OPTIONS EVALUATION REPORT (OER)

CCTV System Renewal

OER 000000001398 revision 4.0

Ellipse project no.: P0008095
TRIM file: [TRIM No]

Project reason: Capability - Asset Replacement for end of life condition
Project category: Prescribed - Security/Compliance

Approvals

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Date submitted for approval	10 November 2017	

Change history

Revision	Date	Amendment
0	21 June 2016	Initial issue
1	23 June 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
5	10 November 2017	Updated to breakdown project into distinct sub-options. Risks, benefits, NPV & ALARP calculations updated.

1. Need/opportunity

The replacement of the Closed-circuit Television (CCTV) cameras, Digital Video Recorders (DVRs) and Uninterruptible Power Supplies (UPSs) is due to significant increase in age related defects and end of life failures. In addition, investing in quad lens and thermal imaging cameras will offer total aerial coverage of substation asset and thermography inspection of energised assets and hot joints accordingly. There is an opportunity of risk reduction and cost saving benefit. The overall benefit is to provide the tool to monitor the substations assets and perform remote inspections. The Needs are:

- Replacing 595 old analogue CCTV cameras at 73 substations.
- Replacing 76 DVRs at 73 substations
- Installing 73 Quad lens cameras at 73 substations
- Replacing 76 UPSs at 73 substations
- Installing 124 thermal imaging cameras at 32 substations

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

2. Related Needs/opportunities

No related Need is available.

3. Options

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

The description and residual risk costs for the Base Case and the option are outlined in Table 1.

Table 1 – Summary of Base Case

Case	Description	Un-escalated Capital Cost ($M)	Residual Risk Cost ($M) pa
Base Case	Do nothing with regards to replacing CCTV camera, DVR, UPSs and installing quad lens camera and thermal imaging camera.	-	2.75
A	Replace CCTV camera, DVR, UPS and install quad lens camera and thermal imaging camera at nominated substations.	7.72	0.33
A(i)	Replace CCTV camera, DVR and UPS	4.59	0.10
A(ii)	Installation of quad lens cameras	0.92	-
A(iii)	Installation of thermal imaging cameras	2.20	0.23

Option A – Replace CCTV cameras, DVRs, UPSs and install quad lens and thermal imaging cameras at nominated substations [OFS 1398]

Option A comprises the following discrete groupings:

(i) Replace CCTV cameras, DVRs & UPSs at nominated substations

(ii) Install quad lens cameras at nominated substations

(iii) Install thermal imaging cameras at nominated substations

The option has been analysed both as a whole (combination of all groups), and individually in order to validate the merits of each group.

Option A(i) – Replace CCTV cameras, DVRs & UPSs at nominated substations

Replace 595 analogue cameras (268 Fixed and 327 PTZ cameras) to IP cameras, 76 DVRs to IP based DVR/NVR, and 76 UPSs with 24 hour backup supply capability in the order of priority, as per Attachment 1, during the next regulatory control period 2018/19-2022/23. For each site the following has been allowed:

- Number of fixed and PTZ cameras set out in Attachment 1
- IP based Digital Video Recorder (DVR)/Network Video Recorder (NVR) with 30 days recording capability
- An UPS with 24 hour backup supply for CCTV system
- Cabling and associated hardware

Following assumptions are considered to identify the risk cost using Risk Tool Analysis:

- Risk has been broken down to consider the consequences of the following:
  - Failure of the CCTV and DVR as a system
  - Failure of a UPS
- Probability of Failure (POF):
  - Probability that CCTV camera may fail (to perform their intended tasks) per year is 13%[1] (pre investment) and 1%[2] (post investment).
  - Probability that any DVR may fail (to perform their intended task) is 49%[3] (pre investment) and 1%[4] (post investment).
  - Probability that UPS may fail (to perform their intended tasks) per year is 70%[5] (pre investment) and 5%[6] (post investment).
- Consequences:
  - Personal Injury:

[1] Pre investment POF is based on TransGrid defect maintenance expenditure data from July 2015 to Sept 2015.

