



# FINAL REPORT

## PROPOSED NEW LARGE TRANSMISSION NETWORK ASSET

### BEACONSFIELD WEST 330/132 kV SUBSTATION PROVISION OF A THIRD 330/132 kV TRANSFORMER

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## **EXECUTIVE SUMMARY**

This final report covers a proposal for the construction of a new large transmission network asset to overcome limitations in the capacity of the 330/132kV transformers at Beaconsfield West 330/132kV substation.

Section 1 provides a description of the context of this final report within the regulatory process and summarises the outcomes of that process.

Section 2 describes in detail the regulatory requirements, nature of the growing load in the area, the supply arrangements at Beaconsfield West, the limitations in the capacity of the 330 kV transformers at Beaconsfield West and the need for augmentation of that capacity. The agreed network performance requirements (planning criterion), against which the need and effectiveness of augmentation options are assessed, is presented.

In Section 3 one reasonable augmentation option, and a range of other potential options that were considered but not developed, are described. The one reasonable option involves the installation of a third 375 MVA 330/132 kV transformer at Beaconsfield West, on land to be acquired adjacent to the existing substation, by summer 2009/10.

The capital costs of this option are estimated to be \$15 million.

In Section 4 the results of an application of the regulatory test are presented. As there is only one option it is clearly the lowest cost option, nevertheless the present value of its costs are presented and are considered reasonable.

In Section 5 it is concluded that Option 1 satisfies the regulatory test. Consequently it is proposed to construct that option.



## **1. Introduction**

### **1.1. Purpose and Scope**

TransGrid owns the majority of the transmission network within NSW and is responsible, inter alia, for planning and developing its network to meet the requirements of customers within the state and to facilitate operation of the National Electricity Market (NEM). As part of its planning responsibilities and the requirements of the National Electricity Rules (the Rules) TransGrid consults with NEM registered participants, NEMMCO and interested parties on emerging limitations within its transmission network and options being considered to relieve them.

This final report has been prepared in accordance with Clause 5.6.6 (h) of the Rules. It relates to a proposal for a new large transmission network asset that will address emerging limitations in the capacity of the 330/132 kV transformers at Beaconsfield West 330/132 kV substation to reliably supply the load at that site.

It includes:

- A summary of the load forecast for the area;
- A description of the network reliability standard that has been adopted for planning purposes;
- A description of transmission network limitations identified by TransGrid that have led to the necessity for an augmentation of the transformer capacity at Beaconsfield West;
- A description of all reasonable network and non-network options that have been identified to meet these limitations;
- An analysis of the ranking of these options in accordance with the Australian Energy Regulator's (AER's) regulatory test;
- An assessment of the outcome of the regulatory test and proposed actions; and
- Information that may be relevant to persons who may wish to dispute any aspect of this final report.

### **1.2. Outline of Consultation Process**

TransGrid published a description of the limitations in the capacity of the network supplying the southern and inner metropolitan areas of Sydney in its Annual Planning Reports each year from 2002 - 2007. This covered network limitations that were emerging in a number of areas including Beaconsfield West. The APR 2007 included a separate item to cover limitations in the capacity of the transformers at Beaconsfield West and foreshadowed publication of an application notice.

In October 2007 TransGrid published an application notice covering a proposal for a new large transmission network asset that would address the network limitations described in Section 2.5. A summary of the application notice was published on NEMMCO's website on 30<sup>th</sup> November 2007. Interested parties were invited to make submissions in the period to 16<sup>th</sup> January 2008. No submissions were received. There was one enquiry relating to a possible network support proposal however that party did not make a submission.

TransGrid has applied the regulatory test to all known reasonable options to meet the network limitations described in this final report and have determined the option that satisfies the test.

Accordingly TransGrid has completed its obligations under clause 5.6.6 (b) of the Rules and will proceed in accordance with the proposed actions detailed in Section 5 of this final report.

Persons wishing to dispute any matter in this final report are referred to Section 6.

A summary of this final report has been published on NEMMCO's website.

## **2. Identification of a Necessity for Augmentation**

### **2.1. Regulatory Requirements**

#### **2.1.1. Requirements of the National Electricity Rules**

This final report covers a proposal for a new large transmission network asset.

The requirements of the National Electricity Rules for new large transmission network asset proposals are set out in Clause 5.6.6. This requires applicants (in this case TransGrid), inter-alia, to:

- Set out the reasons for proposing the new large transmission network asset, including the actual or potential constraint or inability to meet network performance requirements;
- Describe all reasonable network and non-network options to address the constraint;
- Rank the options in accordance with the principles of the AER's regulatory test including detailed analysis of why the applicant considers the new large transmission network asset satisfies the regulatory test;
- Provide analysis of why the applicant considers the new large transmission network asset is a reliability augmentation; and
- Provide an augmentation technical report or consents to proceed from affected TNSPs if the new large transmission network asset is likely to have a material internetwork impact.

These requirements are underpinned by Clause 5.6.2 (c) of the Rules, which requires that a necessity for an *augmentation* or *extension* to the transmission system should be identified by network service providers.

#### **2.1.2. Requirements of the Regulatory Test**

The regulatory test may be applied in either one of two ways. The regulatory test states that an option satisfies the test if:

- (a) in the event the option is necessitated principally by inability to meet the service standards linked to the technical requirements of schedule 5.1 of the NER or in applicable regulatory instruments - the option minimises the costs of meeting those requirements, compared with alternative option/s in a majority of reasonable scenarios;
- (b) in all other cases - the option maximises the expected net economic benefit to all those who produce, consume and transport electricity in the national electricity market compared to the likely alternative option/s in a majority of reasonable scenarios. Net economic benefit equals the market benefit less costs.

The Rules define a reliability augmentation as:

A transmission network augmentation that is necessitated principally by inability to meet the minimum network performance requirements set out in schedule 5.1 or in relevant legislation, regulations or any statutory instrument of a participating jurisdiction.

Thus for reliability augmentations clause (a) of the test should be used. That is for reliability augmentations the option that passes the regulatory test is the one that minimises the cost of meeting the minimum network performance requirements set out in schedule 5.1 of the Rules or via a jurisdictional or customer requirement.

### **2.2. Jurisdictional Requirements – Reliability Criterion**

As stated in its Annual Planning Report, TransGrid is expected by the NSW jurisdiction to plan and develop its transmission network on an “N-1” basis. That is, there will be no inadvertent loss of load (other than load which is interruptible or dispatchable) following an outage of a single circuit (a line or a cable) or transformer, during periods of forecast high load.

In fulfilling this obligation TransGrid must also recognise specific customer requirements. Thus it may modify the standard N-1 approach where requested to do so by a distribution network owner or major directly connected end-use customer.

These requirements are underpinned by the introduction in 2005 of mandatory licence conditions for DNSPs which inter-alia set out reliability standards for subtransmission and distribution networks. The

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licence conditions specify N-1, one minute reliability levels at connection points supplying load greater than minimum values that range from 5-15 MVA depending on the type of load. The licence conditions also specify N-2 reliability levels for EnergyAustralia's network supplying the CBD area.

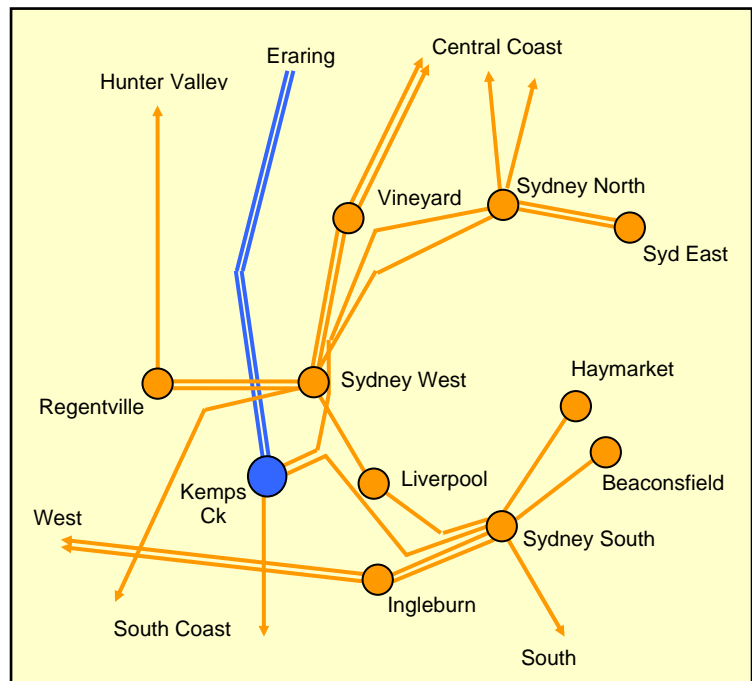
EnergyAustralia and TransGrid have agreed, when considering the need to augment the 330/132 kV transformer capacity at Beaconsfield West, to apply the same planning reliability criterion that is used for supply to the inner metropolitan area of Sydney. This is a "modified N-2" criterion and is implemented as follows:

1. With all network elements in service the loading on each element is not to exceed the "recurrent cyclic" rating of that element.
2. Following concurrent outages of a 330 kV cable or 132 kV cable and a 132 kV cable or a 330/132 kV transformer the loading on each remaining element is not to exceed the "recurrent cyclic" rating of that element whilst operator actions such as opening of other network elements and transferring of loads via lower voltage networks are taking place.
3. Following concurrent outages of a 330 kV cable or 132 kV cable and a 132 kV cable or a 330/132 kV transformer and following operator actions:
  - The loading on each remaining element is not to exceed the "recurrent cyclic" rating of that element; and
  - The voltage levels at end-user premises are to be within acceptable levels following switching of reactive plant and operation of transformer tap-changers.

### 2.3. Supply Arrangements at Beaconsfield

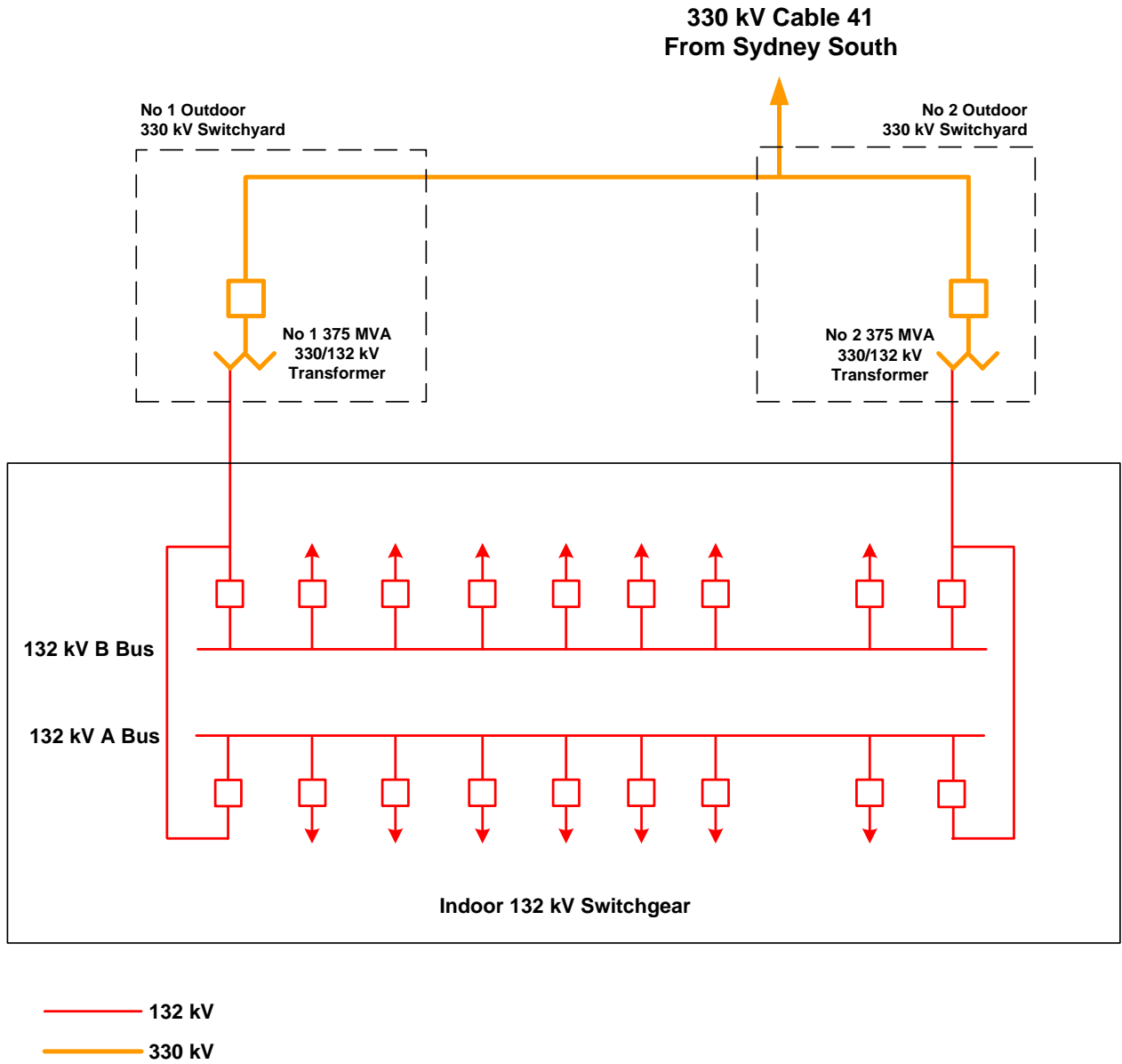
Beaconsfield West 330/132 kV substation is one of a number of 500 kV and 330 kV substations that individually provide supply to nearby suburban areas in Sydney and collectively provide supply to the Sydney CBD and surrounding suburbs as indicated in the diagram at right. They are interconnected by an extensive network of 330 kV and 132 kV transmission lines and cables owned by TransGrid and EnergyAustralia (not all shown in the diagram).

Beaconsfield West is connected to one of two 330 kV cables that emanate from Sydney South 330/132 kV substation. The other 330 kV cable terminates at Haymarket 330/132 kV substation.



At Beaconsfield West the 330 kV cable no 41 from Sydney South is terminated onto two 330/132 kV 375 MVA transformers in outdoor 330 kV switchyards. A number of 132kV substations in the Sydney CBD, inner western suburbs and eastern suburbs of Sydney are supplied from cables connected to the indoor 132 kV busbar. These supply arrangements are indicated in simplified form in the figure on the next page.

