

**PROPOSED NEW LARGE NETWORK ASSET  
ADELAIDE CENTRAL REGION  
SOUTH AUSTRALIA**

**APPLICATION NOTICE**

ElectraNet Pty Ltd  
(ABN 41 094 482 416)

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## EXECUTIVE SUMMARY

### Discussion

ElectraNet's transmission service responsibilities in Adelaide's central business district are soon to be significantly affected by increased reliability and security of supply obligations. Those revised obligations are contained in the July 2008 edition of the South Australian Electricity Transmission Code (ETC) that is issued by the Essential Services Commission of South Australia (ESCOSA) on a five-yearly basis.

In those revised ETC standards, that will take effect from 1<sup>st</sup> July 2008, ESCOSA defines a new region that specifically and intentionally targets the main business and commercial centre of Adelaide. This region is assigned a higher level of supply reliability and security than was previously afforded it in order to better-reflect its commercial and business significance to the State. The new region has been named 'Adelaide Central', and has been defined as "that area of Adelaide which is located east of West Terrace, north of South Terrace, west of East Terrace, and south of the River Torrens". It is referred to in the new ETC as a Category 6 load.

For that new load category, ElectraNet is required to provide N-1 transmission line capacity and must have constructed, commissioned, and have commercially available, a new substation that is located to the west of King William Street, and that is capable, in conjunction with the existing East Terrace substation, of providing N-1 transformer capacity into Adelaide Central for at least 100% of the agreed maximum demand of that newly-defined region on a continuous basis, by 31 December 2011.

ElectraNet's immediate response to the requirement of the July 2008 ETC was to locate a suitable site on the western side of the Adelaide central business district on which to construct the new substation. The location of the substation site was a critical variable that had to be determined and secured in order to simplify the identification of options that would facilitate connection to the existing transmission network. Nineteen potential parcels of land were identified, and that number was subsequently reduced to three following more thorough investigation.

ElectraNet then set out to confirm the availability and cost of each of the three sites, and conducted a high-level estimate to determine the relative cost of constructing a substation of identical capacity at each location. The results of those estimates enabled the three sites to be compared from a financial perspective, and despite being the most expensive parcel of land of the three, the site to the south-west of the Adelaide Central region proved comprehensively to be the least-expensive option when the costs of establishing the necessary infrastructure and constructing the substation at that site were included, thus satisfying the underlying principal of the Regulatory Test for reliability augmentations as promulgated by the Australian Energy Regulator.

Both ETSA Utilities and ESCOSA were approached to seek their opinion on the suitability of the site; ESCOSA from a Code-compliance perspective, and ETSA Utilities from a technical perspective. Both gave their support for its purchase. ETSA Utilities confirmed that it would be able to readily establish a 66kV switchyard, using gas insulated switchgear (GIS), on a portion of the City West site and install three 160MV.A capacity 66kV underground cables from that switchyard to connect the new substation to ETSA Utilities' 66kV Adelaide Central network (which would also necessitate the upgrading of the four ETSA Utilities-owned 66/11kV substations that supply the CBD to enable that additional capacity to be fully utilised). ETSA also identified opportunities for the future installation of additional -275/66kV transformers at City West for the purpose of providing additional 66kV injection into its adjacent southern and western suburbs networks, proving the site to be strategically ideal for ETSA Utilities' current and future needs.

Given the central location of the site, ElectraNet identified four points on its transmission network from which supply to the new substation could relatively easily be provided; ElectraNet's 275kV switchyard, to the north-west, adjacent Torrens Island Power Station (TIPS), and ElectraNet's 275/66kV substations at Kilburn, to the north, Magill, to the east, and Happy Valley, to the south. East Terrace substation could not be considered since it is supplied radially out of Magill substation and would not therefore comply with the N-1 transmission line requirement of the July 2008 ETC, as mentioned earlier.

Magill and Happy Valley were ruled out based simply on cost, since both required extensive deep-network augmentation in addition to the cost of the connection between either of those locations and the new "City West" substation in order for them to be viable alternatives. The two remaining locations were then analysed in more detail, and are discussed at length in Section 6.2.3 of this report. The results of that analysis identified supply from TIPS as the more technically and economically superior point of 275kV supply for the new substation.

### Recommendation

As a consequence of the requirements contained in the July 2008 ETC, and the subsequent investigations, analyses and considerations that followed, this Application Notice recommends the implementation of Option 1, namely:

- The construction adjacent the south-west extremity of the Adelaide Central region of a 275/66kV substation comprising one 300 MV.A transformer and associated infrastructure, plant and 275kV switchgear. Provision will also be made to install a 300 MV.A transformer for a planned additional connection point into the southern suburbs 66kV network. The substation is designed for an ultimate layout of 6 x 300 MV.A transformers, 1 phase shifter and 3 x 275 kV cable entries;
- The establishment of a 275kV transmission connection rated at 900 MV.A continuous cyclic rating from TIPS 275 kV switchyard to supply that new substation; and
- The establishment by ETSA Utilities of a 66kV GIS switchyard, the installation of three 160MV.A capacity 66kV underground cables from that switchyard to connect the new substation to ETSA Utilities' 66kV CBD network, and the upgrading of the four ETSA Utilities-owned 66/11kV substations that supply the CBD to enable that additional capacity to be utilised;

to augment the transmission and sub-transmission networks in the Adelaide Central region to the standards required by the ETC. The total estimated capital cost of the project is \$236m; \$189m for ElectraNet's portion of the augmentation, and \$47m for the work that ETSA Utilities will be required to perform in order to connect the new substation into the existing Adelaide Central 66kV network. This cost excludes the cost for the additional transformer and associated infrastructure that will be installed at City West for the purpose of reinforcing the southern suburbs 66kV network. Costs are based on 2007 dollar values and *do not* take into account escalations in those costs that may occur during the intervening period to 31 December 2011. Furthermore, those costs assume that both the ElectraNet and ETSA Utilities substations are co-located on the same site.

ElectraNet invites submissions from Registered Participants and interested parties regarding this Application Notice. The closing date for submissions is 27<sup>th</sup> February 2008.

## 1. Introduction

Legislated changes contained in the South Australian Electricity Transmission Code that will take effect from 1 July 2008 will significantly affect the level of electricity supply reliability requirements that ElectraNet has in Adelaide's central business district.

As a direct consequence of those revised ETC standards, a new load category; Category 6, 'Adelaide Central'; has been created, with the intention of distinguishing the main commercial and business area of Adelaide from the surrounding semi-residential and residential areas. Adelaide Central has been defined in that July 2008 ETC as *"that area east of West Terrace, north of South Terrace, west of East Terrace, and south of the River Torrens"*. For the new load category, ElectraNet will be required to provide N-1 transformer and N-1 transmission line capacity into Adelaide Central for at least 100% of agreed maximum demand (AMD) on a continuous basis by means of independent and diverse transmission substations which must be commissioned and commercially available by 31<sup>st</sup> December 2011, one of which must be located west of King William Street. Those criteria have been imposed to guard against common-mode failure of both the existing East Terrace Substation, that presently supplies the majority of the Adelaide central business district (CBD) load, and the new substation that ElectraNet must establish and have commercially available by the end of 2011. The ETC also states that ElectraNet must have sufficient spare transformer availability such that those new reliability standards continue to be met in the event of failure of either of the two transformers that would then be supplying that region.

The remaining choices available to ElectraNet in relation to the final make-up of the Adelaide Central augmentation were the composition of the new substation, its physical location within the confines of the ETC requirements, and from where the new substation was to obtain its 275 kV supply.

Since ElectraNet, as a Transmission Network Service Provider (TNSP), in consultation with ETSA Utilities, is proposing to establish new large network assets with a capital value in excess of \$10m in order to address the ETC requirements, it is required to issue an 'Application Notice' under clause 5.6.6 of the National Electricity Rules (NER, or Rules). The Application Notice must contain information regarding:

- the reasons the augmentation is required, including, if relevant, why it is considered a 'reliability augmentation', as defined in the NER;
- feasible options available to address the future supply requirements, including non-network alternatives;
- the recommended solution, including the timetable for implementation; and
- why the solution satisfies the Regulatory Test prescribed by the AER.

This document contains a description of the works that ElectraNet and ETSA Utilities will cooperatively undertake to meet the reliability of electricity supply obligations for the Adelaide Central region. The proposed works contained in this report are based on:

- the prescriptive reinforcement obligations required of ElectraNet by ESCOSA, as contained in the July 2008 ETC;
- the public consultation undertaken jointly by ElectraNet and ETSA Utilities by way of the publication of an RFI/RFP, issued in October 2006, to identify potential non-network options to address those increased reliability-of-supply requirements; and
- the analysis of feasible transmission network options in accordance with the Regulatory Test.

The option that ElectraNet, in close consultation with ETSA Utilities, is recommending, minimises the present value (PV) of the costs to Registered Participants in the National Electricity Market (NEM) while meeting the reliability standards in the NER, the July 2008 ETC, and the Electricity Distribution Code (EDC). It will enable ElectraNet to fulfil its obligation to ensure a reliable supply during single-network contingencies at the least cost to the market and therefore to end-use customers.

In addition, this solution creates an alternative supply point option for both the southern and western suburbs, thus ensuring maximum asset utilisation through the sharing of common infrastructure.

## 2. Background: electricity supply system

### 2.1 Geographic Area

Adelaide's CBD and the north eastern suburbs are grouped together and defined as a Category 5 load in the prevailing July 2003 ETC. That combined load is supplied by the Dry Creek East, East Terrace, Magill and Northfield group of connection points, and includes the Adelaide CBD, North Adelaide, and the suburbs of Linden Park, Burnside, Kent Town, Norwood, Magill, Campbelltown, Prospect, Northfield, Ingle Farm, Modbury, Golden Grove, Tea Tree Gully, and Holden Hill, among others. The geographic area is shown in Figure 1.

As of the 1<sup>st</sup> of July 2008, the date from which the July 2008 ETC will take effect, that load area will be divided into two regions as discussed. The new load area, which will be known as the "Adelaide Central region", has been assigned a new, increased level of reliability, referred to as Category 6. The remaining portion of the existing Category 5 load area will retain its present categorisation. The geographical bounds of the existing Category 5 load that will become the new Category 6 load region are shown in Figure 2.



Figure 1: Approximate geographic boundary of the Category 5 load area as defined in the presiding July 2003 ETC.





Figure 2: The Adelaide Central region as defined in the July 2008 ETC.

## 2.2 Existing supply arrangements

Primary supply to the CBD and the north eastern suburbs is presently provided by ElectraNet's East Terrace, Magill, Dry Creek East and Northfield 275/66 kV substations. A 66 kV sub-transmission system that is operated by ETSA Utilities and that comprises an interconnected 66 kV system, then reticulates electricity throughout the region via numerous ETSA Utilities 66/11kV, 66/33kV and 33/11kV substations.

East Terrace, Magill, Dry Creek East and Northfield substations are presently grouped together to form a single connection point for the purposes of the current ETC service standards, with the load classified as a Category 5 load. That means that, for that Category 5 load, there is presently a requirement for ElectraNet to have sufficient transmission line and transformer capacity installed to be able to continuously supply the total forecast load of that region with any single item of transmission plant out of service (N-1), and to supply all of the CBD and a given percentage of the remaining load with two independent items of transmission plant out of service (N-2). Under those standards, ElectraNet, with reliance on support from ETSA Utilities' interconnected 66kV network, has sufficient transmission infrastructure installed to meet its obligations for some time into the future.

The overall arrangement of the near Metropolitan 275 kV transmission system is shown in Figure 3, and the configuration of ETSA Utilities' 66 kV and 33 kV distribution networks is shown in Figure 4.

## 2.3 Committed Network Developments

Neither ElectraNet nor ETSA Utilities are aware of any proposal to establish, and have commissioned by 31 December 2011, a new substation to the west of King William Street that would, in conjunction with the existing East Terrace substation, be capable of providing N-1 transformer capacity into Adelaide Central for at least 100% of the agreed maximum demand of that newly-defined region on a continuous basis. Nor are they aware of any committed network developments that will provide continuous N-1 transmission line capacity for that same load area.

## 2.4 Existing and committed generation facilities and demand side management

Although there is an increasing presence of small embedded generation (in particular, wind and solar generation) in the CBD in response to Government initiatives to make Adelaide a more environmentally friendly city, the level of that generation is presently not sufficient to offer a viable solution to the increased reliability requirements that must be provided for the Adelaide Central load region.

Furthermore, since there are no existing generation facilities of significant capacity within a radius of about five kilometres of the Adelaide CBD, it is ElectraNet's and ETSA Utilities' joint opinion that a new generation facility in close proximity to the Adelaide Central region would not gain Development Approval nor public support given that it would have to be of sufficient scale (of the order of 250MW) to supply the entire Adelaide Central load and be available instantaneously in the event that either the Magill-East Terrace 275kV cable or the East Terrace 275/66kV transformer fail.

Due to the commercial nature of the load, which is reflected in the daily electricity usage for the Adelaide Central region (at a maximum during office hours and then falling away sharply outside of those hours), demand side management, or the disconnection of customers under predetermined agreements between those customers and the supplier at times of peak load when a contingency occurs, does not represent a practical method of achieving Code compliance. Nor does it align with the intent of the Code change that ESCOSA has made in the interests of improving the reliability of supply to the central business district of Adelaide.

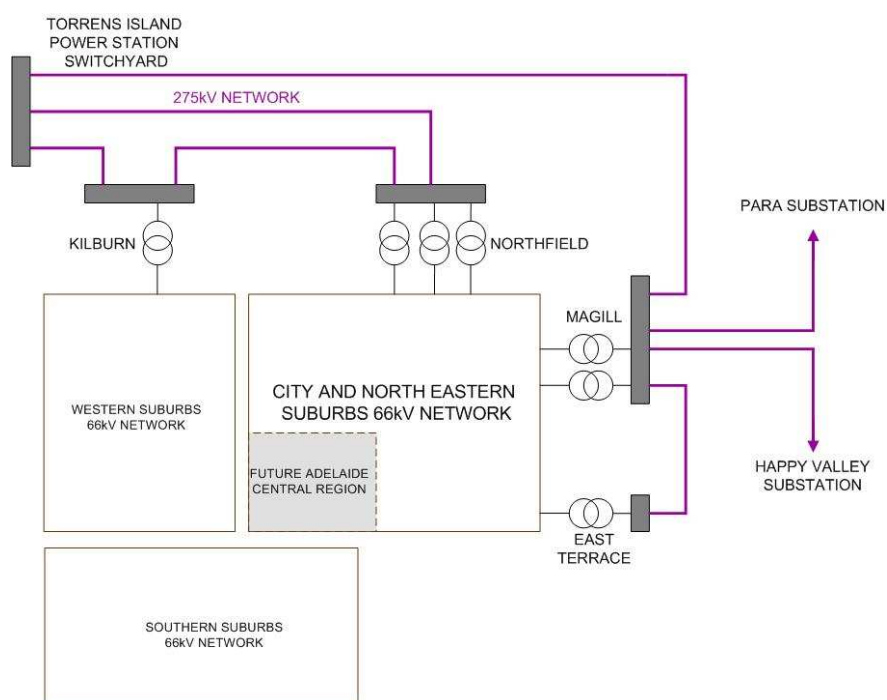


Figure 3: Near Metropolitan 275kV Supply System

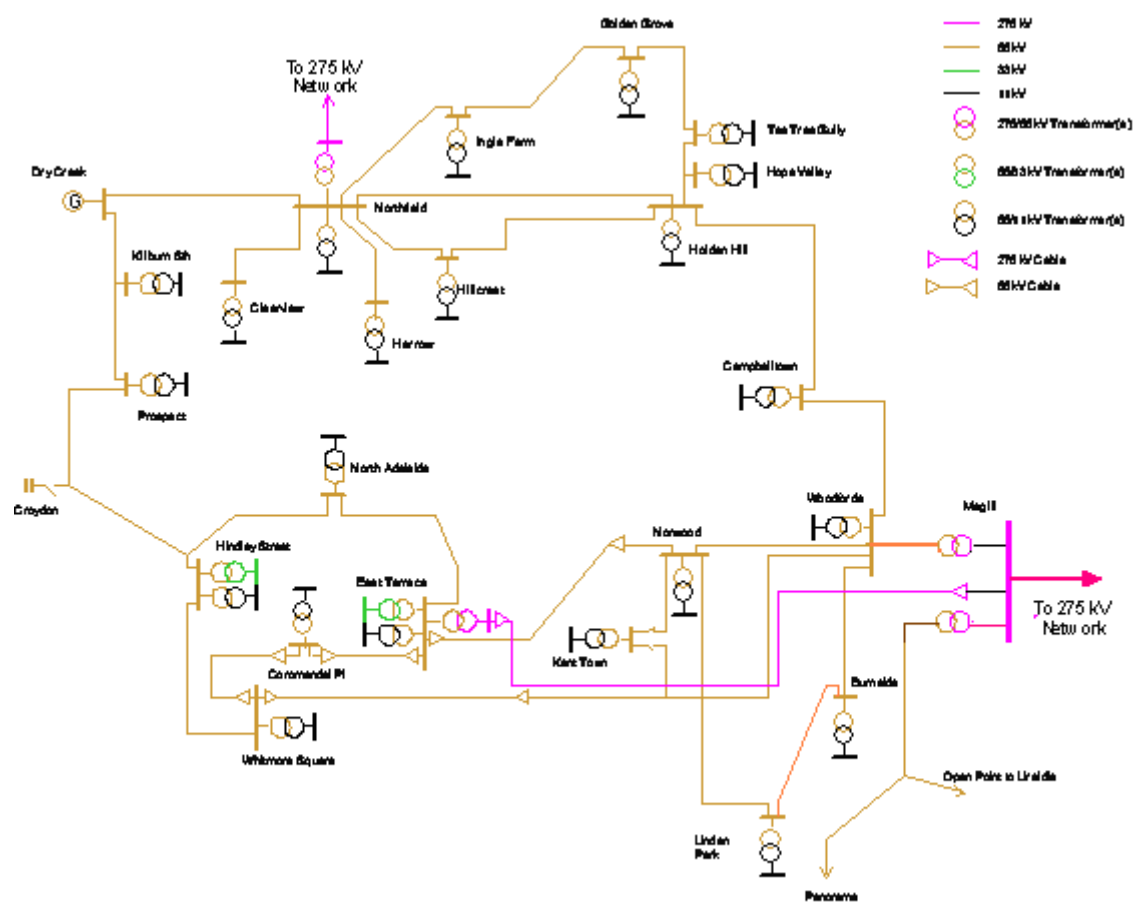


Figure 4: Existing arrangement of ETSA Utilities' 66 kV network for the North Eastern suburbs and Adelaide Central load areas

### 3 Background: electricity demand

#### 3.1 Overview

The demand forecasts that underpin the recommendations of this Application Notice are consistent with the ten-year demand and energy forecasts published in ElectraNet's 2007 Annual Planning Review and the ESIPC's 2007 Annual Planning Report.

Electricity demand forecasts over a ten-year period are obtained from ETSA Utilities and customers at each connection point in ElectraNet's transmission system. Those forecasts take account of demand-side management programmes in-place and foreseen by ETSA Utilities, and embedded generation which may have the effect of reducing the forecast demand to be supplied via each transmission connection point.

#### 3.2 Load forecast

The growth in electrical load in a region is dependent on many variables, including economic growth, housing and commercial development, industrial growth, spot-load increases that occur in response to local requirements, and environmental conditions (predominantly weather conditions). In the case of the Adelaide Central region, much of the load comprises office and commercial tenancy, with a significant component of that load attributable to air-conditioning and heating of those premises. However, in recent years developers have increasingly introduced high density apartment-style accommodation to the region.

The combined load forecast for the Adelaide CBD and north eastern suburbs for the coming 10-year period has been provided by ETSA Utilities to ElectraNet. A subsequent forecast for the newly-defined Adelaide Central region has also been provided. Both of those forecasts are shown in Table 1. The forecast summer peak demand is based on medium growth, hot weather, and excludes transmission losses and generator auxiliary loads.

CONNECTION POINT		06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
CBD and North-Eastern suburbs	MW	763	783	805	827	850	873	897	921	947	973	999
	MV.A	803	824	847	871	895	919	944	969	997	1024	1052
Adelaide Central	MW	221	226	231	236	242	247	253	259	264	271	277
	MV.A	233	238	243	248	255	260	266	273	278	285	292

*Table 1*

*Forecast summer peak demand for both the Adelaide CBD and north eastern suburbs region, and the "Adelaide Central" load region (medium economic growth)*

### 3.3 Pattern of use

Peak demand in the Adelaide Central region is experienced during the 'office hours' of a normal working weekday in summer, and is driven by high temperatures and the resulting high air conditioning loads, the increasing reliance on computers and associated hardware, as well as the growing density of offices and urban living.

As can be seen in Figure 5, summer weekday electricity demand in the Adelaide Central region remains high throughout the day, with a significant drop in demand during evening and night-time hours. Electricity demand during the weekends falls away markedly due to the closure of many offices.

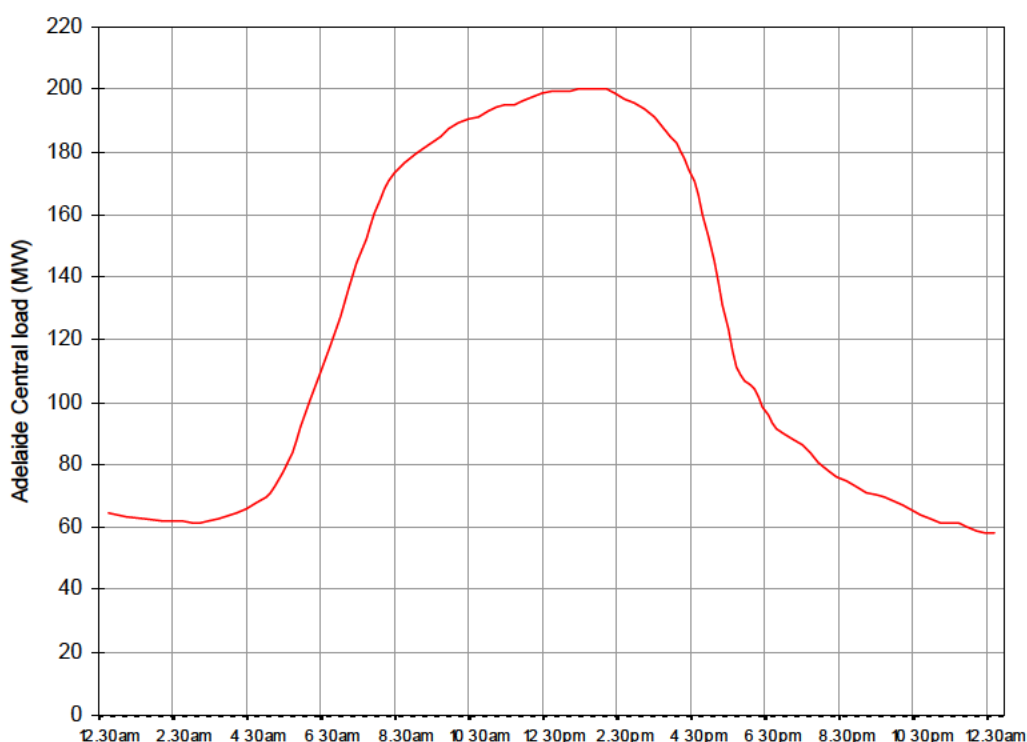


Figure 5: Adelaide Central Daily Load Curve – peak summer day  
Monday 5<sup>th</sup> February 2007

## 4 Adelaide Central Service Obligations

As a TNSP operating in the South Australian jurisdiction of the NEM, ElectraNet is bound by the service obligations of the NER and the ETC. Similarly, ETSA Utilities, as a Distribution Network Service Provider (DNSP), is bound by the service obligations of the NER and the EDC. Those Codes place differing obligations on ElectraNet and ETSA Utilities, with the Rules focussing on power system security and quality of supply, and the ETC and EDC concentrating on supply reliability at individual connection points.

### 4.1 National Electricity Rules

As mentioned previously in this report, the July 2008 ETC specifically states that ElectraNet must, after 31 December 2011, provide N-1 transmission line and N-1 transformer capacity into Adelaide Central for at least 100% of agreed maximum demand, and must provide that capacity on a continuous basis by means of independent and diverse transmission substations. That directive aligns with the intent of Schedule 5.1.2.1 of the NER, '*Credible contingency events*', that states, in part, that ElectraNet, as a Network Service Provider, must plan, design, maintain, and operate its transmission network to allow the transfer of power from generating units to customers with all facilities or equipment associated with the power system in service, and "*may be required by a Registered Participant under a connection agreement to continue to allow the transfer of power with certain facilities or plant associated with the power system out of service*"; that is, under N-1 conditions.

### 4.2 South Australian Electricity Transmission Code

ElectraNet is also bound by the service obligations of the ETC. The ETC focuses primarily on supply reliability at individual connection points. The following relevant service standards are contained in the ETC.

#### *Clause 2.1 Quality of supply and system reliability*

##### 2.1.1 Quality of supply

*A transmission entity shall use its best endeavours to plan, develop and operate the transmission network to meet the standards imposed by the National Electricity Rules in relation to the quality of transmission services such that there will be no requirements to shed load to achieve these standards under normal and reasonably foreseeable operating conditions.*

##### 2.1.2 System reliability

*A transmission entity shall use its best endeavours to plan, develop and operate the transmission system so as to meet the standards imposed by the National Electricity Rules in relation to transmission network reliability such that there will be minimal requirements to shed load under normal and reasonably foreseeable operating conditions.*

The ETC also assigns reliability standards for each connection (exit) point or group of connection points within the transmission network and thereby imposes specific requirements on ElectraNet for planning and developing its transmission network. The ETC includes additional obligations with regard to response times, spares holdings, and reporting requirements. The following provides a summary of ElectraNet's service obligations for the Adelaide Central region based on the ETC requirements that will apply from 1 July 2008 (refer Clause 2.10 of the July 2008 ETC).



Until 31<sup>st</sup> December 2011, ElectraNet must...

- not contract for an amount of agreed maximum demand greater than 100% of installed transmission line or equivalent transformer capacity; and
- provide transmission line capacity and equivalent transformer capacity for at least 100% of agreed maximum demand.

After 31<sup>st</sup> December 2011, ElectraNet must...

- provide N-1 transmission line and transformer capacity into Adelaide Central for at least 100% of agreed maximum demand; and
- provide that transmission line and transformer capacity “on a continuous basis by means of independent and diverse transmission substations (which must be commissioned and commercially available), one of which must be located west of King William Street”;
- use its best endeavours to restore contracted transmission line capacity within 4 hours of an interruption; and
- in the event of a transformer failure, use its best endeavours to repair the installed transformer or install a replacement transformer as soon as possible so as to minimise the likelihood of an interruption as a result of the failure of the other transformer also supplying the Adelaide Central region.

In addition, after 31<sup>st</sup> December 2011, ElectraNet must...

- in the event that agreed maximum demand into Adelaide Central exceeds the line capacity or transformer capacity standards specified above, use its best endeavours to ensure that the line capacity or transformer capacity into Adelaide Central meets the required standards in 12 months, and in any case, within 3 years.

The July 2008 ETC can be viewed in its entirety at the following website:

<http://www.escosa.sa.gov.au/webdata/resources/files/060906-R-ElecTransCodeET05.pdf>

## 5 Projected Network Limitations

As an integral part of their charter as TNSPs and DNSPs, ElectraNet and ETSA Utilities are continually ensuring that their transmission and distribution networks meet the service obligations of the NER, the ETC, and the EDC.

Prior to publication of the July 2008 ETC, ElectraNet had identified the need for additional transformer capacity into the CBD and north eastern suburbs regions in order that the level of supply reliability to that region be maintained in the event of failure of the existing East Terrace 275/66kV transformer, in accordance with the standards documented in the July 2003 ETC. However, ElectraNet has recently examined the possibility of cyclically rating the East Terrace transformer, and following further investigations, has confirmed that the transformer can be loaded to about 280MV.A under emergency conditions, rather than the 225MV.A nameplate limit that had previously been applied<sup>1</sup>. That increased rating has consequently had the effect of deferring the need for that reinforcement for several years to about 2014/15.

With consideration for the importance of the load in central Adelaide, and in line with world trends, ESCOSA has independently deemed it necessary to significantly increase supply reliability to Adelaide's commercial and business centre by 31 December 2011, and is using the July 2008 ETC as the vehicle with which to implement the required augmentation. However, in recent times the world demand for plant and equipment has increased significantly, and this has translated into much longer lead-times on the delivery of transformers, power cables and switchgear. Considering the aforementioned, ElectraNet is mindful that any other such factors, which are outside of the control of ElectraNet, may adversely affect ElectraNet's ability to achieve the stipulated completion date of 31<sup>st</sup> December 2011.

From the above discussion, the projected limitation commonly identified by ElectraNet, ESCOSA, and the ESIPC, is the reliability of supply to the main commercial and business centre of Adelaide. Consequently, since the reason for this project is the need to increase the reliability of the electricity supply to the Adelaide Central region, ElectraNet considers the augmentation recommended in this report to be a "reliability augmentation", and has accordingly assessed using the Regulatory Test for reliability augmentations, as promulgated by the AER.

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<sup>1</sup> The revised rating is based on an ambient temperature of 45°C, a hot-spot temperature of 130°C, and an overload period of eight hours. Those revised inputs give the transformer summer normal and emergency cyclic ratings of 250MV.A and 270MV.A ratings respectively.



## 6 Options considered

### 6.1 Non-network options

ESCOSA's requirement for ElectraNet to augment the electricity supply to the Adelaide Central region, as communicated in the 1 July 2008 ETC (published in July 2006), clearly puts the onus on ElectraNet to implement the necessary transmission augmentation to achieve the increased level of supply reliability required by that ETC, and therefore did not actively pursue nor consider any non-network solutions. Rather, ElectraNet and ETSA Utilities jointly issued a Request for Information / Request for Proposals (RFI/RFP) paper in October 2006 that discussed the need to augment the transmission network that supplies Adelaide's central business district, and that invited submissions from Registered Participants and interested parties with regard to the identified network limitations. However, no submissions were received in response to that report. That paper, titled "Projected Network Limitations, Adelaide Central Region, South Australia", can be viewed at:

[http://www.electranet.com.au/images/pdfs/public\\_consultation/CBDRFI\\_RFP.pdf](http://www.electranet.com.au/images/pdfs/public_consultation/CBDRFI_RFP.pdf)

Notwithstanding the absence of submissions in response to that initial RFP/RFI, should a non-network service provider believe that it is able to provide a superior non-network solution to the network solution proposed by ElectraNet in this Application Notice, this Application Notice affords that entity a further opportunity to make such a submission. Any such submission must be received by ElectraNet within the time-frame stipulated in section 12 of this document, and must clearly demonstrate that their alternative proposal is credible, transparent, economically viable, technically feasible, and able to be implemented, commissioned, and commercially available by 31<sup>st</sup> December 2011.

### 6.2 Transmission Network options

#### 6.2.1 Transmission substation site selection

ElectraNet recognised that the location of the substation site was a critical variable that had to be determined and secured in order to simplify the identification of options that would facilitate connection to the existing transmission network. Accordingly, ElectraNet immediately commenced a comprehensive search for available land that was of specific minimum size, location, and of appropriate land-use zoning. ElectraNet simultaneously advertised in the local news-paper to ensure that a thorough land search was conducted. Altogether nineteen (19) potential parcels of land were identified, and following thorough research of those sites, that number was reduced to three. ElectraNet's assessment of the nineteen sites was based on considerations such as the complexity of the substation design for each site, their proximity to residential and commercial buildings, existing infrastructure, access and finally, the strategic benefits which may be derived from that specific location (i.e. their proximity to the Adelaide Central, Southern Inner Metropolitan, and western inner metropolitan 66kV supply areas). Major considerations when assessing each site were the likelihood of acceptance by key stakeholders of the proposed construction and of gaining development approval at the specific location.

ElectraNet then proceeded to confirm the availability and cost of each of the three sites, and conducted a high-level estimate to determine the relative cost of constructing an appropriately designed substation of identical capacity at each location (for instance, whether the substation had to be multi-story or single-story, what facades would be required, land-contamination constraints, and so on). The results of the comparison of the sites that was then able to be made are provided below, with each of the three sites expressed as a percentage of the least-cost option. As can be seen from those results, the site to the south-west of the Adelaide Central region proved comprehensively to be the least-cost option when the cost of constructing a substation and establishing the infrastructure required for each of the sites was included.

- a) City south-west (area  $\pm 20,000\text{m}^2$ ) - cost factor 100%
- b) Inner City (area  $\pm 2,000\text{m}^2$ ) - comparable cost factor 129%
- c) City north-west (area  $\pm 4,900\text{m}^2$ ) - comparable cost factor 132%

ETSA Utilities was then invited to provide its opinion on the suitability of each of the three sites. ETSA Utilities declared that it was in favour of the least cost site that ElectraNet had identified over the other two sites since it had the additional benefit to ETSA Utilities of enabling it to provide future additional 66kV injection into its neighbouring southern and western metropolitan 66kV networks. The main drivers for these additional injection points are briefly described below.

*For the southern suburbs 66kV sub transmission network...*

- In 2011/12 the existing 275/66kV transformers, that are located in the southern reaches of the southern suburbs 66kV network at Happy Valley and Morphett Vale East, will overload and trip under a single-transformer contingency of one of those transformers at times of high load; and
- Similarly, in 2011/12, 66kV sub-transmission lines in the northern portion of the southern suburbs 66kV network will overload in the event of a single contingency on the 66kV network.

To eliminate those limitations, ETSA Utilities has informed ElectraNet that it will formally request that ElectraNet install a 300MV.A 275/66kV transformer that injects into the northern portion of the southern suburbs 66kV network, notionally at the proposed City West substation since this is ideally sited to eliminate both the connection point limitation and the 66kV sub transmission overloads. However, ETSA Utilities' request is highly dependent on City West substation being commissioned and operational by the summer of 2011/12. Should City West not be available by that date, ElectraNet would be obliged to provide an alternative 275kV point of supply to a new substation that would be dedicated to providing additional 66kV injection into the southern metropolitan 66kV network.

*And, for the western suburbs 66kV sub transmission network...*

- Supply to the western suburbs 66kV network is presently supplied by 275/66kV connection points at Kilburn, LeFevre and TIPS, in the northern extremities of that region. In 2016/17 the western suburbs connection point transformer capacity will be exceeded in the event of failure of one of the existing 275/66kV transformers supplying that 66kV sub transmission network, and, as for the southern suburbs network, sub transmission lines in both the northern and southern portions of that network will overload under 66kV line contingencies.

To eliminate those limitations, ETSA Utilities has informed ElectraNet that it proposes to request that ElectraNet install a 300MV.A 275/66kV transformer that injects into the southern portion of the western suburbs 66kV network, again, notionally at the proposed City West substation since, as with the transformer that would be dedicated to the southern suburbs network, City West is ideally located to enable the proposed western suburbs transformer to eliminate both the connection point limitation and the 66kV sub transmission overloads.

It must be stressed, however, that because the installation of a second transformer at City West substation is specifically for the purpose of providing an additional injection into ETSA Utilities' southern suburbs 66kV network, any costs related to that augmentation will be excluded from the financial analysis and considerations of the Adelaide Central augmentation since they are not costs that have been incurred as crucial elements of establishing the new point of supply to the Adelaide Central region. Similarly, costs incurred

in installing at City West substation a third transformer to provide an additional injection point into the western suburbs 66kV network in 2016/17, are not attributable to the establishment of City West substation, and consequently have been excluded from the present-value cost analysis of the various options considered.

Having gained the support of ETSA Utilities for the proposed site of the new substation, ESCOSA was approached to seek its opinion on the location of the proposed site, specifically in light of the requirements specified in the 1 July 2008 ETC. ESCOSA was supportive of the site, and confirmed that it complies with the locational requirements as stated in the ETC.

Furnished with the support of those two major stakeholders, ElectraNet subsequently entered into negotiations with the owner and has now secured the land.

The site for the new substation is located in relatively close proximity to the south-western extremity of the newly defined Adelaide Central load region, but still within the larger Adelaide Metro Area, and is ideally located and of sufficient size to enable ETSA Utilities to provide additional 66kV connections to its southern and western 66 kV networks from that site. The design of the substation and the rating of plant have been undertaken with those possible expansions in mind, but care has been taken to attribute to the Adelaide Central project only those costs specifically associated with achieving the increase in supply reliability to the Adelaide Central region as required by the July 2008 ETC.

#### 6.2.2 Transmission substation – initial & anticipated ultimate composition

Based on load-flow studies covering the fifteen years following commissioning of City West substation, it is envisaged that City West will ultimately comprise three 275kV cable bays (two cables to TIPS, and one to East Terrace substation), one phase-shifting transformer, and six 300MV.A 275/66kV transformers, as follows:

- Two transformers dedicated to the supply of the Adelaide Central region (the Adelaide Central load is forecast to exceed the summer emergency cyclic rating of the initial Adelaide Central transformer, in the event of failure of the East Terrace transformer, in about 2025/26);
- Two transformers providing supply to ETSA Utilities' southern suburbs 66kV network (the installed transformer capacity supplying the southern suburbs under single contingency will be exceeded in about 2020/21);
- One transformer dedicated to supplying ETSA Utilities' western suburbs 66kV network (the western suburbs load will exceed the single-contingency capacity of the transformers supplying that region in about 2027/28); and
- One spare transformer.

Allowance has also been made for one phase-shifting transformer to enable supply to the Adelaide Central load to be proportionally shared between East Terrace and City West substations on the basis of their installed transformer capacities.

The Richmond Road site has an area of about 22,000m<sup>2</sup>, and although of an irregular shape, has sufficient area to house both ElectraNet's and ETSA Utilities' infrastructure requirements required of that ultimate layout, provided that gas insulated switchgear is used. However, should air insulated switchgear be opted for, the considerable increase in land needed to accommodate the required infrastructure would severely limit the ultimate configuration of the substation, and would likely necessitate the establishment of additional substations in the area in the future to house one or more of those additional transformers discussed above.

One possible site layout is shown in Figure 6, with a single-line diagram of the likely ultimate layout of City West substation shown in Figure 7. A high-level scope of works for the initial development of City West is shown in red/brown in Figure 7, and will comprise the following:

- ◆ The establishment of the site and associated infrastructure;
- ◆ The installation of:
  - 1 x standard 275kV double bus transformer feeder;
  - 1 x standard 275kV double bus line feeder;
  - 1 x standard 275kV double bus coupler;
  - 2 x standard 275kV double bus sections, but excluding
    - 1 x circuit breaker
    - 2 x current transformer
    - 1 x disconnector
    - 2 x earth switches on one side; and
- ◆ The establishment of 1 x 66kV GIS switchyard.

Conceptual investigations indicate that the 275kV connection between TIPS and City West substation will comprise between three and five kilometres of overhead line out of TIPS, having a minimum rating of 926MV.A, with the remainder of the route to City West comprising underground cable that will have a continuous rating of 700MV.A and a cyclic rating of 900MV.A. The cable's 700MV.A rating is a minimum rating, and is based on forecast loads and daily load profiles of both the southern and western suburbs load areas, as well as that of the Adelaide Central region, for the fifteen-year period following commissioning of the new substation. However, the final cable size as well as the cable-to-overhead ratio will be determined in the detailed scope development that will be conducted in the next phase of the project.

Due to the capacitive nature of the cable, a significant amount of reactive power will be introduced into the transmission network at times of light load. Initial studies have indicated that 2 x 50Mvar 275kV reactors will be required to limit transmission voltages during those times of light load, and that those reactors ideally be placed at Para substation to provide maximum benefit to the wider network during those periods. However, the final location of those reactors will be investigated in more detail in the next phase of the project.

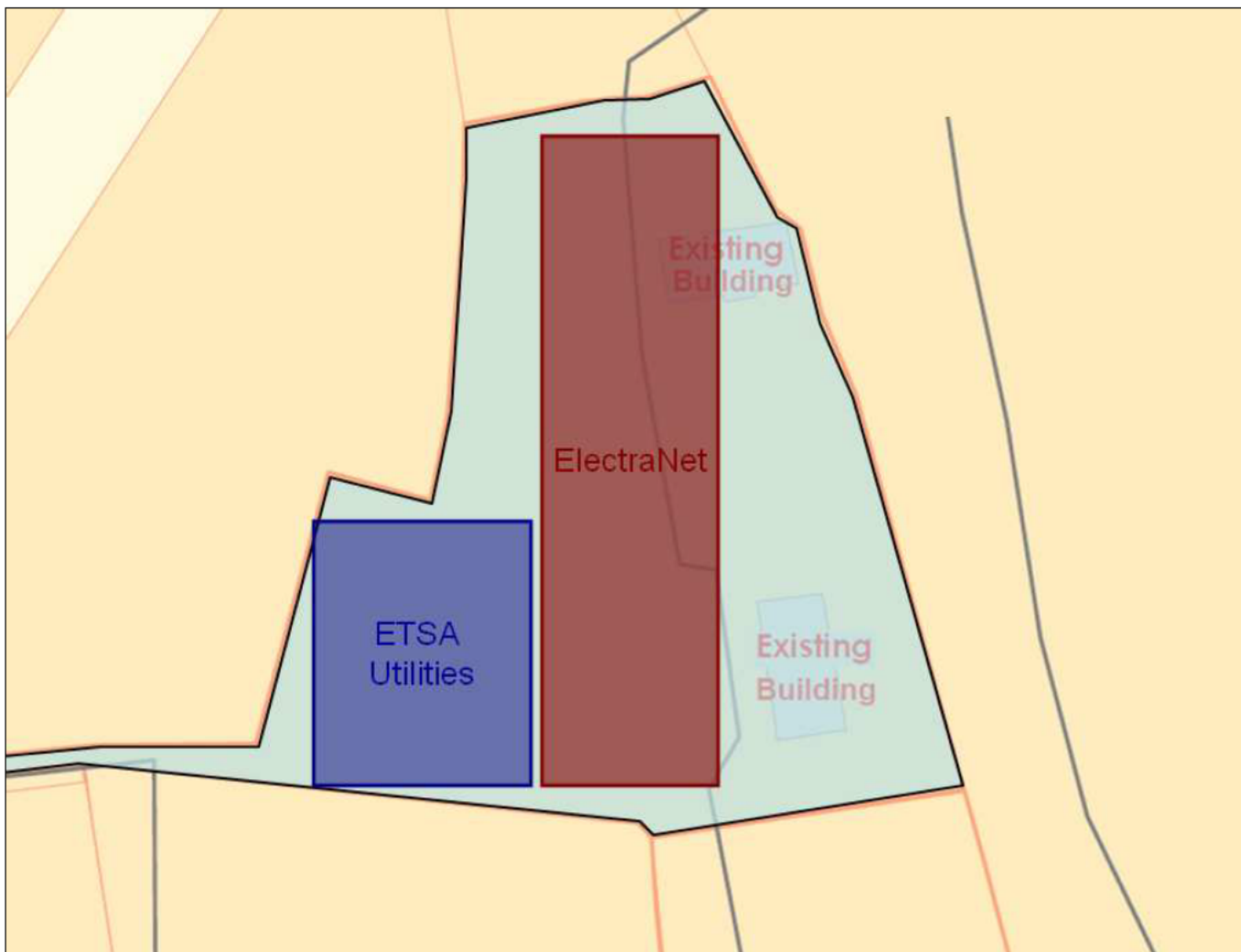


Figure 6: Proposed location of ElectraNet's and ETSA Utilities' infrastructure at the City West site  
(actual physical layout to be determined during phase 2 investigation)

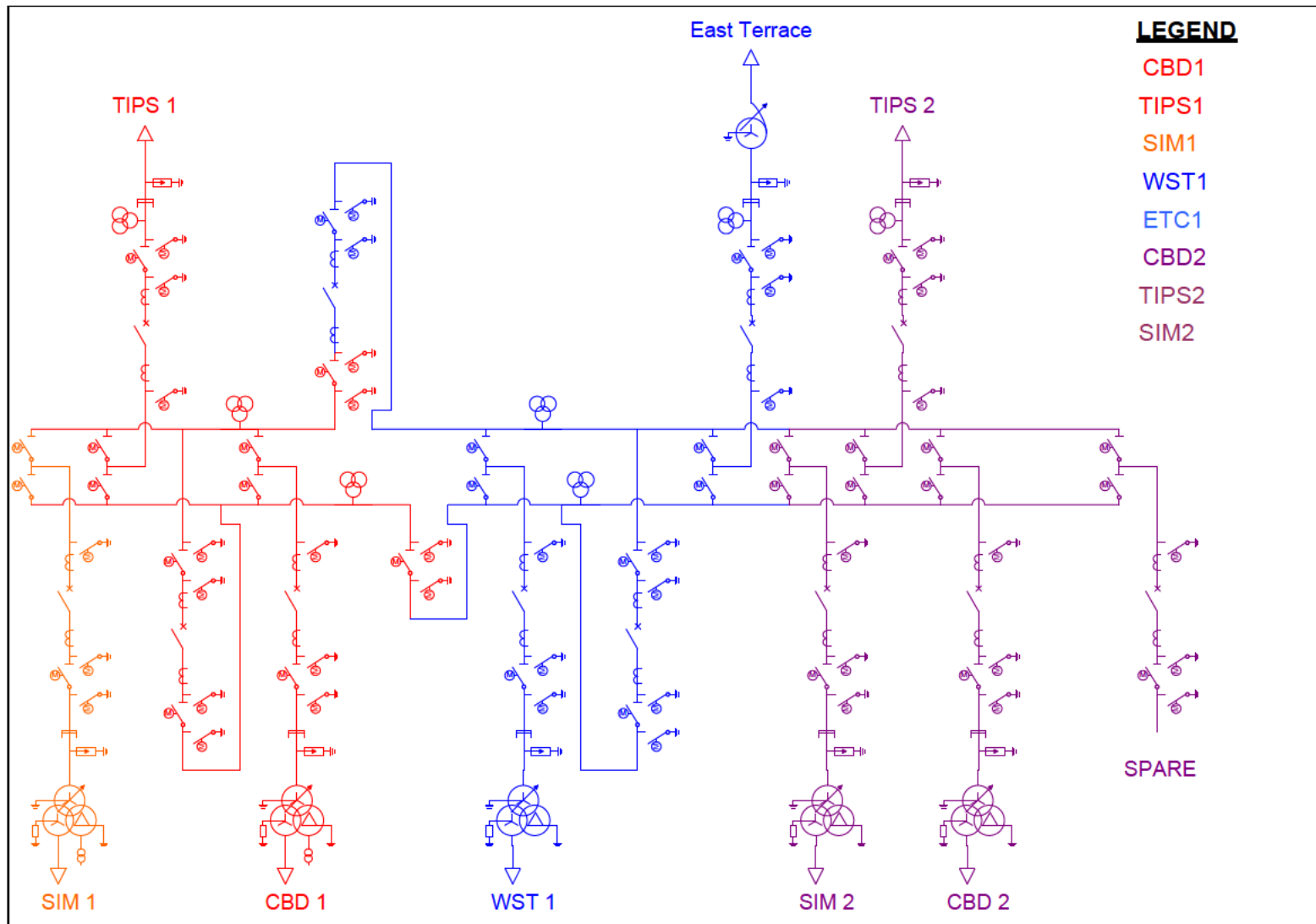


Figure 7: Anticipated ultimate configuration of City West substation

### 6.2.3 Transmission connection options

ElectraNet then had to decide on the best means of supplying the new substation. Four sources of 275kV supply were readily identified. They were:

- TIPS switchyard, to the north-west;
- Kilburn, to the north;
- Magill, to the east; or
- Happy Valley, to the south.

Those four alternatives are shown schematically in Figure 8.

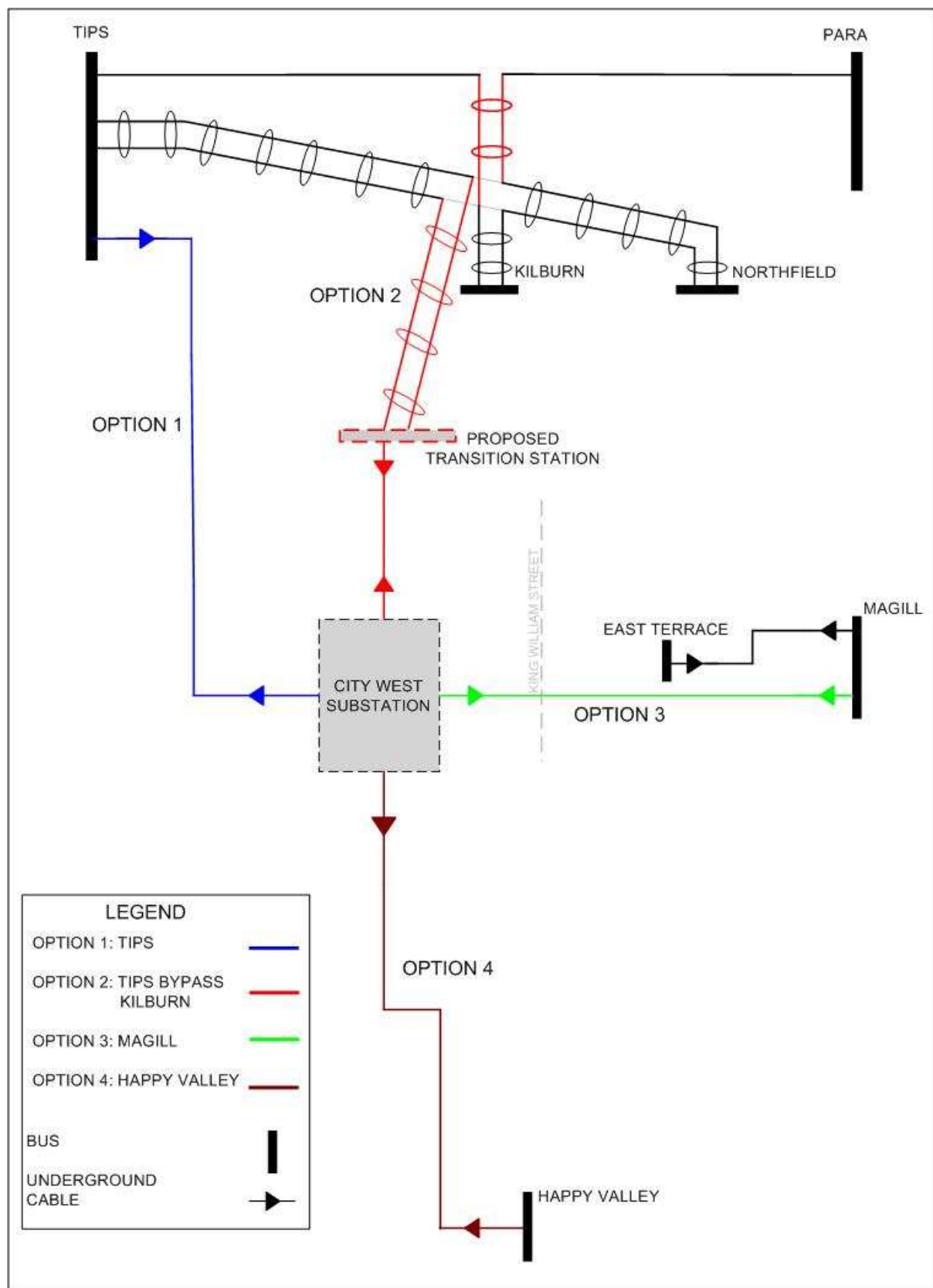


Figure 8: Four 275kV supply alternatives to City West substation



Given that the cost to purchase the land and establish City West substation would be common to all four transmission network solutions that ElectraNet had identified, the component that would have most bearing on which alternative would be selected was the cost of providing 275kV supply to the substation. Further analysis of the four alternatives revealed that supplying City West from either Happy Valley or Magill substations would not only involve the obvious costs of establishing the 275kV connection between Happy Valley or Magill, and the new substation, but also substantial reinforcement of the transmission network behind those two substations, costing in the order of \$90m for Happy Valley (\$30m to create another circuit between Cherry Gardens and Happy Valley, and \$60m to increase the rating of the Para to Magill line), and \$60m for Magill (to increase the rating of the Para to Magill line). Those additional 'deep network' augmentation costs resulted in the overall cost of the Happy Valley and Magill options rising to more than 160% and 120%, respectively, of that of the lowest cost option. The extent of the price difference of implementing either of those two options was deemed sufficiently large to not consider them further. The TIPS and Kilburn options then remained.

The Kilburn option was then examined in more detail. Kilburn and Northfield substations are supplied from TIPS via a TIPS-Kilburn-Northfield-TIPS 275kV loop. The rating of each of those lines is 674MV.A, and the Kilburn 275kV bus, that forms part of that loop, is rated at 1600A, or 760MV.A. Consequently, the maximum combined load of Northfield, Kilburn, and the load on the cable to City West substation, must be limited to 674MV.A. That load level will be realised in 2015/16, and would necessitate the up-rating of those lines to a higher rating. That would be achieved by stringing a second conductor per phase in each line segment, and with the additional mechanical loading that the second conductor would place on the line structures, a significant number of those structures have been identified as needing to be replaced. The estimated cost of that work is \$50m. Shortly after rebuilding those lines, the Kilburn 275kV bus would become the limiting element in the loop, and would require the rebuilding of a substantial portion of Kilburn substation, at an estimated cost of \$30m. Even with the deferral of those additional costs for as long as is technically viable, their inclusion in the overall cash-flow analysis of the Kilburn alternative caused the gap in the PV cost between it and the TIPS alternative to widen dramatically, giving ElectraNet reason to investigate variations on the initial TIPS proposal of cabling all the way from TIPS to City West.

Supply from TIPS switchyard was then considered in greater detail, and an overhead corridor that would likely gain Development Approval for at least part of the route was identified. That alternative was subsequently costed and, involving no deeper network augmentation, as with the direct TIPS-City West cable alternative, proved to be a far more cost effective solution than the Kilburn alternative in terms of present value cost and, as a result, became the contender to the TIPS-direct solution. Those two methods of providing supply to City West proved convincingly to be the two highest-ranked alternatives, and consequently, establishing City West substation on the site to the south-west of the Adelaide Central region and supplying it either directly from TIPS via underground cable or indirectly from TIPS via a combination of overhead line and underground cable became the two preferred options. ElectraNet then proceeded to analyse those two options in greater detail, as discussed below.

#### 6.2.3.1 Option 1 – “TIPS – Direct (cable)”

This option proposes supplying City West substation directly from TIPS switchyard via a 700MV.A 275kV underground cable, a route length of about 18 kilometres. Costs used in the financial analysis of this option are based on using underground cable for the entire route between TIPS and City West substation. However, ElectraNet will still endeavour to use overhead construction for as much of the route out of TIPS as Development Approval, within the required timeframe, will allow, in order to reduce the overall cost of this option. It should also be noted that the actual route that the connection between TIPS and City West will take has not yet been determined. The 18 kilometre route-length that has been used in costing the TIPS-City West connection has been derived by averaging the various potential traffic routes between TIPS and City West along which that connection may possibly be permitted. ElectraNet will work in close consultation with local councils, relevant government bodies, residents, and businesses, in determining the best compromise for the final route.

A brief description of the initial works required to establish City West substation, as well as anticipated future works that will be required for the Adelaide Central region during the fifteen-year period following the commissioning of that substation, is given in Table 2, and a schematic representation of Option 1 is provided in Figure 9.

The size, or rating, of the 275kV cable that ElectraNet intends to install (700MV.A) to supply the new City West substation is being proposed for two reasons, as discussed below.

Firstly, the size was originally identified on technical grounds. A brief account of that analysis follows.

Given the ideal location of City West substation to supply not only the newly-defined Adelaide Central region, but also the southern and western metropolitan 66kV networks, the future growth in those two additional regions was also considered, and the prospect of eventually splitting the rapidly-expanding southern suburbs region into two separate regions; a north portion and a south portion; was examined. It was concluded that, should this occur, the northern portion would require two transformers of about 300MV.A each to adequately supply that region under (N-1) conditions for the foreseeable future (fifteen years and beyond).

Similarly, the western suburbs 66kV network, which is now supplied from Kilburn, TIPS, and LeFevre 275/66kV substations, will require additional 66kV injection possibly by as early as 2016/17. A single 300MV.A 275/66kV transformer would be adequate for that 15-year planning period from 2011/12.

Just outside of the 15-year period from 2011/12, the Adelaide Central region will require yet another transformer to satisfy the ETC's continuous (N-1) transformer requirement.

Consequently, ElectraNet's analysis has enabled it to conclude that City West substation will, in all likelihood, ultimately comprise five 300MV.A 275/66kV transformers; two dedicated to the Adelaide Central region, two to the southern suburbs 66kV network, and one to the western suburbs 66kV network.

The increasing number of transformers at City West as time progresses will by necessity have to be accompanied by augmentation of the transmission network supplying that substation. ElectraNet's studies have identified that the ultimate configuration of the transmission network supplying the Adelaide Central region would most likely comprise two 275kV 700MV.A cables from TIPS to City West, and a 450MV.A 275kV cable tying City West to East Terrace substations. That configuration provides a total transmission network capacity of 1850MV.A to supply the ultimate installed transformer capacity at City West of 1800MV.A (5 x 360MV.A emergency cyclic rating).

Secondly, from an economic perspective, the cost of a 700MV.A cable is of the order of 15% to 20% more than that of a 450MV.A cable (this difference lies mainly in the cable procurement costs – installation and reinstatement costs are similar for either cable). Should

a 450MV.A cable be opted-for in preference to 700MV.A cables, a second 450MV.A cable would have to be installed, albeit about five years later, to match the capacity that the larger cable would provide. Taking that into consideration, financial analysis demonstrates that 700MV.A cables provide the present value least-cost solution. Given that small incremental increase in cost, and when considered in the context of the significant overall cost of purchasing and installing the cable, ElectraNet believes that its decision is both a prudent investment decision, and one that ensures alignment with the intent and requirements of Clause 5.6.2 of the NER (planning period) and Clause 5.1.1 of the ETC ET/05 ("Good electricity industry practice"). From a Regulatory perspective, the additional cost of the larger cable does not alter the ranking of the options as determined by application of the Regulatory Test<sup>2</sup>.

Furthermore, it is important to note that the thermal characteristics of an underground cable are significantly different from those of an overhead transmission line, and as a consequence, a cable with a normal continuous rating of around 700 MVA can be effectively matched to an overhead line with a rating of 926 MVA.

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<sup>2</sup> In section 9.1 of this Application Notice, the robustness of the ranking of the options is tested by varying key inputs, one being the cost of only the cable for each option. In that sensitivity analysis, the cable cost has been varied by 20% above and 20% below the estimated cost (an amount greater than the 15% to 20% cost difference between a 700MV.A cable and a 450MV.A cable, as discussed above). Despite those variations, it is demonstrated that Option 1 remains the least present value cost option on application of the Regulatory Test. Those results are provided in Table 4 of that section.

Option 1 – City West supplied from TIPS 275kV switchyard via an underground cable		
<u>Date required</u>	<u>Proposed Augmentation</u>	<u>Total capital cost</u>
31 December 2011	<p>Establish a substation at the recently-acquired site in the vicinity of the south-west extremity of the Adelaide Central region comprising one 300MV.A 275/66kV transformer dedicated to augmenting the transformer capacity supplying the Adelaide Central region, in accordance with the ESCOSA's requirement;</p> <p>Establish a 700MV.A 275kV connection directly between TIPS 275kV switchyard and City West substation, a route length of about 18 kilometres, via an underground cable; and</p> <p>The establishment by ETSA Utilities of a 66kV GIS switchyard on a portion of the City West site, the installation of three 160MV.A capacity 66kV underground cables from that switchyard to connect the new substation to ETSA Utilities' 66kV CBD network, and the upgrading of the four ETSA Utilities-owned 66/11kV substations that supply the CBD to enable that additional capacity to be utilised.</p> <p>Install a 300MV.A 275/66kV transformer at City West substation dedicated to supplying ETSA Utilities' southern suburbs 66kV sub transmission network.</p>	<p>\$189m (ElectraNet)</p> <p>\$47m (ETSA Utilities)</p>
2015/16	<p>Install a second 225MV.A 275/66kV transformer at East Terrace substation; and</p> <p>The establishment by ETSA Utilities of a 66kV cable from East Terrace substation to ETSA Utilities' 66/11kV Hindley Street substation.</p>	<p>(\$20m*) (ElectraNet)</p> <p>\$25m (ElectraNet)</p> <p>\$20m (ETSA Utilities)</p>
2016/17	<p>Install a 300MV.A 275/66kV transformer at City West substation dedicated to supplying ETSA Utilities' western suburbs 66kV sub transmission network.</p>	<p>( \$20m* ) (ElectraNet)</p>

*Table 2*

*Option 1: "TIPS – Direct, cable": capital works required*

\* The costs associated with plant and equipment that is proposed to be installed at City West substation as part of the proposed southern and western suburbs augmentations have been excluded from the financial analysis of the various Adelaide Central augmentation options that have been considered to ensure that those Adelaide Central options are compared equally.

The decision to install a 700MV.A cable right from the onset, rather than a 450MV.A cable, which would, in conjunction with East Terrace substation, have sufficient capacity to supply the Adelaide Central load for a considerable period into the future, was based on the supply requirements of not only the Adelaide Central region, but also of the southern and western suburbs supply areas.

ETSA Utilities has studied its southern metropolitan 66kV supply network and determined that it will require a new 275/66kV supply point into that network by 2011/12 in order to avoid overloading both the transformers that presently supply that region and the 66kV sub-transmission lines in the southern reaches of that network, under contingency conditions. Three supply options were identified, one being the creation of a new connection point at ElectraNet's proposed City West substation. Subsequent application by ETSA Utilities and ElectraNet of the Regulatory Test demonstrated that establishing that new injection point at City West represented the least present-value cost solution for market participants, and pending no superior solutions in response to ETSA Utilities Evaluation Report RFP-ER 003/04, "Electricity Supply to the Southern Inner Metropolitan Region of Adelaide", that discusses their proposal, ETSA Utilities will officially request of ElectraNet that ElectraNet establish a new 275/66kV supply point into ETSA Utilities' southern suburbs 66kV network at City West substation. That report can be viewed on ETSA Utilities' website, a link to which is provided below.

<http://www.etsautilities.com.au/default.jsp?xcid=873>

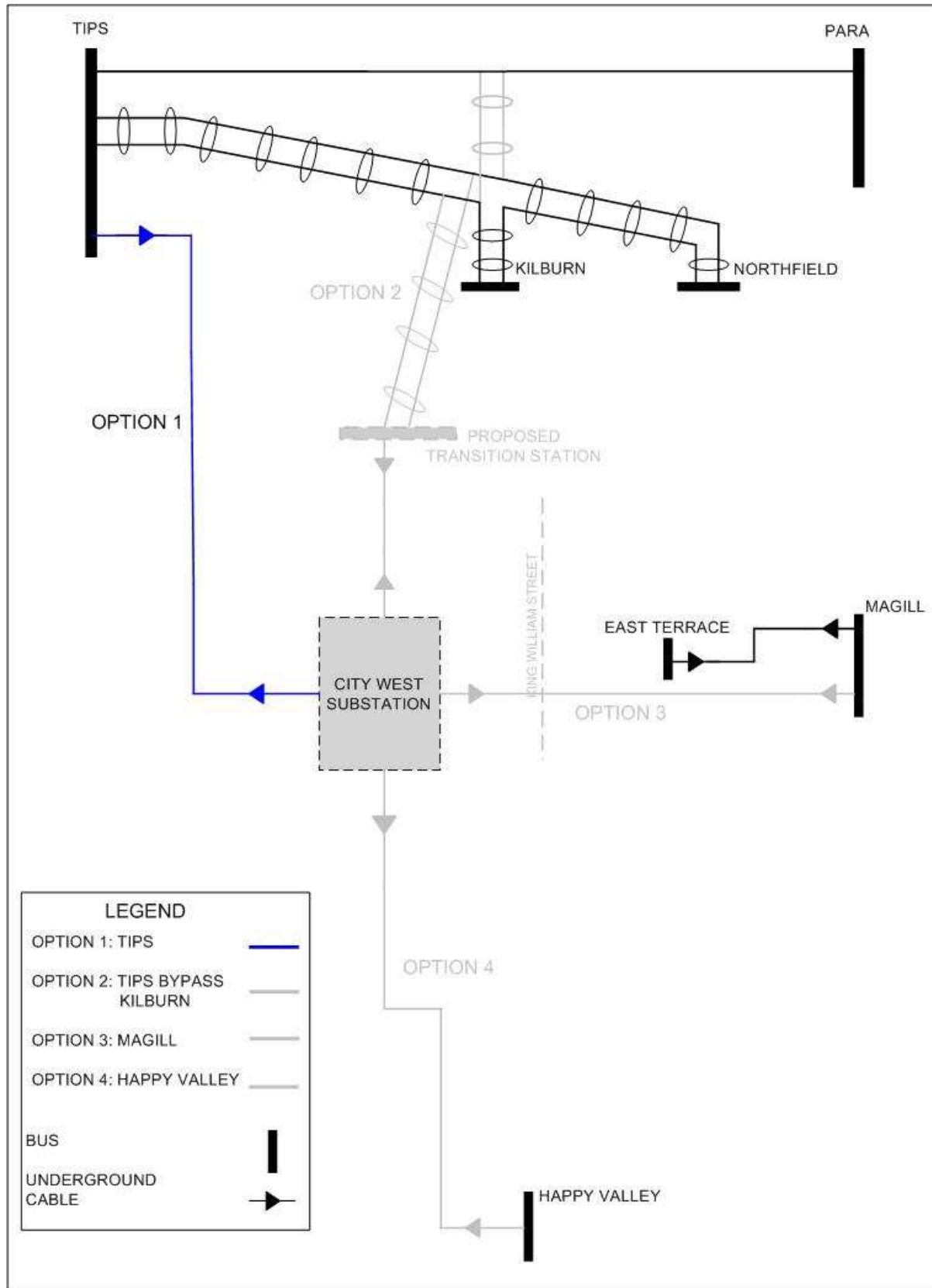


Figure 9

Option 1: City West supplied directly from TIPS 275kV switchyard ... "TIPS - Direct"

### 6.2.3.2 Option 1a – “TIPS – Direct (overhead)”

This option is identical to Option 1 in that it proposes to supply the City West substation directly from TIPS switchyard with an entirely new circuit; the difference being that this Option proposes the construction of an overhead 275kV line for as much of the route as possible, as opposed to an underground 275kV cable all the way. The overhead line would be rated at 926 MV.A as are other 275kV overhead lines in the vicinity, and will match the capacity of the cable, which has a minimum cyclic continuous rating of 900 MV.A.

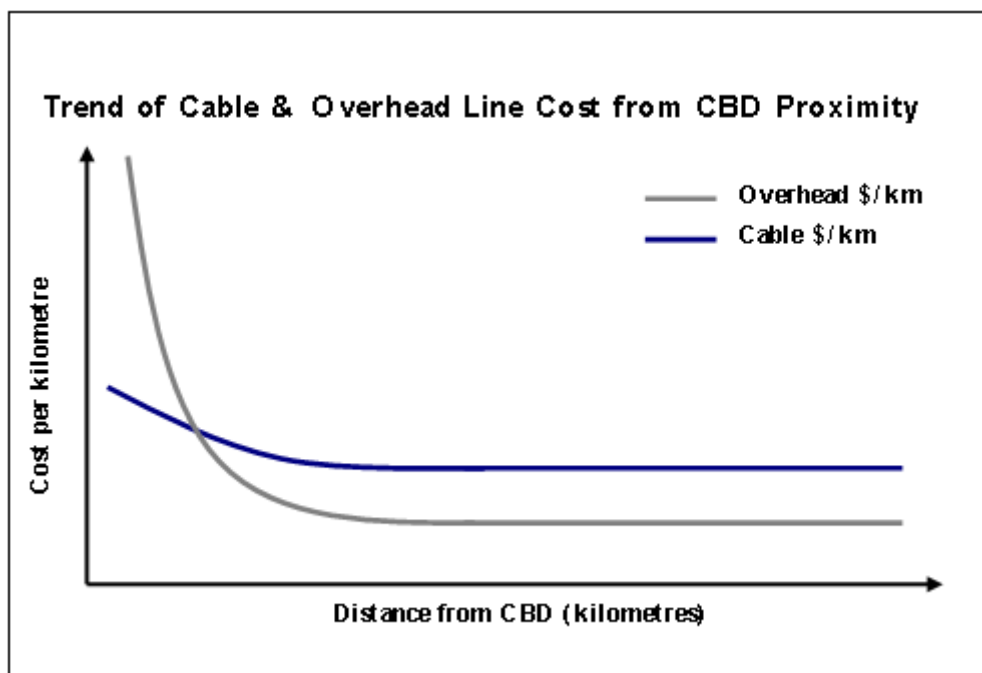
As with the other options discussed in this paper, the actual route of the 275kV connection between TIPS and City West substation is yet to be determined. Accordingly, should overhead be achievable for all or part of the final route decided upon, that overhead section could follow a route ranging anywhere from directly along Port Road, through to following the existing TIPS–Kilburn 275kV line to as far as Kilburn substation, then continuing southwards towards the Adelaide CBD. Consequently, the ratio of overhead construction to underground cable that is actually able to be achieved is as yet uncertain. That ratio will be influenced by the Development Approval process, which, in turn, will be impacted by key factors, including:

- ❖ The major visual impact of overhead structures in the Adelaide metropolitan area and their potential to create major community issues;
- ❖ The fact that this project is currently supported and sponsored by the South Australian Government Office of Major Projects and Infrastructure as a Crown development, under Section 49 of the Development Act, based on the assumption that most of the transmission line would be underground;
- ❖ The likelihood that an overhead proposal would be declared a Major Development or Project under section 46 of the Development Act. Should that situation eventuate, construction of the line would require an Environmental Impact Study or an equivalent assessment, and would potentially add an additional 2 to 3 years to the intended completion date for this project;
- ❖ Indications from affected Councils along the line-route that they will oppose an overhead line proposal. This will likely have the potential to apply political pressure on relevant Government Agencies and Ministers to seek an alternative proposal;
- ❖ The securing for the length of the route of the overhead portion a 50-metre-wide easement, required of any 275kV overhead transmission line; a process which will be very lengthy and one that would potentially require the compulsory acquisition of various properties along that route, for which ElectraNet would have to gain Ministerial approval;
- ❖ The high probability that an overhead solution not be granted Development Approval;
- ❖ The requirement for expensive specially designed and tested line structures that are deemed aesthetically pleasing;
- ❖ Objections from Public lobby groups; and
- ❖ The possible invoking of the *Environment Protection and Biodiversity Conservation Act* (EPBC) in the event that the line route for any overhead section of the line traverse protected wetland areas, again detrimentally impacting the time required to obtain Development Approval.

Each of the above are ‘Risk Factors’, and can be assigned to one or other of the following groups:

- a) Risk of not obtaining Development Approval; and
- b) Risk of time to obtain Development Approval.

The estimation of the cost of the 275kV connection between TIPS and City West substation is difficult to determine with any accuracy at this stage of ElectraNet's investigations since the exact line route has not yet been determined with any surety. Consequently, until the line route and its composition have been confirmed, ElectraNet and its consultants are proceeding to estimate, as accurately as available information will allow, the cost of providing supply to City West substation from TIPS entirely via underground cable, as well as that of using overhead construction for the entire route. The purpose of that exercise is to enable ElectraNet to get an indication of the most economically beneficial ratio of underground to overhead construction, and to then determine how close it can get to achieving that ratio with consideration for physical and Development Approval constraints. Early results of that analysis are provided below.



Graphical depiction of the cost per kilometre of overhead transmission line and underground cable construction with increasing distance from the CBD

The difference in cost-per-kilometre for overhead line construction varies considerably, and is based on many factors. Some of those factors are the required rating and voltage of the line, the type of towers and/or poles that are used, soil type, height restrictions for structures, Development Approval restrictions, span lengths, the number of existing services that will have to be crossed, the number of structures that will be required to support changes in route direction, traffic management during construction, environmental restrictions, and work time (time-of-day) restrictions. Two of the more significant cost factors are the cost of acquiring an easement for any overhead portions of the line, and public consultation and communication costs, both of which can vary substantially depending on the chosen line route. As can be seen from the above graphical plot, the cost of a overhead construction increases exponentially as it approaches the city centre, and rapidly overtakes the cost of a cable in that same proximity.

When compared with overhead construction, cable costs are more predictable since easements are a far lesser component of the overall cost, and are minimally affected by surrounding existing infrastructure, no matter the proximity to the CBD. Traffic management



during installation appears to be the main contributing factor to the increase in the cost of the any cable option the closer to the CBD the cable progresses.

With consideration for the above discussion, it can be seen that determining the ideal ratio of cable to overhead construction is a complex exercise. It is closely intertwined with local political and a wide range of technical factors, all of which have bearing on the risks of either not meeting the required time-frame for completion of the project, or not being able to achieve Development Approval for any overhead construction at all. To that end, ElectraNet will endeavour to consider all feasible/practicable combinations and determine their individual risks. The solution with the most acceptable risk profile will then be chosen to ensure a successful project outcome that falls within cost and time constraints, and that has the assurance of gaining Development Approval. ElectraNet will pursue this analysis in far greater detail in the next phase of this project.

Option 1a – City West supplied from TIPS 275kV switchyard via an overhead line		
<u>Date required</u>	<u>Proposed Augmentation</u>	<u>Total capital cost</u>
31 December 2011	<p>Establish a substation at the recently-acquired site in the vicinity of the south-west extremity of the Adelaide Central region comprising one 300MV.A 275/66kV transformer dedicated to augmenting the transformer capacity supplying the Adelaide Central region, in accordance with the ESCOSA's requirement;</p> <p>Establish a 926MV.A 275kV connection directly between TIPS 275kV switchyard and City West substation, a route length of about 18 kilometres, via an overhead transmission line; and</p> <p>The establishment by ETSA Utilities of a 66kV GIS switchyard on a portion of the City West site, the installation of three 160MV.A capacity 66kV underground cables from that switchyard to connect the new substation to ETSA Utilities' 66kV CBD network, and the upgrading of the four ETSA Utilities-owned 66/11kV substations that supply the CBD to enable that additional capacity to be utilised.</p> <p>Install a 300MV.A 275/66kV transformer at City West substation dedicated to supplying ETSA Utilities' southern suburbs 66kV sub transmission network.</p>	<p>Cost is undetermined, but it is considered to be of a very high risk (ElectraNet)</p> <p>\$47m (ETSA Utilities)</p> <p>(\$20m*) (ElectraNet)</p>
2015/16	<p>Install a second 225MV.A 275/66kV transformer at East Terrace substation; and</p> <p>The establishment by ETSA Utilities of a 66kV cable from East Terrace substation to ETSA Utilities' 66/11kV Hindley Street substation.</p>	<p>\$25m (ElectraNet)</p> <p>\$20m (ETSA Utilities)</p>
2016/17	<p>Install a 300MV.A 275/66kV transformer at City West substation dedicated to supplying ETSA Utilities' western suburbs 66kV sub transmission network.</p>	<p>(\$20m*) (ElectraNet)</p>

*Table 3*

*Option 1a: "TIPS – Direct, overhead construction": capital works required*

\* The costs associated with plant and equipment that is proposed to be installed at City West substation as part of the proposed southern and western suburbs augmentations have been excluded from the financial analysis of the various Adelaide Central augmentation options that have been considered to ensure that those Adelaide Central options are compared equally.

### 6.2.3.3 Option 2 – “TIPS, Kilburn by-pass”

Option 2 proposes supplying Kilburn and Northfield substations from the TIPS-Para 275kV line rather than via the existing TIPS-Kilburn-Northfield-TIPS arrangement. Supply to City West substation would then be achieved by using the then-surplus sections of the TIPS-Kilburn and TIPS-Northfield lines out of TIPS, and constructing a dual-circuit overhead line to connect those sections of line to an over-under transition station that would be constructed in a suitable location as far south as practically possible, and from that transition station, connecting to City West substation via an underground cable.

That new arrangement for the first stage of this option would be achieved by:

- cutting into the TIPS-Para line, to the north, and constructing about 2 kilometres of dual-circuit 275kV line south to the physical junction of the TIPS-Kilburn, Kilburn-Northfield, and TIPS-Northfield circuits;
- reconfiguring the lines at that junction to create a TIPS-Kilburn-Northfield-Para circuit;
- establishing a 275kV over-under transition station in the vicinity of Regency Road;
- constructing a dual-circuit 275kV overhead line from that transition station northwards to connect into the remaining sections of the TIPS-Northfield and TIPS-Kilburn lines, thus establishing a direct connection between TIPS and the transition station that effectively by-passes Kilburn substation; and
- installing an underground cable between the transition station and City West substation, some 8.4 kilometres to the south.

In reconfiguring the transmission network in the manner described above, the 926MV.A transfer capacity that the TIPS-Para line presently provides will effectively be reduced to the rating of the Kilburn-Northfield line, or about 674MV.A, and should that line be up-rated to 926MV.A, the transfer capacity would then be limited by the rating of the Kilburn substation 275 kV bus, or about 760MV.A. To restore the 926MV.A rating of the TIPS-Para line, a second conductor per phase would have to be strung on the Kilburn-Northfield portion of the line, resulting in additional mechanical loading on the existing structures supporting that line. That additional mechanical loading would necessitate the replacement of some of those structures with structures that have a greater load-bearing capacity. The cost of that additional “deep network” reinforcement is estimated to be \$35m. The cost of replacing the Kilburn 275kV bus and associated plant and equipment is estimated to be \$30m.

Similarly, the ratings of the sections of the existing TIPS-Kilburn and TIPS-Northfield lines that this option proposes using will be exceeded under contingency conditions. As with the Kilburn-Northfield line discussed above, increasing the ratings of the TIPS-Kilburn and TIPS-Northfield lines would involve stringing a second conductor for each phase of those two line segments, resulting in additional mechanical loading on the structures supporting those lines, and again, necessitating the replacement of some of those structures with structures that have a greater load-bearing capacity. The cost of that work is estimated to be \$62m.

As with Option 1, a brief description of the initial works required to establish City West substation, as well as anticipated future works that will be needed to maintain the required reliability standards for the Adelaide Central region for the fifteen-year period following the commissioning of City West, is provided in Table 4, and a schematic representation of this option is provided in Figure 10.

Option 2 – TIPS, Kilburn by-pass		
<u>Date required</u>	<u>Proposed Augmentation</u>	<u>Total capital cost</u>
31 December 2011	<p>Establish City West substation identically to as was described for Option 1, and provide 275kV supply to that substation by:</p> <ul style="list-style-type: none"> <li>cutting into the TIPS-Para line, to the north, and constructing about 2 kilometres of dual-circuit 275kV line south to the physical junction of the TIPS-Kilburn, Kilburn-Northfield, and TIPS-Northfield circuits;</li> <li>reconfiguring the lines at that junction to create a TIPS-Kilburn-Northfield-Para circuit;</li> <li>rebuilding the Kilburn-Northfield portion (approximately 9.5km) of the TIPS-Kilburn-Northfield-Para dual circuit line with twin conductor to achieve a higher rating;</li> <li>establishing a 275kV over-under transition station in the vicinity of Regency Road;</li> <li>constructing a dual-circuit 275kV overhead line from that transition station northwards to connect into the remaining sections of the TIPS-Northfield and TIPS-Kilburn lines, thus establishing a direct connection between TIPS and the transition station that effectively by-passes Kilburn substation;</li> <li>installing a 700MV.A 275kV underground cable between the transition station and City West substation, some 8.4 kilometres to the south;</li> <li>Increase the rating of the original sections of the TIPS-Kilburn and TIPS-Northfield overhead lines by stringing a second conductor for each phase of those two line segments, and replacing specific towers with structures having greater load-bearing capacity; and</li> </ul> <p>The establishment by ETSA Utilities of a 66kV GIS switchyard on a portion of the City West site, the installation of three 160MV.A capacity 66kV underground cables from that switchyard to connect the new substation to ETSA Utilities' 66kV CBD network at Whitmore Square, and the upgrading of the four ETSA Utilities-owned 66/11kV substations that supply the CBD to enable that additional capacity to be utilised.</p> <p>Install a 300MV.A 275/66kV transformer at City West substation dedicated to supplying ETSA Utilities' southern suburbs 66kV sub transmission network.</p>	<p>\$261m (ElectraNet)</p> <p>\$47m (ETSA Utilities)</p>
2015/16	<p>Install a second 225MV.A 275/66kV transformer at East Terrace substation; and</p> <p>The establishment by ETSA Utilities of a 66kV cable from East Terrace substation to ETSA Utilities' 66/11kV Hindley Street substation.</p>	<p>(\$20m*) (ElectraNet)</p> <p>\$25m (ElectraNet)</p> <p>\$20m (ETSA Utilities)</p>
2016/17	<p>Install a 300MV.A 275/66kV transformer at City West substation dedicated to supplying ETSA Utilities' western suburbs 66kV sub transmission network.</p>	<p>(\$20m*) (ElectraNet)</p>

*Table 4: Option 2: "TIPS, Kilburn by-pass": capital works required*

\* The costs associated with plant and equipment that is proposed to be installed at City West substation as part of the proposed southern and western suburbs augmentations have been excluded from the financial analysis of the various Adelaide Central augmentation options that have been considered to ensure that those Adelaide Central options are compared equally.

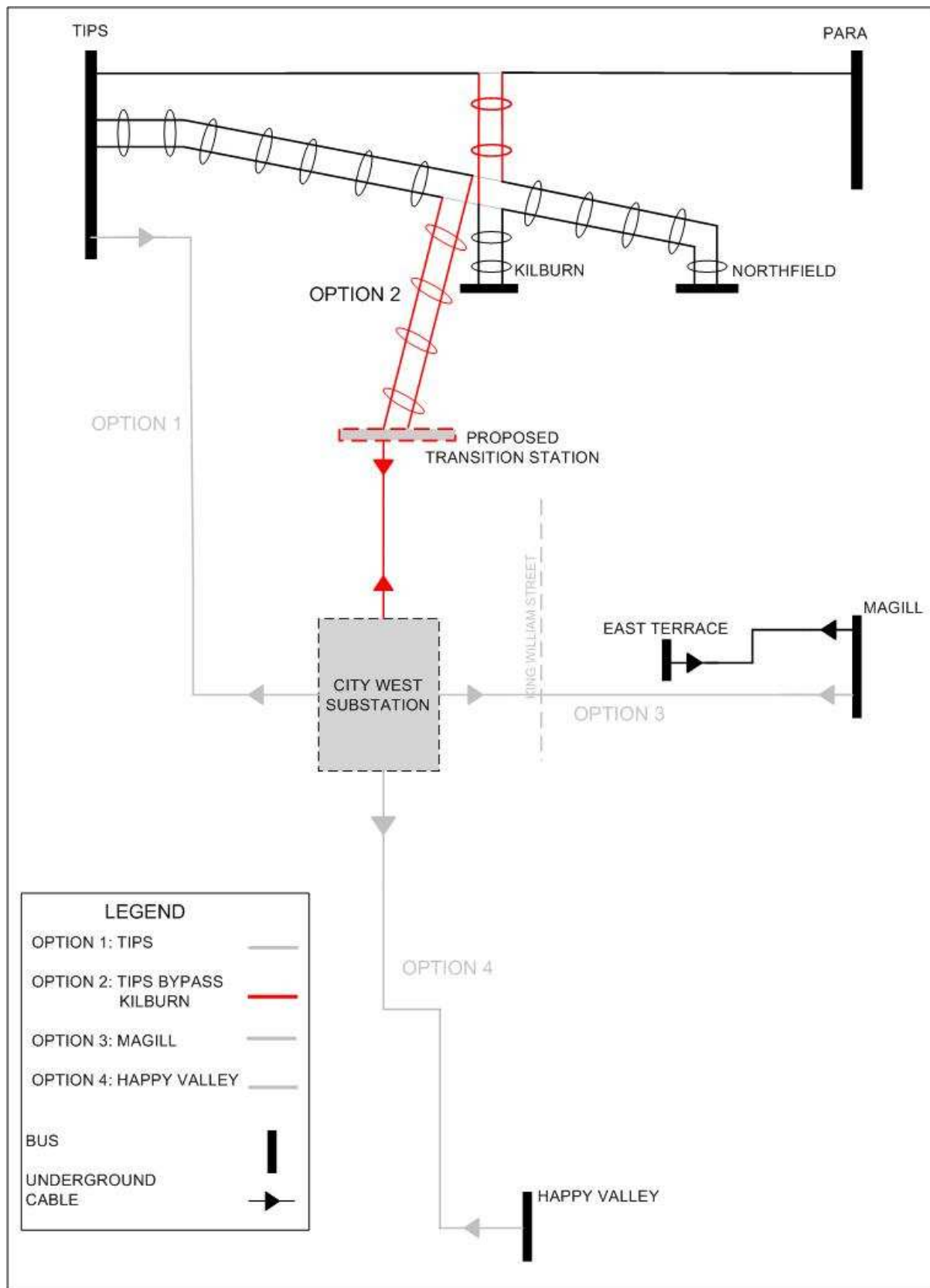


Figure 10

Option 2: City West supplied indirectly from TIPS 275kV switchyard ... *"TIPS, Kilburn by-pass"*

### 6.3 Distribution connection options

To meet the Electricity Distribution Code Reliability Standards, ETSA Utilities plans its CBD 66kV network to a continuous N-1 level of security during forecast peak load conditions; that is, no loss of customer supply during a single 66kV event. Typically, the new high-capacity 66kV cables used in the CBD can carry up to 160MVA of load, depending on installation restrictions such as size and depth of cable trench. System network modelling has shown that initially the new City West connection point will supply up to 160MVA of load into the Adelaide Central region at peak load times, with that load increasing each year at the approximate CBD growth rate of 2.3%. To manage that demand it will be necessary to install three 66kV cables to connect City West substation to the existing ETSA Utilities CBD network, providing a total connection capacity of up to 320MVA (maximum potential connection capacity of two cables with the third out of service). That capacity is well matched to the ElectraNet transformer capacity of 300MVA.

ETSA Utilities' preferred option is to connect City West substation to the CBD 66kV network via three high-capacity 66kV cables, at an estimated cost of \$47m. That cost includes establishment of an indoor 66kV substation at City West and cutting into the existing Whitmore Square to Coromandel Place 66kV cable to create a direct City West to Coromandel Place 66kV circuit and two City West to Whitmore Square circuits. Whitmore Square substation already has direct 66kV cable connections to two other CBD substations (Hindley Street substation and Coromandel Place substation), and the remaining CBD substation at East Terrace (via the existing Coromandel Place to East Terrace 66kV cable). Therefore, power can readily be supplied to the Adelaide Central region by the proposed arrangement. The costs of the associated protection, telecommunications and earthing systems upgrades that are required at the existing CBD substations to manage the new connections are included in the above figure.

A second alternative that ETSA Utilities considered but discarded because of a higher initial cost of \$100m and higher cost over the evaluation period was to install 66kV cables directly to three of ETSA Utilities' existing CBD substations from City West. Unfortunately that solution requires a major substation upgrade of the existing Hindley Street substation (switchgear limitation), the advancement of the planned fifth CBD substation, and longer cable runs for two of the three 66kV cables. Although a benefit of this option would be the additional 66kV line redundancy provided to the Hindley Street Substation and the future fifth CBD substation, those benefits cannot be directly related to the Adelaide Central reinforcement.

The third alternative that ETSA Utilities considered but discarded, again because of the higher initial cost of \$76 million and higher cost over the evaluation period, was to install two 66kV cables from City West to Whitmore Square substation and one 66kV cable from City West to the existing CBD Hindley Street substation. Unfortunately that solution would require a major upgrade of the existing Hindley Street substation (switchgear limitation).

## 7 Scenarios considered

### 7.1 Context for Evaluation of Options

All feasible options to the identified supply requirements must be viewed in the context of wider developments in the NEM. ElectraNet is not aware of any inter-state nor intra-state transmission network augmentations that would impact the decision by the ESCOSA to increase supply reliability to the Adelaide Central region.

### 7.2 Assumed Market Development Scenarios

The Regulatory Test for reliability augmentations requires that options to address network requirements be assessed against a number of reasonable scenarios. Those scenarios need to consider:

- The existing network;
- Future network developments;
- Variations in load growth;
- Committed generation and demand side developments; and
- Potential generation and demand side developments.

The purpose of this approach is to test the PV costs of the options being evaluated under a range of plausible scenarios.

#### 7.2.1 Existing Network and Future Transmission Development

Existing and future network developments that have the potential to impact supply arrangements to the Adelaide Central region have been included as anticipated projects in the underlying analysis.

#### 7.2.2 Variations in Demand Growth

The forecast demand growth used in this assessment was based on medium economic conditions and hot weather forecasts (10% Probability of Exceedence, or PoE) for electricity usage. Use of 10% PoE weather forecasts is consistent with Australian TNSP practice when planning the backbone 275kV network.

The forecasts include all known information about existing and planned demand-side management initiatives, and include independent forecasts of existing and planned local embedded generation.

For the purposes of the Adelaide Central augmentation studies, scenarios assuming both high (4%) and low (1%) demand growth were also considered to ensure the robustness of the findings of this report, which are based on medium load growth (2.3% per annum).

#### 7.2.3 Existing and Committed Generators and Demand Side Developments

The public consultation undertaken as part of the RFI process confirmed that there are no committed generators proposing establishment in the Adelaide metropolitan region in the foreseeable future. For that reason, no scenarios have been developed in which the output of existing or committed generators is increased. Any demand-side management initiatives will not impact on reliability of supply requirements for the Adelaide Central region (it will only reduce peak load).

#### 7.2.4 Potential New Generation

ElectraNet is not aware of any potential new generation proposals that will impact supply to the Adelaide Central region.

However, as electricity demand continues to grow, it is forecast that additional generation will be required within the South Australian region. It has been assumed for the purposes of planning studies examining future supply requirements to the Adelaide Central and metropolitan areas that, although entry of new generation will occur in the foreseeable future to meet the increasing electricity demand, that new generation plant will be located such that its direct impact on the Adelaide Central region will be indiscernible.



## 8 Format and Inputs to Analysis

### 8.1 Regulatory Test Requirements

The requirement for the comparison of options to address future supply needs is contained in the Regulatory Test<sup>3</sup>. The Regulatory Test requires that, for reliability augmentations, the recommended option be the option that “minimises the present value of costs, compared with a number of alternative options in a majority of reasonable scenarios”.

The Regulatory Test contains guidelines for the methodology to be used to identify the lowest cost option. Information to be considered includes construction, operating and maintenance costs, and the cost of complying with existing and anticipated laws and regulations. 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.

### 8.2 Inputs to Analysis

A solution to address future supply requirements in the Adelaide Central region as outlined in this document is required to satisfy reliability requirements linked to Schedule 5.1 of the NER and the requirements of the South Australian ETC.

According to the Regulatory Test, this means that the PV costs of all options must be compared, and the least cost solution is considered to satisfy the Regulatory Test. The results of that evaluation, carried out using a discounted cash flow model to determine the PV cost of the two options, are shown in section 9. ElectraNet has assumed a pre-tax real Weighted Average Cost of Capital (WACC) of 7.17% as the discount rate, which equates to a nominal WACC of 8.3%.

Cost inputs to the economic analysis are described below.

### 8.3 Cost of Network Augmentations

The economic analysis considers all foreseeable cost impacts of the proposed network augmentations to market participants.

The capital cost<sup>4</sup> to implement each of the feasible options outlined in section 6 has been estimated by ElectraNet based on a conceptual scope of works. Sensitivity studies have been carried out using variations in the capital cost estimates of plus and minus 20%.

### 8.4 Other Inputs to Analysis

While the solution that ElectraNet and ETSA Utilities are jointly proposing to address the identified future supply requirements is to be implemented by 31 December 2011, the economic analysis of the two options includes the costs of anticipated future projects that will be needed to maintain the required reliability standards for the Adelaide Central region during the fifteen-year period following commissioning of the substation, as mentioned previously in this report.

Timings for anticipated projects are based on meeting future electricity supply requirements for the Adelaide Central region using load forecasts prepared by ETSA Utilities in March 2007 and published in ElectraNet's Annual Planning Report 2007. Actual timings of the anticipated projects may change as a result of the ongoing review of load forecasts for the Adelaide Central and metropolitan regions of Adelaide, and other market developments, during the 15-year planning horizon.

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<sup>3</sup> ElectraNet is required to evaluate solutions for new transmission developments under the Regulatory Test in accordance with clause 5.6 of the NER.

<sup>4</sup> In 2007 dollars

The sensitivity of the timing of those anticipated projects to a range of market development scenarios, and therefore the incidence of the capital expenditure, has been included as part of the economic analysis to ensure that the findings are robust.

## 9 Economic Analysis

### 9.1 Inputs to Analysis

ElectraNet has elected to use a fifteen year period over which to undertake the economic analysis. That analysis takes into account the total capital cost of implementing each of the two options as well as the costs of any progressive augmentations that would be required during the fifteen year period from the 2011/12 commissioning date to 2026/27, for either option. All cost estimates that have been used are current as at 2007.

In accordance with the requirements of the Rules, ElectraNet has used the “Regulatory Test for reliability augmentations” to identify the recommended option. That test compares the present value of each of the two options remaining in contention over a suitable period of time and under a range of feasible scenarios. It is then the ranking of those options, rather than their actual present value, that is important, since the Regulatory Test requires that the recommended option have the lowest present value cost to market participants when considered under a range of assumed scenarios.

As well as deciding to use a 15-year analysis period as an appropriate period for economic analysis, as mentioned, ElectraNet has also assumed a discount rate of 7.17% as the appropriate before-tax discount rate, and has conducted sensitivity analyses using alternative discount rates of 5% and 9% to test that advice. Similarly, the \$36/MW.h cost of losses figure that is currently used in the NEM, and that was used in the analysis supporting this document, was also tested at \$20/MW.h and \$50/MW.h.

In addition to examining the impact of a range of reasonable scenarios, as required by the Rules, the sensitivity of the option-ranking to other critical parameters was also examined. Table 4 shows the parameters that were investigated in the sensitivity analysis, the range over which they were varied, and the resulting ranking of the two options when subjected to those variations.

Parameter	Range over which the parameter was varied	Option 1 TIPS Direct		Option 2 Kilburn by-pass	
		Present Value Cost	Rank	Present Value Cost	Rank
Growth rate	Low (1%pa)	\$250	1	\$310	2
	Medium (2.3%pa)	\$254	1	\$314	2
	High (4%pa)	\$259	1	\$319	2
Capital cost (Both ElectraNet's and ETSA Utilities' costs varying)	80%	\$208	1	\$255	2
	100%	\$254	1	\$314	2
	120%	\$301	1	\$373	2
Capital cost (Only ElectraNet's costs varying)	80%	\$218	1	\$265	2
	100%	\$254	1	\$314	2
	120%	\$290	1	\$363	2
Capital cost (Only ETSA Utilities' costs varying)	80%	\$244	1	\$304	2
	100%	\$254	1	\$314	2
	120%	\$264	1	\$324	2
Capital cost (Only ElectraNet's <u>cable cost</u> varying)	80%	\$236	1	\$305	2
	100%	\$254	1	\$314	2
	120%	\$273	1	\$323	2
Discount rate	5%	\$295	1	\$364	2
	7.17%	\$254	1	\$314	2
	9%	\$173	1	\$279	2
Cost of losses (\$/MW.h)	\$20	\$245	1	\$305	2
	\$36	\$254	1	\$314	2
	\$50	\$262	1	\$322	2
Evaluation period (years)	10	\$194	1	\$241	2
	15	\$254	1	\$314	2
	25	\$329	1	\$402	2

*Table 4*  
*Sensitivity Analysis*

As can be seen from the results of the economic analysis provided in Table 4, Option 1 has the lowest present value cost under all of the scenarios considered, with sensitivity studies on key variables that ElectraNet has no control over demonstrating the robustness of that finding.

On the basis of the economic analysis and subsequent sensitivity testing, Option 1 is the option that satisfies the Regulatory Test.

## 9.2 Inter-network Impact

ElectraNet is required under the NER to assess whether a new large network asset is reasonably likely to have a material inter-network impact. ElectraNet has determined that the proposed new large network asset will not impose power transfer constraints nor adversely impact the quality of supply within adjacent networks.

## 10 Summary and Conclusions

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

- The augmentation proposed in this document is defined as a 'reliability augmentation' under the NER as it will prevent interruptions to supply during critical single-contingency events in the transmission network supplying the Adelaide Central region.
- There is no acceptable 'do-nothing' option as ElectraNet is required to meet the new ETC reliability standard for the Adelaide Central Region.
- ElectraNet and ETSA Utilities issued a joint RFI/RFP paper in October 2006 that invited comment and submissions on the projected limitations that would impact the Adelaide Central region, to which no responses were received.
- Planning studies were undertaken to evaluate potential network options that would satisfy the ETC requirements, from which two viable options were identified.
- Economic analysis carried out in accordance with the Regulatory Test has identified the proposed augmentation, Option 1 (establishing a new substation adjacent the south-western corner of the Adelaide Central region and supplying that substation from TIPS switchyard directly via an underground cable) as the least-cost solution over the 15-year period of the analysis in all of the credible scenarios considered. Sensitivity studies demonstrated that the results of that analysis are robust to variations in capital cost and other factors beyond the control of ElectraNet. Option 1 is therefore considered to satisfy the Regulatory Test.
- As part of the initial establishment of City West substation, ElectraNet and ETSA Utilities will also install a second 300MV.A 275kV transformer and associated switchgear at City West substation for the sole purpose of providing an additional 66kV injection point into ETSA Utilities' southern suburbs 66kV network. All costs associated with installing that second transformer have been *excluded* from the financial calculations associated with the Adelaide Central augmentation. The additional southern suburbs connection point is the subject of a separate consultation currently being undertaken by ETSA Utilities and ElectraNet.

## 11 Recommendation

Based on the conclusions drawn from the preceding analysis, the NER requirements relating to New Large Network Assets, and the increased supply reliability standards that ElectraNet is required to meet for the Adelaide Central region, as prescribed by ESCOSA in the July 2008 ETC, it is recommended that the following action be taken to address those future increased supply reliability requirements for the Adelaide Central region, with commissioning and commercial availability of the large network assets that will realise those increased reliability levels to be achieved by 31 December 2011:

- Establish, on an ElectraNet-owned site on the south-west extremity of the Adelaide Central region, the location of which has been endorsed by ESCOSA as meeting the locational requirements set out in the 1 July 2008 ETC, a substation comprising one 300MV.A 275/66kV transformer dedicated to the provision, in conjunction with the single 225MV.A 275/66kV transformer at the existing East Terrace substation, of N-1 continuous transformer capacity to the Adelaide Central region, and a second 300MV.A 275/66kV transformer dedicated to supplying ETSA Utilities' southern metropolitan 66kV network, the costs for which will be excluded from any financial considerations associated with the Adelaide Central augmentation;
- Provide 275kV supply to that substation from TIPS 275kV switchyard. As has been discussed in this report, it is ElectraNet's intention to pursue overhead construction out of TIPS for as much of the line route as is possible in order to minimise the overall cost of the project. ElectraNet will attempt to optimise the line-to-cable ratio when the detailed scope is investigated in the next phase of the project (phase 2). The ratio of line to cable will be dependent on State government, local council, and public support for the establishment of a 275kV overhead line, and whether a suitable 275kV line easement can be obtained. However, the degree of 'optimality' of that ratio that will be achieved will be restricted by the time remaining until the 31 December 2011 commissioning and commercial availability date required of this project, given that sufficient time be allowed to construct the substation and establish the 275kV connection to that substation; and
- The establishment by ETSA Utilities of a 66kV GIS switchyard, the installation of three 160MV.A capacity 66kV underground cables from that switchyard to connect the new substation to ETSA Utilities' existing 66kV CBD network, and the upgrading of the four ETSA Utilities-owned 66/11kV substations that supply the CBD to enable that additional capacity to be utilised;

at a total estimated cost of \$236m, of which \$189m will be attributable to ElectraNet's portion of the required works, and \$47m to ETSA Utilities' (2007 prices).

## 12 Consultation

The Request for Information/Request for Proposals paper titled "Projected Network Limitations, Adelaide Central Region, South Australia" was issued in accordance with NER and ESCOSA Guideline 12 requirements.

The options that have been considered in this report have been subjected to the Regulatory Test for reliability augmentations promulgated by the AER as required under both the NER and Guideline 12. Based on the results contained within this report, and in the absence of any submission in response to this Application Notice, the requirements of the NER and Guideline 12 will have been met, and ElectraNet and ETSA Utilities will be in a position to make their investment decision.

In accordance with NER requirements, ElectraNet and ETSA Utilities therefore invite submissions from Registered Participants and interested parties on this Application Notice.

Submissions are due by the close of business on 27<sup>th</sup> February 2008.

Please address submissions to:

*Jan Lombard,  
Network Reliability,  
ElectraNet,  
PO Box 7096,  
Hutt Street Post Office,  
Adelaide, South Australia, 5000  
[Lombard.Jan@electranet.com.au](mailto:Lombard.Jan@electranet.com.au)  
Tel: (08) 8404 7102  
Fax: (08) 8404 7440*

Following consideration of submissions, ElectraNet and ETSA Utilities expect to publish a Final Report in March 2008.



## 13 Glossary

Adelaide Central	That area of Adelaide which is located east of West Terrace, north of South Terrace, west of East Terrace, and south of the River Torrens.
AER	Australian Energy Regulator
AMD	Agreed Maximum Demand – for a connection point or a group of connection points, it is the demand specified as such in the connection agreement between ElectraNet and the relevant transmission customers or ETSA Utilities.
Application Notice	A notice made available to Registered Participants and Interested Parties pursuant to clause 5.6.6 of the Rules
Distribution Code – EDC	South Australian Electricity Distribution Code – as issued by ESCOSA
DNSP	Distribution Network Service Provider
ElectraNet	ElectraNet is the principal transmission network service provider in South Australia. It is a privately owned company that has a long term lease for the operation, maintenance, and development of the South Australian transmission system which comprises plant and equipment mainly operating at voltages of 132 kV and above. ElectraNet is registered with NEMMCO as a Transmission Network Service Provider (TNSP)
Equivalent Transformer Capacity	Capacity to transform energy to meet demand using means including, but not limited to:  transmission system capability; and  network support arrangements,  as defined in the ESCOSA Electricity Transmission Code.
ESCOSA	Essential Services Commission of South Australia established under the Essential Services Commission Act 2002
ETC	South Australian Electricity Transmission Code issued by ESCOSA
ETSA Utilities	ETSA Utilities is South Australia's principal Distribution Network Service Provider (DNSP), and is responsible for the distribution of electricity to all distribution grid connected customers within the State under a regulatory framework. ETSA Utilities is a partnership of Cheung Kong Infrastructure Holdings Ltd (CKI), Hong Kong Electric International Ltd (HEI), and Spark Infrastructure
Guideline 12 (GL 12)	ESCOSA Electricity Industry Guideline 12 – Demand Management for Electricity Distribution Networks
Market Participant	A person who has registered with NEMMCO as a Market Generator, Market Customer or Market Network Service Provider under Chapter 2
NEM	National Electricity Market

NEMMCO	National Electricity Market Management Company Limited
NPV	Net Present Value
Registered Participant	A person who is registered with NEMMCO as a Network Service Provider, a System Operator, a Network Operator, a Special Participant, a Generator, a Customer or a Market Participant
Regulatory Test	The test promulgated by the AER, which all major regulated network augmentation investments must comply with
RFI	Request for Information
RFP	Request for Proposals
Rules	National Electricity Rules (Rules) formerly the National Electricity Code (NEC)
TNSP	Transmission Network Service Provider
TUOS	Transmission Use of System charges applicable to Registered Participants in the NEM
WACC	Weighted Average Cost of Capital

Scenario A				Low load Growth															
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
			10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
Option 1				TIPS Direct															
TIPS Direct		224.471																	
	10/11	224.471	0	235.7	232.6	227.4	222.2	216.9	211.7	206.5	201.2	196.0	190.7	185.5	180.3	175.0	169.8	164.5	
* WDV		45		3.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	
* Depreciation over		0.015		2.1	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	
* Opex		0.0717		9.9	16.7	16.3	15.9	15.6	15.2	14.8	14.4	14.1	13.7	13.3	12.9	12.5	12.2	11.8	
* WACC																			
=> TUOS	0			15.0	25.5	25.1	24.7	24.3	24.0	23.6	23.2	22.8	22.4	22.1	21.7	21.3	20.9	20.6	
=> NPV of TUOS		\$203.22																	
Install 2nd East Tce tfr		51.1905																	
	10/11	51.1905	0	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
* WDV		45		0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
* Depreciation over				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
* Opex		0.015		0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
* WACC		0.0717		0.0	0.0	0.0	0.0	0.0	0.0	2.2	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	
=> TUOS	0			0.0	0.0	0.0	0.0	0.0	0.0	3.4	5.8	5.7	5.6	5.5	5.4	5.3	5.2	5.1	
=> NPV of TUOS		\$25.74																	
Total TUOS per year				15.0	25.5	25.1	24.7	24.3	24.0	23.6	23.2	22.8	22.4	22.1	21.7	21.3	20.9	20.6	
NPV of total TUOS		\$228.96																	
Cost of Losses																			
	10/11		0	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
Losses after implementation (MW)			0	21.8	23.0	24.4	25.6	27.0	28.7	30.3	32.0	33.9	36.0	38.3	40.1	41.9	43.9	45.9	
Cost of Losses \$	0		0	1.7	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.6	2.7	2.9	3.0	3.2	3.3	3.5	
=> NPV of Cost of Losses		\$20.90																	
Reliability Costs																			
	10/11		0	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
=> NPV of Reliability Costs		\$0.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total for Option 1		\$249.86																	

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Scenario B		Medium load Growth																
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
Option 1			TIPS Direct															
TIPS Direct	224.471																	
	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26		
* WDV	224.471	0	235.7	232.6	227.4	222.2	216.9	211.7	206.5	201.2	196.0	190.7	185.5	180.3	175.0	169.8	164.5	
* Depreciation over	45		3.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	
* Opex	0.015		2.1	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	
* WACC	0.0717		9.9	16.7	16.3	15.9	15.6	15.2	14.8	14.4	14.1	13.7	13.3	12.9	12.5	12.2	11.8	
=> NPV of TUOS		0	15.0	25.5	25.1	24.7	24.3	24.0	23.6	23.2	22.8	22.4	22.1	21.7	21.3	20.9	20.6	
=> NPV of TUOS	\$203.22		235.7	5.5														
Install 2nd East Tce tfr																		
	51.1905																	
	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26		
* WDV	51.1905	0	0.0	0.0	0.0	0.0	53.8	53.1	51.9	50.7	49.5	48.3	47.1	45.9	44.7	43.5	42.3	
* Depreciation over	45		0.0	0.0	0.0	0.0	0.7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
* Opex	0.015		0.0	0.0	0.0	0.0	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
* WACC	0.0717		0.0	0.0	0.0	0.0	2.2	3.8	3.7	3.6	3.5	3.5	3.4	3.3	3.2	3.1	3.0	
=> TUOS		0	0.0	0.0	0.0	0.0	3.4	5.8	5.7	5.6	5.5	5.5	5.4	5.3	5.2	5.1	5.0	
=> NPV of TUOS	\$29.37																	
Total TUOS per year			15.0	25.5	25.1	24.7	27.7	29.8	29.3	28.8	28.4	27.9	27.4	27.0	26.5	26.1	25.6	
NPV of total TUOS	\$232.59																	
Cost of Losses																		
	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26		
Losses after implementation (MW)	0	22.4	23.6	25.0	26.3	27.7	29.4	31.1	32.8	34.8	36.9	39.3	41.1	43.0	45.0	47.1		
Cost of Losses \$	0	1.7	1.8	1.9	2.0	2.1	2.2	2.4	2.5	2.6	2.8	3.0	3.1	3.3	3.4	3.6		
=> NPV of Cost of Losses	\$21.44																	
Reliability Costs																		
	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26		
=> NPV of Reliability Costs	\$0.00	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total for Option 1	\$254.03																	

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Scenario C		High load Growth																
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
Option 1			TIPS Direct															
	224.471																	
	10/11		11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
	224.471	0	235.7	232.6	227.4	222.2	216.9	211.7	206.5	201.2	196.0	190.7	185.5	180.3	175.0	169.8	164.5	
	45		3.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	
	* Depreciation over																	
	* Opex	0.015	2.1	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	
	* WACC	0.0717	9.9	16.7	16.3	15.9	15.6	15.2	14.8	14.4	14.1	13.7	13.3	12.9	12.5	12.2	11.8	
	=> TUOS	0	15.0	25.5	25.1	24.7	24.3	24.0	23.6	23.2	22.8	22.4	22.1	21.7	21.3	20.9	20.6	
	=> NPV of TUOS	\$203.22																
Install 2nd East Tce tfr																		
	51.1905																	
	10/11		11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
	51.1905	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	45		0.0	0.0	0.0	0.7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
	* Depreciation over																	
	* Opex	0.015	0.0	0.0	0.0	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
	* WACC	0.0717	0.0	0.0	0.0	2.2	3.8	3.7	3.6	3.5	3.5	3.4	3.3	3.2	3.1	3.0	2.9	
	=> TUOS	0	0.0	0.0	0.0	3.4	5.8	5.7	5.6	5.5	5.5	5.4	5.3	5.2	5.1	5.0	4.9	
	=> NPV of TUOS	\$33.22																
Total TUOS per year																		
			15.0	25.5	25.1	28.1	30.1	29.7	29.2	28.7	28.3	27.8	27.4	26.9	26.4	26.0	25.5	
NPV of total TUOS																		
	\$236.45																	
Cost of Losses																		
		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
	Losses after implementation (MW)	0	23.2	24.4	25.8	27.2	28.6	30.4	32.1	33.9	36.0	38.1	40.6	42.5	44.4	46.5	48.7	
	Cost of Losses \$	0	1.8	1.8	2.0	2.1	2.2	2.3	2.4	2.6	2.7	2.9	3.1	3.2	3.4	3.5	3.7	
	=> NPV of Cost of Losses	\$22.16																
Reliability Costs																		
		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
	=> NPV of Reliability Costs	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	\$0.00																	
Total for Option 1																		
	\$258.61																	

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Scenario A		Low load Growth																	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26			
Option 2 Kilburn By-pass		0																	
	292.845	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26			
	292.845	0	307.5	296.7	289.8	283.0	276.2	269.3	262.5	255.7	248.8	242.0	235.2	228.3	221.5	214.7			
	45		6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8			
	0.015		2.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6			
	0.0717		12.9	21.8	21.3	20.8	20.3	19.8	19.3	18.8	18.3	17.8	17.4	16.9	16.4	15.9			
		0	19.5	33.2	32.7	32.2	31.7	31.2	30.8	30.3	29.8	29.3	28.8	28.3	27.8	27.3			
Install 2nd East Tce tfr	51.1905	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26			
	51.1905	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	45		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	0.015		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	0.0717		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
		0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Total TUOS per year			19.5	33.2	32.7	32.2	31.7	34.7	36.6	36.0	34.8	34.3	33.7	33.1	32.5	32.0			
NPV of total TUOS		\$290.87																	
Cost of Losses																			
Losses after implementation (MW)			10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
Cost of Losses \$			0	20.0	21.1	22.2	23.4	24.9	26.1	27.6	29.1	30.5	32.4	34.4	36.7	38.7	40.5	42.4	
=> NPV of Losses		\$19.07	0	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.6	2.8	2.9	3.1	3.2	
Reliability Costs																			
=> NPV of Reliability Costs			10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
			0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total for Option 2		\$309.93																	

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Scenario B			Medium load Growth														
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Option 2			0														
Kilburn By-pass	292.845																
* WDV	292.845	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
* Depreciation over	45		307.5	303.5	296.7	289.8	283.0	276.2	269.3	262.5	255.7	248.8	242.0	235.2	228.3	221.5	214.7
* Opex	0.015		4.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
* WACC	0.0717		2.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
=> TUOS		0	12.9	21.8	21.3	20.8	20.3	19.8	19.3	18.8	18.3	17.8	17.4	16.9	16.4	15.9	15.4
=> NPV of TUOS	\$265.13		19.5	33.2	32.7	32.2	31.7	31.2	30.8	30.3	29.8	29.3	28.8	28.3	27.8	27.3	26.8
Install 2nd East Tce tfr																	
	51.1905	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
* WDV	51.1905	0	0.0	0.0	0.0	0.0	53.8	53.1	51.9	50.7	49.5	48.3	47.1	45.9	44.7	43.5	42.3
* Depreciation over	45		0.0	0.0	0.0	0.0	0.7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
* Opex	0.015		0.0	0.0	0.0	0.0	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
* WACC	0.0717		0.0	0.0	0.0	0.0	2.2	3.8	3.7	3.6	3.5	3.5	3.4	3.3	3.2	3.1	3.0
=> TUOS		0	0.0	0.0	0.0	0.0	3.4	5.8	5.7	5.6	5.5	5.5	5.4	5.3	5.2	5.1	5.0
=> NPV of TUOS	\$29.37																
Total TUOS per year			19.5	33.2	32.7	32.2	35.2	37.1	36.5	35.9	35.3	34.7	34.2	33.6	33.0	32.4	31.9
NPV of total TUOS	\$294.49																
Cost of Losses																	
Losses after implementation (MW)		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Cost of Losses \$		0.00	20.5	21.6	22.8	24.0	25.5	26.8	28.3	29.8	31.3	33.2	35.3	37.6	39.7	41.5	43.5
=> NPV of Losses	19.56	0.00	1.6	1.6	1.7	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.7	2.8	3.0	3.1	3.3
Reliability Costs																	
		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
=> NPV of Reliability Costs	\$0.00	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total for Option 2	\$314.06																

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Scenario C		High load Growth																
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
Option 2			0															
Kilburn By-pass			0															
	292.845																	
*WDV	292.845	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
* Depreciation over	45		307.5	303.5	296.7	289.8	283.0	276.2	269.3	262.5	255.7	248.8	242.0	235.2	228.3	221.5	214.7	
* Opex	0.015		4.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	
*WACC	0.0717		2.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	
=> TUOS			12.9	21.8	21.3	20.8	20.3	19.8	19.3	18.8	18.3	17.8	17.4	16.9	16.4	15.9	15.4	
=> NPV of TUOS	\$265.13		19.5	33.2	32.7	32.2	31.7	31.2	30.8	30.3	29.8	29.3	28.8	28.3	27.8	27.3	26.8	
Install 2nd East Tce tfr																		
	51.1905	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
*WDV	51.1905		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
* Depreciation over	45		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
* Opex	0.015		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
*WACC	0.0717		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
=> TUOS			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
=> NPV of TUOS	\$33.22																	
Total TUOS per year			19.5	33.2	32.7	32.2	31.7	31.2	30.8	30.3	29.8	29.3	28.8	28.3	27.8	27.3	26.8	
NPV of total TUOS	\$298.35																	
Cost of Losses																		
Losses after implementation (MW)		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
Cost of Losses \$			21.2	22.3	23.6	24.8	26.4	27.7	29.3	30.8	32.4	34.3	36.5	38.9	41.0	42.9	45.0	
=> NPV of Losses	\$20.22		1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.6	2.8	2.9	3.1	3.2	3.4	
Reliability Costs																		
=> NPV of Reliability Costs	\$0.00	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total for Option 2	\$318.57																	