Revised Proposal

Attachment 5.13.M.2

Low Voltage CONSAC_HDPE program CBA summary

January 2019

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Low Voltage CONSAC / HDPE program CBA summary

Introduction

Ausgrid has reviewed the risks associated with low voltage Consac and high density polyethylene insulated (HDPE) cable 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:

- Underground cables < = 1 kV.

A variation has been incorporated into the CONSAC/HDPE model to account for cable failure history. Where a cable experiences a failure, an adjustment to the probability of failure is applied. Given Ausgrid will repair cables to restore supply to customers, a number of CONSAC/HDPE cables have already experienced failures. Given a cable has already experienced one failure and that cable condition is generally similar across the entire feeder, it is reasonable to expect that a cable which has experienced a failure, has a higher probability of experiencing more failures. Therefore an adjustment to the probability of failure has been applied to cable with recorded failures.

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.

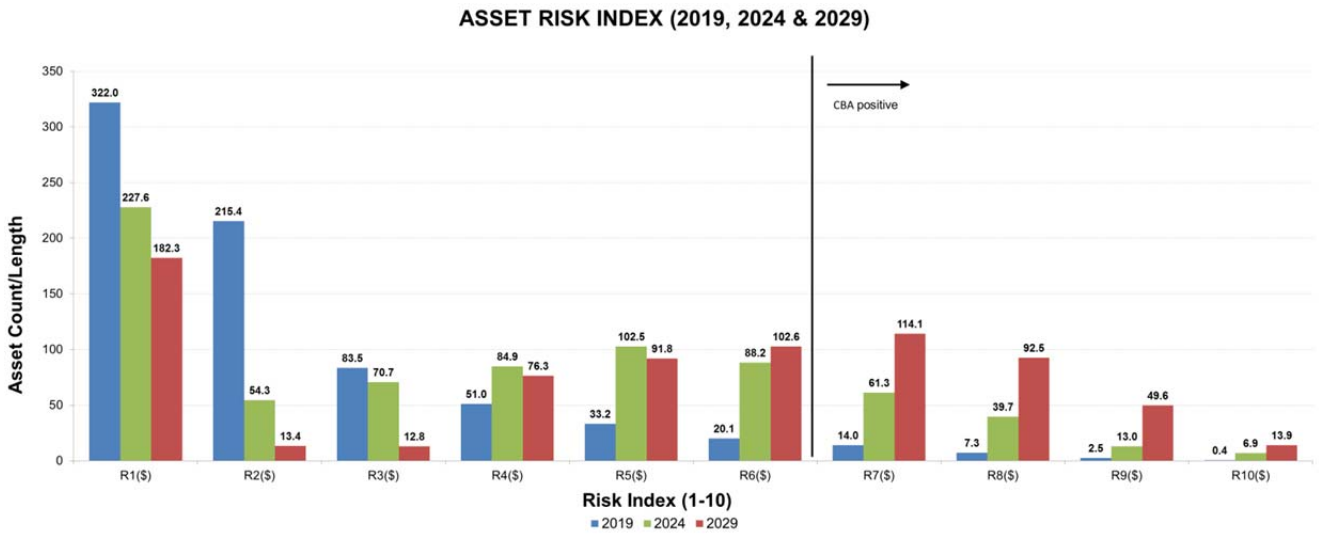
Based on the analysis completed, the model output is supporting the replacement of 120.9 km of Consac and HDPE by the end of FY24. This includes 18.5 km committed for replacement during FY19 and a total of 102.4 km of Consac and HDPE cable which are cost benefit positive (those with a Risk Index of 7 or above) during FY20 to FY24.

In forming this decision Ausgrid considered three options and performed sensitivity analysis as described 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.

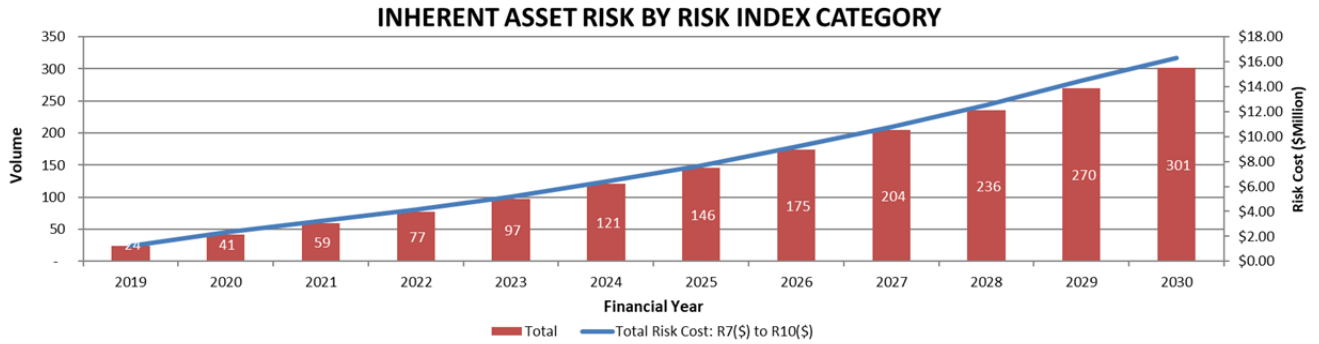
Risk Index

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 Consac and HDPE cables that are cost benefit positive is shown in the figure below.



Option One – Base Case (Reactive Replacement)

The base case (reactive replacement) for Consac and HDPE cables is not relevant. Following a failure, repair is undertaken to restore customers in an appropriate timeframe. Therefore, replacement is only considered viable when it is planned. The table below shows the number of failures that would require a reactive repair per annum.

Financial Year	FY20	FY21	FY22	FY23	FY24
Volumes for repair[1]	257	300	339	376	411

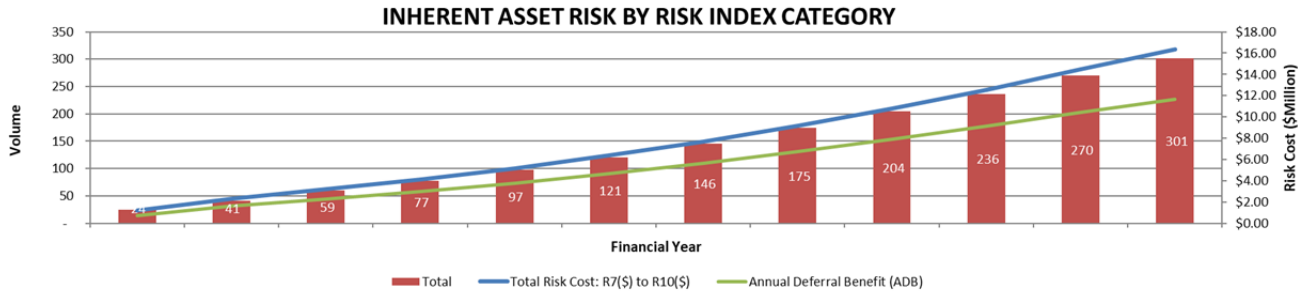
Note 1: This is the forecast number of repairs required.

Option Two – Replace where cost benefit positive

Given Ausgrid plans to replace 18.5 km of Consac and HDPE cable in FY19, the recommended planned replacement volume during FY20 to FY24 is 102.4 km of Consac and HDPE cable. 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)	22.9	18.0	18.0	19.8	23.7

Based on this volume, the annual deferral benefit against the inherent risk for all assets 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.



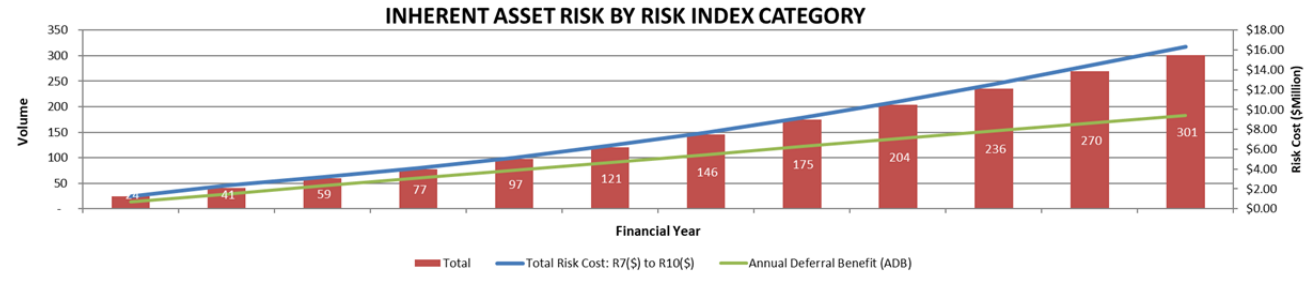
This option provides the maximum benefit to customers as it leads to the avoidance of risk at the point at which the benefits exceed the costs. However, the large delivery requirement in FY20 will not be reasonably achievable due to the constraints on network access, physical access and other resourcing 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 Consac and HDPE cable that are cost benefit positive during FY20 to FY24. This replacement strategy results in approximately 20.5km replaced (rounded) per year.