**Supply Arrangements at Beaconsfield West**



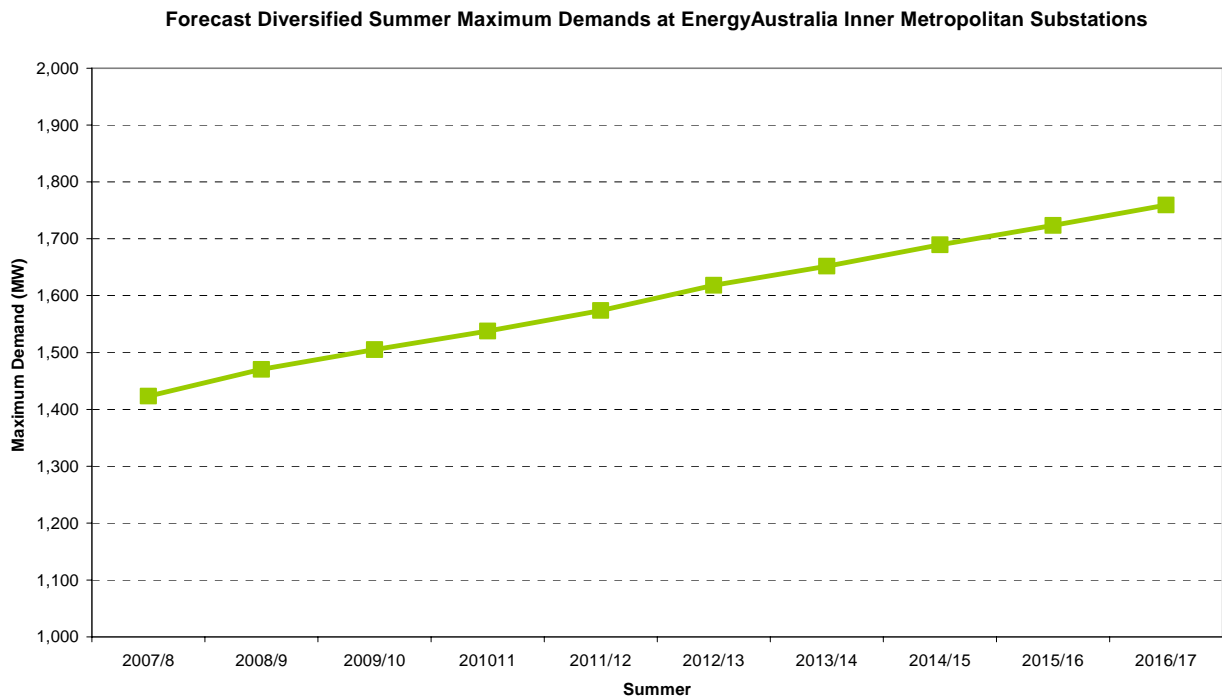
## 2.4. Local Load Forecast

The most recent forecast diversified loads at EnergyAustralia Inner Metropolitan Substations which are supplied in part by Beaconsfield West is given in Table 1 and depicted in Figure 1 below.

**Table 1 EnergyAustralia Inner Metropolitan Substations:  
Forecast Summer Maximum Demands**

Summer	MW
2007/08	1423.4
2008/09	1470.4
2009/10	1505.1
2010/11	1537.9
2011/12	1573.9
2012/13	1618.3
2013/14	1651.9
2014/15	1689.6
2015/16	1723.3
2016/17	1759.3

**Figure 1 - Forecast Diversified Summer Maximum Demands  
at EnergyAustralia Inner Metropolitan Substations**



## **2.5. Description of Network Limitations**

The transformer capacity at Beaconsfield West is expected to be adequate over a ten year planning horizon both with all network elements in service and for a single transformer outage at Beaconsfield West.

However the modified N-2 reliability criterion (refer to section 2.2) requires inter-alia the consideration of co-incident outages of a 330 kV cable and a 330/132 transformer. For a co-incident outage of the Sydney South – Haymarket 330 kV cable no 42 and a 330/132 kV transformer at Beaconsfield West the remaining in service transformer at Beaconsfield West would be overloaded during high load periods.

For this network limitation periods of risk have emerged. Therefore remedial measures need to be implemented as soon as practicable.

## **2.6. Joint Planning**

EnergyAustralia and TransGrid have jointly planned the 330 kV and 132 kV networks supplying the Sydney CBD and surrounding suburbs for many years. The most recent major increase in supply capacity to the inner metropolitan area, the establishment of Haymarket 330/132 kV substation and associated 330 kV cable from Sydney South, was facilitated by joint planning.

TransGrid and EnergyAustralia have carried out joint annual planning reviews as required by Clause 5.6.2 (b) of the Rules. As required by Clause 5.6.2(c) they have identified that the constraints described in Section 2.5 give rise to a need for a network augmentation.

Arising from this joint planning is the network option described in Section 3.

## **2.7. Reliability Augmentation**

It follows from Sections 2.1 – 2.5 that the proposals covered by this final report constitute a reliability augmentation and that the regulatory test will be applied in accordance with Clause 1(a) of the test.

## **2.8. Material Internetwork Impact**

The Rules require TransGrid to assess whether a proposed new large network asset is reasonably likely to have a material internetwork impact. TransGrid has determined that none of the options described in Section 3 will impose power transfer constraints or adversely impact on the quality of supply to EnergyAustralia's transmission networks.

## **2.9. Consideration of DSM and Local Generation**

TransGrid and EnergyAustralia are presently undertaking a demand management program aimed at reducing the rate of growth of the summer maximum demand in the inner metropolitan area of Sydney. The above load forecast incorporates the impact of this program.

TransGrid and Energy Australia will continue to address demand management issues in the area to ensure that demand management has been fully utilised to defer the need for network augmentation if possible.

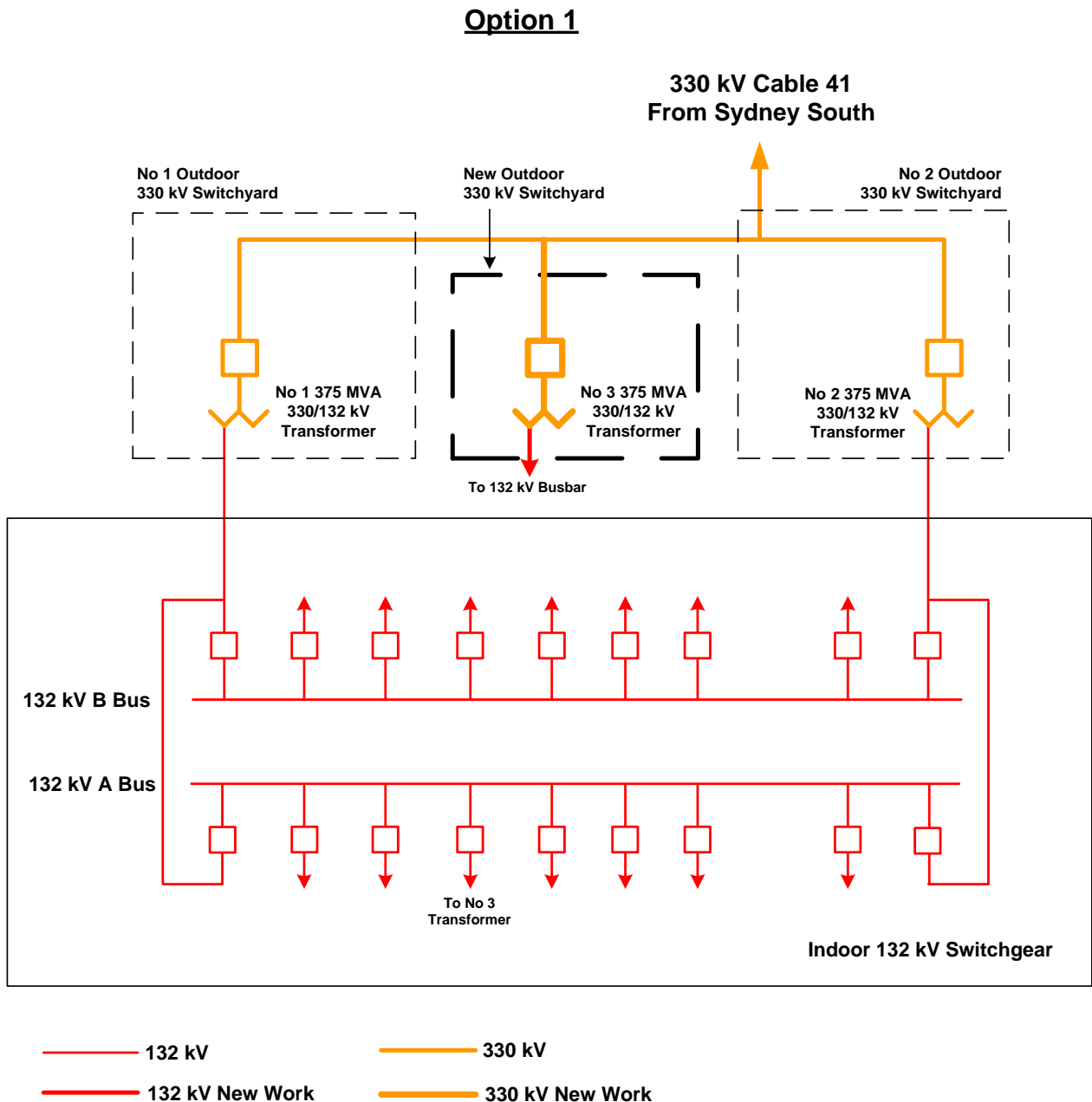
### 3. Options

Through joint planning TransGrid and EnergyAustralia have developed one reasonable network option to meet the network limitations described in Section 2.5. This is described in Section 3.1. Other developments that were considered but that have not been put forward as reasonable options are described in Section 3.2.

#### 3.1. Option 1

Option 1 would involve installation of a third 375 MVA 330/132 kV transformer at Beaconsfield West by summer 2009/10. The new transformer would be connected similarly to the other two transformers at Beaconsfield West; to the 330 kV cable no 41 from Sydney South and to the 132 kV busbar. There is not sufficient space at Beaconsfield West to accommodate this development. Therefore an extension of the Beaconsfield West site would be required. A suitable site has been identified adjacent to the existing substation.

This option is illustrated in the figure below.



## **3.2. Other Developments that were Considered**

### **3.2.1. Transfer of Beaconsfield Load to other Load Areas**

It is not possible to transfer any part of the Beaconsfield load to other load areas without creating network limitations in other parts of the network that would require a network augmentation at least as costly as Option 1.

### **3.2.2. New 330 kV Substation in the Beaconsfield Area**

A new 330 kV substation in the Beaconsfield area (supplied from the existing 330 kV cable no 41) may be feasible but would be much more costly than Option 1. It could only be considered a reasonable option if Option 1 was not available or if it addressed other network limitations in addition to those described in Section 2.5.

Due to age and maintainability issues at Beaconsfield West the existing substation will have to be replaced in the medium term. A new substation site is likely to be needed to meet that requirement; however this would not overcome the existing limitations in a timely manner.

### **3.2.3. Major New 330 kV Development**

To meet general requirements for development of supply to the Sydney CBD and inner metropolitan area a major new 330 kV development is being considered. This would involve the construction of significant 330 kV line, cable and substation works. Such a development would have a significant lead time for planning and construction with 2012/13 being considered for the initial stage of completion. Suitable options must address a number of network limitations including those that are remote from the Beaconsfield area. For these reasons it is not considered reasonable to incorporate the Beaconsfield transformer capacity limitations into this development.

This development will be consulted upon separately.

## **4. Application of the Regulatory Test**

An application of the regulatory test considering the single network option has been carried out. A summary of the results is presented in the following sections.

### **4.1. Form of the Regulatory Test**

As discussed in Section 2 the new large transmission network asset covered by this final report is a reliability augmentation and the regulatory test is to be applied in accordance with Clause 1(a) of the test:

- (a) in the event the option is necessitated principally by inability to meet the service standards linked to the technical requirements of schedule 5.1 of the NER or in applicable regulatory instruments - the option minimises the costs of meeting those requirements, compared with alternative option/s in a majority of reasonable scenarios;

TransGrid's interpretation of the regulatory test for reliability augmentations is as follows.

The following costs should be included:

- Capital costs of options;
- O&M costs of options; and
- Costs of complying with laws, regulations and applicable administrative requirements in relation to the option;

The following avoided costs should not be included:

- Reductions in electrical losses;
- Reductions in unserved energy;
- Deferrals or avoidance of generation or transmission investment elsewhere in the NEM (ie not associated with the option); and
- Avoided fuel costs elsewhere in the NEM.

Market development scenarios are only relevant to the extent that they affect the timing of the onset of network limitations and/or the ability of options to meet those limitations.

### **4.2. Preliminary Regulatory Test Application - Summary**

#### **4.2.1. Costs**

For the regulatory test application only the capital and operating & maintenance costs of Option 1 have been explicitly included.

There are no known committed, advanced or publicly announced generation developments that are likely to affect the timing of the onset of the network constraints described in Section 2.5 or the ability of Option 1 to meet those constraints.

As there is only one option being considered the operation of government tax or subsidy schemes need not be explicitly included as they will not affect the ranking of options. Similarly the inclusion of other network constraints in the area that may occur within the 10 year planning horizon need not be explicitly included.

#### **4.2.2. Scenarios**

There are no known committed, advanced or publicly announced generation developments that are likely to affect the timing of the onset of the network constraints described in Section 2.5 or the ability of Option 1 to meet those constraints.

The need for Option 1 is determined by a network limitation that is current and as discussed in Section 2.5 remedial measures must be implemented as soon as practicable. Variations in the load forecast due, for example to different economic growth rates will not affect this requirement.

Considering the above factors only a single market development scenario has been considered, which corresponds to a medium economic growth outcome and which does not explicitly model NEM generation developments.

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**4.2.3. Results**

The present value of costs of Option 1 has been calculated for a base case of financial and technical assumptions. Sensitivity tests of these calculations due to reasonable variations to the major assumptions have been carried out.

The base case assumptions and the range over which sensitivity tests were conducted are shown in Table 2. The results of the analysis are shown in Table 3 and Table 4. Details of the base case economic model are shown in Appendix A.

**Table 2 Base Case Values and Range of Values Used in Sensitivity Checks**

Parameter	Base Case Value	Sensitivity Checks at
Real Discount Rate	9%	6% and 12%
Annual O&M Cost	2% of Capital Cost	1% and 3% of Capital Cost
Asset Lifetimes Transformers	30 years	20 and 40 years
Capital Costs	Nominal Value	±25% increase

**Table 3 Comparison of Options – Base Case**

Option	Description	PV of Costs (\$M)	Rank
Option 1	Installation of a third 375 MVA 330/132 kV transformer at Beaconsfield West.	9.1	1

**Table 4 Comparison of Options - Results of Sensitivity Studies**

Sensitivity Case	PV of Costs of Option 1 (\$M)	Rank
Base Case	9.1	1
12% Discount Rate	9.0	1
6% Discount Rate	8.9	1
25% Increase in Capital Costs	11.4	1
25% Decrease in Capital Costs	6.8	1
Decrease in Asset Lives	9.9	1
Increase in Asset Lives	8.7	1
Decreased O&M Cost	8.5	1
Increased O&M Cost	9.8	1

Clearly as there is only one option this is the highest ranked option in each case. These results have been included because:

- Sensitivity testing on key input variables is a mandatory requirement of the regulatory test; and
- To show that for the range of key input variables, the present values of costs of Option 1 are reasonable.



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**Appendix A - Least Cost Analysis of Base Case**

**Beaconsfield West 3rd 330/132 kV Transformer - Preliminary Application of the Regulatory Test: Option 1**

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Residual
Install 3rd 330/132 kV Tx Including Land Purchase			15.0									-10.5
O+M Costs				0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	
Total Expenditure			15.00	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	-10.50
<b>PV of Costs (\$Million)</b>	<b>9.1</b>											
<b>Total Capex Costs (\$Million)</b>	<b>15.0</b>											