OPTIONS EVALUATION REPORT (OER)

Mudgee Reinforcement

OER- 000000001697 revision 2.0

Ellipse project no(s): P0010130
TRIM file: [TRIM No]

Project reason: Reliability - To meet connection point reliability requirements
Project category: Prescribed - Augmentation

Approvals

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Date submitted for approval	9 January 2017	

Change history

Revision	Date	Amendment
0	8/11/16	Initial Issue.
1	27/11/16	Updated risk costs and NPVs.
2	9/01/17	Updated NPV of Option C to reflect need for reinvestment in battery storage after 10 years.

1. Need/opportunity

The Independent Pricing and Regulatory Tribunal (IPART) was asked to recommend a reliability planning standard for electricity transmission in NSW, and in doing so have recommended a new reliability standard based on levels of reliability redundancy and an annual unserved energy allowance.

IPART's optimisation model makes recommendations on the optimal value of expected unserved energy at each Bulk Supply Point (BSP) which the TNSP is expected to meet.

The new reliability standard is to be applied from 1 July 2018 for each BSP, should the NSW Minister for Infrastructure approve the *Electricity transmission reliability standards - Draft Report May 2016*[a] and the *Electricity transmission reliability standards - Supplementary Draft Report September 2015*[b]. The latter draft (supplementary) report advised that:

"The allowance for expected unserved energy for Mudgee that should be included in the NSW transmission reliability standard is 14 minutes (maximum value per year in minutes at average demand)."

2. Related needs/opportunities

These Needs are related in that they are also addressing an excess of unserved minutes per IPART's draft reliability standard[c]:

- Need 1696 – Molong Reinforcement
- Need 1649 – Reliability of Supply to Broken Hill

3. Options

Base case

This option is to continue to operate the present Mudgee 132 kV tee-arrangement and maintain the reliability level at the present 30 expected unserved energy (USE) minutes by using TransGrid's historical 132 kV transmission line outage data (refers to NOS-1697).There is an informal back-up for the Mudgee load available via Essential Energy's distribution network within about 1 hour. This back-up requires Essential Energy to manually close these connections to allow temporary supply to the Mudgee area.

The scope of the option is to maintain the present tee connection to Essential Energy's Mudgee substation arrangement through ongoing maintenance. There is no capital expenditure. However, this option would result in the Mudgee 132 kV tee-connection point not compliant with the proposed network reliability standard which does not meet the need and is therefore not technically feasible.

The primary risk for TransGrid not addressing the identified need is non-compliance with the *Draft Electricity Transmission Reliability Standards.*

The risk cost of not addressing this Need is therefore composed of the following components:

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[a] *Electricity transmission reliability standards - An economic assessment Energy — Draft Report May 2016, https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/investigation-section-12-publications-electricity-transmission-reliability-standards/draft_report_-_electricity_transmission_reliability_standards_-_may_2016.pdf, retrieved on 2nd December 2016.*

[b] *Electricity transmission reliability standards - Unserved energy allowances for Inner Sydney and Broken Hill, Molong, Mudgee, Munyang and Wellington Town Energy — Supplementary Draft Report September 2015, https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/investigation-section-12-publications-electricity-transmission-reliability-standards/supplementary-draft-report-electricity-transmission-reliability-standards-september-2016.pdf, retrieved on 2nd December 2016.*

[c] See Note 1

- exposing customer connections to an excess of 16 minutes[d] of unserved energy.
- application of a fine similar to the civil penalty as defined in the National Electricity Law (1996).[e]
- damage to TransGrid's reputation (negative media coverage).
- litigation by customers/consumer groups.

