Revised Proposal

Attachment 5.13.M.16

High Voltage Drop-out Fuses program CBA summary

January 2019

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Introduction

Ausgrid has reviewed the risks associated with high voltage drop-out fuses (HDOs) by undertaking a quantitative risk assessment. There has been identified a specific switch type which Ausgrid has had a number of condition issues and functional failures, these are considered to have a higher risk associated with worker safety during operating. 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 - <= 11KV; Fuse

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.

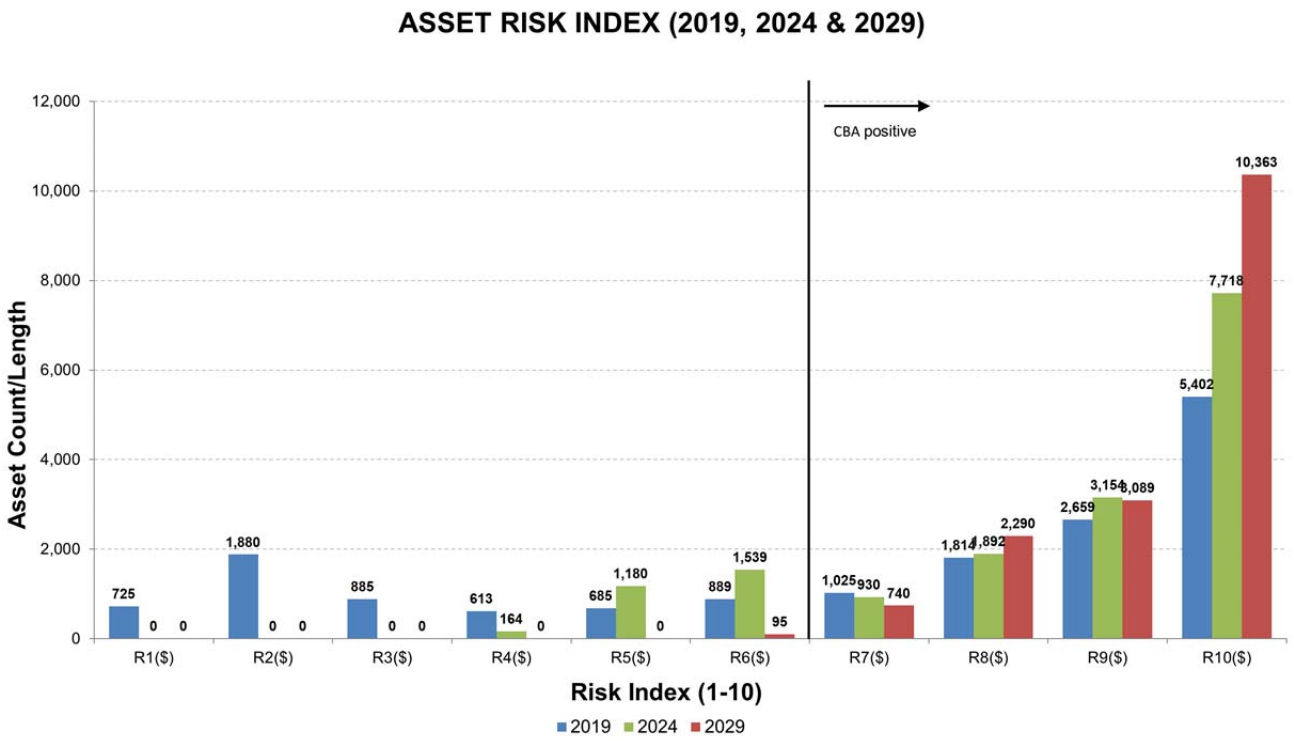
Based on the analysis completed, the model output is supporting the replacement of 13,694 HDOs by the end of FY24. This includes a total of 700 HDOs which have been committed in FY19 and a total of 12,994 HDOs which are cost benefit positive between FY20 to FY24.

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

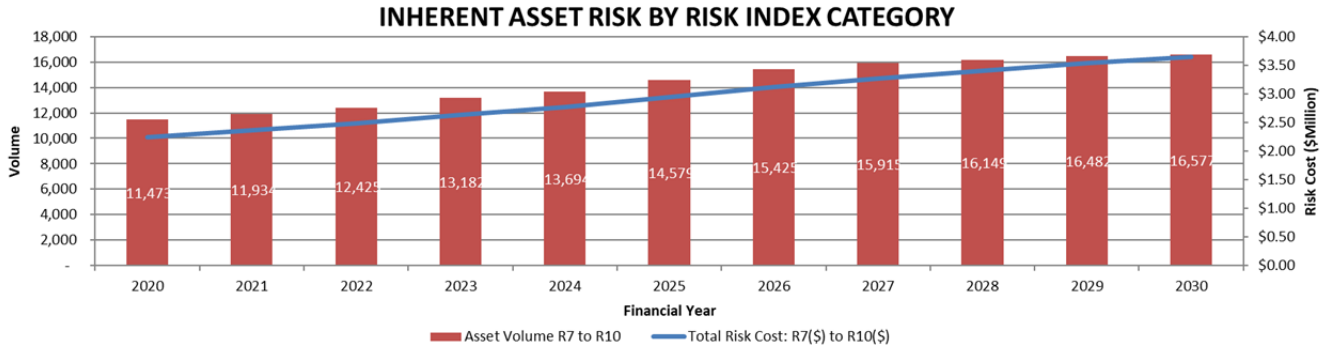
Risk Index

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 HDOs that are cost benefit positive is shown in the figure below.

