are usually diesel generators and their usage is restricted by factors such as the following:

(i) Most are currently unable to synchronise with the mains supply (ie – they can only supply the building in which they are located if it is first disconnected from the electricity network); and

(ii) Most have limited on site fuel storage (ie – can only operate for limited periods [10 – 12 hours] without transporting additional diesel fuel into the CBD via tankers).

ERPL has been actively investigating for a considerable time how these limitations may be overcome. Discussions are well advanced with some building owners regarding retrofitting synchronisation equipment, conversion of diesel generators to gas (so that the generators can be connected to the natural gas network) and contractual arrangements for generator operation.

Further work is needed to address these issues to allow these small local generators to provide support to the electricity network during contingencies. As with the DSM initiatives, it is essential that there is certainty that sufficient generation is available to meet customer requirements – for an extended period if necessary – to defer the need for network investment. Without this, reliability of supply to the CBD Area may not be able to be maintained.

Based on the above factors, ENERGEX and Powerlink have concluded that existing local generation is not able to address the CBD Area supply requirements in 2005 or 2006. Together with network investment, however, it may be able to enhance reliability of supply to the CBD under specific network contingencies. It is also possible that the relevant technical and other issues can be addressed to the extent that small local generators can be used to provide network support so as to defer network investment in the medium to long-term. ENERGEX will continue to consider these proposals as part of future investigations and consultations to assess whether it is economic to defer further network development through this mechanism.

5.2.4 New Local Generation

ENERGEX and Powerlink are not aware of any large generation facilities proposed for the Brisbane CBD or surrounding area.

It is believed that developers will continue to provide small standby generator units in high rise buildings to provide electricity during outages. There has been discussion between ERPL and such developers about designing these units so they can supply power to the network during an outage. There has also been discussion about installing co-generation facilities where the waste heat can be utilised.

Although this generation may be useful in the medium to long term, ENERGEX and Powerlink have concluded that new generation will be insufficient to reliably meet CBD Area supply requirements in 2005 or 2006.

5.3 Network Options Identified

5.3.1 General

In addition to the consultation process to identify possible non-network solutions, ENERGEX and Powerlink also carried out joint studies to determine the most appropriate network solution to address the future requirements in the Brisbane CBD Area. These comprehensive studies included load flow analysis, calculation of fault levels[15] at all relevant substations, cost assessments and consideration of the interrelationship between supply to the CBD Area and to surrounding suburbs.

As outlined in section 3.2, planning studies show that from the summer of 2005/06 onwards, the thermal capacity of some 33kV lines and 110/33kV and 33/11kV transformers may be exceeded during contingencies. In addition, action is required to ensure a reliable power supply can be maintained to the Brisbane CBD Area in the event of a single contingency on one of the five existing 110kV circuits supplying the Brisbane CBD Area from summer 2005/06 onwards.

Evaluation of network options focussed on determining the network voltage which delivers the most cost effective augmentation to the CBD Area both in the near and longer term. Augmentation options at 275kV, 110kV and 33kV were developed for analysis.

All development options involved a series of works, as no single network development is able to address the increasing electricity demand that is expected to occur throughout the Brisbane CBD Area.

5.3.2 Option 1 - Augmentation at 275kV

Option 1 addresses the future CBD Area supply requirements by constructing a new 275kV network connection between existing sites at Belmont and Ann Street, upgrading the existing 110kV network supplying the CBD Area, and carrying out works to increase the capacity of existing substations within the CBD Area.

Proposed Augmentations	Capital Cost ($M)	Date required
To Increase Power Transfer Capability to the CBD Area		
Construct new 275kV network connection between Belmont and Ann Street with indoor 275/110kV substation	$82.4	Late 2006
Install new 110kV underground connection between the existing Charlotte Street Substation and a 110kV substation at the existing Wellington Road Substation	$14.7	Late 2006
Connect existing Belmont-Newstead 110kV line into Murarrie Substation; retension section of existing line between Murarrie and Newstead	$14.1	Late 2005
Extend and reconfigure 110kV busbar[16] at the existing Charlotte Street Substation	$6.7	Late 2005

[15] Short circuits on electricity networks can cause high fault currents to flow. These fault currents can be many times higher than normal load currents and the power network must be specially designed to withstand and interrupt the highest fault currents that are expected to occur.

[16] A busbar is an item of substation equipment that makes a common connection between several circuits.

To Increase Substation Capacity within the CBD Area		
Expand 110kV switching capability at existing Newstead site; install new 110kV underground connection to McLachlan Street	$21.1	Late 2005
Install 110/11kV transformers (2 x 60MVA) at existing McLachlan Street Substation with associated substation works	$19.7	Late 2005
Install 110/11kV transformers (2 x 60MVA) at existing Ann Street site with associated substation works	$19.1	Late 2006
Install 110/11kV transformers (2 x 60MVA) at existing Wellington Road Substation with associated substation works	$13.7	Late 2006

To Increase Power Transfer Capability to the CBD Area

The principal works proposed in Option 1 involve construction of a 275kV transmission connection from Belmont substation to the existing Ann Street Substation site by late 2006[17]. This proposed new 275kV feeder would provide a significant new injection of power into the CBD Area and prevent thermal overloads of the existing 110kV transmission system during N-1 contingencies.

There are presently no transformers or switchgear at the Ann Street site. Some substation building and cabling works have already been completed as part of a multi-storey building to cater for a 110/11kV substation. Major high-cost structural works and additional space would be required to allow the Ann Street site to also house two 275/110kV transformers to allow connection from the proposed 275kV line into the 110kV distribution system in the CBD Area[18]. Minor substation works would be required at Belmont.

The works for Option 1 include the installation of a short section of underground 110kV circuit between the McLachlan Street Substation and the Ann Street site. This is necessary to prevent overload of the single Ann Street to McLachlan Street circuit and enable a reliable supply to be maintained during an outage of the proposed 275kV Belmont-Ann Street connection. Two new 110kV underground cables would also be required between Charlotte Street and Wellington Road in late 2006. This would allow transfer of power from the new 275kV supply to the CBD Area to meet increasing demand from customers supplied from the existing Wellington Road Substation[19].

The above works are proposed for completion by late 2006. However, as outlined in the 'Request for Information' document, action needs to be taken to address supply requirements arising from late 2005 onwards. ENERGEX and Powerlink have determined that an upgrade of the existing 110kV network can be carried out in 2005 to ensure that a reliable power supply can be maintained during 110kV network contingencies, thereby economically deferring the major works until 2006. The proposed upgrade works include reconfiguration of the existing 110kV line between Belmont and Newstead to connect it into Murarrie Substation[20], retensioning of the existing line in the section between Murarrie and Newstead, and reconfiguration of the network at Charlotte Street. These works will deliver additional electricity to the CBD Area, and allow the cost-effective deferral[21] of major expenditure on the 275kV supply connection for one year.

[17] Belmont is the most cost-effective 275kV substation to supply the CBD Area taking into account distance and existing infrastructure.

[18] Cost estimates for the 275kV connection should be considered the minimum anticipated cost. Estimates for indoor 275kV substation arrangements included in this document are considered conservative. In addition, detailed fault level studies were not carried out for Option 1. Fault level requirements may necessitate the replacement of some substation equipment which has not been allowed for in the cost estimate for the proposed new 275kV connection.

[19] That is, from the new Ann Street 275/110kV substation via existing underground cables between Ann Street and Charlotte Street, and then via the proposed new cables from Charlotte Street to Wellington Road.

[20] This involves the construction of short sections of line near the existing Murarrie Substation and allows line switching at Murarrie substation.

[21] Most of the initial less expensive works would be required anyway within a few years; implementing these works by late 2005 results in a lower overall cost.

To Increase Substation Capacity Within the CBD Area

A range of predominantly substation works in 2005 and 2006 would address forecast future overloads in the existing 33/11kV substations at Wellington Road and Astor Terrace and Victoria Park 110/33kV Substation.

Option 1 proposes that 110/11kV substations be established at the existing McLachlan St 33/11kV Substation in late 2005 and at the existing Ann Street site in late 2006. To establish a 110kV substation at McLachlan Street requires the installation of 110kV switchgear, 110/11kV transformers and the provision of supply to the substation at 110kV. ENERGEX has determined this supply is best provided from Murarrie via Newstead[22]. This option therefore proposes expansion of the existing 110kV switching capability[23] at Newstead and installation of two new 110kV underground cables from Newstead to McLachlan Street (2.1km).

The installation of 110/11kV transformer capacity at McLachlan Street and Ann Street reduces the loading on existing 33/11kV transformers at McLachlan Street and Astor Terrace. It therefore provides sufficient capacity to prevent overloading at these substations as electricity demand in the CBD Area grows.

Installation of 110/11kV transformers at these existing sites also reduces loading on nearby 110/33kV and 110/11kV transformers. Hence installation of 110/11kV transformers at McLachlan Street and Ann Street Substations also addresses anticipated capacity limitations at Victoria Park 110/33kV Substation. Ann Street also results in some reduction in the amount of power required to be supplied through the transformers at Charlotte Street.

Under Option 1, it is proposed that a new 110/11kV injection also be established at the existing Wellington Road Substation, supplied from the proposed new 110kV underground circuits between Charlotte Street and Wellington Road. The installation of two 60MVA 110/11kV transformers at Wellington Road will allow this substation in East Brisbane to meet future supply requirements in the inner eastern suburbs and the CBD Area. The 110/11kV substation will overcome the existing 33/11kV transformer limitations at Wellington Road and provide for timely replacement of plant nearing the end of its service life. It will also reduce loading on the 110/33kV transformers at Doboy (Wellington Road is currently supplied at 33kV from the existing Doboy Substation in the Murarrie area).

The above 275kV and 110kV works proposed in this option will significantly improve the electricity transfer capability into the CBD Area, and substantially increase the capacity of key CBD Area substations. Load flow analysis has confirmed the combination of works in Option 1 would address the future supply requirements up to and including the summer of 2006/07 identified in the previous 'Request for Information' document.

Proposed augmentation Option 1 is not expected to materially impact other transmission networks within the National Electricity Market.

[22] The only other alternative is to connect the existing 110kV underground cables between Newstead and Victoria Park into the McLachlan Street Substation. These cables pass quite close to McLachlan Street. However, this alternative is not technically feasible as these cables have insufficient capacity to supply the additional load.

[23] Replacement of the 110kV Gas Insulated Switchgear (GIS) at Newstead is required to maintain a reliable supply to the upgraded substation at McLachlan Street, to the existing 110/33kV substation at Victoria Park and to the existing Queensland Rail intake substation at Mayne. Replacement is necessary as the existing equipment is located on a small platform under a tower and there is insufficient space to extend the switchgear at this existing site.

Anticipated/Modelled Projects

Under Option 1, as in all options, further works will be required beyond 2006 to maintain a reliable power supply as the CBD Area continues to grow. The anticipated/modelled projects[24] likely to be required in Option 1 based on current load forecasts are shown in the table below[25]. Scenarios have been developed to test the sensitivity of the analysis to factors which might affect the assumptions regarding anticipated/modelled projects.

Significant expenditure is expected from 2007-2014 to increase the transfer capacity of the 110kV network from Belmont to the CBD Area, and to meet load growth requirements in the inner eastern suburbs surrounding Coorparoo. The establishment of the proposed 275kV connection between Belmont and Ann Street under Option 1 does not eliminate the need for further works in the lower voltage distribution system. This may at first seem counter-intuitive. A 275kV feeder is a high capacity connection and could perhaps be expected to satisfy load requirements for a significant period. However, planning studies have identified that the existing 110kV infrastructure in the Brisbane CBD Area is not yet sufficiently well developed to fully support the proposed new 275kV feeder under contingency conditions[26].

The anticipated establishment of Coorparoo 110/33kV Substation with 110kV supply teed from the Belmont to Murarrie lines in late 2007 will address load growth requirements in the area supplied by the existing Coorparoo, Holland Park and Camp Hill 33/11kV Substations.

