Revised Proposal

Attachment 5.13.M.3

High Voltage Overhead Lines program CBA summary

January 2019

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Introduction

Ausgrid has reviewed the risks associated with high voltage overhead lines by undertaking a quantitative risk assessment. This document covers the outcomes of cost benefit analysis and should be reviewed in conjunction with the cost benefit analysis (CBA) modelling methodology report[1].

Scope

This model covers the following RIN categories:

- OVERHEAD CONDUCTORS - > 1 KV & < = 11 KV
- OVERHEAD CONDUCTORS - > 11 KV & < = 22 KV ; SWER
- OVERHEAD CONDUCTORS - > 11 KV & < = 22 KV ; MULTIPLE-PHASE

Analysis Outcome

The analysis was completed using historical data up to and including FY18. The CBA models forecast risk from FY19 onwards. The volumes included in FY19 are reflective of Ausgrid's committed program in this year.

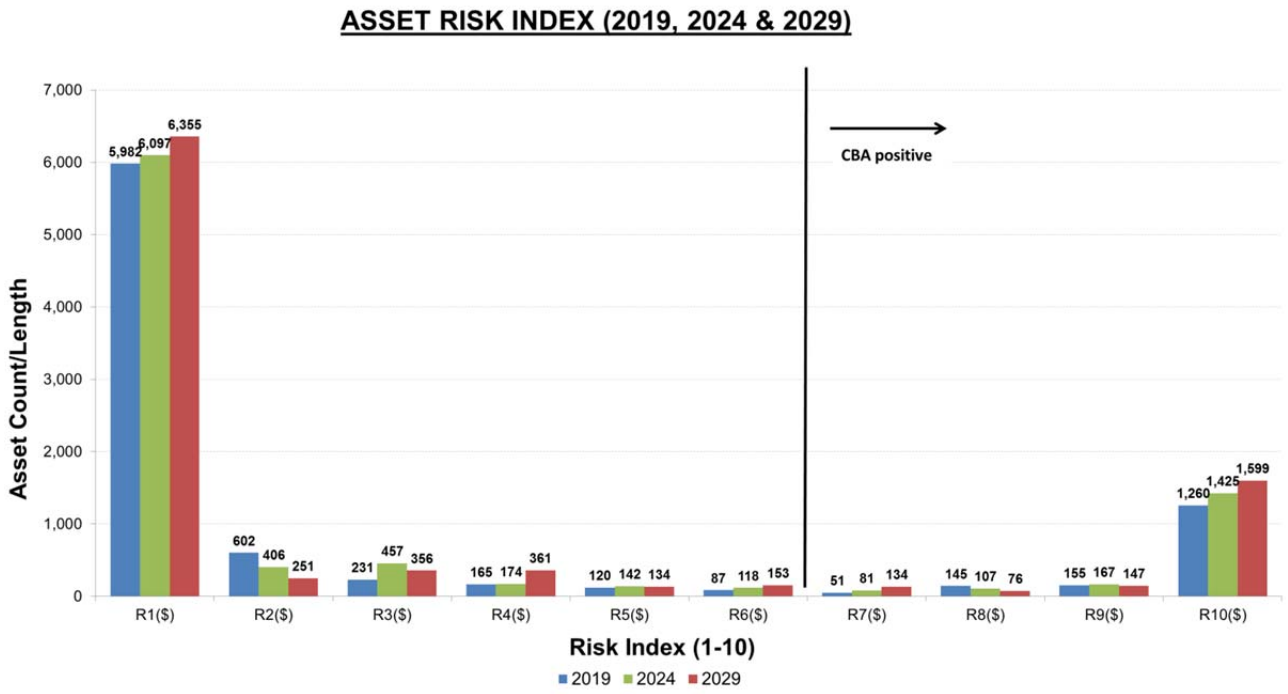
Based on the analysis completed, the model output is supporting the replacement of 1,780 km of high voltage overhead lines by the end of FY24. This includes 179 km of high voltage overhead lines committed for replacement during FY19 and a total of 1,601 km of high voltage overhead lines which are cost benefit positive (those with a Risk Index of 7 or above) during FY20 to FY24.

In forming this decision Ausgrid considered three options and performed sensitivity analysis as described later in this document. Ausgrid is recommending Option 3 for the levelled replacement of all assets which are cost benefit positive by the end of FY24.

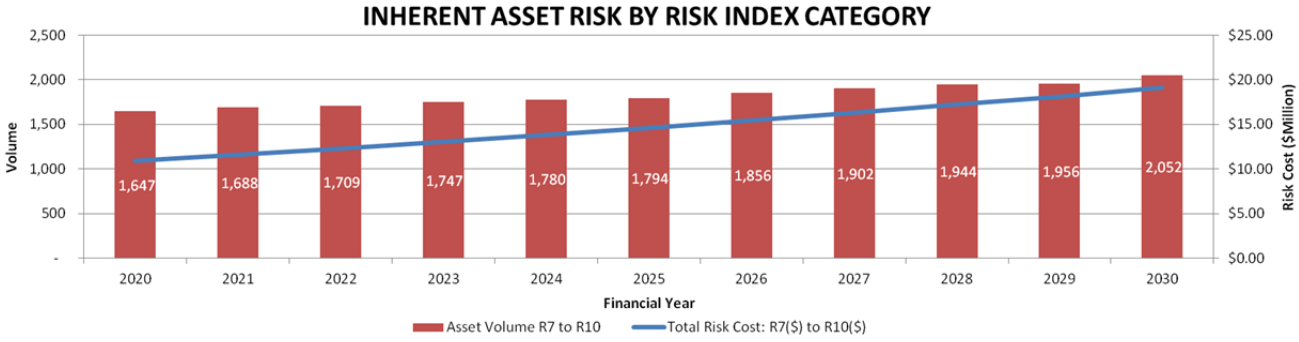
Risk Index

The normalised risk index below considers the probability of failure, consequence of failure and the annualised replacement cost.

[1] Attachment 5.13.M.0 – Repex program CBA modelling methodology



The inherent risk of high voltage overhead lines that are cost benefit positive is shown in the figure below.

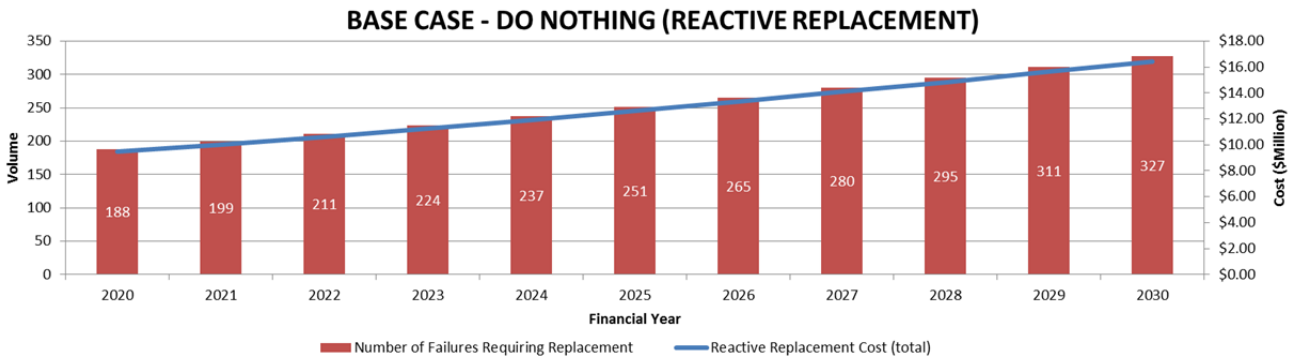


Option One – Base case (reactive replacement)

Under a base case (reactive replacement) scenario, if Ausgrid were to adopt a reactive replacement strategy, the minimum replacement volume during FY20 to FY24 is 1,059 km of high voltage overhead lines. The table below shows the volume of assets which will require reactive replacement in the year that they are forecast to fail.

Financial Year	FY20	FY21	FY22	FY23	FY24
Volumes for replacement	188	199	211	224	237

This table shows the number of failures that will result in the minimum volume of replacement required without a proactive replacement strategy in place.

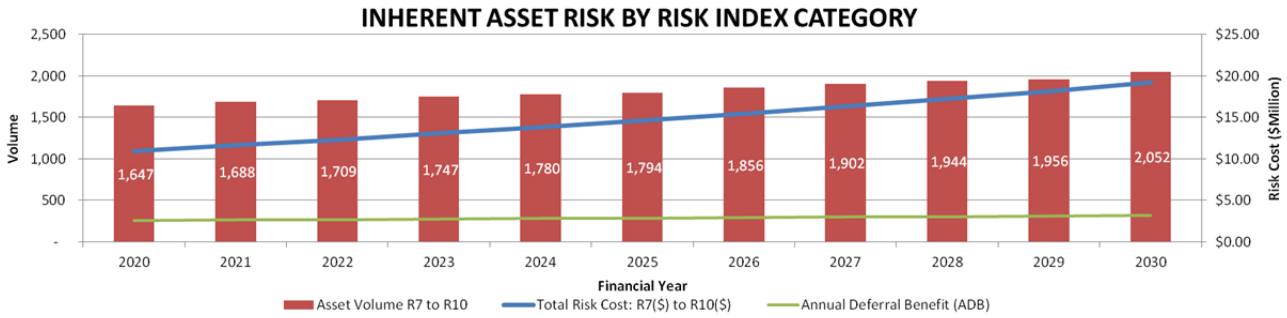


Option Two – Replace where cost benefit positive

Given Ausgrid plans to replace 179 km of high voltage overhead lines in FY19, the recommended planned replacement volume during FY20 to FY24 is 1,601 km of high voltage overhead lines. The table below shows the year in which these assets should be replaced based on when the benefit to customers exceeds the annualised deferral benefit:

Financial Year	FY20	FY21	FY22	FY23	FY24
Volumes for replacement (km)	1,468	42	21	38	33

Based on this volume, the annual deferral benefit against the inherent risk for all assets with a Risk Index of 7 to 10 is shown in the figure below. The annual deferral benefit remains lower than the total risk as Ausgrid is not targeting the planned replacement of assets that are not cost benefit positive.



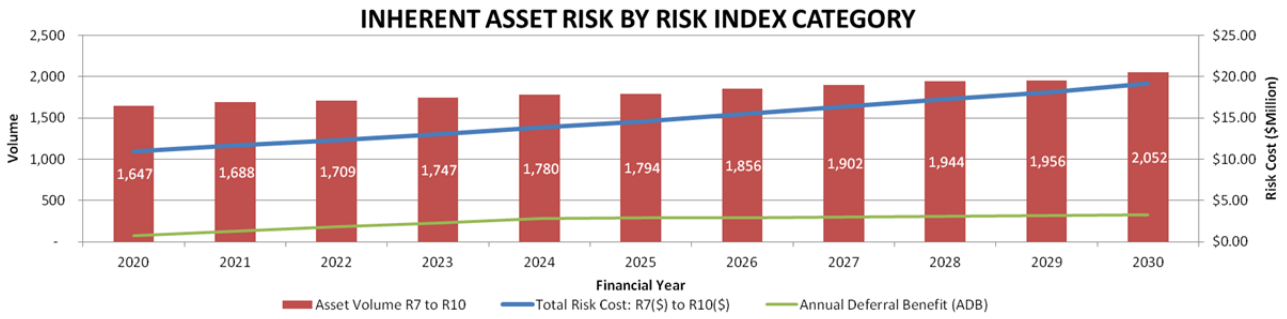
This option provides the maximum benefit to customers as it leads to the avoidance of risk at the point at which the benefits exceed the costs. However, the large delivery requirement in FY20 will not be reasonably achievable due to constraints on network access, physical access and delivery resourcing.

Option Three – Replace all cost benefit positive by the end of the period

Given the delivery constraint, under this option Ausgrid have considered the levelled replacement of high voltage overhead lines that are cost benefit positive during FY20 to FY24. This replacement strategy results in 320 km of high voltage overhead lines (rounded) replaced per year.

Financial Year	FY20	FY21	FY22	FY23	FY24
Volumes for replacement (km)	320	320	320	320	320

Based on this replacement volume, the annual deferral benefit against the inherent risk for all assets with a Risk Index of 7 to 10 is shown in the figure below.



This option balances achieving value for customers with consideration of the delivery limitations and is therefore the recommended option.

Data input

		Data Source
Population	9,987 km	GIS – Asset Register
Object Types	HV Line	GIS – Asset Register
Conditional & Functional Failures / Time Period	5,288 failures 6 years	SAP – Defect Records
Asset standard life	58.03 years	RAB life
WACC	3.90%	Regulated Rate

Planned Replacement Cost

A weighted average for the period per asset was used in this model.

Cost	Data Source
$41,923	2020-24 Revised Regulatory Proposal (FY19 real direct costs +25% of indirect costs)

Crow-AMSAA parameters

The Crow-AMSAA parameters have been developed by applying asset age to failure correlation using Ausgrid historical data relating to failures and assets.

β_{good}	3.2452	$\beta_{average}$	3.6707	β_{poor}	4.0963
$\lambda_{average}$	9.88E-07				

Adjustments factors

Probability of Failure (PoF)	• Actual Failure Data • Age • Conductor type • Distance to coast
Probability of Consequence (PoC)	• Proximity to school • Spatial risk score (based on factors including bushfire risk and people / traffic exposure)

Model calculated failures

	2020	2021	2022	2023	2024
Failures	938	996	1,057	1,121	1,187

Sensitivity

Ausgrid tested the sensitivity of the applied grossly disproportionate factor by applying a factor of 6, based on the public safety risk. The impact of these changes is a 2% reduction in the overall recommended replacement quantities during FY20 to FY24.

Modelled inherent incident consequences

In determining the probability of severity, Ausgrid has utilised available information to determine the rate of occurrence of an event by each severity. These values were then tested for sensitivity.

Safety (specifically worker safety for this asset type)
Worker Safety ICR – 0.10% (Ausgrid recorded ICR)
Public Shock ICR – 0.07% (Ausgrid recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$ 4,469,292	0.000011	10	0.007	100
Major	$ 446,929	0.000023	8	0.013	50
Moderate	$ 44,693	0.000114	6	0.067	10
Minor	$ 4,469	0.000225	4	0.133	5
Insignificant	$ 447	0.001327	2	0.780	0.9

Average **safety** consequence per asset: $624 per event.

Ausgrid have proposed that inherently a fatality would occur due to a failure of a high voltage overhead line every 100 years based on the population and industry experience. Changing the probability of severity to 0.013 (or a fatality every 50 years) increases the average safety consequence by 81% and increases the recommended replacement volume by 8 km during FY20 to FY24. Changing the probability of severity to 0.003 (or a fatality every 200 years) reduces the average safety consequence by 41% and reduces the recommended replacement volume by 17.5 km during FY20 to FY24.

Fire
ICR – 2.50% (Ausgrid's recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$ 66,000,000	0.000011	10	0.00045	100
Major	$ 6,600,000	0.000023	8	0.001	50
Moderate	$ 660,000	0.000112	6	0.005	10
Minor	$ 66,000	0.002247	4	0.090	0.5
Insignificant	$ 6,600	0.022576	2	0.904	0.05

Average **fire** consequence per asset: $10,027 per event.

Ausgrid have proposed that inherently a severe fire would occur due to a failure of a high voltage overhead line every 100 years based on the population and NSW industry experience. Changing the probability of severity to 0.0009 (or a severe fire every 50 years) increases the average fire consequence by 75% and increases the recommended replacement volume by 89 km during FY20 to FY24. Changing the probability of severity to 0.00022 (or a severe fire every 200 years) reduces the average fire consequence by 37% and reduces the recommended replacement volume by 53 km during FY20 to FY24.

Environment
ICR – 0%

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$ 10,193,119	n/a	1	n/a	n/a
Major	$ 4,558,501	n/a	1	n/a	n/a
Moderate	$ 1,019,312	n/a	1	n/a	n/a
Minor	$ 101,931	n/a	1	n/a	n/a
Insignificant	$ 10,193	n/a	1	n/a	n/a

Average **environment** consequence per asset: $ n/a.

Ausgrid have considered that there are negligible environmental consequences relating to high voltage overhead lines. There have been no recorded environmental impacts (excluding fire) as a result of these assets.

Loss of supply

Ausgrid's failure data has been reviewed to estimate the proportion of failures resulting in unserved energy and reasonable switching / restoration times.

Outage Type	HV	Data Source
Proportion of failures resulting in unserved energy	14%	SAP - defect data
VCR	$40.73/kWh	AEMO / AER
Automatic protection time/Proportion load	0 min / 0%	N/A
Switching time/Proportion load	1.0 hrs / 95%	Estimated
Restoration/repair time/Proportion load	4 hrs / 5%	Estimated
Time without supply	0.16 hrs	Calculated

Average **loss of supply** consequence per asset: $7,242 per event.

Finance

		Data Source
Annual deferral benefit of reactive	$1,888	20% increase on planned replacement cost applied at the WACC
Repair cost	$2,336	FY13-FY18 actuals (Direct '19)
Proportion replaced	20%	SAP – defect data
Weighted replacement/repair cost	**$11,930**	Calculated
Maintenance original asset per annum	$160	Estimate based on historical maintenance
Maintenance replacement asset per annum	$160	Estimate based on historical maintenance
Maintenance benefit per asset per annum	**$0**	Calculated

Average **financial** consequence/benefit per asset: $11,930 per event.

AVERAGE TOTAL CONSEQUENCE per asset: $29,823 (including POC x C($))