Revised Proposal

Attachment 5.13.M.12

High Voltage Air Break Switches program CBA summary

January 2019

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Introduction

Ausgrid has reviewed the risks associated with Air Break Switches (ABS) 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 a portion of the forecast mapped to the following RIN categories:

- SWITCHGEAR - < = 11 KV ; SWITCH
- SWITCHGEAR - > 22 KV & < = 33 KV ; SWITCH

Also included in this RIN category are:

- High Voltage CBD Isolator and Earth Switches (refer to separate document[2]),
- High Voltage Fuse Switches (refer to separate document[3]), and
- Distribution Substations where the whole substation is cost benefit positive (refer to separate document[4]).

Analysis Outcome

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

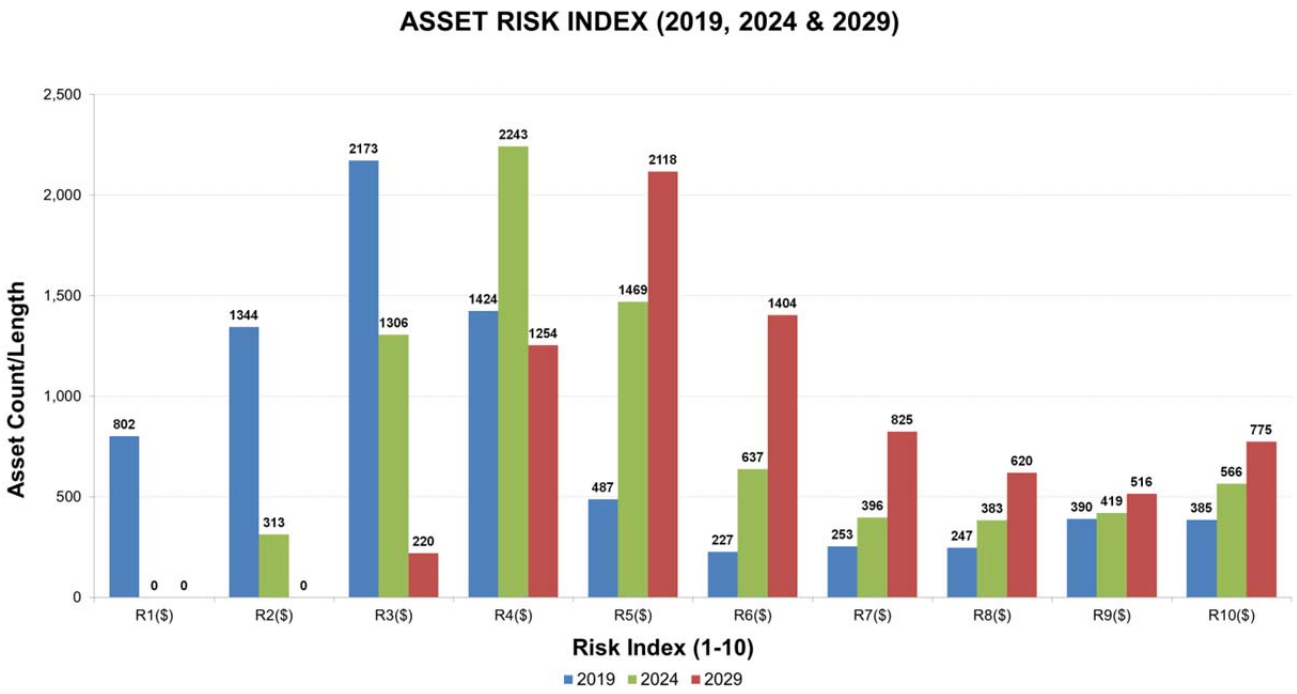
Based on the analysis completed, the model output is supporting the replacement of 1,764 ABS by the end of FY24. This includes 247 ABS committed for replacement during FY19 and a total of 1,517 ABS which are cost benefit positive (those with a Risk Index of 7 or above) during FY20 to FY24.

