OPTIONS EVALUATION REPORT (OER)

Electric Fence Topping Replacement

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Approvals

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Change history

Revision	Date	Amendment
0	23 June 2016	Initial issue
1	16 September 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	1 November 2016	Amendment
3	29 November 2016	Update to format
4	30 November 2016	Amendment by Author

1. Need/opportunity

The benefit of replacing electric fence topping is to reduce age related defects, high corrective maintenance cost and the risk of unauthorised entry of intruder. The Need involves:

> Replacing electric fence topping at 57 substation sites.

The work will be staggered across the duration of the next regulatory control period, 2018/19-2022/23.

2. Related Needs/opportunities

Potential pairing with existing or upcoming projects can deliver cost efficiency. Attachment A.1 contains the list of related Needs.

3. Options

All dollar values in this document are expressed in un-escalated 2016/17 dollars.

Base Case

The description, capital cost and risk cost for the Base Case and options are provided in Table 1.

Table 1 – Summary of Base Case ($ millions)

Base Case	Description	Non-escalated Capital Cost	Residual Risk Cost pa
Base Case	Do nothing with regards replacing electric fence topping at nominated substations	-	1.12
A	Replace electric fence topping with razor wire at nominated substation sites	3.87	0.02
B	Replace electric fence topping with barbed wire at nominated substation sites	3.59	0.19

Option A – Replacement of electric fence topping with razor wire [OFS 1451A]

Replace electric topping with razor wire at 16 prioritised substations, and conditionally replace electric topping with razor wire at the remaining substations (41 substations). The 16 substations are prioritised over the 41 substations as the topping does not provide the required additional defence. The prioritisation of the substations is provided in Attachment A.2.

Option B – Replacement of electric fence topping with barbed wire [OFS 1451B]

Replace electric topping with barbed wire at 16 prioritised substations, and conditionally replace electric topping with barbed wire at the remaining substations (41 substations). The 16 substations are prioritised over the 41 substations as the topping does not provide the required additional defence.

For both options, the works involved with replacing electric fence topping are:

> Removal of existing electric fence topping

> Modification of existing fence for the installation of concertina razor wire

> Removal of redundant cabling and high voltage pulse generation unit

Following assumptions are considered to identify the risk cost for Option A and Option B using Risk Tool Analysis:

- Probability of Failure (POF):
  - Probability that electric fence topping may fail (to perform their intended tasks) per year is 58%[1] (pre investment) and 1%[2] (post investment) for Option A and 10%[3] (post investment) for Option B.
- Consequences:
  - Personal Injury: The likelihood of consequence (LoC) for personal injury has remained 0.06% for both pre and post investment based on the rate of unauthorised entry in TransGrid substation sites.
  - Service Interruption: The LoC for service interruption (electricity) has remained 1% for both pre and post investment. This is based on the fact that both a high voltage electrocution/arc flash and an unauthorised operation of equipment by an intruder will cause a service interruption.
  - Repair cost to TransGrid substation asset: It is considered that damage to TransGrid asset caused by intruder would cost $20k considering TransGrid unauthorised entry rate of 4% per annum.

Following cost saving benefit is considered for Net Present Value (NPV) calculation:

- It is a benefit to save $26k per annum for electric fence maintenance of 57 substation sites based on security related defect maintenance data from July – Sept 2015.

4. Evaluation

Evaluation of the proposed options has been completed using both commercial considerations and the ALARP (as low as reasonably practical) regulatory requirements. The results of these evaluations are outlined below.

4.1 Commercial evaluation

The result of commercial evaluation for each of the options is summarised in Table 2.

Table 2 – Commercial evaluation ($ million)

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Financial NPV @10%	Rank
Base Case	Do nothing with regards to not replacing electric fence topping at substations with razor wire, and run electric fence topping till failure at other substations	N/A	N/A	1.12	N/A	N/A	3
A	Replace electric fence topping with razor wire at prioritised substations	3.87	0.04	0.02	3.25[4]	1.84	1

[1] Pre investment POF is calculated based on defect rate of electric fence topping from 2009 – 2015.