VCR Risk Cost

$$VCR\ risk\ cost = Excess\ USE\ in\ MWh * VCR^{f}$$

$$Excess\ USE\ in\ MWh = \frac{excess\ USE\ in\ "minutes"}{60} * \{estimated\ average\ annual\ demand\ at\ Molong\ in\ MW\}$$

$$Excess\ USE\ in\ MWh = \frac{16}{60} hrs * 8.22\ MW^{g} = 2.2\ MWh$$

$$\therefore VCR\ risk\ cost\ = 2.2\ MWh/year * \$38{,}350/MWh = \$\mathbf{84{,}370\ per\ annum}$$

Note that the VCR risk cost is expected to be the same every year of the 2018 – 2023 regulatory period, as the Mudgee load is forecast to be constant during the period.[h]

Reliability Risk Cost

$$Reliability\ risk\ cost = VCR\ risk\ cost + litigation\ cost^{i}$$

$$\therefore Reliability\ risk\ cost = \$84{,}370 + \$203$$

$$\therefore \boldsymbol{Reliability\ risk\ cost} = \$\mathbf{84{,}573\ per\ annum}$$

Financial Risk Cost

$$Financial\ risk\ cost\ = civil\ penalty^{j} + investigation\ cost^{k}$$

$$\therefore \boldsymbol{Financial\ risk\ cost}\ = \$\mathbf{219\ per\ annum}$$

Reputation Risk Cost

$$Reputational\ risk\ cost\ = external\ consultations\ \&\ communications\ costs^{l}$$

$$\therefore \boldsymbol{Reputational\ risk\ cost}\ = \$\mathbf{10\ per\ annum}$$

Total Risk Cost

$$total\ risk\ cost = Reliability\ risk\ cost + financial\ risk\ cost + reputational\ risk\ cost$$

$$\therefore total\ risk\ cost = \$\mathbf{84{,}573} + \$219 + 10$$

$$\therefore\ \boldsymbol{total\ risk\ cost} = \$\mathbf{84{,}802\ per\ annum}$$

A risk-cost summary extract from the Investment Risk Tool appears in Attachment 1. A full risk cost breakdown report is available on PDGS.

[d] That is, the existing 30 minutes minus the allowable 14 minutes.

[e] As the standard has not been signed off by the Minister at time of writing, it is uncertain whether any fines may apply for non-compliance. However, we have assumed that a fine similar to that stipulated in the NEL clause 2AA is entirely within the realm of possibility.

[f] 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.

[g] IPART's Supplementary Draft Report (September 2016) defines Average Demand as the total energy supplied during the year (MWh) divided by the number of hours in the year. TransGrid historical data in 2015 shows an average demand of 2.4 MW at Molong.

[h] TransGrid 2016, *Transmission Annual Planning Report*, 30 June 2016.

[i] This component is an assumed litigation risk cost.

[j] As per NEL clause 2AA. Assuming the Need goes unaddressed for the duration of the five-year regulatory period.

[k] This component is an assumed financial risk cost.

