NEED/OPPORTUNITY STATEMENT (NOS)

Making the Grid Smarter - Yass 330 kV Area Loads Special Protection System (SPS)

NOS- 000000001472 revision 2.0

Ellipse project no.: P0008572
TRIM file: [TRIM No]

Project reason: The project improves network security.
Project category: Prescribed - Augmentation

Approvals

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Date submitted for approval	12 December 2016	

1. Background

The National Electricity Rules (NER) require TransGrid to consider the effects of non-credible (e.g. multiple) contingencies that may give rise to cascading failures. AEMO, AEMC and TransGrid have all identified the need for investment to prevent or minimise the effects of interruptions following a non-credible event.

NER Requirements

TransGrid is required to operate the NSW transmission system according to the provisions of the NER. The NSW main system is planned and operated taking into account single credible contingencies defined under Clause S5.1.2.1 of the NER:

> *Network Service Providers must plan, design, maintain and operate their transmission networks and distribution networks 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, whether or not accompanied by the occurrence of certain faults (called credible contingency events).*

In addition to planning for and managing credible contingencies, Clause S5.1.8 of the NER specifies requirements for non-credible contingencies including provision for emergency controls to minimise disruption to the transmission network and to significantly reduce the probability of cascading failure:

> *In planning a network a Network Service Provider must consider non-credible contingency events such as busbar faults which result in tripping of several circuits, uncleared faults, double circuit faults and multiple contingencies which could potentially endanger the stability of the power system. In those cases where the consequences to any network or to any Registered Participant of such events are likely to be severe disruption a Network Service Provider and/or a Registered Participant must install emergency controls within the Network Service Provider's or Registered Participant's system or in both, as necessary, to minimise disruption to any transmission or distribution network and to significantly reduce the probability of cascading failure.* In the event of a partial or system wide collapse, there are potential impacts, including market impacts, associated with the loss of intra-regional or inter-regional transfers, loss of supply to large load areas and high market prices.

AEMO review

AEMO has undertaken a study under existing and future load growth and generation scenarios and have identified several non-credible contingencies that may result in voltage and/or frequency collapse within the NSW transmission system. AEMO commissioned a report titled *Potential sites for emergency control schemes (ECS) in the NEM* – 29 April 2013. This report states that significant stability constraints may arise under a number of non-credible conditions and states that these conditions show potential for the implementation of emergency control schemes to prevent widespread impacts on the network.

AEMC review

On 4 August 2010, the AEMC published the final report for the *Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events*. This report was commissioned in response to an extreme weather event (heat wave) in late January 2009 in Victoria and South Australia which resulted in supply interruptions to business and residential customers.

The Ministerial Council on Energy (MCE) (now the Standing Council on Energy and Resources (SCER)) provided a review of this report in June 2012. In this review the SCER supported further review of reliability and planning standards, including the NER to consider high impact-low probability events caused by Extreme Weather Events such as bushfires, drought or lightning which may result in significant loss of supply.

NSW experience

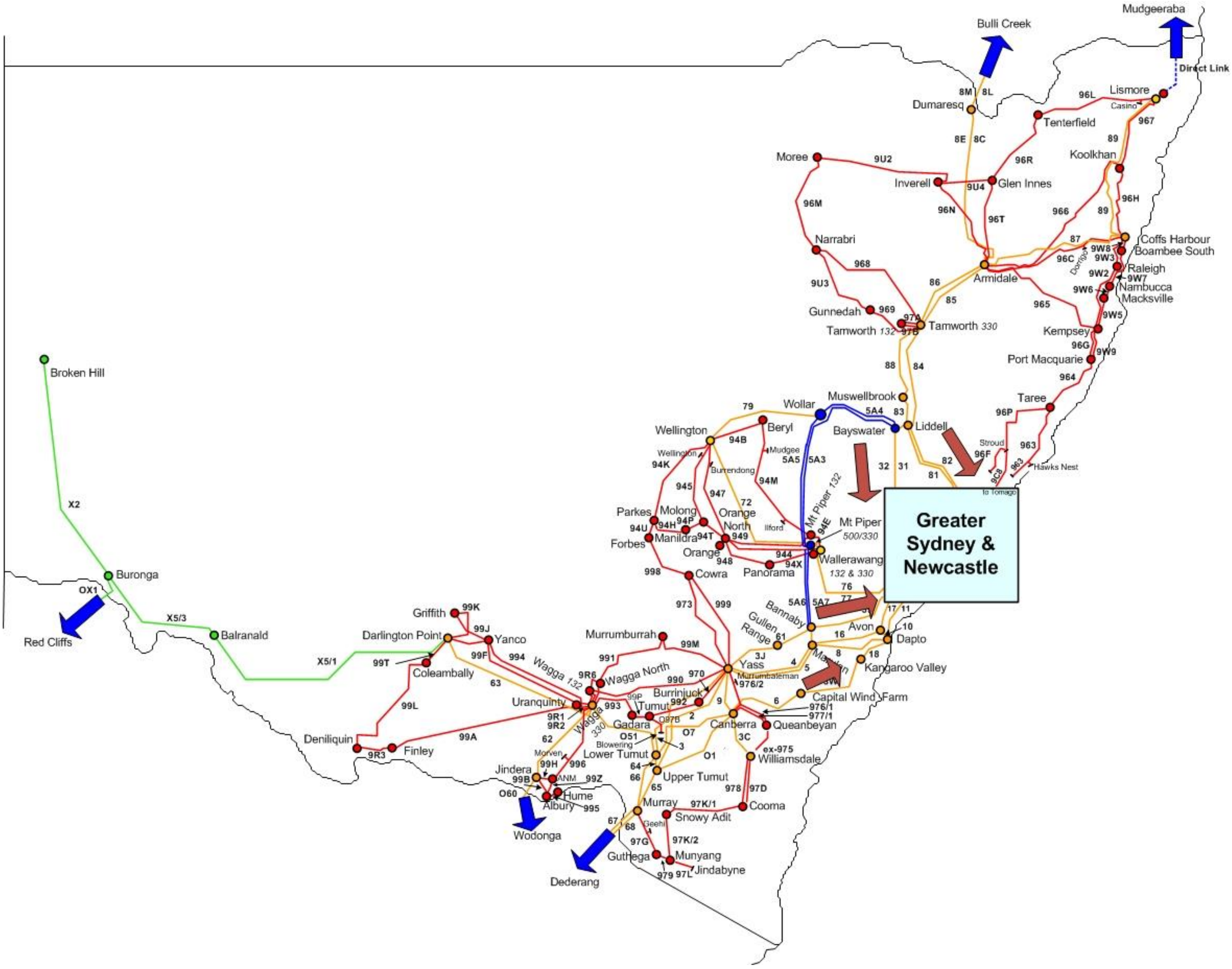
During drought conditions in 2001, widespread bushfires in NSW caused four of the six 330kV circuits south of Bayswater and Liddell power stations to trip repeatedly. The affected line pairs were 31 / 32 between Bayswater and Sydney, and 81 / 82 between Liddell and Newcastle.

Under these conditions, the Network Controller switched the circuits back into service to the extent permitted by the fires, and just managed to avoid a system voltage collapse by restoring one circuit only 50 seconds before a second parallel circuit tripped.

Similarly during bushfires in December 2002, various combinations of three, four and five concurrent line outages occurred in the network. The outages usually involved the line pairs 21 / 22 between the Central Coast and Sydney North, 25 / 26 between the Central Coast and Sydney West, 5A1 / 5A2 (500kV) between Eraring and Kemps Creek, and 76 / 78 between Wallerawang and Sydney South. These historical events indicate that multiple contingencies have a realistic probability of occurring.

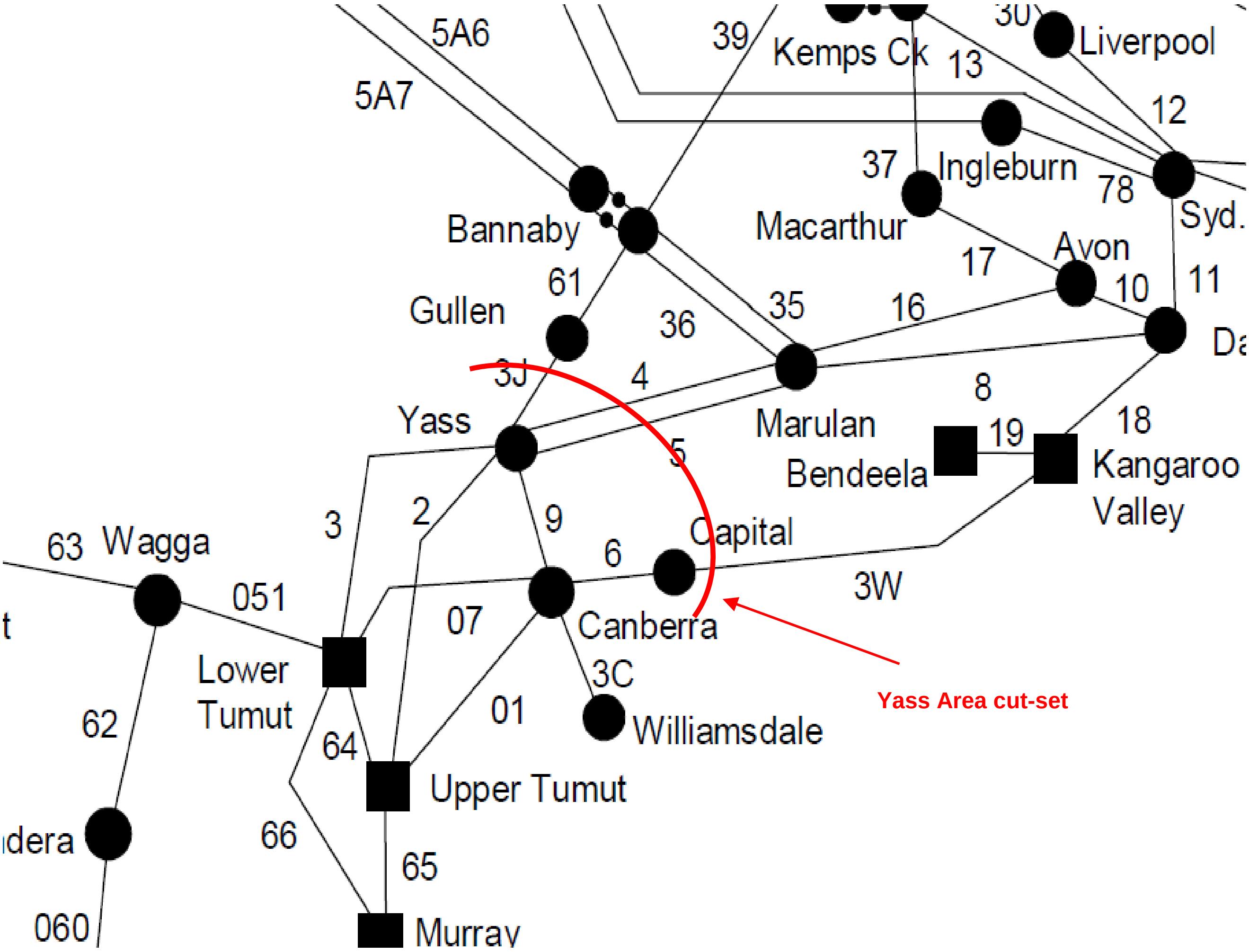
While 60 percent of NSW’s energy is generated west of the Great Dividing Range, it must be delivered to the east coast, where most of the state's load is located. The Sydney, Wollongong and Newcastle areas use 75 percent of the total energy used in NSW. A geographic diagram showing the transmission network power flows in these areas is provided below in Figure 1.

Figure 1: Power Flows into the Sydney /Newcastle/ Wollongong Load Area



TransGrid studies indicated that loss of both Yass – Marulan (4 and 5) and Yass – Bannaby 330 kV (3J or 61) lines at times of high transfer in a northerly direction from Snowy and Victoria could result in significant flows on the Canberra – Capital – Kangaroo Valley – Dapto 330 kV path. The flow could be more than 2000 MW. This could result in significant overloading leading to loss of the line (even damage to the lines). Such a multiple contingency event could result in voltage collapse and significant under-frequency in the NSW and QLD regions, and significant over-frequency in Victoria and South Australia. Refer Figure 2 for a network overview.

Figure 2: **330 kV lines feeding the Sydney metropolitan**



TransGrid

2. Need/opportunity

In order to meet the National Electricity Rules (NER) requirements to protect the NSW high voltage transmission system against high impact low probability multiple simultaneous contingencies, there is an opportunity for TransGrid to implement control, protection or other systems to manage the stability of frequency and voltage following these multiple contingencies.

2.1 Risks

The primary risk of TransGrid not addressing this need is a cost of unsupplied demand to customers in the greater Yass and Sydney area.

The risk cost was calculated using the Risk Tool, and considers the worst-case outage of multiple 330 kV lines within the Yass Area cut-set shown in Figure 2 causing a loss of load of 8,000 MW[1]. The load restoration time is estimated to be 8 hours[2] . Furthermore, during works to restore the load, it is expected that the demand will decrease over time, as such a factor of 0.5 is used to account for this. The probability of such an event occurring is deemed to be 1 in 100 years[3].

Unserved Energy Risk Cost

Unserved energy is calculated as:

$$Unserved\ Energy\ = (MW\ at\ risk * \ 0.5 * failure\ duration) * \ (overall\ failure\ rate)$$

$$Unserved\ Energy\ = (8000\ MW\ * \ 0.5\ * 8\ hrs)\ * \ 1\%$$

$$\therefore\ Unserved\ Energy\ = \ 320\ MWh$$

The risk cost of unserved energy has been calculated as follows:

$$Risk\ Cost\ of\ Unserved\ Energy\ = \ Unserved\ Energy\ * \ VCR$$

$$Risk\ Cost\ of\ Unserved\ Energy\ = \ 320\ MWh * \$38{,}350/MWh^4$$

$$\therefore\ Risk\ Cost\ of\ Unserved\ Energy\ = \ \$12.32\ million\ per\ year$$

Other Risk Cost

In addition there are financial and reputational risk costs totalling $0.25million[5].

Total Risk Cost

Total risk cost = Unserved energy risk cost + other risk costs

∴ Total risk cost = $12.57 million per annum.

[1] This event is noted to occur during severe bushfires, and it is expected that the NSW load will be at maximum demand, resulting in 8,000 MW load lost due to the worst case combination of multiple 330 kV line outages..

[2] Restoration time is based on TransGrid Control Room historical experience and OM666 Black Start.

[3] It is assumed that this type of outage is a 1 in 100 year event.

[4] TransGrid's Investment Risk Tool bases the Value of Customer Reliability (VCR) on figures published by AEMO in its Value of Customer Reliability Review - Final Report, September 2014. In this case we use the mixed residential/industrial figure of $38,350/MWh.

[5] The additional risks are due to this type of event occurring and the costs are derived from the risk tool.

3. Related needs/opportunities

- Need 1473 – North West 330kV Smart Grid Control
- Need 1482 – Sydney South 330 kV Smart Grid Controls
- Need 1484 – Snowy 330 kV Area Smart Grid Control
- Need 1487 – Eraring 500 kV Smart Grid Control
- Need 1491 – Sydney North West 330 kV Smart Grid Control
- Need 1522 – Sydney West Area 330 kV Smart Grid Control

4. Recommendation

It is recommended that options be evaluated to address the potential for voltage collapse and significant frequency excursions in the Yass area during the 2018/19 to 2022/23 Regulatory Control Period.

Attachment 1 Risk costs summary

Current Option Assessment - Risk Summary

Project Name: Yass 330 kV Area Loads Special Protection System

Option Name: 1472 - Base Case

Option Assessment Name: 1472 - Base case - Assessment 1

Rev Reset Period: Next (2018-23)

Major Component	No.	Minor Component	Sel. Hazardous Event	LoC x CoF ($M)	Failure Mechanism	NoxLoC xCoF ($M)	PoF (Yr 1)	Total Risk ($M)	Risk ($M) (Rel)	Risk ($M) (Op)	Risk ($M) (Fin)	Risk ($M) (Peo)	Risk ($M) (Env)	Risk ($M) (Rep)
Multiple lines 4_5_3J_61 outages	1	Conductor (inc Joints)	Unplanned Outage - HV (Multiple lines 4_5_3J_61 outages)	$1,257.20	Break	$1,257.20	1.00%	$12.57	$12.32		$0.00			$0.25
				$1,257.20		$1,257.20		$12.57	$12.32		$0.00			$0.25

Total VCR Risk: $12.27 Total ENS Risk:

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