[2] Post investment POF is considered based on experience that the defect rate of replaced electronic device is very low.

[3] Pre investment POF is based on TransGrid defect maintenance expenditure data from July 2015 to Sept 2015.

[4] Post investment POF is considered based on experience that the defect rate of replaced electronic device is very low.

[5] Pre investment POF is calculated based the average age of our UPS fleet being 10-years, and the probability that a 10-year-old UPS may become faulty is 70%.

[6] Similar to footnote 7, with the probability that a new UPS may become faulty being 5%.

- For CCTV camera and DVR, the likelihood of consequence (LoC) for personal injury is 0.04%. This is based on a rate of unauthorised entry in TransGrid substation sites of 4%, and a 1% probability of electrocution.
- For UPS, the likelihood of consequence (LoC) for personal injury is 0.0004%. This is based on a rate of unauthorised entry in TransGrid substation sites of 4%, a 1% probability of electrocution and a 1% probability of substation auxiliary supplies being down.

– Service Interruption:

- The LoC for service interruption (electricity) is assumed to be 1% for CCTV camera and DVR. This is based on the fact a high voltage electrocution/arc flash and an unauthorised operation of equipment by an intruder will cause a service interruption.
- The LoC for service interruption (electricity) is assumed to be 0.01% for UPS. This is based on the fact a 1% probability of service interruption and a 1% probability that substation auxiliary supplies are down.

– Repair cost to TransGrid substation asset: It is considered that damage to TransGrid asset caused by intruder would cost $20K based on TransGrid unauthorised entry rate of 4% per annum for CCTV DVR and UPS.

Following assumptions are considered to identify the cost saving benefit:

> CCTV camera: It is expected that replacing these cameras with their modern day equivalents will reduce corrective maintenance cost by approximately $29k per annum based on historical maintenance expenditure during July to Sept 2015.

> DVR: It is expected that the defect maintenance cost will be reduced by $15k per annum if DVRs are replaced based on maintenance expenditure from July to Sept 2015.

> UPS: In the event of failure of auxiliary power supplies, UPS is able to provide backup supply for CCTV system in verifying intrusion, fire and condition monitoring alarms/incidents, and enable accurate and rapid response to a verified incident. There is an opportunity to save post incident investigation cost due to service interruption by $12.5k per year.

Option A(ii) – Install quad lens cameras at nominated substations

Installation of 73 quad lens cameras at 73 substation sites in the order of priority, as per Attachment 1, during the next regulatory control period 2018/19-2022/23. For each site the following has been allowed:

> Installation of a quad lens camera for each site around the centre of the switchyard to provide 360° panoramic view.

> Cabling and associated hardware to support the installation of the quad lens.

Following assumptions are considered to identify the cost saving benefit:

> A quad lens camera would provide total aerial coverage of a substation site and provide an opportunity for remote visual inspection of substation sites and their key assets. It is expected that a benefit of approximately $219k per annum is realised through reduced inspections across the targeted substations

> These cameras will also provide rapid and accurate response to an asset incident. There is an opportunity to reduce callout cost by $26k per year based on irregularities from Jan – Dec 2015. In summary $245k can be saved per annum by installing quad lens cameras.

Option A(iii) – Install thermal imaging cameras at nominated substations

Installation of 124 thermal imaging cameras at 32 substation sites in the order of priority, as per Attachment 1, during the next regulatory control period 2018/19-2022/23. For each site the following has been allowed:

> Installation of thermal cameras at those sites identified

- Cabling and associated hardware to support the installation of the thermal cameras.

Following assumptions are considered to identify the risk cost using Risk Tool Analysis:

- A single hazardous event, that being conductor drop failure due to an undetected hotspot, has been used in determining risk.
- Probability of Fail has therefore not been applied to the thermal camera, but rather to the hazardous event itself.
- Probability of Failure (POF):
  - Probability of a conductor drop incident per year is 0.125%[7] (pre-investment) and 0.0625%[8] (post-investment)
- Consequences:
  - Personal Injury: The likelihood of consequence (LoC) for personal injury is 2.05%[9].
  - Service Interruption: The LoC for service interruption (electricity) is assumed to be 2%[10]. Load at risk is assessed as the average NSW site load of 170MW, and that the whole substation is out of service.
  - Repair cost to TransGrid substation asset: It is considered that damage to TransGrid assets caused by a conductor drop would cost approximately $462K[11].

Following assumptions are considered to identify the cost saving benefit:

- There is an opportunity to save thermography survey cost by $66k based on TransGrid standard cost for thermography survey.
- An opportunity exists to save night time post-investigative costs by $120k for fire and security alarms.
- Through early hot spot detection via thermal cameras, it is estimated to save approximately $4.38k pa in additional emergency rapid response costs.

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.

[7] Pre investment POF is based on TransGrid hot spot defect maintenance expenditure data from July 2000 to July 2017.

[8] Post investment POF is based on an estimated 50% reduction in undetected hot spot conductor failure due to thermal camera observations on site.

[9] LoC for personal injury is based on the average site Safety Risk LoC derived from the Substation Criticality v2.0 spreadsheet, and then applying a 50% factor that a conductor drop would result in electrocution.

[10] LoC for service interruption is consistent with assessments made for steelwork risk costs

[11] Repair cost is based on a weighted average of: (i) 10% damage to TRF at average value $5M; (ii) 90% damage to bay with average value $300K. Therefore weighted average is $770K. Applying a 60% likelihood of striking equipment on a conductor fail, CoF is $462K.

Table 2 – Commercial evaluation ($ million)

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Rank
Base Case	Do nothing with regards to replacing CCTV camera, DVR, UPSs and installing quad lens camera and thermal imaging camera.	NA	NA	1.82	NA	2
A	Replace CCTV camera, DVR, UPS and install quad lens camera and thermal imaging camera at nominated substations	7.72	0.017	0.33	8.14	1
A(i)	Replace CCTV camera, DVR and UPS	4.59	0.010	0.10	7.32	-
A(ii)	Installation of quad lens cameras	0.92	0.002	-	0.67	-
A(iii)	Installation of thermal imaging cameras	2.20[12]	0.005	0.23	0.15	-

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 CCTV, DVR, quad lens camera, thermal imaging camera and UPS are assumed to be 15 years. Technical life of cabling is assumed to be 45 years.
- Maintenance cost used for the preferred option A is 1% of the capital cost.

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

Sensitivities on economic Net Present Value (NPV) for the option 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 CCTV camera, DVR, UPS and install quad lens camera and thermal imaging camera at nominated substations.	4.91	13.51
A(i)	Replace CCTV camera, DVR and UPS	4.77	11.52

[12] CAPEX spend amended from $4.59m (OFS) to $2.20m

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A(ii)	Installation of quad lens cameras	0.35	1.21
A(iii)	Installation of thermal imaging cameras	(0.20)	0.78

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 below.

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 CCTV camera, DVR, UPS and install quad lens camera and thermal imaging camera at nominated substations.	7,715	15/45 years	757
A(i)	Replace CCTV camera, DVR and UPS	4,015[13]	15/45 years	434
A(ii)	Installation of quad lens cameras	810[13]	15/45 years	88
A(iii)	Installation of thermal imaging cameras	2,201	15 years	238

[13] Original CAPEX value reduced when15years depreciation of 45 year life asset is factored.

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	280	410	0	N/A	N/A	N/A
A	10	30	0	270	380	0
A(i)	0	0	0	200	300	0
A(ii)	N/A	N/A	N/A	N/A	N/A	N/A
A(iii)	10	220	0	0	220	0

Table 6 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[14]	Annualised CAPEX	Reasonably practicable[15]?
A	652[16]	757	No
A(i)	630	434	Yes
A(ii)	N/A	88	No
A(iii)	22	238	No

Option A is not reasonably practicable.