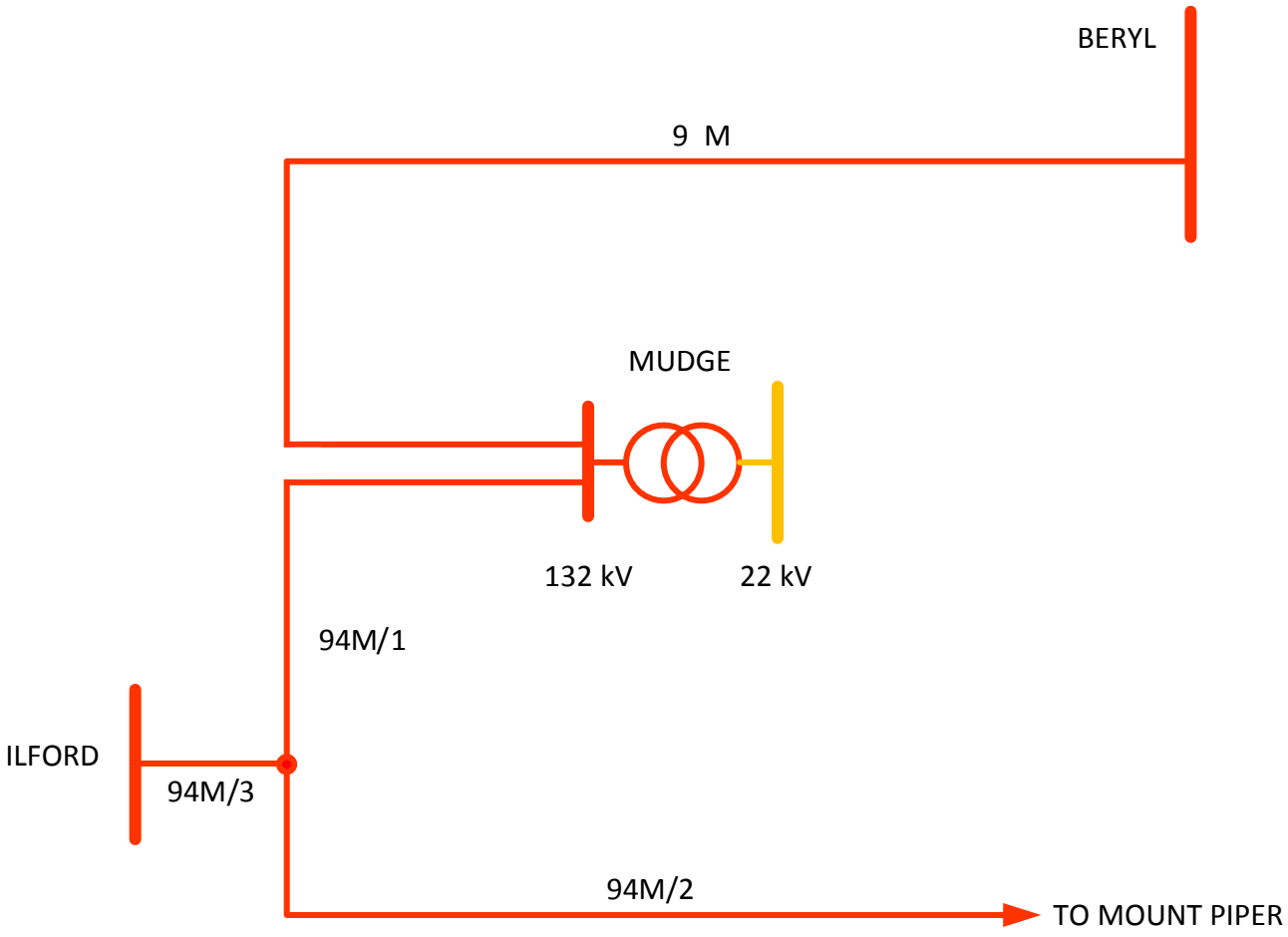
[l] This component is an assumed reputational risk cost.

Option A — Establish a 132 kV busbar at Mudgee substation (Essential Energy), turning in/out Line 94M

This option is to establish a 132 kV busbar at Essential Energy's Mudgee substation, and convert the Mudgee tee-arrangement into a loop in/out to improve the reliability of the 132 kV connection point.

The turn in/out 132 kV arrangements would provide an additional redundancy as shown in Figure 1. By implementing this option, it is expected that should there be a fault on either Line 94M or 94M/1; Mudgee will still be supplied from the other line section. The failure rate is the probability of failure of the two line sections turning in and out of the Mudgee busbar. The probability of both transmission line sections outages will be significantly lower than the probability of a single transmission line section outage.

