



## **FINAL REPORT**

# **PENNANT HILLS 11kV ZONE DEVELOPMENT**

**22<sup>nd</sup> September 2008**

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## EXECUTIVE SUMMARY

This paper has been prepared to report on upgrade work that is proposed to develop the electricity supply network in the Pennant Hills load area in accordance with Clause 5.6.2 (h) of the National Electricity Rules. The work proposed by this report is classified as a new small distribution asset.

A Distribution Network Service Provider does not need to consult on an option which would be a new small network asset. Accordingly, EnergyAustralia has not previously consulted on this project.

To provide a safe and reliable electricity supply for existing customers and provide capacity for future loads, EnergyAustralia is faced with a primary need to provide additional supply system capacity to meet forecasted load demands. The provision of additional capacity is required to meet network performance requirements set by EnergyAustralia in accordance with Schedule 5.1 of the Rules.

This report covers the following issues:

**Section 1** of the paper provides a background of the Pennant Hills zone substation supply area and the need for augmentation of the 11kV network.

**Section 2** describes the issues associated with the increase in 11kV feeder loading and the projected load forecast. The concept of service standard, as implemented by EnergyAustralia is discussed.

**Section 3** describes the proposed augmentation in relation to the National Electricity Rule (the Rules). Pennant Hills zone substation and its associated 11kV distribution network is classified as a distribution system asset by the Rules, and the proposed development is classified as a small network asset as it involves expenditure of below \$10 million.

**Section 4** describes the options that were considered, including Demand Management:

- Option 1 – A new feeder from Pennant Hills zone via route 1.
- Option 2 – A new feeder from Pennant Hills zone via route 2.
- Option 3 – A new feeder from Hornsby zone.

**Section 5** presents a cost analysis of the options presented in Section 4.

**Section 6** concludes the preferred option is Option 1 – A new feeder from Pennant Hills zone via route 1.

The conclusion to develop Option 1 is made on a least cost test (in accordance with the Regulatory Test) to provide increased future capacity and to meet EnergyAustralia's reliability standard. The estimated capital cost for this option is \$1.8 million and is scheduled for completion in July 2009.

## 1. BACKGROUND

This Final Report has been prepared to advise on the upgrade work that is proposed to be carried out on the 11kV network at Pennant Hills which is a part of North West Sydney load area to maintain loading within reliability standards. The information provided includes:

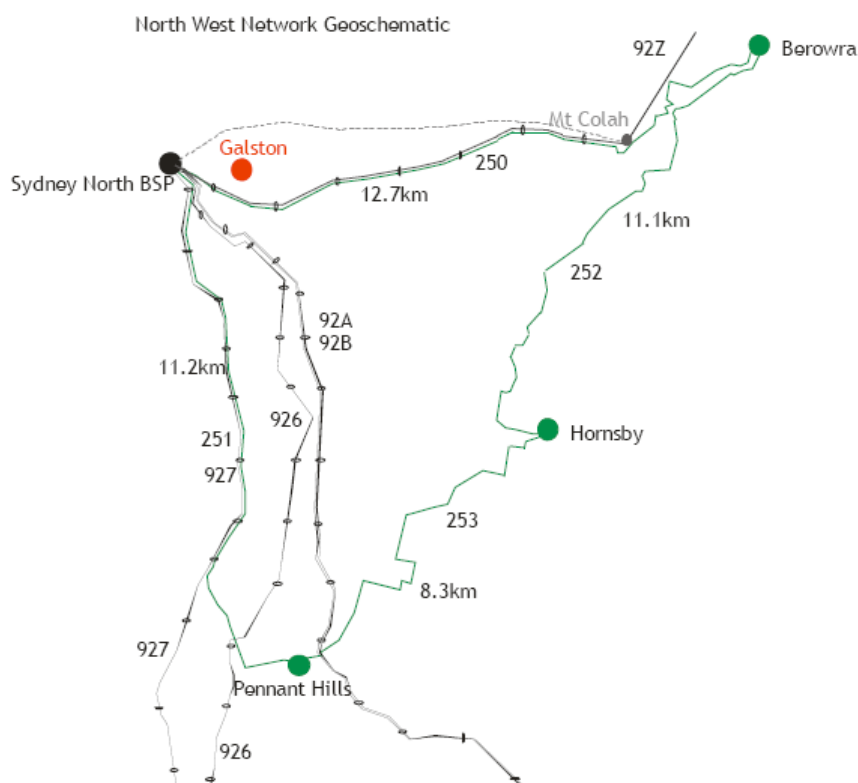
- A discussion of emerging supply system limitations identified by EnergyAustralia that have lead to the necessity for augmentation of the distribution network in the area.
- A discussion of the service standard that has been adopted for planning purposes.
- Descriptions of options for development of the electricity supply in the area.
- Details of the outcomes of cost effectiveness analysis for the options that have been considered.

Pennant Hills 132/11kV zone substation was commissioned in 1983 and is equipped with two 45MVA 132/11kV transformers and one 50MVA 132/11kV transformer. It is supplied by overhead feeder 253 connected to Hornsby Zone Substation and another overhead feeder 251 from Sydney North Bulk Supply Point (BSP).

Pennant Hills zone supplies the suburbs of Beecroft, Carlingford, Cheltenham, Pennant Hills, Dural, Normanhurst, Thornleigh, Cherrybrook, Hornsby and Westleigh. Currently, several 11kV feeders are approaching EnergyAustralia service standard load limit in the normal state and any contingency failures on these feeders at times of high or peak loading can not be adequately restored in accordance with the Design Planning Criteria.

Action is required to ensure loading on the constrained 11kV feeders remains within the service standard.

Below is a geographic diagram of the North West Sydney network area.



**Figure 1: Current Configuration in the North West Sydney Load Area**

## **2. ISSUES**

### **2.1. Applied Service Standard**

The service standards that are applicable to a consideration of supply constraints affecting the Pennant Hills supply area are summarised below:

#### **2.1.1. Applicable to all Network Elements**

The minimum requirement for any network element is that, with all elements in service, the thermal capacity is required to meet at least 115% of forecast demand. The requirements described in the following sections are additional to this requirement.

#### **2.1.2. Overhead Subtransmission Line and Zone Substations**

For a failure of a single critical element (i.e. N-1 conditions) within zone substations supplying greater than 10MVA of load and for overhead subtransmission network, the forecast demand is not to exceed the thermal capacity for more than 1% of the time i.e. a total aggregate time of 88 hours per annum; up to a maximum of 20% above the thermal capacity. Recovery of load should be within one minute.

Under normal conditions (i.e N conditions), the thermal capacity is required to meet at least 115% of forecast demand.

#### **2.1.3. 11kV Distribution Network**

For urban feeders (i.e. feeders with an actual maximum demand greater than 0.3MVA/km), the expected demand is to be no more than 80% of feeder thermal capacity (under system normal operating conditions), with switchable interconnection to adjacent feeders to enable restoration following an unplanned failure of a single network element (i.e. N-1 conditions). The 11kV network where in a number of feeders forms an interrelated system, the limits apply to the average loading of the feeders within the one system.

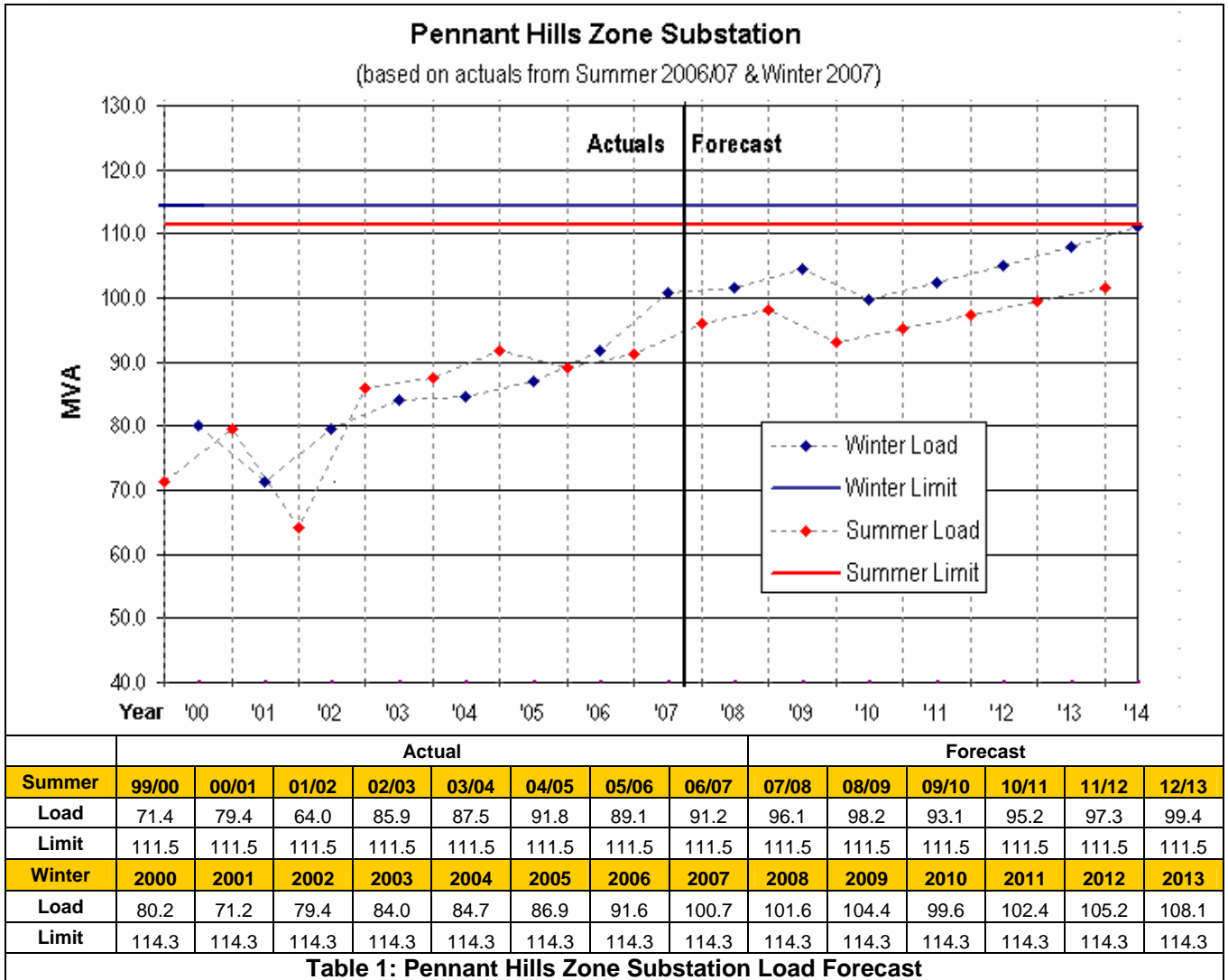
For 11kV networks, voltage drops of up to 5% are regarded as satisfactory. Higher voltage drops are permissible provided that the network connection provided to low voltage customers is within the limits specified in Australian Standard AS2926.

### **2.2. Description of Network Constraints**

#### **2.2.1. Pennant Hills Zone Substation**

Pennant Hills Zone Substation has a firm capacity of 111.5MVA in summer and 114.3MVA in winter. The load is forecast not to exceed firm capacity until beyond 2015.

Load forecast for Pennant Hills Zone Substation is shown in the graph below.



**2.2.2. Pennant Hills Zone 11kV Network**

Under current loading conditions, the 11kV feeders supplied from panels 26 and 44 at Pennant Hills zone do not comply with Design Planning Criteria with summer and / or winter load levels in excess of 80% utilisation under normal operating conditions. Additionally, any emergency switching at these panels will be restricted following a first contingency 11kV outage at times of peak load. These restrictions would result in load not being able to be picked up, or not being able to meet the 11kV network service standard under the N-1 condition.

These issues with the 11kV network result in the necessity to carry out the augmentation for the Pennant Hills 11kV distribution network described in this report.

**3. TYPE OF AUGMENTATION**

The requirements of the National Electricity Rules (the Rules) for new asset proposals are outlined in Section 5.6 and depend on the cost, purpose and function of the new asset.

The 11kV Pennant Hills zone development is classified as distribution system assets by the Rules. The Rules (clauses 5.6.2(e) and (f)) require that, where analysis indicates that any relevant technical limits of a distribution system will be exceeded, that the Distribution Network Service Provider (DNSP) must notify any affected Registered Participants of these limitations and of the expected time for corrective action and consult with affected Participants and interested parties on the possible options to address the projected limitations of the relevant distribution system. A

Network Service Provider does not need to consult on a network option that would be a small network asset, or for options that do not augment the system.

Each of the options considered under Section 4 are considered new small distribution network assets as they involve a network augmentation with expenditure less than \$10 million. A DNSP is not required to consult of a project that is a new small distribution asset and hence no consultation paper was issued in regards to this project.

The new capacity provided by the proposed augmentation has been necessitated by the need to meet the service standard described in Section 2 and has therefore been treated as a reliability driven augmentation for the purposes of the Regulatory Test. Consequently, EnergyAustralia has used a least cost test to examine the options identified to address projected system limitations.

## 4. OPTIONS CONSIDERED

### 4.1. Demand Management

An assessment of Demand Management opportunities in the Pennant Hills area was carried out in May 2008. To achieve a one year deferral of the proposed investment, a Demand Management option would need to identify and implement 1.9MVA of demand management on feeders 26 & 44 by November 2009. This represents 17% of the total demand of the group of feeders, and the demand reduction would need to be targeted in the specific locations that will enable all loads to be served during critical failures. The savings from a one year deferral is \$74/kVA, which is low.

Considering the large size of the demand reduction required, the relatively low savings, and short time frame, the Demand Management screening test concluded that it is not reasonable to expect that demand management could defer the proposed investment cost effectively.

### 4.2. Option 1 – A new feeder from Pennant Hills zone via route 1

This option involves developing a new 11kV feeder of 1.35km route length from Pennant Hills zone to the vicinity of the Thorn St and Bellamy St intersection using existing ducts where available and a number of open point changes on the network. The new feeder and subsequent network re-configuration will ensure that feeders connected to panels 26 and 44 will meet the required service standard.

The following utilisation summary shows the constrained 11kV feeders at Pennant Hills before and after the proposed work. It considers the inter-related group of feeders – 26, 44, 33 and the new proposed feeder connected to panel 43. However, the average normal state utilisation does not reflect the ability of feeders to carry emergency loads, nor the reality that the pick up scenarios can often be worse than the percentages indicate.

Average Normal State Utilisation	Do Nothing		After Option 1	
	Current Utilisation	Forecast Utilisation - 6 Years	Current Utilisation	Forecast Utilisation - 6 Years
Panel 26	99%	129%	59%	77%
Panel 44	85%	110%	34%	45%
Panel 33	35%	46%	58%	76%
Panel 43 (new)	N/A	N/A	57%	74%

Table 2: Utilisation Summary Before and After Option 1

The total estimated capital cost of this option is \$1.8M. The Net Present Cost (NPC) is \$1.7M.

### 4.3. Option 2 – A new feeder from Pennant Hills zone via route 2

This option requires installation of new feeder of 3.5km route length from Pennant hills zone to the panel 26 tee to S 2696 Chilvers. The forming of a new feeder split the existing panel 26 feeder to

relieve existing loads. Additionally, it also involves a number of open point changes to balance the loads on the feeders in the area. This option meets the required service standard on the feeder panels 26, 44 & 33.

The total estimated capital cost of this option is \$3M. The Net Present Cost (NPC) is \$2.9M.

#### 4.4. Option 3 – A new feeder from Hornsby zone

This option involves installation of a new feeder of 6.5km length from Hornsby zone to the vicinity of the Thorn St and Bellamy St intersection with the same open point changes and network reconfiguration as detailed in Option 1.

The total estimated capital cost of this option is \$5M. The Net Present Cost (NPC) is \$4.8M.

## 5. ANALYSIS OF OPTIONS

### 5.1. Base Case Analysis

The results of the base case economic analysis are summarised in table 3 below using the base discount rate of 8.5%.

Options	NPC (\$M) *	Capital Cost (\$M)
Option 1: A new feeder from Pennant Hills zone via route 1	1.7	1.8
Option 2: A new feeder from Pennant Hills zone via route 2	2.9	3.0
Option 3: A new feeder from Hornsby zone	4.8	5.0

\* The net present cost includes operation and maintenance cost

**Table 3: Base Case Economic Analysis**

Refer to Appendix A for further details of the base case economic analysis.

Under the base case condition, Option 1 is the least cost option.

### 5.2. Sensitivity Analysis

The NPC results for variations in discount factor and capital cost are shown in table 4 below:

Scenario	NPC		
	Option 1 (\$M)	Option 2 (\$M)	Option 3 (\$M)
7% discount factor	1.8	3.0	4.9
10% discount factor	1.7	2.9	4.8
25% decrease in capital cost	1.3	2.2	3.6
25% increase in capital cost	2.2	3.6	6.1

**Table 4: NPC results for variations in discount factor and capital cost**

Option 1 is the least cost option under all analysed sensitivity scenarios.

#### 5.2.1 Variations in Load Growth Rates

Variation in load growth rates will not affect the cost of the supply options as the 11kV network is already constrained at time implementation of the preferred option. Hence, it is not included in the sensitivity analysis.

## **6. CONCLUSION**

Option 1 is the least cost option for all analysed scenarios and is thus the recommended course of action to be taken by EnergyAustralia.

EnergyAustralia intends to develop a new 11kV feeder of 1.35km from Pennant Hills zone substation to ensure the service standard is met for the 11kV distribution network in the Pennant Hills load area. All works are anticipated to be completed by July 2009.

This service availability date may change if the project is affected by circumstances beyond EnergyAustralia's control, such as changes in the timing of customer load increases or other issues such as: delays in the approval process, equipment supply difficulties, unforeseen technical constraints, acts of God and industrial action.

## 7. APPENDIX A – ECONOMIC ANALYSIS OF BASE CASE

WACC = 0.085

**Option 1** – A new feeder from Pennant Hills zone via route 1

Actions	NPV (\$M)	CAPEX (\$M)	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Total estimated capital cost	1.62	1.79	0.00	1.33	0.46							
Operation & Maintenance	0.10			0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
<b>Total</b>	<b>1.72</b>	<b>1.79</b>										

**Option 2** – A new feeder from Pennant Hills zone via route 2

Actions	NPV (\$M)	CAPEX (\$M)	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Total estimated capital cost	2.71	3.00	0.00	2.23	0.77							
Operation & Maintenance	0.17		0.00	0.00	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.04
<b>Total</b>	<b>2.87</b>	<b>3.00</b>										

**Option 3** – A new feeder from Hornsby zone

Actions	NPV (\$M)	CAPEX (\$M)	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Total estimated capital cost	4.52	5.00	0.00	3.71	1.29							
Operation & Maintenance	0.28		0.00	0.00	0.02	0.06	0.06	0.06	0.06	0.06	0.06	0.06
<b>Total</b>	<b>4.79</b>	<b>5.00</b>										

1) All costs are quoted in 2007/08 real dollars. Year 07/08 refers to 2007/08.