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that Option A is not reasonably practicable, and therefore not required to satisfy the organisation's SFAIRP/ALARP obligations.

The option to address the condition of the identified assets, Option A, is the preferred option for all assets identified.

This option has been selected due to its technical viability and reduction in safety and reliability risk. This option provides significant technical benefits and provides the greatest positive Net Present Value (NPV).

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 DG1 to detailed scoping for Option A.

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

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

[16] 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 – List of sites based on risk assessment

Table 7 arranges the substations from highest to lowest priority based on substation criticality ranking. Here lowest value of priority indicates highest priority. This list outlines list of CCTV camera (both fixed and PTZ), DVR, UPS to be replaced and quad lens camera and thermal imaging camera to be installed for each substation site.

Table 7 – Substation Priority

Substation Name	ID	Priority	Total IP Camera	IP Camera (Fixed)	IP Camera (PTZ)	DVR/NVR	UPS	Quad lens Camera	Thermal imaging camera
SYDNEY SOUTH 330KV	SYS	1	16	8	8	1	1	1	4
SYDNEY WEST 330KV	SYW	2	9	2	7	1	1	1	4
SYDNEY EAST 330KV	SE1	3	12	6	6	1	1	1	4
SYDNEY NORTH 330KV	SYN	4	16	9	7	1	1	1	4
BEACONSFIELD 330KV	BFW	5	38	23	15	1	1	1	2
CANBERRA 330KV	CA1	6	4	2	2	1	1	1	4
HAYMARKET 330KV	HYM	7	28	18	10	1	1	1	2
DAPTO 330KV	DPT	8	11	5	6	1	1	1	4
NEWCASTLE 330KV	NEW	9	10	6	4	1	1	1	4
ARMIDALE 330KV	AR1	10	5	1	4	1	1	1	4
TAMWORTH 330KV	TA1	11	7	3	4	1	1	1	4
WAGGA 330KV	WG1	12	4	2	2	1	1	1	4
BANNABY 330kV	BBY	13	6	2	4	1	1	1	4
BANNABY 500KV	BBY	13	6	2	4	1	1	1	4
WILLIAMSDALE 330KV	WDL	15	8	2	6	1	1	1	4
INGLEBURN 330KV	ING	16	8	4	4	1	1	1	4
KEMPS CREEK 500KV	KCR	17	9	4	5	1	1	1	4
VINEYARD 330KV	VYD	18	12	6	6	1	1	1	4
DUMARESQ 330KV	DMQ	19	5	1	4	1	1	1	4
YASS 330KV	YSN	20	7	3	4	1	1	1	4
ERARING PS	ER0	21	11	2	9	1	1	1	4
BAYSWATER PS	BAY	22	10	3	7	1	1	1	4
LOWER TUMUT 330KV	LT1	25	4	2	2	1	1	1	4
MT PIPER 330KV	MTP	26	15	6	9	1	1	1	4
MUNMORAH PS	MN1	27	5	2	3	1	1	1	4
UPPER TUMUT 330KV	UT1	29	19	12	7	2	2	1	4
VALES POINT PS	VP1	30	8	3	5	1	1	1	4
WALLERAWANG	WW1	31	11	3	8	1	1	1	4

Substation Name	ID	Priority	Total IP Camera	IP Camera (Fixed)	IP Camera (PTZ)	DVR/NVR	UPS	Quad lens Camera	Thermal imaging camera
330KV									
LIVERPOOL 330KV	LP1	32	9	5	4	1	1	1	4
TOMAGO 330KV	TOM	33	6	2	4	1	1	1	4
WELLINGTON 330KV	WL1	34	7	2	5	1	1	1	4
WOLLAR 500KV	WOL	35	8	4	4	1	1	1	4
BROKEN HILL 220KV	BKH	36	3	1	2	1	1	1	
HOLROYD 330kV	HLD	37	12	12	0	2	2	1	
ROOKWOOD ROAD	RWR	38	23	8	15	2	2	1	
MACARTHUR 330KV	MAC	39	6	2	4	1	1	1	
JINDERA 330KV	JDA	40	3	1	2	1	1	1	
MARULAN 330KV	MRN	41	4	2	2	1	1	1	
REGENTVILLE 330KV	RGV	42	6	2	4	1	1	1	
TUGGERAH 330KV	TGH	43	5	2	3	1	1	1	
ORANGE 132KV	ORG	44	12	8	4	1	1	1	
WAGGA 132KV	WG2	45	2	1	1	1	1	1	
ORANGE NORTH 132KV	ONO	47	6	1	5	1	1	1	
WAGGA NORTH 132KV	WGN	48	7	2	5	1	1	1	
AVON 330KV	AVS	49	4	0	4	1	1	1	
COFFS HARBOUR 132KV	COF	54	8	2	6	1	1	1	
COOMA 132 NEW	COA	55	12	6	6	1	1	1	
COWRA 132KV	CW2	56	5	2	3	1	1	1	
GUNNEDAH 132KV	GN2	59	6	4	2	1	1	1	
INVERELL 132KV	INV	62	4	2	2	1	1	1	
KANGAROO VALLEY 330KV	KVS	63	5	0	5	1	1	1	
KEMPSEY 132KV	KS2	64	6	2	4	1	1	1	
MT PIPER 132KV	MPP	65	5	2	3	1	1	1	
QUEANBEYAN 132kV	QBY	67	7	3	4	1	1	1	
TAMWORTH 132KV (NEW)	TMW	68	7	4	3	1	1	1	
MUSWELLBROOK 330KV	MRK	71	7	2	5	1	1	1	
GLEN INNES 132KV	GNS	73	5	3	2	1	1	1	
MOLONG 132KV	MOL	74	6	2	4	1	1	1	
PANORAMA 132KV	PMA	75	5	2	3	1	1	1	
BERYL 132KV	BER	76	5	2	3	1	1	1	

Substation Name	ID	Priority	Total IP Camera	IP Camera (Fixed)	IP Camera (PTZ)	DVR/NVR	UPS	Quad lens Camera	Thermal imaging camera
PORT MACQUARIE 132KV	PMQ	77	5	3	2	1	1	1	
WARATAH WEST 330KV	WRH	78	6	3	3	1	1	1	
FORBES 132KV	FB2	81	7	2	5	1	1	1	
MOREE 132KV	MRE	82	6	4	2	1	1	1	
PARKES 132KV	PKS	83	5	1	4	1	1	1	
TAREE 132KV	TRE	85	7	2	5	1	1	1	
NARRABRI 132KV	NB2	86	6	4	2	1	1	1	
NAMBUCCA 132KV	NAM	87	5	2	3	1	1	1	
TENTERFIELD 132KV	TTF	88	4	3	1	1	1	1	
WALLERAWANG 132 kV (NEW)	WWS	89	6	2	4	1	1	1	
KOOLKHAN 132KV	KLK	90	4	2	2	1	1	1	
GULLEN RANGE 330KV	GUR	93	7	2	5	1	1	1	
CAPITAL WIND FARM 330KV	CWF	94	7	3	4	1	1	1	
			595	268	327	76	76	73	124

Attachment 2 – Commercial evaluation report

Option A NPV calculation

Project_Option Name	Substation Security System Upgrade (Option A)

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	$4.64m	*NPV / Capital (Ratio)*	*0.60*
NPV @ upper bound rate	13.00%	$2.32m	*Pay Back Period (Yrs)*	*0.18 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$8.57m	*IRR%*	*18.16%*

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%	$8.14m	*NPV / Capital (Ratio)*	*1.05*
NPV @ upper bound rate	13.00%	$4.91m	*Pay Back Period (Yrs)*	*2.69 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$13.51m	*IRR%*	*22.91%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.74m*
Systems (reliability)	*$0.74m*	*$0.22m*	*$0.52m*	*ENS Penalty*	*$0.00m*
Financial	*$1.80m*	*$0.10m*	*$1.70m*	*All other risk benefits*	*$1.68m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$2.42m
People (safety)	*$0.21m*	*$0.01m*	*$0.20m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$2.12m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$2.75m	$0.33m	$2.42m		
Cost savings and other benefits			$0.44m	Benefits in the economic NPV**	$2.86m
Total Benefits			$2.86m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.02m	Write-off cost	$0.00m
Capital - initial $m	-$7.72m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$1.10m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs

Option A(i) NPV calculation

Project_Option Name	Substation Security System Upgrade (Option A(i)) - CCTV DVR

1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	$5.90m		*NPV / Capital (Ratio)*	*1.28*
NPV @ upper bound rate	13.00%	$3.72m		*Pay Back Period (Yrs)*	*0.25 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$9.52m		*IRR%*	*25.12%*

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%	$7.32m		*NPV / Capital (Ratio)*	*1.59*
NPV @ upper bound rate	13.00%	$4.77m		*Pay Back Period (Yrs)*	*2.04 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$11.52m		*IRR%*	*27.75%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.30m*
Systems (reliability)	*$0.30m*	*$0.00m*	*$0.30m*	*ENS Penalty*	*$0.00m*
Financial	*$1.80m*	*$0.10m*	*$1.70m*	*All other risk benefits*	*$1.90m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$2.20m
People (safety)	*$0.20m*	*$0.00m*	*$0.20m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$1.96m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$2.30m	$0.10m	$2.20m		
Cost savings and other benefits			$0.06m	Benefits in the economic NPV**	$2.26m
Total Benefits			$2.26m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.01m	Write-off cost	$0.00m
Capital - initial $m	-$4.59m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.83m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs

Option A(ii) NPV calculation

Project_Option Name	Substation Security System Upgrade (Option A(ii)) - Quad Lens

1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	$0.67m		*NPV / Capital (Ratio)*	*0.73*
NPV @ upper bound rate	13.00%	$0.35m		*Pay Back Period (Yrs)*	*0.19 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$1.21m		*IRR%*	*19.13%*

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%	$0.67m		*NPV / Capital (Ratio)*	*0.73*
NPV @ upper bound rate	13.00%	$0.35m		*Pay Back Period (Yrs)*	*3.61 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$1.21m		*IRR%*	*19.13%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.00m*
Systems (reliability)	*$0.00m*	*$0.00m*	*$0.00m*	*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	$0.00m
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.25m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$0.00m	$0.00m	$0.00m		
Cost savings and other benefits			$0.25m	Benefits in the economic NPV**	$0.25m
Total Benefits			$0.25m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$0.92m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.11m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs

Option A(iii) NPV calculation

Project_Option Name	Substation Security System Upgrade (Option A(iii)) - Thermal V

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-$0.88m	*NPV / Capital (Ratio)*	*-0.40*
NPV @ upper bound rate	13.00%	-$0.98m	*Pay Back Period (Yrs)*	*0.02 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$0.68m	*IRR%*	*1.88%*

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%	$0.15m	*NPV / Capital (Ratio)*	*0.07*
NPV @ upper bound rate	13.00%	-$0.20m	*Pay Back Period (Yrs)*	*5.96 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$0.78m	*IRR%*	*11.13%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.22m*
Systems (reliability)	*$0.44m*	*$0.22m*	*$0.22m*	*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	$0.22m
People (safety)	*$0.01m*	*$0.01m*	*$0.00m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.14m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$0.45m	$0.23m	$0.22m		
Cost savings and other benefits			$0.14m	Benefits in the economic NPV**	$0.36m
Total Benefits			$0.36m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.01m	Write-off cost	$0.00m
Capital - initial $m	-$2.20m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.17m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs