NEED/OPPORTUNITY STATEMENT (NOS)

Making the Grid Smarter - Armidale north coast Line Overload Load Shedding (LOLS) Expansion

NOS- 000000001458 revision 2.0

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Project reason: Imposed Standards - Control Systems to meet NER requirements
Project category: –Prescribed - Augmentation

Approvals

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1. Background

The National Electricity Rules (NER) requires TransGrid to consider the effects of non-credible (e.g. multiple) contingencies which 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 has identified several non-credible contingencies which 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.

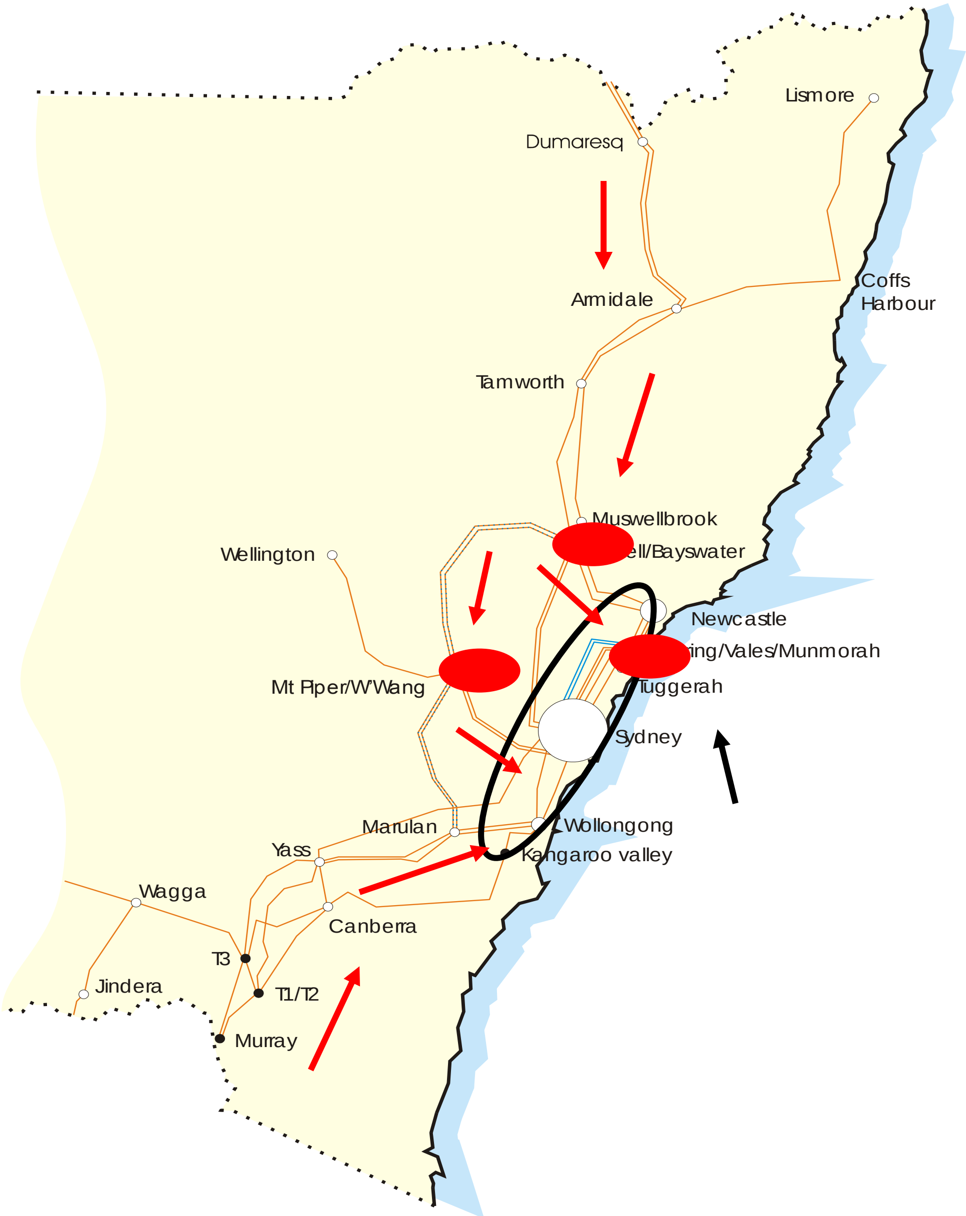
NSW experience

During drought conditions in 2001, widespread bushfires in NSW caused four of the six 330 kV 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 (500 kV) 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 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 have identified non-credible contingencies of both Line 87 and one of 132 kV lines (Line 965, 966, 96C, 96H, 96L and 96R) in Armidale north coast area could lead to overloading on 132 kV lines 966 and 96C. Armidale north coast Line Overload Load Shedding (LOLS) scheme was implemented to ensure that loading on 132kV lines 966 and 96C do not exceed their contingency ratings. Under the existing Armidale north coast LOLS scheme, if the power flow exceeds the contingency rating of any of these lines and the overload remains after a time delay of 25 seconds; the scheme commences tripping the following feeders in Table 1 at Coffs Harbour, Koolkhan, and Kempsey in the order given below, until the overload no longer exists.

Trip Sequence	Substation	Feeder	Voltage (kV)
Group 1	Coffs Harbour	703	66
Group 2	Koolkhan	0896	66
Group 3	Koolkhan	0825	66
		0826	66
Group 4	Kempsey	All	66 and 33
Group 5	Coffs Harbour	705	66
		706	66
Group 6	Coffs Harbour	711	66

Table 1 – Existing arrangement of Armidale north coast LOLS scheme

2. Need/opportunity

When the Armidale north coast LOLS scheme was implemented, 896 was the only feeder supplying Essential Energy's Maclean substation. However a second feeder (feeder 8G1) to Maclean substation was recently commissioned by Essential Energy. Hence load at Maclean will not be interrupted if only feeder 0896 is tripped under the existing LOLS scheme.

In order to meet the NER requirement to protect the NSW high voltage transmission system against high impact, low probability multiple simultaneous contingencies, there is a need to ensure that loading on 132kV lines 966 and 96C do not exceed their contingency ratings.

2.1 Risks

The primary risk of TransGrid not addressing this need is a cost of unsupplied demand to customers in Armidale north coast area.

The risk cost was calculated using the Risk Tool and as follows:

$$Unserved\ Energy = \sum_{\substack{i = for\ all \\ 132\ kV\ trips}} \left[MW\ at\ risk_i * P_{line\ 87\ failure} * P_i\right]$$

$$\therefore\ Unserved\ Energy\ =\ 52.7\ MWh^1$$

[1] Refer to the attached file "1458- Unserved Energy.xlsx"

Where:

- Failure rate of 330 kV line 87 = 0.324 / year with a restoration time of 17.8 hours
- Failure rate of North Coast 132 kV lines[2] = 0.39 /year per 100 km with a restoration time of 23.5 hrs
- Load at risk is the total North Coast area load once firm capacity is reached, as a cascading overloads will be the result of the LOLS scheme not working effectively

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

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

$$VCR\ Risk\ Cost\ of\ Unserved\ Energy = 52.7\ MWh * \$38{,}350/MWh^{3}$$

$$\therefore\ VCR\ Risk\ Cost\ of\ Unserved\ Energy = \$2.02\ million\ per\ year$$

In addition, there are financial, environmental and reputational risk costs of $1.08m per annum

Therefore the total risk cost is $3.1m per annum.

3. Related needs/opportunities

None.

4. Recommendation

It is recommended that options be evaluated to address the potential overload on Line 966 and 96C within the 2018-2023 regulatory period.

[2] This is the total failure rate for lines 965, 966, 96C, 96H, 96L and 96R – outage of these lines lead to increased loading on 966 and 96C.

[3] 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.

Attachment 1 Risk costs summary

Current Option Assessment - Risk Summary

Project Name: Armidale north coast Line Overload Load Shedding (LOLS) Expansion

Option Name: 1458 - Base Case

Option Assessment Name: 1458 - Preferred Option - 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)
Conductor Overload	1	Conductor (inc Joints)	Conductor Drop (Conductor Overload)	$4.42	Break	$4.42	70.00%	$3.10	$2.06		$0.04	$0.01	$0.35	$0.65
				$4.42		$4.42		$3.10	$2.06		$0.04	$0.01	$0.35	$0.65

Total VCR Risk: $2.02 Total ENS Risk: $0.00

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