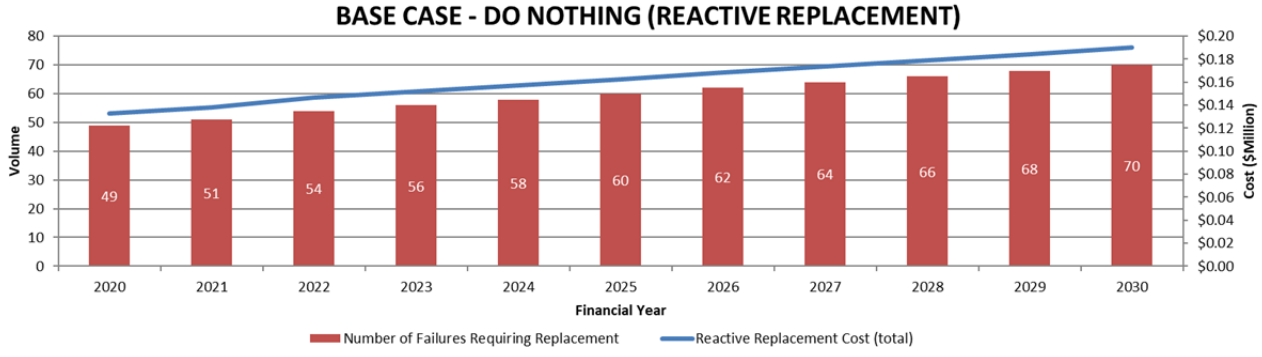


Option One – Base Case (Reactive Replacement)

Under a base case scenario, if Ausgrid were to adopt a reactive replacement strategy, the minimum replacement quantity during FY20 to FY24 is 268 HDOs. 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	49	51	54	56	58

This quantity represents the minimum required replacement volume with no proactive strategy is adopted.



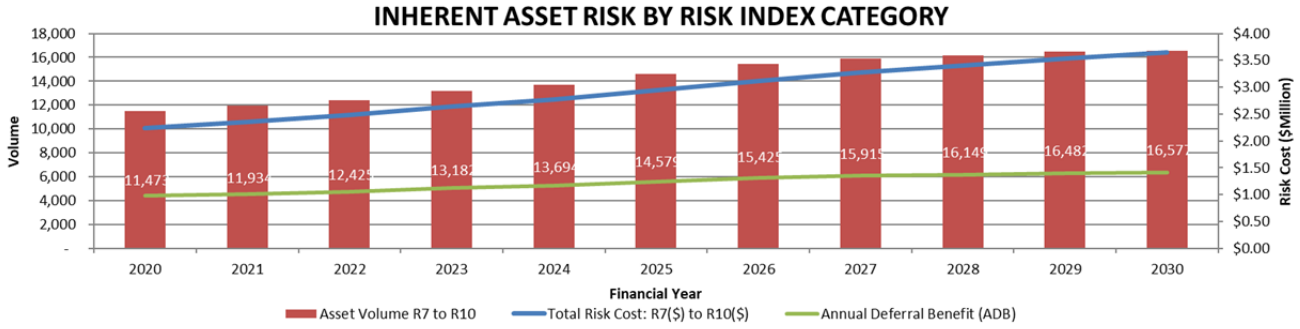
Option Two – Replace where cost benefit positive

Given Ausgrid plans to replace 700 HDOs in FY19, the recommended replacement quantity from the model is 12,994 HDOs. 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	10,773	461	491	757	512

The large quantity in FY20 is due to a backlog of HDOs which are cost benefit positive and using this option would all be replaced in the first year.

Based on this replacement quantity, the annual deferral benefit against the inherent risk for all assets included in and above Risk Index 7 is shown in the figure below. The annual deferral benefit remains lower than the total risk as Ausgrid is not targeting any assets that are not cost benefit positive.



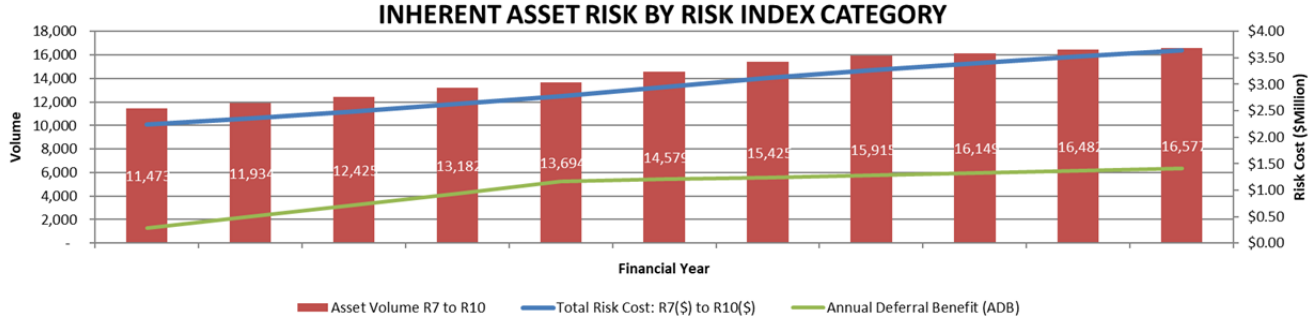
This option provides the maximum benefit to customers as it leads to the avoidance of risk at the point at which the benefits exceed the costs. However, the large delivery requirement in FY20 will not be reasonably achievable due to the constraints on network access, physical access and staff resourcing.

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

Given the delivery constraints, under this option Ausgrid have considered the levelled replacement of all HDOs that are cost benefit positive by the end of FY24. This results in approximately 2,598 HDOs being replaced per year.

Financial Year	FY20	FY21	FY22	FY23	FY24
Quantity for replacement	2,598	2,599	2,599	2,599	2,599

Based on this replacement quantity, the annual deferral benefit against the inherent risk for all assets above Risk Index 7 is shown in the figure below.



This option balances achieving value for customers with consideration of the constraints associated with efficient delivery.

Data input

		Data Source
Population	16,577	SAP – Asset Register
Object Types	FUSE_HLDR – HV Dropout Fuse Holder	SAP – Asset Register
Conditional & Functional Failures / Time Period	1,398 failures 6 years	SAP – Defect Records
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.

Cost	Data Source
$2,261	2020-24 Revised Regulatory Proposal (FY19 real direct costs +25% of indirect costs)

Weibull parameters

Developed by applying asset age to failure correlation using Ausgrid historical failure and asset data.

β_{good}	1.6427	$\beta_{average}$	1.6835	β_{poor}	1.7243
η_{good}	55.8409	$\eta_{average}$	50.6486	η_{poor}	46.1520

b (intercept)	-6.6076

Adjustments factors

Probability of Failure (PoF)	• Actual Failure Data • Age • Equipment Manufacturer Model • Inspected corrosion
Probability of Consequence (PoC)	• Bushfire area

Model calculated failures

	2020	2021	2022	2023	2024
Failures	245	257	269	280	291

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 fire risk. The impact of these changes is a 12% reduction to the overall recommended replacement quantities.

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 – 0.08% (Ausgrid recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$ 4,469,292	0.000029	10	0.036	149
Major	$ 446,929	0.000042	8	0.053	101
Moderate	$ 44,693	0.000120	6	0.150	36
Minor	$ 4,469	0.000240	4	0.300	18
Insignificant	$ 447	0.000369	2	0.461	12

Average **safety** consequence per asset: $1,476 per event.

Ausgrid has had a number of near miss events associated with HDOs and determined that there is potential for a fatality so have calibrated the probability of severity for a severe incident to 149 years. Changing the probability of severity to 0.072 (or 1 fatality every 75 years), increases the average safety consequence by 87% and increases the recommended replacements by 975 planned over the period. Changing this to 0.018 (or 1 fatality every 200 years), reduces the average safety consequence by 44% and reduces the recommended replacements by 254 planned over the period.

Fire
ICR – 0.77% (Ausgrid's recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$ 66,000,000	0.000008	10	0.0010	558
Major	$ 6,600,000	0.000017	8	0.0022	254
Moderate	$ 660,000	0.000077	6	0.010	56
Minor	$ 66,000	0.001540	4	0.200	2.8
Insignificant	$ 6,600	0.006058	2	0.787	0.7

Average **fire** consequence per asset: $6,768 per event.

Ausgrid has experienced a number of grass fires as a result of a failed HDO during the observation period. Changing the probability of severity to 0.2 for a severe outcome (or 1 every 279 years), increases the average fire consequence by 75% and increases the recommended replacements by 2,428 planned over the period. Changing this to 0.0005 for a severe fire (or 1 every 1115 years), reduces the average fire consequence by 38% and reduces the recommended replacements by 1,718 planned over the period.

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.

There are negligible environmental consequences relating to HDOs.

Loss of supply
Ausgrid's failure data has been reviewed to determine the proportion of failures resulting in unserved energy, with consideration of the number of outages recorded using data from Ausgrid's outage management system (OMS).

Outage Type	HV	Data Source
Proportion of failures resulting in unserved energy	38%	OMS - 3 year average
VCR	$40.73/kWh	AEMO / AER
Average interruption duration	2.30 hrs	OMS - 3 year average
Time without supply	0.86 hrs	Calculated

Average **loss of supply** consequence per asset: $865 per event.

Finance

		Data Source
Annual deferral benefit of reactive	$102	20% increase on planned replacement cost applied at the WACC
Repair cost	$2,549	FY13-FY18 actuals (Direct '19)
Proportion replaced	20%	SAP – Asset Register
Weighted replacement/repair cost	**$2,106**	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: $2,106 per event.

AVERAGE TOTAL CONSEQUENCE per asset: $11,215 (including POC x C($))