[2] Post investment POF for Option A is considered based on experience that the razor wire is remarkably difficult to cut using hand tools and more injurious and hard to pass. As a result, more effective in reducing risk of unauthorised entry. So the defect rate of replaced razor wire is very low.

[3] Post investment POF for Option B is higher than razor wire based on the fact that barb wire is easy to cut with standard tools and less effective in reducing risk of unauthorised entry compared to razor wire.

[4] NPV calculation is available in PDGS.

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Financial NPV @10%	Rank
B	Replace electric fence topping with barb wire at prioritised substations	3.59	0.04	0.19	2.50	1.31	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% (lower bound) and 13% (upper bound).
- Technical life of razor wire is assumed to be 40 years.
- Maintenance cost used for the options A and B is 1% of the capital cost.

Option A is preferred based on the financial returns and technical solution.

Sensitivities on economic NPV for the options with changing discount rates are shown in Table 3.

Table 3 – Discount rate sensitivities ($ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Replace electric fence topping with razor wire at prioritised substations	6.31	1.62
B	Replace electric fence topping with barb wire at prioritised substations	5.07	1.14

4.2 SFAIRP/ALARP evaluation

In the context of the Network Asset Risk Assessment Methodology, the SFAIRP (So Far As Is Reasonably Practicable)/ALARP (As Low As Reasonably Practical) principle is applicable to the following Key Hazardous Events:

- Contact with electricity
- Unauthorised access to site

Options to reduce the network safety risk as per the risk treatment hierarchy have been considered in other lifecycle stages of the asset, and it has been determined that no reasonably practicable options exist to reduce the risk further than those capital investment options listed in Table 4.

Evaluation of the proposed options has been completed against the SFAIRP (So Far As Is Reasonably Practicable)/ALARP (As Low As Reasonably Practical) obligation, as required by the Electricity Supply (Safety and Network Management) Regulation 2014 and the Work Health and Safety Act 2011. The Key Hazardous Events and the disproportionality multipliers considered in the evaluation are as follows:

- Contact with electricity/Unauthorised access to site - 3 times the safety risk cost and 10% of the reliability risk cost

The results of this evaluation are summarised in the tables below.

Table 4 – Feasible options ($ thousand)

Option	Description	CAPEX	Expected Life	Annualised CAPEX
Base	Do nothing	N/A	N/A	N/A
A	Replace electric fence topping with razor wire at prioritised substations	3,870	40 years	10
B	Replace electric fence topping with barb wire at prioritised substations	3,590	40 years	9

Table 5 – Annual risk calculations ($ thousand)

Option	Annual Residual Risk			Annual Risk Savings		
	Safety Risk	Reliability Risk	Bushfire Risk	Safety Risk	Reliability Risk	Bushfire Risk
Base	199	250	0	N/A	N/A	N/A
A	3	4	0	200	250	0
B	34	44	0	160	210	0

Table 6 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[5]	Annualised CAPEX	Reasonably practicable[6]?
A	610[7]	100	Yes
B	510	90	Yes

Both Options A and B are reasonably practicable.

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that Option A is the preferred option as it is reasonably practicable and provides the greatest network safety risk reduction. Option A is also preferred based on financial returns and technical solution.

Regulatory Investment Test

The Regulatory Investment Test for Transmission (RIT-T) is not required for this Need.

5. Recommendation

It is recommended to progress via Decision Gate 1 (DG1) to detailed scoping for Option A.

[5] The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

[6] Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

[7] The Network safety Reduction is calculated as 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction. SFAIRP/ALARP calculation is available in PDGS.

Attachment 1

A.1 Combining current Need with existing Needs

Some of the substation rebuild projects include the security treatment like replacement of electric fence with razor wire as part of their scope of work; however some of these did not. Table 7 shows the substation rebuild projects with related Need.

Table 7 – Related Needs

Need Name	Need No.	Comments
Vales Point 330/132 Substation Rebuild	DCN 231	Excludes electric fencing with razor wire
Canberra Substation Rebuild	DCN 238	Excludes electric fencing with razor wire
Munmorah 330kV Substation Condition	DCN 269	Excludes electric fencing with razor wire
Newcastle Substation Condition	DCN 74	Excludes electric fencing with razor wire
Orange 132/66Kv Substation Rebuild	DCN 208	Excludes electric fencing with razor wire
Yanco 132kV Substation Rebuild	DCN 138	Includes replacement of electric fence with razor wire
Forbes Substation Condition	DCN 196	Excludes electric fencing with razor wire
Burrinjuck 132/11 Substation Rebuild	DCN 128	Excludes electric fencing with razor wire

A.2 Substation prioritisation

Table 8 lists the substations with the highest electric fence topping score to lowest in order to determine the ranking of substations. The electric fence topping score is dependent on multiple factors that are listed below.

- Condition/age of existing electric fence topping. This considers energised and de-energised electric fence topping
- Criticality of the substation
- Whether the substation is located in regional NSW or not.
- Location of the substation, which considers proximity of the substation to public facilities

Weights are applied on the above factors, with condition/age having the highest weighting, followed by regional, location and criticality.

Table 8 also outlines pre investment risk cost and post investment risk cost per site based on Investment Risk Tool Analysis and electric fence topping score.

Table 8 – Prioritisation of substations for Option A

Region	Substation ID	Substation	Substation Ranking	Pre investment Risk Cost/site per annum	Post investment Risk cost/site per annum ($)
CR	SYS	Sydney South Substation	1	70k	1210
CR	SE1	Sydney East Substation	2	48k	828

Region	Substation ID	Substation	Substation Ranking	Pre investment Risk Cost/site per annum	Post investment Risk cost/site per annum ($)
NR	NEW	Newcastle Substation	3	47k	806
NR	AR1	Armidale Substation	4	41k	699
SR	CA1	Canberra Substation	5	40k	684
CR	SYW	Sydney West Substation	6	39k	669
CR	SYN	Sydney North Substation	7	37k	642
NR	TA1	Tamworth 330kV Substation	8	33k	562
SR	WG1	Wagga 330kV Substation	9	29k	507
CR	ING	Ingleburn Substation	10	26k	443
CR	KCR	Kemps Creek Substation	11	24k	408
CR	DPT	Dapto Substation	12	23k	403
NR	ER0	Eraring 500/330kV Substation	13	23k	388
CR	VYD	Vineyard Substation	14	22k	379
CR	WL1	Wellington Substation	15	22k	374
NR	MN1	Munmorah 330kV Substation	16	21k	362
CR	RGV	Regentville Substation	17	21k	362
CR	LP1	Liverpool Substation	18	21k	362
NR	VP1	Vales Point Substation	19	20k	349
NR	TGH	Tuggerah Substation	20	19k	321
SR	LT1	Lower Tumut (LTSS) Switching Station	21	17k	299
SR	JDA	Jindera Substation	22	17k	299
CR	WW1	Wallerawang 330	23	17k	297
SR	MRN	Marulan Substation	24	16k	283
CR	MTP	Mount Piper 500kV/330kV Substation	25	16k	283
NR	COF	Coffs Harbour Substation	26	16k	276
CR	MAC	Macarthur 330kV Substation	27	16k	276
CR	ORG	Orange Substation	28	15k	264
CR	WOL	Wollar 500/330kV Substation	29	15k	262
SR	BBY	Bannaby Substation 500kV	30	15k	256
CR	AVS	Avon 330kV Switching Station	31	15k	254

Region	Substation ID	Substation	Substation Ranking	Pre investment Risk Cost/site per annum	Post investment Risk cost/site per annum ($)
SR	BBY	Bannaby Substation 330kV	32	15k	254
SR	URQ	Uranquinty 132kV Switching Station	33	14k	250
SR	DNT	Darlington Point Substation	34	14k	242
SR	WDL	Williamsdale 330kV Substation	35	14k	242
CR	CW2	Cowra Substation	36	14k	240
SR	DN2	Deniliquin Substation	37	14k	238
SR	ALB	Albury 132kV Substation	38	14k	233
CR	KVS	Kangaroo Valley Switching Station	39	13k	228
SR	TU2	Tumut Substation	40	13k	226
CR	MPP	Mount Piper 132kV Substation	41	13k	225
CR	MOL	Molong Substation	42	13k	218
SR	FNY	Finley Substation	43	12k	214
SR	ANM	Australia News Print Substation	44	12k	211
NR	GNS	Glen Innes Substation	45	12k	206
SR	WGN	Wagga North 132kV Substation	46	12k	206
SR	BKH	Broken Hill 220kV Substation	47	12k	202
SR	MRU	Murrumburrah Substation	48	12k	202
CR	FB2	Forbes Substation	49	12k	202
CR	BER	Beryl Substation	50	11k	195
CR	PKS	Parkes Substation	51	11k	193
SR	BRG	Buronga Switching Station	52	11k	184
CR	ONO	Orange North Switching Station	53	11k	183
SR	BRD	Balranald Substation	54	10k	173
SR	QBN	Queanbeyan Substation	55	10k	173
CR	PMA	Panorama Substation	56	9k	161
SR	C02	Capital Wind Farm Substation	57	9k	154

Attachment 2 – Commercial evaluation report

Option A NPV calculation

Project_Option Name	Electric fence replacement (Option A razor wire)

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	$1.84m	*NPV / Capital (Ratio)*	*0.47*
NPV @ upper bound rate	13.00%	$0.63m	*Pay Back Period (Yrs)*	*0.15 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$4.16m	*IRR%*	*15.49%*

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%	$3.25m	*NPV / Capital (Ratio)*	*0.84*
NPV @ upper bound rate	13.00%	$1.62m	*Pay Back Period (Yrs)*	*3.57 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$6.31m	*IRR%*	*19.00%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.25m*
Systems (reliability)	*$0.25m*	*$0.00m*	*$0.25m*	*ENS Penalty*	*$0.00m*
Financial	*$0.66m*	*$0.01m*	*$0.65m*	*All other risk benefits*	*$0.85m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$1.10m
People (safety)	*$0.20m*	*$0.00m*	*$0.20m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.87m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$1.12m	$0.02m	$1.10m		
Cost savings and other benefits			$0.03m	Benefits in the economic NPV**	$1.12m
Total Benefits			$1.12m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.04m	Write-off cost	$0.00m
Capital - initial $m	-$3.87m	Major Asset Life (Yrs)	40.00 Yrs
Residual Value - initial investment	$1.45m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs

Option B NPV calculation

Project_Option Name	Electric fence replacement (Option B Barbed wire)

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	$1.31m	*NPV / Capital (Ratio)*	*0.37*
NPV @ upper bound rate	13.00%	$0.31m	*Pay Back Period (Yrs)*	*0.14 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$3.26m	*IRR%*	*14.34%*

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%	$2.50m	*NPV / Capital (Ratio)*	*0.70*
NPV @ upper bound rate	13.00%	$1.14m	*Pay Back Period (Yrs)*	*3.93 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$5.07m	*IRR%*	*17.68%*

Benefits

Risk cost	As Is	To Be	Benefit		
Systems (reliability)	*$0.25m*	*$0.04m*	*$0.21m*	*VCR Benefit*	*$0.21m*
Financial	*$0.66m*	*$0.11m*	*$0.55m*	*ENS Penalty*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.71m*
People (safety)	*$0.20m*	*$0.03m*	*$0.16m*	Total Risk benefits	$0.92m
Environment	*$0.00m*	*$0.00m*	*$0.00m*		
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.74m
Total Risk benefits	$1.12m	$0.19m	$0.92m	**excludes VCR benefits*	
Cost savings and other benefits			$0.03m	Benefits in the economic NPV**	$0.95m
Total Benefits			$0.95m	***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.04m	Write-off cost	$0.00m
Capital - initial $m	-$3.59m	Major Asset Life (Yrs)	40.00 Yrs
Residual Value - initial investment	$1.35m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs