Introduction   **14031 Protection Systems Unit Asset Replacement**

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Project description

This project is to replace Protection Scheme relay assets that have reached the end of their techncial and economic lives. Different options are considered including - run to failure (requiring corrective maintenance action to replace the failed unit) and replacement plans (a capital project to undertake relay replacement before failure). This project is to replace 416 Protection Scheme relay assets that have reached the end of their techncial and economic lives.

Project options

Base case

Business as usual with no capital expenditure however we assume you will need to replaced 10 units each year which considered in corrective replacement costs

Option 1

The total population of relays requiring changeout is 416 (see protection system tab). It is assumed that a 1% annual failure rate will apply to the population. Corrective maintenance will be used to changeout failed units and routine maintenance costs are based on the average trendline annual cost. In this option a capital project to replace relays before failure is undertaken over a five year period in 2019-2023.

Option 2

Replace 366 relays in 2024-28, as by this time 50 relays have already been replaced corrective replacement (10 per year).

Key modelling assumptions

Financial year runs from 1 July to 30 June.

Real 2018 $ are used for all monetary values unless otherwise stated.

Inputs to the model

Parameter/Input	Description	Source
Discount rate	Real pre-tax discount rate	ElectraNet estimate
Current financial year	Year to start analysis	When the capital investment is due to occur for the project
Time horizon	Length of time under consideration	Total project life including useful life and if the project occurred in the next regulatory period
Capital costs	Amount of capital investment in real terms for each project option	Estimated capital costs in the estimate from project center
Useful life	Length of time capital investments are expected to provide service	Useful life estimated from orginal economic justification on project center
Routine maintenance	Annual amount of estimated routine maintenance in real terms	Detailed Opex Assessment
Corrective maintenance	Amount of estimated corrective maintenance in real terms	Detailed Opex Assessment
Corrective Replacement Cost	Cost of replacing 10 protection system units as they fail	Detailed Opex Assessment
Outage cost	Amount additional MWh of unserved energy when analogue relays fail	Reduced Outage Time
Risk Cost Reduction	Value of risk associated with each of the different options	See detailed risk models

I0 Inputs
User provided parameters and inputs to the model

Inputs

General parameter inputs

Parameter	Unit	Value	Source		Low	Medium	High
				Sensitivities			
Inflation rate	Percentage	2.00%	RBA		1.50%	2.00%	3.00%
Discount rate (real, pre-tax): estimate	Percentage	6.00%	ElectraNet estimate		4.50%	6.00%	8.50%
Discount rate (real, pre-tax): lower bound	Percentage	4.50%	ElectraNet estimate				
First year of analysis	Year	2019	Current financial year				
Base financial year for analysis	Year	2018	Base year				
Time horizon	Years	20	ElectraNet				

Capital cost

Sensitivities			Comment
Low	Medium	High	
70%	100%	130%	Standard sensitivities used

Capital cost inputs

Option	Asset	Amount	Start year	End year	Commission Year	Asset life
Option 1	Relays 2019	5,860,346	2019	2019	2020	20
Option 1	Relays 2020	5,860,346	2020	2020	2021	20
Option 1	Relays 2021	5,860,346	2021	2021	2022	20
Option 1	Relays 2022	5,860,346	2022	2022	2023	20
Option 1	Relays 2023	5,860,346	2023	2023	2024	20
Option 2	Relays 2024	5,155,978	2024	2024	2025	20
Option 2	Relays 2025	5,155,978	2025	2025	2026	20
Option 2	Relays 2026	5,155,978	2026	2026	2027	20
Option 2	Relays 2027	5,155,978	2027	2027	2028	20
Option 2	Relays 2028	5,155,978	2028	2028	2029	20

Costs inputs

Cost type	Cash/Non-cash	Low	Percentage Medium	High	Comment
Corrective Maintenance	Cash	70%	100%	130%	Standard sensitivities used
Routine Maintenance	Cash	70%	100%	130%	
Corrective Replacement Cost	Cash	70%	100%	130%	
Outage Cost	Cash	70%	100%	130%	

Financial year Corrective Maintenance	Units	2019 $	2020 $	2021 $	2022 $	2023 $	2024 $	2025 $	2026 $	2027 $	2028 $	2029 $	2030 $	2031 $	2032 $	2033 $	2034 $	2035 $	2036 $	2037 $	2038 $	Comment
Base case	2018 $	312,141	305,781	299,420	293,059	286,698	441,667	434,839	428,012	421,184	414,357	767,751	753,185	738,620	724,054	709,489	694,924	682,753	670,583	658,413	646,242	Due to the large number of Protection Relays scheduled for replacement the maintenance for the base case is calculated on the median age of 40 years old (Relay List Tab). The
Option 1	2018 $	259,346	205,525	152,217	101,939	47,989	81,020	114,050	147,081	180,112	213,541	244,226	274,911	305,596	336,281	367,336	387,408	407,481	427,553	447,626	467,940	base case incorporates lower corrective maintenance costs for the corrective replacement of 40 relays each year and higher corrective maintenance costs for remaining relays.
Option 2	2018 $	312,141	305,781	299,420	293,059	286,698	47,527	51,469	55,410	59,351	63,293	211,488	215,149	218,810	222,472	226,133	363,804	366,199	368,594	370,989	373,384	Under a planned replacement the worst assets will be replaced first which is why a lower corrective maintenance cost is applied from the beginning of the project.
		10		20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	

Financial year Routine Maintenance	Units	2019 $	2020 $	2021 $	2022 $	2023 $	2024 $	2025 $	2026 $	2027 $	2028 $	2029 $	2030 $	2031 $	2032 $	2033 $	2034 $	2035 $	2036 $	2037 $	2038 $	Comment
Base case	2018 $	78,819	78,928	79,036	79,144	79,253	79,171	79,250	79,330	79,409	79,488	79,419	79,483	79,547	79,611	79,676	79,740	79,790	79,839	79,889	79,939	Due to the large number of Protection Relays scheduled for replacement the maintenance for the base case is calculated on the median age of 40 years old (Relay List Tab). The
Option 1	2018 $	79,719	80,636	81,544	83,217	84,136	83,850	83,563	83,277	82,990	82,700	82,533	82,365	82,197	82,030	81,860	81,741	81,622	81,504	81,385	81,264	base case incorporates lower routine maintenace costs for the corrective replacement of 40 relays each year and higher routine maintenance costs for remaining relays. Under a
Option 2	2018 $	78,819	78,928	79,036	79,144	79,253	83,327	83,293	83,259	83,225	83,190	81,905	81,885	81,865	81,845	81,825	81,073	81,059	81,045	81,031	81,016	planned replacement the worst assets will be replaced first which is why a lower routine maintenance cost is applied from the beginning of the project.

Financial year Corrective Replacement Cost	Units	2019 $	2020 $	2021 $	2022 $	2023 $	2024 $	2025 $	2026 $	2027 $	2028 $	2029 $	2030 $	2031 $	2032 $	2033 $	2034 $	2035 $	2036 $	2037 $	2038 $	Comment
Base case	2018 $	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	838,000	Cost of corrective replacement assuming 40 units fail each year, until the Unit asset replacement project starts. Option 1 and 2 have benefits accuring as soon CAPEX spend
Option 1	2018 $	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	begins. This is due to the prioritisation of works such that the assets most prone to failure will be replaced first.
Option 2	2018 $	838,000	838,000	838,000	838,000	838,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Financial year Outage Cost	Units	2019 $	2020 $	2021 $	2022 $	2023 $	2024 $	2025 $	2026 $	2027 $	2028 $	2029 $	2030 $	2031 $	2032 $	2033 $	2034 $	2035 $	2036 $	2037 $	2038 $	Comment
Base case	2018 $	1,240,435	1,213,599	1,186,762	1,159,926	1,133,090	1,106,253	1,079,417	1,052,581	1,025,744	998,908	972,072	945,235	918,399	891,563	864,726	837,890	811,054	784,217	757,381	730,545	Cost relate to reduced outage time. Analogue protection relay requires longer to restore a outages when a failure occurs compared to a digital relay.
Option 1	2018 $	1,240,435	1,017,693	794,952	572,210	349,469	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044		
Option 2	2018 $	1,240,435	1,213,599	1,186,762	1,159,926	1,133,090	1,106,253	910,348	714,443	518,538	322,632	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044	124,044		

Benefit inputs

Benefit type	Cash/Non-cash	Low	Percentage Medium	High	Comment
Risk Cost Reduction	Cash	50%	80%	100%	Lower sensitivities used

Financial year Risk Cost Reduction	Units	2019 $	2020 $	2021 $	2022 $	2023 $	2024 $	2025 $	2026 $	2027 $	2028 $	2029 $	2030 $	2031 $	2032 $	2033 $	2034 $	2035 $	2036 $	2037 $	2038 $	Comment
Base case	2018 $	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A conservative approach to risk has been undertaken as benefits from reducing the risk will not start until over half of the project has been undertaken.
Option 1	2018 $	0	0	0	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	
Option 2	2018 $	0	0	0	0	0	0	0	0	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	1,949,753	

R0 CBA Results
Sensitivities, results and rankings

Input Summary

Parameter selection for sensitivity analysis				Capital cost

Scenario parameters		Capital cost scenario		
	Units	Low	Medium	High
Assumed scenario weighting	% weighting	33%	33%	33%
Discount rate	% real, pre-tax	6.00%	6.00%	6.00%
Capital cost	% of estimate	70%	100%	130%

Cost selection for sensitivity analysis				Corrective Replacement Cost

Scenario cost inputs		Corrective Replacement Cost scenario		
	Units	Low	Medium	High
Corrective Maintenance	% of estimate	100.0%	100.0%	100.0%
Routine Maintenance	% of estimate	100.0%	100.0%	100.0%
Corrective Replacement Cost	% of estimate	70.0%	100.0%	130.0%
Outage Cost	% of estimate	100.0%	100.0%	100.0%

Benefit selection for sensitivity analysis				Reduced outage time

Scenario benefit inputs		Reduced outage time scenario		
	Units	Low	Medium	High
Risk Cost Reduction	% of estimate	80.0%	80.0%	80.0%

Cost Benefit Analysis Results (Quantitative)

Output summary	Net present value of benefits			

NPV results			Scenario		Weighted
Option	Units	Low	Medium	High	NPV
Option 1	2018 $	14,579,926	10,468,829	6,357,733	10,468,829
Option 2	2018 $	10,314,361	8,234,628	6,154,896	8,234,628

Output summary	Ranking of options			

Ranking of options			Scenario		Weighted
Option	Units	Low	Medium	High	ranking
Option 1	2018 $	1	1	1	1
Option 2	2018 $	2	2	2	2