Figure 1: Mudgee supply arrangement post-Option A



The post-option risk cost is composed of the VCR risk cost as follows:

$$VCR\ risk\ cost = USE\ in\ MWh * VCR^{m} = \left(Total\ Energy\ at\ Risk * P_{double\ outage}\right) * VCR$$

Where:

$$P_{double\ outage} = P_{TL1} * P_{TL2}$$

[m] 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.

$$P_{TL1} = \frac{(line\ 94M\ length\ *\ failure\ rate) * duration}{365\ days * 24hr/day} = \frac{\left(29.61km * \frac{0.39\frac{events}{yr}}{100km}\right) * 23.5\ hrs/event^{n}}{365\ days * 24hrs/day} = 0.0003$$

$$P_{TL2} = \frac{\left(line\ 94M/1, 94M/2, 94M/3\ total\ length^{o}\ *\ failure\ rate\right) * duration}{365\ days * \frac{24hr}{day}}$$

$$= \frac{\left(94.89km * \frac{0.39\frac{events}{yr}}{100km}\right) * 23.5\frac{hrs}{event}}{365\ days * \frac{24hrs}{day}} = 0.001$$

$$USE\ in\ MWh = Total\ Energy\ at\ Risk * P_{double\ outages} = 72000\ MWh * (0.0003 * 0.001) = 0.0216$$

$$\therefore\ VCR\ risk\ cost = 0.0216 * \$38{,}350/MWh = \$828/annum^{p}$$

$$USE\ in\ minutes = \frac{USE\ in\ MWh}{Estimated\ average\ annual\ demand\ in\ MW} * 60\ minutes/hr$$

$$\therefore\ USE\ in\ minutes = \frac{0.0216}{8.22} * 60 = 0.16\ minutes$$

This option is expected to reduce the calculated USE minutes from 30 minutes to around 0 minutes, and therefore the post-project risk cost of this option reduce to $828.

The expected capital cost for this option is $13.5 million ± 25% (in un-escalated 2016 - 17 dollars), spread over 5 years. The scope of works included in this option is outlined in OFS-1697A.

Option B — Installation of a three-way switch at the Mudgee 132 kV tee

This option is to install a three-way disconnector, capable of making and breaking line charging current, at the Mudgee 132 kV tee as shown in Figure 2. The three-way switch would enable the supply to Mudgee to come from either Beryl or Mt Piper, or both, improving the reliability of the 132 kV connection point. By implementing this option, it is expected that should there be a fault on either Line 94M or 94M/1; Mudgee will still be supplied from the other line section. The failure rate is the probability of failure of both 94M and 94M/1. The probability of both transmission line sections outages will be significantly lower than the probability of a single transmission line section outage. In addition, Mudgee 132 kV load will be interrupted if there is a fault on 94M/4, however due to the short distance, the probability of this line failure will be low.

The post-option risk cost is composed of the VCR risk cost as follows:

$$VCR\ risk\ cost = USE\ in\ MWh * VCR^{q} = \left(Total\ Energy\ at\ Risk * (P_{double\ outage} + P_{single\ outage})\right) * VCR$$

Where:

$$P_{double\ outage} = P_{TL1} * P_{TL2}$$

[n] It is assumed that the outage duration for line 94M is TransGrid's historical average outage duration of 132 kV transmission lines. It does not rely on Essential Energy's network to back up the supply to Mudgee.

[o] Should any section of the line from Mudgee to Mt Piper tee Ilford fails, the whole line will be taken out of service.

[p] The energy at risk at Molong when the firm capacity is 0 MW during 2015 is 21000 MWh.

[q] 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.

$$P_{TL1} = \frac{(line\ 94M\ length\ *\ failure\ rate) * duration}{365\ days * 24hr/day} = \frac{\left(29.61km * \frac{0.39\frac{events}{yr}}{100km}\right) * 23.5\ hrs/event^{r}}{365\ days * 24hrs/day} = 0.0003$$

$$P_{TL2} = \frac{\left(line\ 94M/1, 94M/2, 94M/3\ total\ length^{s} * failure\ rate\right) * duration}{365\ days * \frac{24hr}{day}}$$

$$= \frac{\left(94.89km * \frac{0.39\frac{events}{yr}}{100km}\right) * 23.5\frac{hrs}{event}}{365\ days * \frac{24hrs}{day}} = 0.00099$$