Financial Year	FY20	FY21	FY22	FY23	FY24
Volumes for replacement (km)	20.5	20.5	20.5	20.5	20.5

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 by the end of the regulatory period with consideration of the delivery limitations and is therefore the recommended option.

Data input

		Data Source
Population	749.2 km	SAP – Asset Register
Object Types	LV cable	GIS – Asset Register
Conditional & Function Failures / Time Period	989 failures 5 years	SAP – Defect Records Last 6 years of data
Asset standard life	52.07 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
$1,049,551	2020-24 Revised Regulatory Proposal (FY19 real direct costs +25% of indirect costs)

Crow-AMSAA parameters

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

β_{good}	2.6593	$\beta_{average}$	3.1123	β_{poor}	3.5652
$\lambda_{average}$	7.7190E-06				

Adjustments factors

Probability of Failure (PoF)	• CONSAC to HDPE Joint • Number of Failures • Distributor Maximum CONSAC Cable Age
Probability of Consequence (PoC)	• n/a

Model calculated failures

	2019	2020	2021	2022	2023	2024
Failures	201	257	300	339	376	411

Sensitivity

Ausgrid tested the sensitivity of the applied grossly disproportionate factor by applying a factor of 6. The impact of these changes is a 1% increase to the overall recommended replacement quantities. Due to there being a higher likelihood of a lower consequence, applying a grossly disproportionate factor of 6 for this model results in a higher overall safety risk.

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 – 0.4% (Ausgrid's recorded ICR)
Public Safety ICR – 0.81% (Ausgrid's recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$4,469,292	0.00005	10.0	0.004	103
Major	$446,929	0.00010	8.0	0.008	50
Moderate	$44,693	0.00242	6.0	0.200	2.1
Minor	$4,469	0.00424	4.0	0.350	1.2
Insignificant	$447	0.00530	2.0	0.438	0.9

Average **safety** consequence per asset: $3,247 per event.

Conservatively, Ausgrid have proposed that inherently a fatality may occur due to a failure of Consac or HDPE cable approximately every 100 years based on the population and industry experience. Changing the probability of severity to 0.008 (or a fatality approximately every 50 years), increases the average safety consequence by ~67% and increases the recommended replacements by ~23% during FY20 to FY24. Changing this to 0.002 (or a fatality approximately every 200 years), reduces the average safety consequence by ~33% and reduces the recommended replacement volume by 10% during FY20 to FY24.

Fire
ICR – 1.50% (Ausgrid's recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$66,000,000	0.000000	10.0	0.0000	N/A
Major	$6,600,000	0.000004	8.0	0.0003	~1,000
Moderate	$660,000	0.000166	6.0	0.0111	30
Minor	$66,000	0.006732	4.0	0.4500	0.7
Insignificant	$6,600	0.008057	2.0	0.5390	0.6

Average **fire** consequence per asset: $2,778 per event.

Conservatively, Ausgrid have proposed that inherently a major fire would occur due to a failure of Consac or HDPE cable approximately every 1,000 years based on the population (predominantly within urban areas where fire is unlikely to spread from a pillar) and industry experience. Changing the probability of severity to 0.0006 (or a major fire approximately every 500 years), increases the average fire consequence by ~9% and increases the recommended replacements by ~2% during FY20 to FY24. Changing the probability of severity 0.00015 (or a major fire every 2,000 years) reduces the average fire consequence by ~4% and reduces the recommended replacements by~1% during FY20 to FY24. While there has been history of fires from underground cables, due to their predominate location and the absence of company or industry experience with severe fires, the model assumes that the failure of CONSAC or HDPE cables will never lead to a severe consequence.

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 Consac or HDPE cable. 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 determine the proportion of failures resulting in unserved energy, with consideration of failure modes.

Outage Type	Feeder	Data Source
Proportion of failures resulting in unserved energy	100%	SAP - Defects recorded
VCR	$40.73/kWh	AEMO / AER
Automatic Protection Time / Load restored at time	0.00 min / 0%	N/A
Average kWh/failure	228.8 kWh	Calculated (Automatic Protection Time and substation load)
Switching time / Load restored at time	4 hrs / 60%	Estimated
Restoration/repair time / Load restored at time	8 hrs / 40%	Estimated
Time without supply	5.6 hrs	Calculated

Average **loss of supply** consequence per asset: $9,321 per event.

Finance

		Data Source
Annual deferral benefit of reactive	$38,671	20% increase on planned replacement cost
Repair cost	$24,364	FY13-FY18 actuals (Direct '19)
Proportion replaced	0%	SAP – Asset Register
Weighted replacement/repair cost	$24,364	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: $24,364 per event.

AVERAGE TOTAL CONSEQUENCE per asset: $39,710 (including POC x C($))