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.

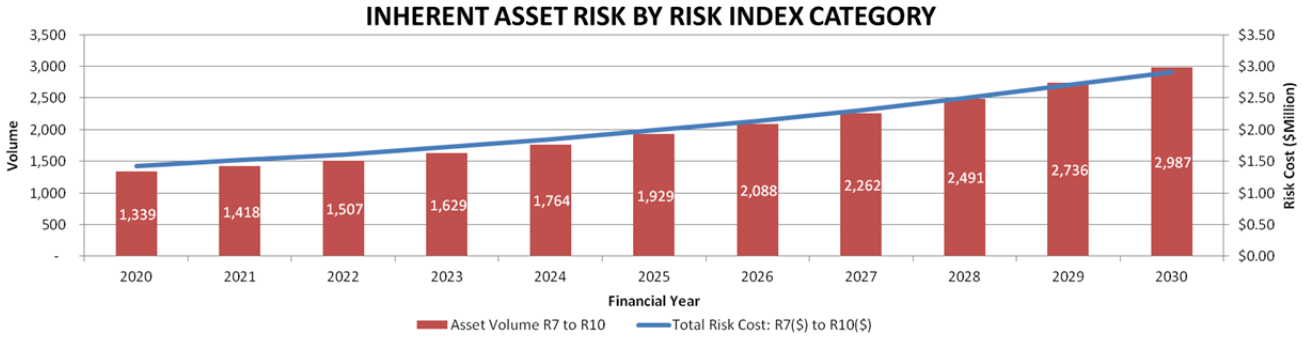
Risk Index

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
[2] Attachment 5.13.M.19 – High Voltage CBD Isolator and Earth Switches program CBA summary
[3] Attachment 5.13.M.12 – High Voltage Fuse Switches program CBA summary
[4] Attachment 5.13.M.9 – Distribution Substations program CBA summary



The inherent risk of ABS that are cost benefit positive is shown in the figure below.

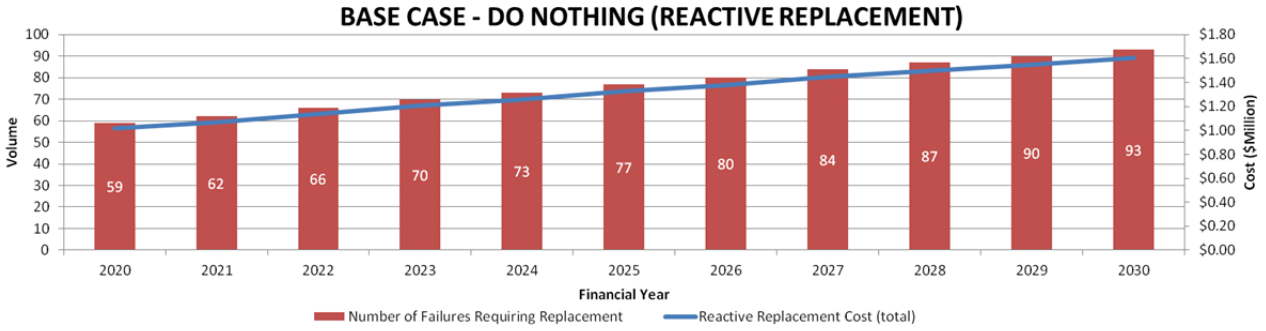


Option One – Base Case (Reactive Replacement)

Under a base case scenario, if Ausgrid were to adopt a reactively replacement strategy, the minimum replacement quantity during FY20 to FY24 is 330 ABS. The table below shows the quantity of assets which will require reactive replacement in the year that they are forecast to fail.

Financial Year	FY20	FY21	FY22	FY23	FY24
Quantity for replacement	59	62	66	70	73

This quantity represents the minimum number of replacements required without a proactive replacement strategy in place.

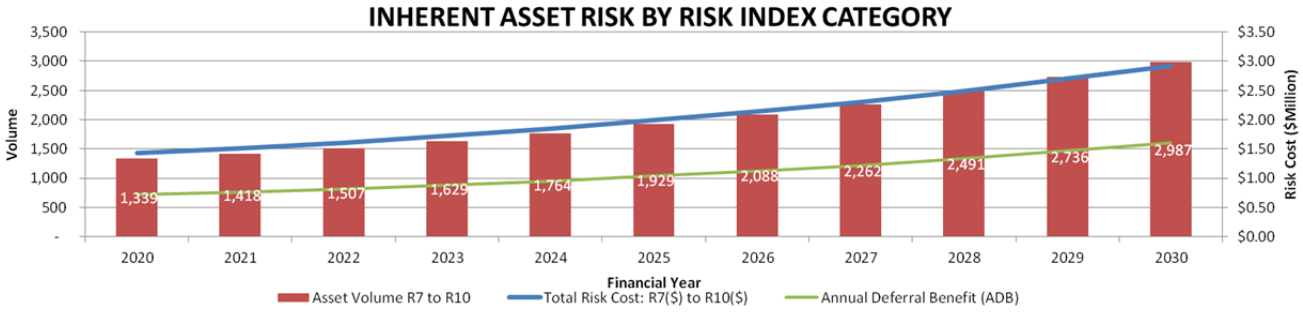


Option Two – Replace where cost benefit positive

Given Ausgrid plans to replace 247 ABS in FY19, the recommended planned replacement quantity during FY20 to FY24 is 1,517 ABS. 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
Quantity for replacement	1092	80	88	122	133

Based on this replacement quantity, 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 network access and other resourcing constraints.

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 ABS that are cost benefit positive during FY20 to FY24. This replacement strategy results in 303 ABS replaced per year.

Financial Year	FY20	FY21	FY22	FY23	FY24
Quantity for replacement	303	303	303	303	303

Based on this replacement quantity, 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.

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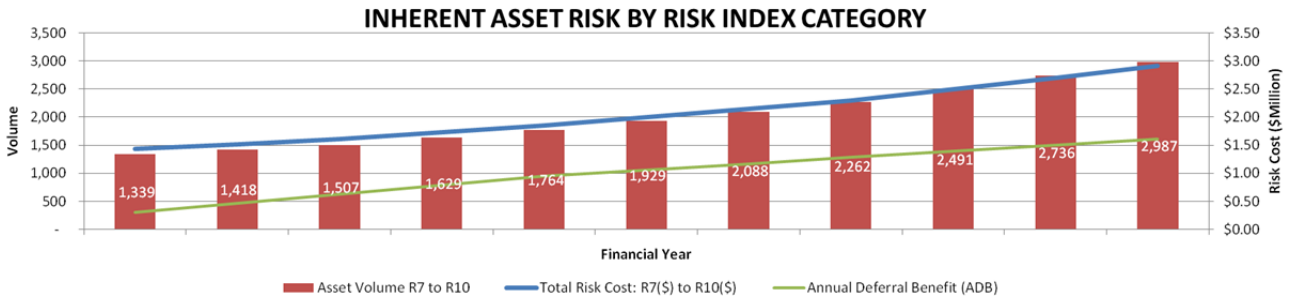

This option balances achieving value for customers with consideration of the delivery limitations and is therefore the recommended option.

Data input

		Data Source
Population	7,732	SAP – Asset Register
Object Types	SW_HV_ABS	SAP – Asset Register
Conditional & Function Failures / Time Period	1,167 failures 6 years	SAP – Defect Records Last 6 years of data
Asset standard life	46.84 years	RAB life
WACC	3.90%	Regulated Rate

Planned Replacement Cost

A weighted average for the period per asset was used in this model due to the different voltage levels involved.

Cost	Data Source
$13,301	2019-24 Revised Regulatory Proposal (FY19 real direct costs +25% of indirect costs)

Weibull parameters

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

β_{good}	1.7113	$\beta_{average}$	1.7531	β_{poor}	1.7949
n_{good}	34.3890	$n_{average}$	31.6080	n_{poor}	29.1663
$b_{(intercept)}$	-6.0543				

Adjustments factors

Probability of Failure (PoF)	• Age • Construction type • Distance to coast • Number of Failures
Probability of Consequence (PoC)	• Bushfire area category • Traffic exposure • People exposure • Construction type • Distance from a school

Model calculated failures

	2019	2020	2021	2022	2023	2024
Failures	195	209	222	235	248	261

Sensitivity

Ausgrid tested the sensitivity of the applied grossly disproportionate factor by applying a factor of 6 to safety and fire consequences, based on the public safety risk. The impact of these changes is a 28% 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 (public and worker safety for this asset type)
Worker Safety ICR – 0% (Ausgrid's recorded ICR)
Public Safety ICR – 0.21% (Ausgrid's recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$4,469,292	0.000005	10.0	0.0025	1000
Major	$446,929	0.000025	8.0	0.0125	200
Moderate	$44,693	0.000050	6.0	0.0250	100
Minor	$4,469	0.000500	4.0	0.2500	10
Insignificant	$447	0.001460	2.0	0.7075	3.54

Average **safety** consequence per asset: $346 per event.

Ausgrid have proposed that inherently a fatality would occur due to a failure of an ABS every 1,000 years based on the population and industry experience. Changing the probability of severity to 0.005 (or a fatality every 500 years) increases the average safety consequence by 66% and increases the recommended replacement quantity by 22 during FY20 to FY24. Changing the probability of severity to 0.00125 (or a fatality every 2,000 years) reduces the average safety consequence by 33% and reduces the recommended replacement quantity by 15 during FY20 to FY24.

Fire
ICR – 1.03% (Ausgrid's recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$66,000,000	0.0000103	10.0	0.001	500
Major	$6,600,000	0.0000206	8.0	0.002	250
Moderate	$660,000	0.0002575	6.0	0.025	20
Minor	$66,000	0.0025750	4.0	0.25	2.0
Insignificant	$6,600	0.0074366	2.0	0.722	0.69

Average **fire** consequence per asset: $9,670 per event.

Ausgrid have proposed that inherently a severe fire would occur due to a failure of an ABS every 500 years based on the population and industry experience. Changing the probability of severity to 0.002 (or a severe fire every 250 years) increases the average fire consequence by 70% and increases the recommended replacement quantity by 1,559 during FY20 to FY24. Changing the probability of severity to 0.0005 (or a severe fire every 1,000 years) reduces the average fire consequence by 35% and reduces the recommended replacement quantity by 543 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 ABS. 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	Feeder	Data Source
Proportion of failures resulting in unserved energy	5%	Estimated
VCR	$40.73/kWh	AEMO / AER
Automatic Protection Time / Load restored at time	0.00 min / 0%	Currently estimated
Switching time / Load restored at time	1 hrs / 95%	Estimated
Restoration/repair time / Load restored at time	2 hrs / 5%	Estimated
Time without supply	0.05 hrs	Calculated

Average **loss of supply** consequence per asset: $2,463 per event.

Finance

		Data Source
Annual deferral benefit of reactive	$647	20% increase on planned replacement cost applied at the WACC
Repair cost	$3,244	FY13-FY18 actuals (Direct '19)
Proportion replaced	28%	SAP – Asset Register
Weighted replacement/repair cost	**$2,513**	Calculated
Maintenance original asset per annum	$0	Based on historical maintenance
Maintenance replacement asset per annum	$0	Based on historical maintenance
Maintenance benefit per asset per annum	**$0**	Calculated

Average **financial** consequence/benefit per asset: $2,513 per event

AVERAGE TOTAL CONSEQUENCE per asset: $14,992 (including POC x C($))