$$P_{single\ outage} = \frac{(line\ 94M/4\ length\ *\ failure\ rate) * duration}{365\ days * 24hr/day} = \frac{\left(1.5km * \frac{0.39\frac{events}{yr}}{100km}\right) * 23.5\ hrs/event^{t}}{365\ days * 24hrs/day}$$
$$= 0.0000157$$

$$USE\ in\ MWh = Total\ Energy\ at\ Risk * (P_{double\ outage} + P_{single\ outage})$$
$$= 72000\ MWh * (0.0003 * 0.00099 + 0.0000157) = 1.15$$

$$\therefore\ VCR\ risk\ cost = 1.15 * \$38{,}350/MWh = \$4{,}102/annum^{u}$$

$$USE\ in\ minutes = \frac{USE\ in\ MWh}{Estimated\ average\ annual\ demand\ in\ MW} * 60\ minutes/hr$$

$$\therefore\ USE\ in\ minutes = \frac{1.15}{8.22} * 60 = 8.4\ minutes$$

This option is expected to reduce the calculated USE minutes from 30 minutes to around 8.4 minutes, and therefore the post-project risk cost of this option reduce to $0.045 million.

The expected capital cost for this option is $7.147 million ± 25% (in un-escalated 2016 - 17 dollars), spread over3 years. The scope of works included in this option is outlined in OFS-1697B.

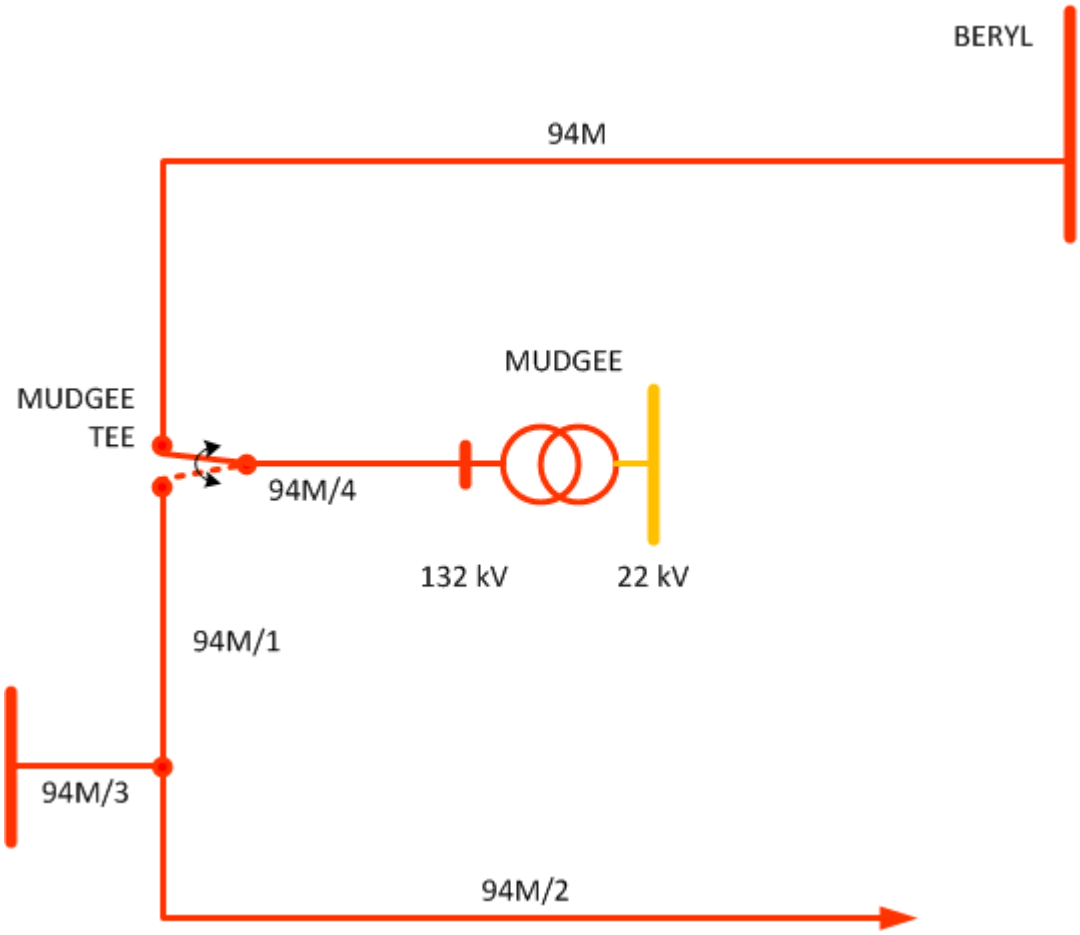
[r] It is assumed that the outage duration for line 94M is TransGrid's historical average outage duration of 132 kV transmission lines. It does not rely on Essential Energy's network to back up the supply to Mudgee.