Significant expenditure is also expected from 2007 onwards to address forecast 275/110kV transformer capacity limitations in the Brisbane area, and enhance supply capability to the areas supplied from Murarrie, such as the Brisbane Port Area.

Anticipated/Modelled Projects (not recommended in this Final Report)	Capital Cost ($M)	Date required
110/33kV substation at Coorparoo, with 2 x 80MVA transformers and teed 110kV supply from Belmont-Murarrie transmission lines	$55.4	Late 2007
Additional 275/110kV transformer capacity at South Pine[27]	$5.5	Late 2008
275kV Belmont – Murarrie with 1 x 375MVA 275/110kV transformer at Murarrie and partial 110kV line relocation	$28.9[28]	Late 2009
Rocklea 275kV busbar	$8.0	Late 2010
Upper Kedron 275/110kV transformer	$12.8	Late 2011
110kV connection Wellington Road - Coorparoo with capacitor banks at Wellington Road	$17.8	Late 2012
Third Rocklea 275/110kV transformer	$8.0	Late 2013

[24] The ACCC Regulatory Test defines 'anticipated projects' as "projects …which have expected commissioning dates within five years" and 'modelled projects' as "other investments which are likely to be commissioned in response to growing demand…".
[25] Additional works at voltages below 33kV will also be required to address localised issues.
[26] That is, when the proposed new 275kV single circuit is out of service, the existing 110kV network will again reach its capability and be unable to supply the forecast customer load.
[27] Replace one of the existing transformers with higher capacity 1 x 375MVA transformer.
[28] Includes dismantling of existing lines.

5.3.3 Option 2 - Augmentation at 110kV

Option 2 addresses the future CBD Area supply requirements by constructing a new 110kV underground connection to Charlotte Street teed from the existing Belmont-Murarrie transmission lines, upgrading the existing 110kV network supplying the CBD Area, and carrying out works to increase the capacity of existing substations within the CBD Area.

Proposed Augmentations	Capital Cost ($M)	Date required
To Increase Power Transfer Capability to the CBD Area		
Partial 110kV line relocation Belmont to Murarrie with teed underground connection to Charlotte Street	$56.7	Late 2006
275kV Belmont – Murarrie with 1 x 375MVA 275/110kV transformer at Murarrie	$22.1[29]	Late 2006
Connect existing Belmont-Newstead 110kV line into the existing Murarrie Substation; retension section of existing line between Murarrie and Newstead	$14.1	Late 2005
Extend and reconfigure 110kV busbar[30] at the existing Charlotte Street Substation	$6.7	Late 2005
To Increase Substation Capacity within the CBD Area		
Expand 110kV switching capability at existing Newstead site; install new underground 110kV connection to McLachlan Street	$21.1	Late 2005
Install 110/11kV transformers (2 x 60MVA) at existing McLachlan Street Substation with associated substation works	$19.7	Late 2005
Install 110/11kV transformers (2 x 60MVA) at existing Ann Street site with associated substation works	$19.1	Late 2006
Install 110/11kV transformers (2 x 60MVA) at existing Wellington Road Substation with associated substation works	$19.0	Late 2006

To Increase Power Transfer Capability to the CBD Area

The principal works proposed in Option 2 involve partial 110kV line relocation between Belmont and Murarrie with a teed underground connection to the existing Charlotte Street Substation by late 2006. This proposed augmentation would provide a significant new injection of power into the CBD Area and prevent thermal overloads of the existing 110kV transmission system during N-1 contingencies.

Under Option 2, most of the existing 110kV lines between Belmont and Murarrie would be replaced. Two 110kV circuits would be established from Belmont to Charlotte Street in the CBD by late 2006. This new supply would be teed from the Belmont – Murarrie lines with underground construction via Wellington Road Substation. In addition, a 275kV transmission line would be constructed between Belmont and Murarrie by late 2006, together with the installation of a 375MVA 275/110kV transformer at Murarrie. This line is required to strengthen supply to the Trade Coast (Brisbane Port) area and will also provide significantly more capacity in the electricity network between Belmont and the CBD Area via Murarrie and Newstead. The new transformer at

[29] Includes dismantling of existing lines.
[30] A busbar is an item of substation equipment that makes a common connection between several circuits.

Murarrie would provide relief to transformers at Belmont[31] and assist in maximising the transfer capability of the existing and new circuits from Belmont and Murarrie to the CBD Area[32].

The above works are proposed for commissioning by late 2006. As described in Option 1, ENERGEX and Powerlink have determined that an upgrade of the existing 110kV network can be carried out in 2005 to ensure that a reliable power supply can be maintained during 110kV network contingencies. The proposed upgrade works include reconfiguration of the existing 110kV line between Belmont and Newstead to connect it into Murarrie substation[33], retensioning of the existing line in the section between Murarrie and Newstead, and reconfiguration of the network at Charlotte Street. This is cost-effective in deferring more expensive works by one year as described in Option 1.

To Increase Substation Capacity Within the CBD Area

A range of predominantly substation works in 2005 and 2006 would address forecast future overloads in the 33/11kV substations at Wellington Road and Astor Terrace and Victoria Park 110/33kV Substation.

Like Option 1, Option 2 proposes that 110/11kV substations be established at the existing McLachlan Street 33/11kV Substation in late 2005 and at the existing Ann Street site in late 2006[34]. To establish a 110kV substation at McLachlan Street requires the installation of 110kV switchgear, 110/11kV transformers and the provision of supply to the substation at 110kV. ENERGEX has determined this supply is best provided from Murarrie via Newstead[35]. This option therefore proposes expansion of the 110kV switching capability [36] at the existing Newstead site and installation of two new 110kV underground cables from Newstead to McLachlan Street (2.1km).

The installation of 110/11kV transformer capacity at McLachlan Street and Ann Street reduces the loading on existing 33/11kV transformers at McLachlan Street and Astor Terrace. It therefore provides sufficient capacity to prevent overloading at these substations as electricity demand in the CBD Area grows.

Installation of 110/11kV transformers at these sites reduces loading on nearby 110/33kV and 110/11kV transformers. Hence installation of 110/11kV transformers at the existing McLachlan Street and Ann Street Substations also addresses anticipated capacity limitations at Victoria Park 110/33kV Substation. Ann Street also results in some reduction in the amount of power required to be supplied through the transformers at Charlotte Street.

Under Option 2, it is proposed that a new 110/11kV injection also be established at the existing Wellington Road Substation, supplied from the proposed new 110kV underground circuits between Charlotte Street and Wellington Road. The installation of two 60MVA 110/11kV transformers at Wellington Road will allow this existing substation in East Brisbane to meet future supply requirements in the inner eastern suburbs and the CBD Area. The 110/11kV works will overcome the existing 33/11kV transformer limitations at Wellington Road and provide for the timely replacement of plant nearing the end of its service life. It will also reduce loading on the 110/33kV

[31] These transformers would otherwise become overloaded during a single transformer contingency.
[32] Through improving load sharing between the circuits.
[33] This involves the construction of short sections of line near the existing Murarrie Substation and allows line switching at Murarrie substation.
[34] There are presently no transformers or switchgear at the existing Ann Street site. Some substation building and cabling works have already been completed as part of a multi-storey building.
[35] The only other alternative is to connect the existing 110kV cables between Newstead and Victoria Park into the McLachlan Street Substation. These cables pass quite close to McLachlan Street. However, this alternative is not technically feasible as these cables have insufficient capacity to supply the additional load.
[36] Replacement of the 110kV Gas Insulated Switchgear (GIS) at Newstead is required to maintain a reliable supply to the upgraded substation at McLachlan Street, to the existing 110/33kV substation at Victoria Park and to the existing Queensland Rail intake substation at Mayne. Replacement is necessary as the existing equipment is located on a small platform under a tower and there is insufficient space to extend the switchgear at this existing site.

transformers at Doboy (Wellington Road is currently supplied at 33kV from the existing Doboy substation in the Murarrie area).

The works proposed in this option will significantly improve the electricity transfer capability into the CBD Area, and substantially increase the capacity of key CBD Area substations. Load flow analysis has confirmed the combination of works in Option 2 would address the future supply requirements up to and including the summer of 2006/07 identified in the previous 'Request for Information' document.

Proposed augmentation Option 2 is not expected to materially impact other transmission networks within the National Electricity Market.

Anticipated/Modelled Projects

Under Option 2, as in all options, further works will be required beyond 2006 to maintain a reliable power supply as the CBD Area continues to grow. The anticipated/modelled projects likely to be required in Option 2 based on current load forecasts are shown in the table below[37]. Scenarios have been developed to test the sensitivity of the analysis to factors which might affect the assumptions regarding anticipated/modelled projects.

The establishment of Coorparoo 110/33kV substation in late 2007 will address load growth requirements in the area supplied by the existing Coorparoo, Holland Park and Camp Hill 33/11kV substations.

Significant expenditure is also expected from 2007 onwards to address forecast 275/110kV transformer capacity limitations in the Brisbane area.

Anticipated/Modelled Projects (not recommended in this Final Report)	Capital Cost ($M)	Date required
Coorparoo 110/33kV Substation with 2 x 80MVA transformers	$29.8	Late 2007
Additional 275/110kV transformer capacity at South Pine	$5.5	Late 2008
Capacitor banks[38] at McLachlan Street	$3.0	Late 2008
Capacitor banks at Wellington Road	$3.0	Late 2010
Rocklea 275 k busbar	$8.0	Late 2011
Upper Kedron 275/110kV transformer	$12.8	Late 2011
Second Murarrie 275/110kV transformer	$8.5	Late 2012
Third Rocklea 275/110kV transformer	$8.0	Late 2013

[37] Additional works at voltages below 33kV are also likely to be required. Lower voltage works typically address localised issues and would be common to all options outlined in this document.
[38] Items of substation equipment that provide voltage support to the electricity network.

5.3.4 Option 3 - Augmentation at 33kV

Option 3 addresses the future CBD Area supply requirements by augmenting the 33kV network to the greatest extent possible, while minimising works at 110kV and 275kV. This approach is only able to address the CBD Area supply requirements for a short period, before further significant works are required.

Proposed Augmentations	Capital Cost ($M)	Date required
To Address Power Transfer Requirements of the CBD Area		
Construct 33kV feeders from the existing Doboy Substation to Wellington Road Substation. Additional transformers at Wellington Road (33/11kV) and Doboy (110/33kV)	$37.0	Late 2006
Construct 33kV feeders from Stafford to the existing Newmarket 33/11kV substation. South Pine to Stafford third 110kV connection with additional transformer at the existing Stafford Substation (110/33kV)	$31.9	Late 2006
Connect existing Belmont-Newstead 110kV line into Murarrie substation; retension section of existing line between Murarrie and Newstead	$14.1	Late 2005
Extend and reconfigure 110kV busbar[39] at the existing Charlotte Street Substation	$6.7	Late 2005
Additional 275/110kV transformer capacity at the existing South Pine Substation[40]	$5.5	Late 2006
To Increase Substation Capacity within the CBD Area		
Install 110/33kV transformers (2 x 120MVA) at the existing McLachlan Street Substation with associated substation works with additional 33/11kV transformers	$32.7	Late 2005
Expand 110kV switching capability at the existing Newstead site; install new 110kV underground connection to McLachlan Street	$21.1	Late 2005
Install 33/11kV transformers (4 x 25MVA) at the existing Ann Street 33/11kV substation with new 33kV cable supply from McLachlan Street	$16.2	Late 2006

As with Options 1 and 2, an upgrade of the existing 110kV network is proposed under Option 3 to address supply requirements in 2005. Other works carried out in 2005 in Options 1 and 2, namely the expansion of the 110kV switching capability at Newstead and the installation of a 110kV underground connection to McLachlan Street, are also required under Option 3.

However, unlike Options 1 and 2, works in Option 3 proposed for completion by late 2006 do not increase the power transfer capability to the Brisbane CBD Area. Instead, they overcome the emerging 110kV network issues by reducing the electricity demand on the 110kV network supplying the CBD Area. This is achieved by upgrading the 33kV network so that some customers currently supplied from the 110kV network to the CBD Area can be supplied through the 33kV network from other 110kV supplies from outside the CBD Area.

[39] A busbar is an item of substation equipment that makes a common connection between several circuits.
[40] Replace one of the existing transformers with higher capacity 1 x 375MVA transformer.

This has the following consequences:

- less power is required to be transferred on the existing 110kV network supplying the CBD Area. This has the effect of allowing the existing network capacity to meet customer demand for a longer period of time than would otherwise occur;
- more power is required to be transferred on the 33kV network supplied from other 110kV lines. More 33kV network connections are required, and 'upstream' work is also required to allow the 110/33kV substations to support the additional load; and
- the loading on the existing 110/33kV and 33/11kV CBD Area substations changes. These changes do not provide sufficient relief to overcome the forecast future transformer overloads. However, the scope of works required to address these future supply requirements is different to Options 1 and 2.

In Option 3, two proposed new 33kV feeders are constructed from the existing Stafford Substation to Newmarket Substation by late 2006. This will allow some of the customers presently supplied from the existing Victoria Park substation in the CBD Area to be supplied from the Stafford Substation (which is supplied from South Pine). Upgrades to the supply at Stafford, comprising 110kV reinforcement between South Pine and Stafford and new transformers at Stafford and South Pine[41], would be required to meet the additional customer load on the existing Stafford substation[42].

In Option 3, two new 33kV feeders would also be required between the existing substations at Doboy (near Murarrie) and Wellington Road in East Brisbane. This would allow more of the customer load in the inner eastern suburbs to be supplied from Doboy. As with Stafford, upgrades to supply capability at Doboy (additional switchgear and a 4th transformer) would be required to meet this additional customer load.

As noted above, Option 3 requires different works to address the forecast thermal overloads on the existing 33/11kV substations at Astor Terrace and Wellington Road, and the existing Victoria Park 110/33kV substation.

The requirement to develop McLachlan Street at 110kV remains under Option 3. It is proposed, however, to upgrade the capacity of the existing McLachlan Street Substation to 110/33kV, rather than 110/11kV and install larger transformers to manage the additional load to be supplied on the 33kV system (2 x 120MVA).

Under Option 3, the existing Ann Street substation would be developed as a 33/11kV substation to reduce loadings on the nearby Astor Terrace and Victoria Park Substations. Similarly, Wellington Road Substation would be further developed as a 33/11kV substation, so the only works required would be the installation of additional transformers to support the expected increase in load in this area.

Load flow studies have confirmed that the works proposed in Option 3 would address the 2005 and 2006 supply requirements identified in the previous 'Request for Information' document. Proposed augmentation Option 3 is not expected to materially impact other transmission networks within the National Electricity Market.

[41] Upgrade of 275kV transformer capacity at South Pine would be required one year earlier than otherwise needed because of the additional load on Stafford, and therefore South Pine Substation.

[42] The cost included in this economic comparison is considered the minimum possible. Additional expenditure may be required to overcome high fault levels as a result of this augmentation.

Anticipated/Modelled Projects

As for Options 1 and 2, it is essential to assess the expected works that are anticipated beyond 2006 in Option 3 to allow an appropriate comparison of options.

In Option 3, a further four 33kV feeders would be needed from the south and south-east in late 2007 to provide the necessary supply to meet future growth in electricity demand in the areas supplied by the existing Scrub Road (Mansfield), Camp Hill, Annerley and Holland Park Substations. This makes a total of 8 new 33kV feeders required under Option 3 in the next three years, with associated trench and land requirements.

Lower voltage lines and equipment at 33kV are generally less costly to install than 275kV or 110kV equipment. However, such equipment has less power transfer capacity, so that more electricity infrastructure is required to achieve the same result. In the case of the CBD, the major load centres within the CBD are already supplied at 110kV (ie – 110kV substations exist at Charlotte Street, Makerston Street, Milton, West End, and Victoria Park[43]). As a result, only limited additional load can be supplied in the CBD Area at 33kV.

For this reason, analysis shows that the 33kV works listed under Option 3 will only be able to maintain a reliable supply during 110kV network contingencies until late 2008. At that time, further 110kV or higher voltage augmentation[44] is expected to be required to transfer additional power to the CBD Area to meet the increasing electricity demand. Under Option 3, the anticipated/modelled projects therefore include the construction of a 110kV underground line to Coorparoo in late 2008 teed from the Belmont-Murarrie transmission lines, and the rebuild/replacement of the existing 110kV line between Belmont and Murarrie at 275kV as discussed in Option 2. Other anticipated/modelled projects in Option 3 include 110kV works to maintain a reliable supply to Wellington Road in late 2007 and significant expenditure from 2010 onwards to address forecast 275/110kV transformer capacity limitations in the Brisbane area.

Anticipated/Modelled Projects (not recommended in this Final Report)	Capital Cost ($M)	Date required
33kV feeders from the existing substation at Wecker Road to Scrub Road (Mansfield) and Camp Hill. Additional 110/33kV transformer at Wecker Road	$21.2	Late 2007
33kV feeders from existing Tennyson Substation to Annerley/Holland Park Substations.	$12.9	Late 2007
Capacitor banks at McLachlan St	$3.0	Late 2007
Partial 110kV line relocation Belmont to Murarrie with teed underground connection to Charlotte Street	$56.7	Late 2008
Belmont – Murarrie 275kV with 1 x 375 MVA transformer	$22.1[45]	Late 2008
Upper Kedron 275/110kV transformer	$12.8	Late 2010
Rocklea 275kV busbar	$8.0	Late 2011
Third Rocklea 275/110kV transformer	$8.0	Late 2012
Second Murarrie 275/110kV transformer	$8.5	Late 2013

[43] Victoria Park Substation is both a bulk supply substation operating at 110/33kV and a local zone substation operating at 33/11kV.
[44] The anticipated/modelled projects in Option 3 assume this augmentation occurs at 110kV, as this can be achieved at a lower capital cost than augmentation at a higher voltage such as 275kV.
[45] Includes dismantling of existing lines.

5.3.5 Other Considerations

Augmentation of the CBD Area at voltages lower than 33kV is not practical. For example, technical limitations in cable size and length mean that augmentation at 11kV cannot carry sufficient additional power to meet CBD Area supply requirements.

The installation of additional transformer capacity at the existing McLachlan and Ann Street Substations is effectively independent of other CBD Area works. Different developments to achieve additional transformer capability at these substations (ie – at 110/11kV and 33/11kV) have been included in Options 1 to 3 above to demonstrate the relative costs of such variations. 110/11kV development at McLachlan and Ann Street could be substituted for 33/11kV development, and vice versa. Such substitution would reduce the cost of Option 3, but the cost variation is not significant in terms of the outcomes of the analysis described in section 7.3.

6 MARKET DEVELOPMENT SCENARIOS

6.1 Context for Evaluation of Options

All feasible solutions to the identified supply requirements must be viewed in the context of wider developments in the National Electricity Market, such as the following:

(a) NEMMCO's Statement of Opportunities (SOO) issued in July 2003 contained information on existing and committed generation developments in Queensland. There is currently a considerable margin between supply capacity and demand, with several large new generating units commissioned in Queensland in the past two years.

(b) The Queensland Government is proceeding with the implementation of its policy requirement for Queensland Energy Retailers to source 13% of their energy from gas-fired generation from 01 January 2005. The 13% Gas Scheme is designed to deliver on the government policy objectives of diversifying the State's energy mix towards a greater use of gas and encouraging new gas infrastructure in Queensland, while reducing the growth in greenhouse gas emissions.

(c) Commonwealth legislation has been in effect since 01 January 2001 to encourage increased generation from renewable energy sources.

(d) The Brisbane City Council planning scheme (ie. Brisbane City Plan 2000) contains a section on energy efficiency. This encourages the use of energy efficient equipment and appliances that minimise greenhouse gas generation.

(e) A draft Sustainable Housing Code has been produced by the South East Queensland Regional Organisation of Councils and is currently being circulated for comment. This draft code contains various "Acceptable Solutions" for sustainable housing. Some of these are as follows:

(i) For individual houses or units:

- natural gas hot water systems;
- gas-boosted solar hot water systems;
- gas cook-tops, ovens and heaters (flued to the outside);
- fluorescent tube light fittings in the kitchen, laundry and main living area;
- renewable energy generation (eg. solar photovoltaic cells); and
- smart electricity meters with displays installed in a highly visible location inside the home.

(ii) For buildings with centrally installed hot water systems:

- low NOx gas water heating systems;
- solar water heaters where less than 25% is provided by booster units;
- heat exchange units that use waste heat from air-conditioning chiller units to supply hot water;
- electric heat pump water heaters; and
- gas-fired co-generation units that supply electricity and use waste heat for heating, cooling and hot water.

The draft code is written such that each sustainable dwelling feature scores points and a minimum number of points are required. While issues remain to be resolved before such a code achieves widespread implementation, it is believed some local councils (such as Brisbane City Council) will soon begin to include at least some aspects of the draft Sustainable Housing Code as mandatory requirements in their planning schemes.

6.2 Assumed Market Development Scenarios

6.2.1 General

The ACCC Regulatory Test requires that options to address future supply requirements 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; and
- potential generation and demand side developments.

The purpose of utilising this approach is to test the Net Present Value (NPV) costs of the options being evaluated under a range of plausible scenarios.

6.2.2 Existing Network and Future Network Developments

Powerlink and ENERGEX have determined that there are no existing or future network developments which could impact the analysis of options to address the CBD Area supply requirements – apart from those already included in the analysis in this document[46].

Planning studies have identified that the scope and timing of some of the works in the alternative development programs outlined in Section 5.0 are sensitive to establishment of the Coorparoo 110/33kV substation. For this reason, it is considered necessary to examine the sensitivity of the financial analysis to a change in assumptions regarding the timing of this development.

The main driver for the Coorparoo 110/33kV substation establishment is the load growth in the areas supplied by the Coorparoo, Holland Park and Camp Hill 33/11kV zone substations. Total electricity demand in these areas was about 48MW in 2002/03, and is forecast to grow by approximately 3.5% per annum over the next 5 years. A targeted demand side initiative could potentially reduce electricity demand in the relevant areas, allowing the deferral of $25-30M of capital expenditure.

A market development scenario has been developed which assumes that a cost-effective demand side initiative could be implemented. This initiative is assumed to reduce demand on the electricity network[47] supplying the Coorparoo, Holland Park and Camp Hill areas by about 3 to 5MW[48]. Such a demand reduction would defer the Coorparoo 110/33kV substation development by two years from the most likely date of late 2007 to late 2009[49].

[46] Network developments outside the Brisbane metropolitan area have no impact on the power flows on the CBD Area network during single network contingencies.
[47] For example, through energy efficiency measures, customer agreements to reduce demand on the electricity network during peak periods etc.
[48] Up to 10MW could potentially defer transformer upgrades and other upstream work in the electricity distribution network in the south-east suburbs of Brisbane.
[49] For medium growth demand forecast.

6.2.3 Variations in Load Growth

ENERGEX and Powerlink carry out the majority of their detailed planning using a medium economic growth, typical weather (50% probability of being exceeded) forecast for electricity usage. These forecasts include all known information about existing and planned demand side initiatives and also include independent forecasts of local embedded generation developments. Three market development scenarios have been developed to simulate the impact of variations in customer load growth as follows:

(i) "Medium" load growth[50];

(ii) "High" load growth[51]; and

(iii) "Half" load growth[52].

Higher or lower load growth could occur due to actual conditions not matching assumptions about economic growth and electricity consumption patterns, or could reflect the impacts of demand side initiatives and/or output from embedded generators. However, no regard has been given to the cause or source of different electricity load forecasts. The purpose of the scenarios is to test the robustness of the option comparison, so the cause is not relevant to the outcome of the analysis.

6.2.4 Existing and Committed Generators

Analysis of potential solutions in this paper is not sensitive to the generation pattern of existing and committed generators. There are no large existing or committed generators in the CBD Area, and the output of existing and committed generators has little impact on the power flows on the CBD 110kV network during contingencies. For this reason, scenarios have not been developed to test assumptions about operational patterns of existing and committed generators.

6.2.5 Potential Large Scale Generation Developments

NEMMCO's recent Statement of Opportunity indicated that additional investment in generation may be required in the National Electricity Market by 2005/06. As discussed in Section 5.0, no new large scale generation was proposed in the Brisbane CBD Area or surrounding suburbs in response to the 'Request for Information' document. Development of such generation in the immediate CBD Area is considered unlikely.

6.2.6 Potential Small Scale Generation Development and/or Demand Side Initiatives

As discussed in Section 5.0, no specific proposals for significant small scale generation or demand side management (DSM) initiatives were proposed for the Brisbane CBD Area or surrounding suburbs in response to the 'Request for Information' document. Despite this, it is considered that, given the interest of governments and the community in sustainable development and greenhouse gas emission reductions, the climate is right for increased demand side management (DSM) initiatives including possible small scale generation developments. Significant impacts on forecast load growth may result in a 3-5 year timeframe. This possible impact has been modelled in the following two market development scenarios:

(i) Half load growth across the entire study area; and

(ii) Targeted DSM in the area supplied by the proposed future Coorparoo 110/33kV substation that allows this substation to be deferred from late 2007 until late 2009[53].

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[50] Consistent with medium growth demand forecast published in Powerlink's 2003 Annual Planning Report. This forecast features higher rates of growth until 2007/08, with growth rates beyond 2007/08 falling to more historically typical levels.

[51] The Higher growth scenario assumes that the high rates of growth in the Medium scenario continue beyond 2008/09, such that a two year interval in the Medium scenario becomes one year.

[52] The Half growth scenario assumes that growth reduces considerably after 2005/06 (which could occur, for example, due to demand side management initiatives) such that electricity demand grows at half the rate forecast in the Medium scenario. In this scenario, a one year interval under the Medium scenario becomes two years.

[53] For medium growth demand forecast. Assumes that electricity demand growth in the relevant area is reduced due to successful targeted DSM projects.

6.2.7 Summary of Market Development Scenarios Investigated

Four market development scenarios have been developed to simulate the impact of variations in load growth and other assumptions as outlined above.

Scenario A	"Medium" load growth forecast.
Scenario B	"Half" load growth forecast.
Scenario C	Targeted demand side management in the area to be supplied by the future Coorparoo 110/33kV substation.
Scenario D	"High" load growth forecast.

7 REGULATORY TEST ANALYSIS

7.1 Regulatory Test Requirements

The requirements for the comparison of options to address future supply requirements are contained in the Regulatory Test prescribed by the ACCC[54].

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". To satisfy the Test, a proposed augmentation must achieve a greater market benefit in most, but not necessarily all, credible scenarios.

The Regulatory Test contains guidelines for the methodology to be used to calculate the Net Present Value (NPV) of the market benefit. For example, where an augmentation is required to satisfy minimum network performance requirements (ie – a reliability augmentation), the methodology published by the ACCC defines "market benefit" as the total net cost to all those who produce, distribute and consume electricity in the National Electricity Market. 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 future supply needs in the Brisbane CBD Area as outlined in this document is required to satisfy reliability requirements linked to Schedule 5.1 of the National Electricity Code and the requirements of the Queensland Electricity Act, Powerlink's Transmission Authority and ENERGEX's Distribution Authority[55].

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 Net Present Value (NPV) of the various options, are shown in Section 7.3.

[54] ENERGEX and Powerlink are required to evaluate options for new network developments under the Regulatory Test in accordance with Clause 5.6 of the National Electricity Code.
[55] Refer to Section 3.0.

Cost inputs to the NPV analysis are as follows:

(i) Cost of Network Augmentations[56]:

The cost of the network augmentations described in the options in Section 5.0 have been estimated by ENERGEX and Powerlink. Sensitivity studies have been carried out using variations in the capital cost estimates of plus or minus 15% (see Section 7.4).

The NPV analysis contains anticipated/modelled projects required from 2007 onwards to address long-term supply reliability requirements. It is essential that future network development requirements are carefully analysed to ensure the impacts of proposed augmentations are properly accounted for in each option. The sensitivity of the timing of subsequent works to load growth and demand side management scenarios (and therefore the incidence of the capital expenditure) has been taken into account in the financial analysis.

(ii) Cost of Losses

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 $25/MWh[57]. Sensitivity studies have also been carried out on the assumed cost of losses (see Section 7.4).

Capital and operating costs for items which are common to all options were not included in the analysis. These common costs include the capital and operating costs of other future works, where these costs are independent of the proposed network augmentations. As such, they have no impact on the relative ranking of options resulting from the analysis.

7.3 Net Present Value Analysis

Financial analysis was carried out to calculate and compare the Net Present Value (NPV) of the costs to market participants of each option under the range of assumed market development scenarios. A fifteen year analysis period was selected, as an appropriate period for financial analysis. A discount rate of 10% was selected as a relevant commercial discount rate, and sensitivity analysis was conducted to test this assumption.

Under the Regulatory Test, it is the ranking of the options which 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.

Table 1 is a summary of the economic analysis contained in Appendix 2. It shows the net present value of each alternative, and identifies the best ranked option, for the range of scenarios considered. The summary shows that Option 2 has the lowest net present value cost under all four scenarios.

[56] In 2003/04 real dollars.

[57] Network losses are a function of the length and capacity of individual network elements, and the power being transferred through them. Additional network elements reduce the amount of power that must be forced through the existing network, and therefore reduce total losses.

Table 1 – Summary of Economic Analysis for the Four Scenarios

Discount rate 10%	**Option 1 Augmentation at 275 kV**		**Option 2 Augmentation at 110 kV**		**Option 3 Augmentation at 33 kV**	
Scenario A Medium Growth	NPV ($M)	$155.39	NPV ($M)	$128.88	NPV ($M)	$153.48
	Rank	3	Rank	1	Rank	2
Scenario B Half Growth	NPV ($M)	$124.17	NPV ($M)	$108.23	NPV ($M)	$123.88
	Rank	3	Rank	1	Rank	2
Scenario C DSM at Coorparoo	NPV ($M)	$141.56	NPV ($M)	$123.38	NPV ($M)	$144.42
	Rank	2	Rank	1	Rank	3
Scenario D High Growth	NPV ($M)	$161.54	NPV ($M)	$132.74	NPV ($M)	$156.69
	Rank	3	Rank	1	Rank	2

7.4 Sensitivity Analysis

In addition to examining the impact of market development scenarios, the sensitivity of the option ranking to other critical parameters was also examined. These critical parameters are as follows:

(i) Capital cost of network augmentation;

(ii) Cost of network losses; and

(iii) Discount rate.

The effect of varying these parameters over their credible range was investigated using standard Monte Carlo techniques.[58] Table 2 shows the parameters that were investigated in the sensitivity analysis, the distribution that was assumed for each parameter and the range of values.

Table 2 – Parameters Investigated in the Sensitivity Analysis

Parameter	Distribution
Capital Cost of Network Augmentation	The capital cost of the options was tested for sensitivity to variations of plus or minus 15% from the expected value. The variation in each cost was modelled as a triangular distribution with the assumption that the costs are statistically independent. This means that the cost of each network component is allowed to vary within plus and minus 15% independently of the overspend or underspend of the other components.
Cost of Network Losses	The sensitivity to the average cost of losses was tested by allowing this parameter to vary randomly between $20/MWh and $30/MWh using a triangular distribution with a mode of $25/MWh.
Discount Rate	The Monte Carlo analysis was repeated using discount rates of 8%, 10% and 12%.

The Monte Carlo analysis assigns a value to each of the above parameters according to its distribution and then ranks the options. This simulation is done many times (in this case, 1,000 times) to cover a large number of combinations of parameters. The analysis identifies which option

[58] Using the @Risk add-in for Microsoft Excel.

is the best ranked option (the option that has the lowest cost on an NPV basis for the largest number of samples) and gives the frequency for which this option 'wins'.

In addition to the above sensitivities, the sensitivity of the ranking of options to the discount rate assumption was also investigated by repeating the above analysis with a discount rate of 8%, 10% and 12%. Table 3 shows the 'winning option' and the frequency for which it 'wins' for each scenario and discount rate across the range of parameters assessed.

Table 3 – Results of Sensitivity Analysis for Varying Discount Rates

	Discount Rate		
	8%	**10%**	**12%**
Scenario A – Medium Growth (Base Case)	Option 2 (100%)	Option 2 (100%)	Option 2 (100%)
Scenario B – Half Growth	Option 2 (100%)	Option 2 (100%)	Option 2 (100%)
Scenario C – Coorparoo DSM	Option 2 (100%)	Option 2 (100%)	Option 2 (100%)
Scenario D – High Growth	Option 2 (100%)	Option 2 (100%)	Option 2 (100%)

As can be seen in Table 3, Option 2 is the best ranked option under all scenarios. These sensitivity analysis results are consistent with the base case economic analysis, and the outcome is robust in terms of the variations in parameters assessed.

On the basis of the financial analysis and the sensitivity studies, Option 2 is the option that satisfies the ACCC Regulatory Test.

Technical details and the construction timetable for Option 2 are provided in Appendix 1.

8 CONCLUSIONS

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

(i) Powerlink and ENERGEX must implement action now to ensure continued reliable electricity supply to the Brisbane CBD Area in 2005 and 2006, and to position Brisbane for future growth.

(ii) Such action is necessary to comply with electricity reliability standards which ENERGEX and Powerlink must meet, as the local Distribution Network Service Provider and Queensland Transmission Network Service Provider respectively. Interruptions to power supply during single network contingencies are not consistent with these reliability standards. Augmentations proposed in this document will prevent such interruptions during critical contingencies, including outages of the 110kV network supplying the CBD Area, and outages in the 33kV supply network. They are therefore 'reliability augmentations' as defined in the National Electricity Code.

(iii) ENERGEX and Powerlink carried out a consultation process in mid 2003. No feasible non-network alternatives to the 2005 and 2006 requirements were identified through this process. ENERGEX is however investigating the potential for the implementation of demand side initiatives to defer network investment beyond 2006.

(iv) Planning studies were carried out to identify network options to address the CBD Area supply requirements. Economic analysis carried out in accordance with the ACCC Regulatory Test has identified that Option 2 (Augmentation at 110kV) is the least cost solution over a fifteen year period of analysis under the majority of scenarios considered. Sensitivity analysis showed that this conclusion was robust to variation in capital cost and other assumptions.

(v) In addition to maximisation of benefit, the ACCC Regulatory Test requires that a Network Service Provider optimise the timing of any proposed network augmentation that is justified under the Regulatory Test. It is evident from the analysis that action is required prior to late 2005, with further action necessary the following year in order to maintain a reliable power supply to customers. Any deferral of timing beyond these dates will result in unacceptable network reliability.

(vi) Due to the program of works that need to be completed concurrently and the lead time required for electricity infrastructure projects, construction of the recommended augmentations is expected to begin from Quarter 2 2004. This will allow the works to be commissioned progressively from late 2005 to late 2006.

9 FINAL RECOMMENDATION

ENERGEX and Powerlink did not receive any submissions to the Application Notice. It is therefore recommended that the draft recommendation for a 'new large network asset' be adopted without change. That is, it is recommended that the following series of works be constructed to address the future supply requirements in the Brisbane CBD Area:

By late 2005:

- Re-arrange the existing Belmont to Newstead 110kV double circuit line to connect it into Murarrie substation and retension the existing line between Murarrie and Newstead;
- Establish an expanded 110kV switching station at the existing Newstead site and install two 110kV underground cables from Newstead to McLachlan Street;
- Establish a 110kV busbar at the existing McLachlan Street 33/11kV Substation and install two 60 MVA 110/11kV transformers; and
- Extend the 110kV busbar and reconfigure the 110kV network at the existing Charlotte Street Substation.

By late 2006:

- Partially relocate existing 110kV lines between Belmont and Murarrie, and establish a teed 110kV underground connection to the existing Charlotte Street Substation;
- Establish Ann Street Substation on existing site with 2 x 60 MVA 110/11kV transformers;
- Install 2 x 60 MVA 110/11kV transformers at the existing Wellington Road 33/11kV Substation; and
- Construct a double circuit 275kV line between the existing Belmont and Murarrie Substations with one 275/110kV 375MVA transformer at Murarrie – to be achieved through partial rebuild/relocation of existing 110kV lines.

The estimated total capital cost of these works is $178.5M[59] Construction is expected to begin in Quarter 2, 2004 for completion by late 2005 and late 2006 as required. Following publication of this report, ENERGEX and Powerlink intend to take immediate steps to implement the above final recommendation.

[59] $2003/04 Real

APPENDIX 1 - TECHNICAL DETAILS OF PROPOSED NEW LARGE NETWORK ASSET

Proposed Augmentations	**Anticipated Construction Start Date**	**Target Commissioning Date**	**Capital expenditure: ENERGEX ($M)**	**Capital expenditure: Powerlink ($M)**
110kV at Newstead - Construct multi-level building - Establish expanded 110kV Gas Insulated Switchgear busbar with 9 x 110kV switchbays - install new double circuit 110kV cable between Newstead and McLachlan Street Substations	Quarter 3 2004	Quarter 4 2005	21.1	
2 x 60 MVA at McLachlan Street Substation - construct multi-level building - establish 110kV Gas Insulated Switchgear busbar with 7 x110kV switchbays - 2 x 60MVA 110/11kV transformers - 4 earthing transformers - 6 x 11kV switchbays	Quarter 3 2004	Quarter 3 2005	19.7	
Extend 110kV busbar at Charlotte Street and reconfigure network - extend 110kV busbar - 4 x 110kV switchbays at Charlotte Street	Quarter 2 2004	Quarter 3 2005	6.7	
Connect existing Belmont – Newstead 110kV line into Murarrie substation - Replace 1.5km of double circuit 110kV line with two double circuit 110kV line sections - Construct 1.5km section of twin conductor double circuit 275kV line between Murarrie and existing line; connect to existing 110kV feeders - Rearrange 110kV connections to establish two additional 110kV circuits between Belmont – Murarrie and Murarrie - Newstead line - 4 x 110kV feeder bays at Murarrie - Retension existing 110kV Murarrie – Newstead line section	Quarter 2 2004	Quarter 4 2005	3.6	10.5

2 x 60MVA 110/11kV transformers at Ann Street - establish 110/11kV indoor substation at Ann Street with 110kV busbar and 8 x 110kV switchbays - 2 x 60MVA 110/11kV transformers - 4 earthing transformers - 42 x 11kV switchbays	Quarter 1 2005	Quarter 3 2006	19.1	
2 x 60MVA 110/11kV transformers at Wellington Road - construct multi-level building - establish 110/11kV busbar with 7 x 110kV switchbays - 2 x 60MVA 110/11kV transformers - 4 earthing transformers - 12 x 11kV switchbays	Quarter 2 2005	Quarter 3 2006	19.0	
110kV Belmont – Murarrie tee Charlotte Street - partial relocation of existing Belmont-Murarrie 110kV lines - construct double circuit 110kV underground connection to Charlotte Street via Wellington Road Substation - teed connection of Charlotte Street cable to Belmont – Murarrie transmission line	Quarter 1 2005	Quarter 4 2006	48.8	7.9
275kV Belmont – Murarrie and 375MVA transformer (110kV relocation) - Construct 9.3km of twin conductor double circuit 275kV line to complete Belmont – Murarrie 275kV connection - 1 x 275kV two circuit breaker diameter at Belmont - 1 x 375MVA 275/110kV transformer at Murarrie - 1 x 275kV transformer ended feeder bay at Murarrie - Upgrade 3 x 110kV feeder bays at Belmont - Partial dismantling of existing Belmont – Murarrie 110kV lines	Quarter 1 2005	Quarter 3 and 4 2006	1.0	21.1
TOTAL CAPITAL EXPENDITURE			**139.0**	**39.5**

APPENDIX 2 - FINANCIAL ANALYSIS

Summary

Discount rate 10%	**Option 1 Augmentation at 275 kV**		**Option 2 Augmentation at 110 kV**		**Option 3 Augmentation at 33 kV**	
Scenario A Medium Growth	NPV ($M)	$155.39	NPV ($M)	$128.88	NPV ($M)	$153.48
	Rank	3	Rank	1	Rank	2
Scenario B Half Growth	NPV ($M)	$124.17	NPV ($M)	$108.23	NPV ($M)	$123.88
	Rank	3	Rank	1	Rank	2
Scenario C DSM at Coorparoo	NPV ($M)	$141.56	NPV ($M)	$123.38	NPV ($M)	$144.42
	Rank	2	Rank	1	Rank	3
Scenario D High Growth	NPV ($M)	$161.54	NPV ($M)	$132.74	NPV ($M)	$156.69
	Rank	3	Rank	1	Rank	2

Development Options	FY	Capex $M	FY	Capex $M	FY	Capex $M	FY	Capex $M
	Scenario A		Scenario B		Scenario C		Scenario D	
Option 1 - Augmentation at 275 kV								
2x60 MVA 110/11 kV transformers McLachlan St	05/06	19.72	05/06	19.72	05/06	19.72	05/06	19.72
110 kV at Newstead & to McLachlan St	05/06	21.13	05/06	21.13	05/06	21.13	05/06	21.13
Extend 110 kV bus at Charlotte Street	05/06	6.74	05/06	6.74	05/06	6.74	05/06	6.74
Belmont - Newstead via Murarrie	05/06	14.13	05/06	14.13	05/06	14.13	05/06	14.13
275kV Belmont - Ann St	06/07	82.36	07/08	82.36	06/07	82.36	06/07	82.36
2x60 MVA 110/11 kV transformers Ann St	06/07	19.07	07/08	19.07	06/07	19.07	06/07	19.07
110 kV Charlotte St - Wellington Rd	06/07	14.70	07/08	14.70	06/07	14.70	06/07	14.70
2x60 MVA 110/11 kV transformers Wellington Rd (no bus)	06/07	13.71	07/08	13.71	06/07	13.71	06/07	13.71
Anticipated/modelled projects								
110 kV to Coorparoo teed from Belmont - Murarrie	07/08	29.31	09/10	29.31	11/12	29.31	07/08	29.31
2x80 MVA 110/33 kV transformers Coorparoo (no bus)	07/08	26.08	09/10	26.08	11/12	26.08	07/08	26.08
South Pine 375 MVA transformer	08/09	5.50	11/12	5.50	08/09	5.50	08/09	5.50
275kV Belmont-Murarrie & 375MVA transf (relocate 110kV)	09/10	28.94	13/14	28.94	10/11	28.94	08/09	28.94
Write off existing Belmont - Murarrie	09/10	2.27	13/14	2.27	10/11	2.27	08/09	2.27
275 kV bus at Rocklea	10/11	8.00	15/16	8.00	10/11	8.00	09/10	8.00
Upper Kedron 275/110 kV transformer	11/12	12.78	17/18	12.78	11/12	12.78	09/10	12.78
Coorparoo - Wellington Rd 110 kV with buses	12/13	14.79	19/20	14.79	12/13	14.79	10/11	14.79
Wellington Rd capacitor banks	12/13	3.00	19/20	3.00	12/13	3.00	10/11	3.00
Third Rocklea 275/110 kV transformer	13/14	8.00	21/22	8.00	13/14	8.00	10/11	8.00
Option 2 - Augmentation at 110 kV								
2x60 MVA 110/11 kV transformers McLachlan St	05/06	19.72	05/06	19.72	05/06	19.72	05/06	19.72
110 kV at Newstead & to McLachlan St	05/06	21.13	05/06	21.13	05/06	21.13	05/06	21.13
Extend 110 kV bus at Charlotte Street	05/06	6.74	05/06	6.74	05/06	6.74	05/06	6.74
Belmont - Newstead via Murarrie	05/06	14.13	05/06	14.13	05/06	14.13	05/06	14.13
2x60 MVA 110/11 kV transformers Ann St	06/07	19.07	07/08	19.07	06/07	19.07	06/07	19.07
2x60 MVA 110/11 kV transformers Wellington Rd	06/07	18.96	07/08	18.96	06/07	18.96	06/07	18.96
110 kV Belmont - Murarrie tee Charlotte St	06/07	56.72	07/08	56.72	06/07	56.72	06/07	56.72
275 kV Belmont - Murarrie & 375MVA transformer	06/07	22.07	07/08	22.07	06/07	22.07	06/07	22.07
Write off existing Belmont - Murarrie	06/07	2.27	07/08	2.27	06/07	2.27	06/07	2.27
Anticipated/modelled projects								
2x80 MVA 110/33 kV transformers Coorparoo	07/08	29.83	09/10	29.83	10/11	29.83	07/08	29.83
South Pine 375 MVA transformer	08/09	5.50	11/12	5.50	08/09	5.50	08/09	5.50
McLachlan St capacitor banks	08/09	3.00	11/12	3.00	08/09	3.00	08/09	3.00
Wellington Rd capacitor banks	10/11	3.00	15/16	3.00	10/11	3.00	09/10	3.00
275 kV bus at Rocklea	11/12	8.00	17/18	8.00	11/12	8.00	09/10	8.00

Development Options	FY	Capex $M	FY	Capex $M	FY	Capex $M	FY	Capex $M
	Scenario A		Scenario B		Scenario C		Scenario D	
Upper Kedron 275/110 kV transformer	11/12	12.78	17/18	12.78	11/12	12.78	09/10	12.78
Second Murarrie 275/110 kV transformer	12/13	8.52	19/20	8.52	13/14	8.52	10/11	8.52
Third Rocklea 275/110 kV transformer	13/14	8.00	21/22	8.00	13/14	8.00	10/11	8.00
Option 3 - Augmentation at 33 kV								
2x120 MVA 110/33kV transformers McLachlan St	05/06	32.70	05/06	32.70	05/06	32.70	05/06	32.70
110 kV at Newstead & to McLachlan St	05/06	21.13	05/06	21.13	05/06	21.13	05/06	21.13
Extend 110 kV bus at Charlotte Street	05/06	6.74	05/06	6.74	05/06	6.74	05/06	6.74
Belmont - Newstead via Murarrie	05/06	14.13	05/06	14.13	05/06	14.13	05/06	14.13
Newmarket 33 kV supply from Stafford	06/07	31.87	07/08	31.87	06/07	31.87	06/07	31.87
South Pine 375 MVA transformer	06/07	5.50	07/08	5.50	06/07	5.50	06/07	5.50
Wellington Rd 33/11 kV from Doboy & 4th Doboy transformer	06/07	36.99	07/08	36.99	06/07	36.99	06/07	36.99
4x25 MVA 33/11 kV transformers at Ann St	06/07	16.17	07/08	16.17	06/07	16.17	06/07	16.17
Anticipated/modelled projects								
Wecker Rd transformer and 33 kV to Coorparoo	07/08	21.15	09/10	21.15	11/12	21.15	07/08	21.15
Tennyson - Holland Park 33 kV cables	07/08	12.85	09/10	12.85	11/12	12.85	07/08	12.85
McLachlan St capacitor banks	07/08	3.00	09/10	3.00	07/08	3.00	07/08	3.00
110 kV Belmont - Murarrie tee Charlotte St	08/09	56.72	11/12	56.72	08/09	56.72	08/09	56.72
275 kV Belmont - Murarrie & 375MVA transformer	08/09	22.07	11/12	22.07	08/09	22.07	08/09	22.07
Write off existing Belmont - Murarrie	08/09	2.27	11/12	2.27	08/09	2.27	08/09	2.27
Upper Kedron 275/110 kV transformer	10/11	12.78	15/16	12.78	10/11	12.78	09/10	12.78
275 kV bus at Rocklea	11/12	8.00	17/18	8.00	12/13	8.00	09/10	8.00
Third Rocklea 275/110 kV transformer	12/13	8.00	19/20	8.00	13/14	8.00	10/11	8.00
Second Murarrie 275/110 kV transformer	13/14	8.52	21/22	8.52	16/17	8.52	10/11	8.52

Scenario A			*Medium Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 1			**Augmentation at 275 kV**														
2x60 MVA 110/11 kV transformers McLachlan St		19.72															
=> DUOS			0.000	0.000	2.175	2.146	2.117	2.088	2.059	2.030	2.001	1.972	1.943	1.914	1.885	1.856	1.827
==> NPV of DUOS	$11.97																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
275kV Belmont - Ann St		82.36															
=> TUOS			0.000	0.000	0.000	9.080	8.959	8.838	8.717	8.596	8.475	8.354	8.233	8.112	7.991	7.869	7.748
==> NPV of TUOS	$43.76																
2x60 MVA 110/11 kV transformers Ann St		19.07															
=> DUOS			0.000	0.000	0.000	2.103	2.075	2.047	2.019	1.991	1.963	1.935	1.907	1.878	1.850	1.822	1.794
==> NPV of DUOS	$10.13																
110 kV Charlotte St - Wellington Rd		14.70															
=> DUOS			0.000	0.000	0.000	1.621	1.599	1.577	1.556	1.534	1.513	1.491	1.469	1.448	1.426	1.405	1.383
==> NPV of DUOS	$7.81																
2x60 MVA 110/11 kV transformers Wellington Rd (no bus)		13.71															
=> DUOS			0.000	0.000	0.000	1.512	1.491	1.471	1.451	1.431	1.411	1.391	1.370	1.350	1.330	1.310	1.290
==> NPV of DUOS	$7.29																
Anticipated/modelled projects																	
110 kV to Coorparoo teed from Belmont - Murarrie		29.31															
=> DUOS			0.000	0.000	0.000	0.000	3.231	3.188	3.145	3.102	3.059	3.016	2.973	2.930	2.887	2.844	2.801
==> NPV of DUOS	$13.56																
2x80 MVA 110/33 kV transformers Coorparoo (no bus)		26.08															
=> DUOS			0.000	0.000	0.000	0.000	2.875	2.837	2.799	2.760	2.722	2.684	2.645	2.607	2.569	2.530	2.492
==> NPV of DUOS	$12.06																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534
==> NPV of TUOS	2.20																
275kV Belmont-Murarrie & 375MVA transf (relocate 110kV)		28.94															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	3.191	3.148	3.106	3.063	3.020	2.978	2.935	2.893	2.850
==> NPV of TUOS	9.91																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.000	0.000	0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	1.05																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811	0.800
==> NPV of TUOS	$2.32																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296
==> NPV of TUOS	$3.09																
Coorparoo - Wellington Rd 110 kV with buses		14.79															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.631	1.609	1.587	1.565	1.544	1.522
==> NPV of DUOS	$2.92																
Wellington Rd capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309
==> NPV of DUOS	$0.59																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835
==> NPV of TUOS	$1.26																
Relative Losses																	
* Losses $			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
=> NPV of Losses	$0.00																
Total for Option 1	**$155.39**																

Scenario A			*Medium Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 2			**Augmentation at 110 kV**														
2x60 MVA 110/11 kV transformers McLachlan St		19.72															
=> DUOS			0.000	0.000	2.175	2.146	2.117	2.088	2.059	2.030	2.001	1.972	1.943	1.914	1.885	1.856	1.827
==> NPV of DUOS	$11.97																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
2x60 MVA 110/11 kV transformers Ann St		19.07															
=> DUOS			0.000	0.000	0.000	2.103	2.075	2.047	2.019	1.991	1.963	1.935	1.907	1.878	1.850	1.822	1.794
==> NPV of DUOS	$10.13																
2x60 MVA 110/11 kV transformers Wellington Rd		18.96															
=> DUOS			0.000	0.000	0.000	2.090	2.062	2.035	2.007	1.979	1.951	1.923	1.895	1.867	1.839	1.812	1.784
==> NPV of DUOS	$10.07																
110 kV Belmont - Murarrie tee Charlotte St		56.72															
=> TUOS/DUOS			0.000	0.000	0.000	6.253	6.170	6.087	6.003	5.920	5.836	5.753	5.670	5.586	5.503	5.420	5.336
==> NPV of TUOS/DUOS	$30.14																
275 kV Belmont - Murarrie & 375MVA transformer		22.07															
=> TUOS			0.000	0.000	0.000	2.433	2.400	2.368	2.336	2.303	2.271	2.238	2.206	2.173	2.141	2.108	2.076
==> NPV of TUOS	$11.73																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	$1.30																
Anticipated/modelled projects																	
2x80 MVA 110/33 kV transformers Coorparoo		29.83															
=> DUOS			0.000	0.000	0.000	0.000	3.289	3.245	3.201	3.157	3.113	3.070	3.026	2.982	2.938	2.894	2.850
==> NPV of DUOS	$13.80																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534
==> NPV of TUOS	$2.20																
McLachlan St capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300	0.295	0.291
==> NPV of DUOS	$1.20																
Wellington Rd capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300
==> NPV of DUOS	$0.87																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811
==> NPV of TUOS	$1.93																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296
==> NPV of TUOS	$3.09																
Second Murarrie 275/110 kV transformer		8.52															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.939	0.927	0.914	0.902	0.889	0.877
==> NPV of TUOS	$1.68																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835
==> NPV of TUOS	$1.26																
Relative Losses																	
* Losses $			0.000	0.000	0.429	0.686	0.369	0.314	0.419	0.421	0.424	0.209	0.102	0.107	0.112	0.118	0.124
=> NPV of Losses	$2.03																
Total for Option 2	**$128.88**																

Scenario A			*Medium Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 3			**Augmentation at 33 kV**														
2x120 MVA 110/33kV transformers McLachlan St		32.70															
=> DUOS			0.000	0.000	3.605	3.557	3.509	3.461	3.413	3.365	3.317	3.269	3.221	3.173	3.124	3.076	3.028
==> NPV of DUOS	$19.84																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
Newmarket 33 kV supply from Stafford		31.87															
=> DUOS			0.000	0.000	0.000	3.514	3.467	3.420	3.373	3.326	3.279	3.233	3.186	3.139	3.092	3.045	2.998
==> NPV of DUOS	$16.93																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534	0.526	0.517
==> NPV of TUOS	$2.92																
Wellington Rd 33/11 kV from Doboy & 4th Doboy transformer		36.99															
=> DUOS			0.000	0.000	0.000	4.078	4.024	3.969	3.915	3.861	3.806	3.752	3.698	3.643	3.589	3.534	3.480
==> NPV of DUOS	$19.66																
4x25 MVA 33/11 kV transformers at Ann St		16.17															
=> DUOS			0.000	0.000	0.000	1.783	1.759	1.735	1.711	1.688	1.664	1.640	1.616	1.593	1.569	1.545	1.521
==> NPV of DUOS	$8.59																
Anticipated/modelled projects																	
Wecker Rd transformer and 33 kV to Coorparoo		21.15															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	2.332	2.301	2.270	2.239	2.207	2.176	2.145	2.114	2.083	2.052	2.021
==> NPV of TUOS/DUOS	$9.78																
Tennyson - Holland Park 33 kV cables		12.85															
=> DUOS			0.000	0.000	0.000	0.000	1.417	1.398	1.379	1.360	1.341	1.322	1.303	1.284	1.266	1.247	1.228
==> NPV of DUOS	$5.94																
McLachlan St capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300	0.295	0.291	0.287
==> NPV of DUOS	1.39																
110 kV Belmont - Murarrie tee Charlotte St		56.72															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	0.000	6.253	6.170	6.087	6.003	5.920	5.836	5.753	5.670	5.586	5.503
==> NPV of TUOS/DUOS	$22.67																
275 kV Belmont - Murarrie & 375MVA transformer		22.07															
=> TUOS			0.000	0.000	0.000	0.000	0.000	2.433	2.400	2.368	2.336	2.303	2.271	2.238	2.206	2.173	2.141
==> NPV of TUOS	$8.82																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.000	0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	$1.12																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296	1.277
==> NPV of TUOS	$3.70																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811
==> NPV of TUOS	$1.93																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823
==> NPV of TUOS	$1.58																
Second Murarrie 275/110 kV transformer		8.52															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.939	0.927	0.914	0.902	0.889
==> NPV of TUOS	$1.34																
Relative Losses																	
* Losses $			0.000	0.000	0.671	1.074	0.363	0.098	0.157	0.165	0.173	0.059	0.000	0.000	0.000	0.000	0.000
=> NPV of Losses	$1.77																
Total for Option 3	**$153.48**																

Scenario B			*Half Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 1			**Augmentation at 275 kV**														
2x60 MVA 110/11 kV transformers McLachlan St		19.72															
=> DUOS			0.000	0.000	2.175	2.146	2.117	2.088	2.059	2.030	2.001	1.972	1.943	1.914	1.885	1.856	1.827
==> NPV of DUOS	$11.97																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
275kV Belmont - Ann St		82.36															
=> TUOS			0.000	0.000	0.000	0.000	9.080	8.959	8.838	8.717	8.596	8.475	8.354	8.233	8.112	7.991	7.869
==> NPV of TUOS	$38.10																
2x60 MVA 110/11 kV transformers Ann St		19.07															
=> DUOS			0.000	0.000	0.000	0.000	2.103	2.075	2.047	2.019	1.991	1.963	1.935	1.907	1.878	1.850	1.822
==> NPV of DUOS	$8.82																
110 kV Charlotte St - Wellington Rd		14.70															
=> DUOS			0.000	0.000	0.000	0.000	1.621	1.599	1.577	1.556	1.534	1.513	1.491	1.469	1.448	1.426	1.405
==> NPV of DUOS	$6.80																
2x60 MVA 110/11 kV transformers Wellington Rd (no bus)		13.71															
=> DUOS			0.000	0.000	0.000	0.000	1.512	1.491	1.471	1.451	1.431	1.411	1.391	1.370	1.350	1.330	1.310
==> NPV of DUOS	$6.34																
Anticipated/modelled projects																	
110 kV to Coorparoo teed from Belmont - Murarrie		29.31															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	3.231	3.188	3.145	3.102	3.059	3.016	2.973	2.930	2.887
==> NPV of DUOS	$10.03																
2x80 MVA 110/33 kV transformers Coorparoo (no bus)		26.08															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	2.875	2.837	2.799	2.760	2.722	2.684	2.645	2.607	2.569
==> NPV of DUOS	$8.93																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558
==> NPV of TUOS	1.33																
275kV Belmont-Murarrie & 375MVA transf (relocate 110kV)		28.94															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.191	3.148	3.106	3.063	3.020
==> NPV of TUOS	4.55																
Write off existing Belmont - Murarrie		2.2741935															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	0.80																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858
==> NPV of TUOS	$0.69																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409
==> NPV of TUOS	$0.34																
Coorparoo - Wellington Rd 110 kV with buses		14.79															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of DUOS	$0.00																
Wellington Rd capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of DUOS	$0.00																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$0.00																
Relative Losses																	
* Losses $			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
=> NPV of Losses	$0.00																
Total for Option 1	**$124.17**																

Scenario B			*Half Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 2			**Augmentation at 110 kV**														
2x60 MVA 110/11 kV transformers McLachlan St		19.72															
=> DUOS			0.000	0.000	2.175	2.146	2.117	2.088	2.059	2.030	2.001	1.972	1.943	1.914	1.885	1.856	1.827
==> NPV of DUOS	$11.97																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
2x60 MVA 110/11 kV transformers Ann St		19.07															
=> DUOS			0.000	0.000	0.000	0.000	2.103	2.075	2.047	2.019	1.991	1.963	1.935	1.907	1.878	1.850	1.822
==> NPV of DUOS	$8.82																
2x60 MVA 110/11 kV transformers Wellington Rd		18.96															
=> DUOS			0.000	0.000	0.000	0.000	2.090	2.062	2.035	2.007	1.979	1.951	1.923	1.895	1.867	1.839	1.812
==> NPV of DUOS	$8.77																
110 kV Belmont - Murarrie tee Charlotte St		56.72															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	6.253	6.170	6.087	6.003	5.920	5.836	5.753	5.670	5.586	5.503	5.420
==> NPV of TUOS/DUOS	$26.24																
275 kV Belmont - Murarrie & 375MVA transformer		22.07															
=> TUOS			0.000	0.000	0.000	0.000	2.433	2.400	2.368	2.336	2.303	2.271	2.238	2.206	2.173	2.141	2.108
==> NPV of TUOS	$10.21																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	$1.21																
Anticipated/modelled projects																	
2x80 MVA 110/33 kV transformers Coorparoo		29.83															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	3.289	3.245	3.201	3.157	3.113	3.070	3.026	2.982	2.938
==> NPV of DUOS	$10.21																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558
==> NPV of TUOS	$1.33																
McLachlan St capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304
==> NPV of DUOS	$0.72																
Wellington Rd capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322
==> NPV of DUOS	$0.26																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882
==> NPV of TUOS	$0.21																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409
==> NPV of TUOS	$0.34																
Second Murarrie 275/110 kV transformer		8.52															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$0.00																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$0.00																
Relative Losses																	
* Losses $			0.000	0.000	0.000	0.429	0.665	0.697	0.731	0.380	0.206	0.317	0.377	0.422	0.451	0.425	0.417
=> NPV of Losses	$2.47																
Total for Option 2	**$108.23**																

Scenario B			*Half Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 3			**Augmentation at 33 kV**														
2x120 MVA 110/33kV transformers McLachlan St		32.70															
=> DUOS			0.000	0.000	3.605	3.557	3.509	3.461	3.413	3.365	3.317	3.269	3.221	3.173	3.124	3.076	3.028
==> NPV of DUOS	$19.84																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
Newmarket 33 kV supply from Stafford		31.87															
=> DUOS			0.000	0.000	0.000	0.000	3.514	3.467	3.420	3.373	3.326	3.279	3.233	3.186	3.139	3.092	3.045
==> NPV of DUOS	$14.74																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534	0.526
==> NPV of TUOS	$2.54																
Wellington Rd 33/11 kV from Doboy & 4th Doboy transformer		36.99															
=> DUOS			0.000	0.000	0.000	0.000	4.078	4.024	3.969	3.915	3.861	3.806	3.752	3.698	3.643	3.589	3.534
==> NPV of DUOS	$17.11																
4x25 MVA 33/11 kV transformers at Ann St		16.17															
=> DUOS			0.000	0.000	0.000	0.000	1.783	1.759	1.735	1.711	1.688	1.664	1.640	1.616	1.593	1.569	1.545
==> NPV of DUOS	$7.48																
Anticipated/modelled projects																	
Wecker Rd transformer and 33 kV to Coorparoo		21.15															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	0.000	0.000	2.332	2.301	2.270	2.239	2.207	2.176	2.145	2.114	2.083
==> NPV of TUOS/DUOS	$7.24																
Tennyson - Holland Park 33 kV cables		12.85															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	1.417	1.398	1.379	1.360	1.341	1.322	1.303	1.284	1.266
==> NPV of DUOS	$4.40																
McLachlan St capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300	0.295
==> NPV of DUOS	1.03																
110 kV Belmont - Murarrie tee Charlotte St		56.72															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.253	6.170	6.087	6.003	5.920	5.836	5.753
==> NPV of TUOS/DUOS	$13.71																
275 kV Belmont - Murarrie & 375MVA transformer		22.07															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.433	2.400	2.368	2.336	2.303	2.271	2.238
==> NPV of TUOS	$5.33																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	$0.91																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371
==> NPV of TUOS	$1.10																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882
==> NPV of TUOS	$0.21																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$0.00																
Second Murarrie 275/110 kV transformer		8.52															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$0.00																
Relative Losses																	
* Losses $			0.000	0.000	0.000	0.671	1.041	1.091	1.144	0.381	-0.011	0.098	0.154	0.158	0.162	0.166	0.170
=> NPV of Losses	$2.75																
Total for Option 3	**$123.88**																

Scenario C			DSM at Coorparoo													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			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
Option 1			**Augmentation at 275 kV**														
2x60 MVA 110/11 kV transformers McLachlan St		19.72															
=> DUOS			0.000	0.000	2.175	2.146	2.117	2.088	2.059	2.030	2.001	1.972	1.943	1.914	1.885	1.856	1.827
==> NPV of DUOS	$11.97																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
275kV Belmont - Ann St		82.36															
=> TUOS			0.000	0.000	0.000	9.080	8.959	8.838	8.717	8.596	8.475	8.354	8.233	8.112	7.991	7.869	7.748
==> NPV of TUOS	$43.76																
2x60 MVA 110/11 kV transformers Ann St		19.07															
=> DUOS			0.000	0.000	0.000	2.103	2.075	2.047	2.019	1.991	1.963	1.935	1.907	1.878	1.850	1.822	1.794
==> NPV of DUOS	$10.13																
110 kV Charlotte St - Wellington Rd		14.70															
=> DUOS			0.000	0.000	0.000	1.621	1.599	1.577	1.556	1.534	1.513	1.491	1.469	1.448	1.426	1.405	1.383
==> NPV of DUOS	$7.81																
2x60 MVA 110/11 kV transformers Wellington Rd (no bus)		13.71															
=> DUOS			0.000	0.000	0.000	1.512	1.491	1.471	1.451	1.431	1.411	1.391	1.370	1.350	1.330	1.310	1.290
==> NPV of DUOS	$7.29																
Anticipated/modelled projects																	
110 kV to Coorparoo teed from Belmont - Murarrie		29.31															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.231	3.188	3.145	3.102	3.059	3.016	2.973
==> NPV of DUOS	$7.08																
2x80 MVA 110/33 kV transformers Coorparoo (no bus)		26.08															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.875	2.837	2.799	2.760	2.722	2.684	2.645
==> NPV of DUOS	$6.30																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534
==> NPV of TUOS	2.20																
275kV Belmont-Murarrie & 375MVA transf (relocate 110kV)		28.94															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.191	3.148	3.106	3.063	3.020	2.978	2.935	2.893
==> NPV of TUOS	8.38																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.000	0.000	0.000	0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	0.98																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811	0.800
==> NPV of TUOS	$2.32																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296
==> NPV of TUOS	$3.09																
Coorparoo - Wellington Rd 110 kV with buses		14.79															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.631	1.609	1.587	1.565	1.544	1.522
==> NPV of DUOS	$2.92																
Wellington Rd capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309
==> NPV of DUOS	$0.59																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835
==> NPV of TUOS	$1.26																
Relative Losses																	
* Losses $			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
=> NPV of Losses	$0.00																
Total for Option 1	**$141.56**																

Scenario C			*DSM at Coorparoo*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 2			**Augmentation at 110 kV**														
2x60 MVA 110/11 kV transformers McLachlan St		19.72															
=> DUOS			0.000	0.000	2.175	2.146	2.117	2.088	2.059	2.030	2.001	1.972	1.943	1.914	1.885	1.856	1.827
==> NPV of DUOS	$11.97																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
2x60 MVA 110/11 kV transformers Ann St		19.07															
=> DUOS			0.000	0.000	0.000	2.103	2.075	2.047	2.019	1.991	1.963	1.935	1.907	1.878	1.850	1.822	1.794
==> NPV of DUOS	$10.13																
2x60 MVA 110/11 kV transformers Wellington Rd		18.96															
=> DUOS			0.000	0.000	0.000	2.090	2.062	2.035	2.007	1.979	1.951	1.923	1.895	1.867	1.839	1.812	1.784
==> NPV of DUOS	$10.07																
110 kV Belmont - Murarrie tee Charlotte St		56.72															
=> TUOS/DUOS			0.000	0.000	0.000	6.253	6.170	6.087	6.003	5.920	5.836	5.753	5.670	5.586	5.503	5.420	5.336
==> NPV of TUOS/DUOS	$30.14																
275 kV Belmont - Murarrie & 375MVA transformer		22.07															
=> TUOS			0.000	0.000	0.000	2.433	2.400	2.368	2.336	2.303	2.271	2.238	2.206	2.173	2.141	2.108	2.076
==> NPV of TUOS	$11.73																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	$1.30																
Anticipated/modelled projects																	
2x80 MVA 110/33 kV transformers Coorparoo		29.83															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.289	3.245	3.201	3.157	3.113	3.070	3.026	2.982
==> NPV of DUOS	$8.64																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534
==> NPV of TUOS	$2.20																
McLachlan St capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300	0.295	0.291
==> NPV of DUOS	$1.20																
Wellington Rd capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300
==> NPV of DUOS	$0.87																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811
==> NPV of TUOS	$1.93																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296
==> NPV of TUOS	$3.09																
Second Murarrie 275/110 kV transformer		8.52															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.939	0.927	0.914	0.902	0.889
==> NPV of TUOS	$1.34																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835
==> NPV of TUOS	$1.26																
Relative Losses																	
* Losses $			0.000	0.000	0.429	0.686	0.369	0.314	0.419	0.421	0.424	0.209	0.102	0.107	0.112	0.118	0.124
=> NPV of Losses	$2.03																
Total for Option 2	**$123.38**																

Scenario C			*DSM at Coorparoo*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 3			**Augmentation at 33 kV**														
2x120 MVA 110/33kV transformers McLachlan St		32.70															
=> DUOS			0.000	0.000	3.605	3.557	3.509	3.461	3.413	3.365	3.317	3.269	3.221	3.173	3.124	3.076	3.028
==> NPV of DUOS	$19.84																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
Newmarket 33 kV supply from Stafford		31.87															
=> DUOS			0.000	0.000	0.000	3.514	3.467	3.420	3.373	3.326	3.279	3.233	3.186	3.139	3.092	3.045	2.998
==> NPV of DUOS	$16.93																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534	0.526	0.517
==> NPV of TUOS	$2.92																
Wellington Rd 33/11 kV from Doboy & 4th Doboy transformer		36.99															
=> DUOS			0.000	0.000	0.000	4.078	4.024	3.969	3.915	3.861	3.806	3.752	3.698	3.643	3.589	3.534	3.480
==> NPV of DUOS	$19.66																
4x25 MVA 33/11 kV transformers at Ann St		16.17															
=> DUOS			0.000	0.000	0.000	1.783	1.759	1.735	1.711	1.688	1.664	1.640	1.616	1.593	1.569	1.545	1.521
==> NPV of DUOS	$8.59																
Anticipated/modelled projects																	
Wecker Rd transformer and 33 kV to Coorparoo		21.15															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.332	2.301	2.270	2.239	2.207	2.176	2.145
==> NPV of TUOS/DUOS	$5.11																
Tennyson - Holland Park 33 kV cables		12.85															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.417	1.398	1.379	1.360	1.341	1.322	1.303
==> NPV of DUOS	$3.11																
McLachlan St capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300	0.295	0.291	0.287
==> NPV of DUOS	1.39																
110 kV Belmont - Murarrie tee Charlotte St		56.72															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	0.000	6.253	6.170	6.087	6.003	5.920	5.836	5.753	5.670	5.586	5.503
==> NPV of TUOS/DUOS	$22.67																
275 kV Belmont - Murarrie & 375MVA transformer		22.07															
=> TUOS			0.000	0.000	0.000	0.000	0.000	2.433	2.400	2.368	2.336	2.303	2.271	2.238	2.206	2.173	2.141
==> NPV of TUOS	$8.82																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.000	0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	$1.12																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296	1.277
==> NPV of TUOS	$3.70																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823
==> NPV of TUOS	$1.58																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835
==> NPV of TUOS	$1.26																
Second Murarrie 275/110 kV transformer		8.52															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.939	0.927
==> NPV of TUOS	$0.47																
Relative Losses																	
* Losses $			0.000	0.000	0.671	1.074	0.363	0.098	0.157	0.165	0.173	0.059	0.000	0.000	0.000	0.000	0.000
=> NPV of Losses	$1.77																
Total for Option 3	**$144.42**																

Scenario D			*High Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 1			**Augmentation at 275 kV**														
2x60 MVA 110/11 kV transformers McLachlan St		19.72															
=> DUOS			0.000	0.000	2.175	2.146	2.117	2.088	2.059	2.030	2.001	1.972	1.943	1.914	1.885	1.856	1.827
==> NPV of DUOS	$11.97																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
275kV Belmont - Ann St		82.36															
=> TUOS			0.000	0.000	0.000	9.080	8.959	8.838	8.717	8.596	8.475	8.354	8.233	8.112	7.991	7.869	7.748
==> NPV of TUOS	$43.76																
2x60 MVA 110/11 kV transformers Ann St		19.07															
=> DUOS			0.000	0.000	0.000	2.103	2.075	2.047	2.019	1.991	1.963	1.935	1.907	1.878	1.850	1.822	1.794
==> NPV of DUOS	$10.13																
110 kV Charlotte St - Wellington Rd		14.70															
=> DUOS			0.000	0.000	0.000	1.621	1.599	1.577	1.556	1.534	1.513	1.491	1.469	1.448	1.426	1.405	1.383
==> NPV of DUOS	$7.81																
2x60 MVA 110/11 kV transformers Wellington Rd (no bus)		13.71															
=> DUOS			0.000	0.000	0.000	1.512	1.491	1.471	1.451	1.431	1.411	1.391	1.370	1.350	1.330	1.310	1.290
==> NPV of DUOS	$7.29																
Anticipated/modelled projects																	
110 kV to Coorparoo teed from Belmont - Murarrie		29.31															
=> DUOS			0.000	0.000	0.000	0.000	3.231	3.188	3.145	3.102	3.059	3.016	2.973	2.930	2.887	2.844	2.801
==> NPV of DUOS	$13.56																
2x80 MVA 110/33 kV transformers Coorparoo (no bus)		26.08															
=> DUOS			0.000	0.000	0.000	0.000	2.875	2.837	2.799	2.760	2.722	2.684	2.645	2.607	2.569	2.530	2.492
==> NPV of DUOS	$12.06																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534
==> NPV of TUOS	2.20																
275kV Belmont-Murarrie & 375MVA transf (relocate 110kV)		28.94															
=> TUOS			0.000	0.000	0.000	0.000	0.000	3.191	3.148	3.106	3.063	3.020	2.978	2.935	2.893	2.850	2.808
==> NPV of TUOS	11.57																
Write off existing Belmont - Murarrie		2.2741935															
=> TUOS			0.000	0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	1.12																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811	0.800	0.788
==> NPV of TUOS	$2.74																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296	1.277	1.259
==> NPV of TUOS	$4.37																
Coorparoo - Wellington Rd 110 kV with buses		14.79															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.631	1.609	1.587	1.565	1.544	1.522	1.500	1.478
==> NPV of DUOS	$4.29																
Wellington Rd capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300
==> NPV of DUOS	$0.87																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811	0.800
==> NPV of TUOS	$2.32																
Relative Losses																	
* Losses $			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
=> NPV of Losses	$0.00																
Total for Option 1	**$161.54**																

Scenario D			*High Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 2			**Augmentation at 110 kV**														
2x60 MVA 110/11 kV transformers McLachlan St		19.72															
=> DUOS			0.000	0.000	2.175	2.146	2.117	2.088	2.059	2.030	2.001	1.972	1.943	1.914	1.885	1.856	1.827
==> NPV of DUOS	$11.97																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
2x60 MVA 110/11 kV transformers Ann St		19.07															
=> DUOS			0.000	0.000	0.000	2.103	2.075	2.047	2.019	1.991	1.963	1.935	1.907	1.878	1.850	1.822	1.794
==> NPV of DUOS	$10.13																
2x60 MVA 110/11 kV transformers Wellington Rd		18.96															
=> DUOS			0.000	0.000	0.000	2.090	2.062	2.035	2.007	1.979	1.951	1.923	1.895	1.867	1.839	1.812	1.784
==> NPV of DUOS	$10.07																
110 kV Belmont - Murarrie tee Charlotte St		56.72															
=> TUOS/DUOS			0.000	0.000	0.000	6.253	6.170	6.087	6.003	5.920	5.836	5.753	5.670	5.586	5.503	5.420	5.336
==> NPV of TUOS/DUOS	$30.14																
275 kV Belmont - Murarrie & 375MVA transformer		22.07															
=> TUOS			0.000	0.000	0.000	2.433	2.400	2.368	2.336	2.303	2.271	2.238	2.206	2.173	2.141	2.108	2.076
==> NPV of TUOS	$11.73																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	$1.30																
Anticipated/modelled projects																	
2x80 MVA 110/33 kV transformers Coorparoo		29.83															
=> DUOS			0.000	0.000	0.000	0.000	3.289	3.245	3.201	3.157	3.113	3.070	3.026	2.982	2.938	2.894	2.850
==> NPV of DUOS	$13.80																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534
==> NPV of TUOS	$2.20																
McLachlan St capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300	0.295	0.291
==> NPV of DUOS	$1.20																
Wellington Rd capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300	0.295
==> NPV of DUOS	$1.03																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811	0.800	0.788
==> NPV of TUOS	$2.74																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296	1.277	1.259
==> NPV of TUOS	$4.37																
Second Murarrie 275/110 kV transformer		8.52															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.939	0.927	0.914	0.902	0.889	0.877	0.864	0.852
==> NPV of TUOS	$2.47																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811	0.800
==> NPV of TUOS	$2.32																
Relative Losses																	
* Losses $			0.000	0.000	0.429	0.686	0.369	0.362	0.435	0.213	0.105	0.108	0.111	0.113	0.116	0.119	0.122
=> NPV of Losses	$1.80																
Total for Option 2	**$132.74**																

Scenario D			*High Growth*														
			1 04/05	*2* 05/06	*3* 06/07	*4* 07/08	*5* 08/09	*6* 09/10	*7* 10/11	*8* 11/12	*9* 12/13	*10* 13/14	*11* 14/15	*12* 15/16	*13* 16/17	*14* 17/18	*15* 18/19
Option 3			**Augmentation at 33 kV**														
2x120 MVA 110/33kV transformers McLachlan St		32.70															
=> DUOS			0.000	0.000	3.605	3.557	3.509	3.461	3.413	3.365	3.317	3.269	3.221	3.173	3.124	3.076	3.028
==> NPV of DUOS	$19.84																
110 kV at Newstead & to McLachlan St		21.13															
=> DUOS			0.000	0.000	2.329	2.298	2.267	2.236	2.205	2.174	2.143	2.112	2.081	2.050	2.019	1.988	1.956
==> NPV of DUOS	$12.82																
Extend 110 kV bus at Charlotte Street		6.74															
=> DUOS			0.000	0.000	0.743	0.733	0.723	0.713	0.703	0.693	0.683	0.673	0.663	0.653	0.644	0.634	0.624
==> NPV of DUOS	$4.09																
Belmont - Newstead via Murarrie		14.13															
=> TUOS/DUOS			0.000	0.000	1.558	1.537	1.516	1.496	1.475	1.454	1.433	1.413	1.392	1.371	1.350	1.329	1.309
==> NPV of TUOS/DUOS	$8.57																
Newmarket 33 kV supply from Stafford		31.87															
=> DUOS			0.000	0.000	0.000	3.514	3.467	3.420	3.373	3.326	3.279	3.233	3.186	3.139	3.092	3.045	2.998
==> NPV of DUOS	$16.93																
South Pine 375 MVA transformer		5.50															
=> TUOS			0.000	0.000	0.000	0.606	0.598	0.590	0.582	0.574	0.566	0.558	0.550	0.542	0.534	0.526	0.517
==> NPV of TUOS	$2.92																
Wellington Rd 33/11 kV from Doboy & 4th Doboy transformer		36.99															
=> DUOS			0.000	0.000	0.000	4.078	4.024	3.969	3.915	3.861	3.806	3.752	3.698	3.643	3.589	3.534	3.480
==> NPV of DUOS	$19.66																
4x25 MVA 33/11 kV transformers at Ann St		16.17															
=> DUOS			0.000	0.000	0.000	1.783	1.759	1.735	1.711	1.688	1.664	1.640	1.616	1.593	1.569	1.545	1.521
==> NPV of DUOS	$8.59																
Anticipated/modelled projects																	
Wecker Rd transformer and 33 kV to Coorparoo		21.15															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	2.332	2.301	2.270	2.239	2.207	2.176	2.145	2.114	2.083	2.052	2.021
==> NPV of TUOS/DUOS	$9.78																
Tennyson - Holland Park 33 kV cables		12.85															
=> DUOS			0.000	0.000	0.000	0.000	1.417	1.398	1.379	1.360	1.341	1.322	1.303	1.284	1.266	1.247	1.228
==> NPV of DUOS	$5.94																
McLachlan St capacitor banks		3.00															
=> DUOS			0.000	0.000	0.000	0.000	0.331	0.326	0.322	0.318	0.313	0.309	0.304	0.300	0.295	0.291	0.287
==> NPV of DUOS	1.39																
110 kV Belmont - Murarrie tee Charlotte St		56.72															
=> TUOS/DUOS			0.000	0.000	0.000	0.000	0.000	6.253	6.170	6.087	6.003	5.920	5.836	5.753	5.670	5.586	5.503
==> NPV of TUOS/DUOS	$22.67																
275 kV Belmont - Murarrie & 375MVA transformer		22.07															
=> TUOS			0.000	0.000	0.000	0.000	0.000	2.433	2.400	2.368	2.336	2.303	2.271	2.238	2.206	2.173	2.141
==> NPV of TUOS	$8.82																
Write off existing Belmont - Murarrie		2.27															
=> TUOS			0.000	0.000	0.758	0.758	0.758	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
==> NPV of TUOS	$1.12																
Upper Kedron 275/110 kV transformer		12.78															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	1.409	1.390	1.371	1.353	1.334	1.315	1.296	1.277	1.259
==> NPV of TUOS	$4.37																
275 kV bus at Rocklea		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811	0.800	0.788
==> NPV of TUOS	$2.74																
Third Rocklea 275/110 kV transformer		8.00															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.882	0.870	0.858	0.847	0.835	0.823	0.811	0.800
==> NPV of TUOS	$2.32																
Second Murarrie 275/110 kV transformer		8.52															
=> TUOS			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.939	0.927	0.914	0.902	0.889	0.877	0.864	0.852
==> NPV of TUOS	$2.47																
Relative Losses																	
* Losses $			0.000	0.000	0.671	1.074	0.363	0.103	0.171	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000
=> NPV of Losses	$1.64																
Total for Option 3	**$156.69**																