[s] Should any section of the line from Mudgee to Mt Piper tee Ilford fails, the whole line will be taken out of service.

[t] It is assumed that the outage duration for line 94M is TransGrid's historical average outage duration of 132 kV transmission lines. It does not rely on Essential Energy's network to back up the supply to Mudgee.

[u] The energy at risk at Molong when the firm capacity is 0 MW during 2015 is 21000 MWh.

Figure 2: Mudgee supply arrangement post-Option B



Option C — Demand management to meet compliance standard

This option is to secure an amount of demand management to reduce the amount of unserved energy on the loss of the Mudgee tee.

Demand management (4.5 MW)[v] can be deployed when there is an outage on line 94M to reduce the calculated USE in minutes from 30 minutes to 13.4 minutes, meeting the IPART USE allowance.

$$VCR\ risk\ cost = USE\ in\ MWh * VCR^{w} = 1.833\ MWh/yr * \$38{,}350\ /MWh = \$70{,}300\ /yr$$

If battery technology is used to provide the demand management, a 5 MWh battery system would be sufficient to meet the planning reliability standard at a cost of $5m. However, with an estimated life of 10 years for battery systems, there would need to be reinvestment in new battery storage every 10 years.

The VCR risk cost of this option would reduce to $70,300, as the battery storage utilised would trigger when 94M line trips.

[v] When carrying out the high-level assessment of demand management requirements, it was assumed that the available demand reduction scheme can provide the required megawatt reduction in increments of no less than 0.5 MW. The nearest increment of demand reduction to reduce the amount of unserved energy at risk is 4.5 MW, which equates to 13.4 minutes or 1.833 MWh/yr.

[w] 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.

Option D — Essential Energy to convert its Mudgee manual changeover to an automated changeover scheme

This option is for Essential Energy to convert its existing manual changeover scheme at Mudgee to an automated changeover scheme. This option has been proposed by Essential Energy in its submission[x] to IPART's 2016 Draft Reliability Standard Supplementary Report:[y]

"*Essential Energy endorse (sic) the recommended allowance for expected unserved energy of 14 minutes for Mudgee, noting that informal arrangements allow back-up supply from Essential Energy's distribution network within about 1 hour.*

Opportunity for a low cost improvement of this time to 15 minutes or less, may be possible by implementing an automated change-over scheme subject to further and detailed investigation.

However, it is stressed that as local growth or customer connections erode existing network capacity, back-up capability decreases and may become comparatively less economic to upgrade to maintain the desire level of reliability."

Furthermore, as this option has not been fully scoped and costed by Essential Energy, it cannot be compared economically with the TransGrid options. Therefore, this option is not being considered feasible at this time.

[x] http://thewire/projects/prew/000000001697/Supporting%20Documents/online-submission-essential-energy-b.-supple-28-oct-2016-161618220.pdf

[y] IPART 2016 Draft Reliability Standard Supplementary Report

4. Evaluation

4.1 Technical evaluation

Of the considered network and non-network options, all options A-D are considered to be technically feasible. However as Option D has not been fully scoped and costed by Essential Energy at this time, it is considered not economically feasible and not evaluated further.

A summary of the technical capability is shown below.

Table 1 - Technical evaluation

Option	Description	Meets the IPART Reliability Standard
Base case	'Do Nothing'	No
A	Establish a 132 kV busbar at Mudgee substation (Essential Energy), turning in/out Line 94M	Yes
B	Installation of a three-way switch at the Mudgee 132 kV tee	Yes
C	Demand management to meet compliance standard	Yes

4.2 Commercial evaluation

The commercial analysis of the technically feasible options is shown below:

Table 2 - Commercial evaluation

Option	Description	Capex ($m)	Yearly Opex ($m)	Post project risk cost ($m)	Economic NPV @ 10% ($m)	Financial NPV @ 10% ($m)	Rank
Base Case	'Do Nothing'	-	-	0.085	-	-	-
A	Establish a 132 kV busbar at Mudgee substation (Essential Energy), turning in/out Line 94M	13.5	0.27	0	(10.15)	(10.63)	3
B	Installation of a three-way switch at the Mudgee 132 kV tee	7.15	0.14	0.05	(6.86)	(7.13)	1
C	Demand management to meet compliance standard	5.00	0.10	0.07	(7.10)	(7.22)	2

The commercial evaluation is based on:

- A 10% discount, with sensitivities based on TransGrid's current AER-determined pre-tax real regulatory WACC of 6.75% for the lower bound and 13% for the upper bound.
- The applied sensitivity on the discount rate given the following NPVs for the preferred option, B:

Table 3 - Preferred Option

Option	Description	Economic NPV @ 6.75% ($m)	Economic NPV @ 13% ($m)
B	Installation of a three-way switch at the Mudgee 132 kV tee	(7.44)	(6.40)

4.3 ALARP Evaluation

An ALARP assessment is triggered by the following hazard and the disproportionate factor:

- Unplanned outage of HV equipment → 3 times the safety risk reduction and taking 10% of the reliability risk reduction as being applicable to safety.

However, as this will only produce 30% of the benefit derived in the economic evaluation, a full ALARP evaluation will not produce an alternative preferred option.

4.4 Compliance with Draft Reliability Standard

The objective of the IPART Electricity Transmission Reliability Standards is to:

- *Move away from a standard that is heavily based on network capability and towards one which better focuses on what customers value*
- *Introduce the concept of positive expected unserved energy into TransGrid's decision making processes*
- *Make explicit provision for the standards to be met using non-network solutions*
- *Not result in a significant change from the current level of reliability experienced by customers*

IPART has recommended that the standards be adopted as a planning standard, and not a performance standard. TransGrid is expected to undertake simulation modelling as part of the planning process, which IPART can review when assessing compliance. IPART has recommended that simulations be undertaken using life-cycle average failure rates rather than actual condition based failure rates.

All of the options A-C enable TransGrid to comply with the new reliability standard by reducing the USE level to within 14 minutes.

4.5 Preferred Option

The preferred option (Option B) is for TransGrid to install a three-way switch on 94M line at the Mudgee tee point.

Capital and Operating Expenditure

The yearly incremental operating expenditure of Option B is estimated to be 2% of the upfront capital cost of the option, which equates to $0.07 million, escalated at a rate of 2.9% per annum.

Regulatory Investment Test

The preferred option would be subject to the RIT-T process, as it exceeds the $6 million threshold for augmentation projects.

5. Recommendation

Based on the economic evaluation and compliance obligation mentioned above, Option B is the preferred option with the highest benefit for achieving IPART draft reliability compliance.

Furthermore, Option B:

- enables TransGrid to meet its supply obligations under the National Electricity Rules.
- significantly reduces TransGrid's risk exposure and reduces the risk from $0.085 million p.a. to $0.045 million.

It is therefore recommended that Option B proceed to the project scoping stage.

Appendix A – Financial and Economic Evaluation

Project_Option Name	Need 1697 - Option A - New substation and line works

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-$10.63m	*NPV / Capital (Ratio)*	*-0.79*
NPV @ upper bound rate	13.00%	-$9.29m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$12.38m	*IRR%*	*-7.49%*

2. Economic Evaluation (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)				
NPV @ standard discount rate	10.00%	-$10.15m	*NPV / Capital (Ratio)*	*-0.75*
NPV @ upper bound rate	13.00%	-$8.96m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$11.65m	*IRR%*	*-6.41%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.08m*
Systems (reliability)	*$0.08m*	*$0.00m*	*$0.08m*	*ENS Penalty*	*$0.00m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$0.08m
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.00m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$0.08m	$0.00m	$0.08m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$0.08m
Total Benefits			$0.08m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.27m	Write-off cost	$0.00m
Capital - initial $m	-$13.50m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment	$6.75m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs

Project_Option Name	Need 1697- Option B- 3-way switch

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$7.13m	*NPV / Capital (Ratio)*	*-1.00*
NPV @ upper bound rate	13.00%	-$6.61m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$7.84m	*IRR%*	*-8.21%*

2. Economic Evaluation (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

NPV @ standard discount rate	10.00%	-$6.86m	*NPV / Capital (Ratio)*	*-0.96*
NPV @ upper bound rate	13.00%	-$6.40m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$7.44m	*IRR%*	*-7.14%*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$0.08m*	*$0.05m*	*$0.04m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*
Environment	*$0.00m*	*$0.00m*	*$0.00m*
Reputation	*$0.00m*	*$0.00m*	*$0.00m*
Total Risk benefits	$0.08m	$0.05m	$0.04m
Cost savings and other benefits			$0.00m
Total Benefits			$0.04m

VCR Benefit	*$0.04m*
ENS Penalty	*$0.00m*
All other risk benefits	*$0.00m*
Total Risk benefits	$0.04m
Benefits in the financial NPV*	$0.00m
**excludes VCR benefits*	
Benefits in the economic NPV**	$0.04m
***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.14m	Write-off cost	$0.00m
Capital - initial $m	-$7.15m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment	$3.29m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs

Project_Option Name	Need 1697- Option C - Battery storage

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$7.22m	*NPV / Capital (Ratio)*	*-1.44*
NPV @ upper bound rate	13.00%	-$6.39m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$8.53m	*IRR%*	*Not measurable*

2. Economic Evaluation (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

NPV @ standard discount rate	10.00%	-$7.10m	*NPV / Capital (Ratio)*	*-1.42*
NPV @ upper bound rate	13.00%	-$6.30m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$8.37m	*IRR%*	*Not measurable*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$0.08m*	*$0.07m*	*$0.01m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*
Environment	*$0.00m*	*$0.00m*	*$0.00m*
Reputation	*$0.00m*	*$0.00m*	*$0.00m*
Total Risk benefits	$0.08m	$0.07m	$0.01m
Cost savings and other benefits			-$0.00m
Total Benefits			$0.01m

VCR Benefit	*$0.01m*
ENS Penalty	*$0.00m*
All other risk benefits	*$0.00m*
Total Risk benefits	$0.01m
Benefits in the financial NPV*	$0.00m
**excludes VCR benefits*	
Benefits in the economic NPV**	$0.01m
***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.10m	Write-off cost	$0.00m
Capital - initial $m	-$5.00m	Major Asset Life (Yrs)	30.00 Yrs
Residual Value - initial investment	$0.17m	Re-investment capital	-$5.00m
Capitalisation period	1.00 Yrs	Start of the re-investment period	2029-30