Essential Energy
10.06.02 Resilience Undergrounding High Risk Locations Investment Case

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Network Resilience Project

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	Name	Division	Title & Function	Date
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Revisions

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3.		
4.		
5.		

Table of Contents

1.	**Executive Summary**	**4**
2.	**Background**	**5**
3.	**Key Benefits of Undergrounding**	**5**
4.	**Resilience & Climate Change**	**5**
4.1	Climate Modelling	5
5.	**Customer Appetite for Addressing Resilience**	**8**
6.	**Options**	**9**
6.1	Undergrounding	9
6.2	Composite Poles	9
6.3	Standalone Power Systems (SAPS)	9
7.	**Value Justification**	**10**
7.1	Climate Data Usage and Probability of Failure Impact	10
7.2	Risk Benefit	11
7.3	Sensitivity Analysis	13
8.	**Recommendation**	**13**
References		**14**
Key Terms and Definitions		**14**

1. Executive Summary

Business Case	10.06.02 Resilience Undergrounding High Risk Locations Investment Case
Description	Essential Energy is introducing a risk based undergrounding program to replace high risk assets that will be more prone to future failures due to climate change. To improve resilience and strengthen the future network the business is proposing to replace 40km of overhead network with underground.
Drivers for Program	During the 2019/20 bushfires Essential Energy's network experienced widespread damage including the failure of approximately 2,600 poles. Whilst this particular year was much larger than any previously experienced natural event it was not an isolated event with bushfires destroying approximately 95 poles per annum (exclusive of 2019/20). Through climate change modelling it has been established that for parts of our network the exposure to bushfires (and other perils) will increase over time.
Risk & Value Benefits	Despite the higher upfront material cost for undergrouding, maintainance and risk reductions have shown total lower life cycle costs than overhead network. By proactively increasing the underground component, the network will become more resillient to bushfire damage and improve recovery timeframes during natural disasters.
Options	Options considered to address resilience to future environmental perils brought about by a changing climate include: - Undergrounding - Composite poles - SAPS Recommend Option 1 to underground high risk locations up to 40km - [redacted] over the period with NPV of $37.3M.
Estimated expenditure FY24$	2024/25: [redacted]; 2025/26: [redacted]; 2026/27: [redacted]; 2027/28: [redacted]; 2028/29: [redacted]

All values are in full year 2023-24 real dollar terms

2. Background

Essential Energy has 1.34 million poles on the network. The total population has an average age of 37.2 years, with 25% of the population made up of untreated timber poles at an average age of 58 years.

Timber CCA poles are currently the primary distribution pole type with composite (woven fibreglass) poles as an alternate option. Timber poles are not bushfire resistant and can be subject to termite and fungal decay. In the 2019/20 fires 3,200 timber poles were damaged or destroyed.

Unsurprisingly the assets associated with the overhead network (poles, pole top equipment and conductor) contribute over 2/3rds of the total network reliability risk on the network. This is due to not only the size of the network but its susceptibility to environmental impacts. It is expected with a changing climate that these environmental perils will increase in particular with growing bushfire risk and east coast low weather events.

Whilst Essential Energy is reviewing several other investments to reduce the risks posed now and into the future from bushfires some high risk sections of network can be more cost effective to underground. Undergrounding the network has always been an interest to our customers through regulatory customer engagement and engagement for the 2024-29 regulatory period yielded similar interest.

This project forms part of our Resilience Plan (**Attachment 6.02**) to underground high risk areas where it is beneficial.

3. Key Benefits of Undergrounding

Undergrounding of the network has a clear advantage of avoiding the opportunity for assisted failures from the surrounding environment inclusive of:

- *Vegetation Impact:* Vegetation impact is one of the largest causes of outages on the Essential Energy network accounting for approximately 17.11% of Customer Minutes Lost (CML) in FY22, this is despite rigorous vegetation management practices.
- *Wind:* Primarily wind events contribute to vegetation impact however it also places increased strain on overhead assets and has the opportunity for conductor clashing to occur and accounted for 33.96% of CML in FY22.
- *Vehicles:* Third party collisions with overhead (OH) conductor pose significant risks both to the network and to the occupants. Whilst Essential Energy maintains assets to certain clearances to mitigate this risk collisions still occur although these aren't a large contributor to outage performance.
- *Fauna:* Fauna coming into contact with lines results in both transient and permanent faults and accounted for 11.15% of CML in FY22. There is also a significant number of "no fault found" type faults that would have some attribution to fauna.
- *Fire:* Bushfires have historically impacted predominately timber poles with only minor impact to OH conductor. Bushfire is one of Essential Energy's leading causes of assisted pole failure. In fire prone locations CCA poles have been repeatedly burnt and replaced after short service lives. The CCA treatment on timber poles promotes combustion and afterglow, while ash and smoke from burnt CCA timber is harmful.
- *Vegetation Management:* Undergrounding the network reduces the burden of vegetation management as clearance zones can be reduced improving operational costs, visual aesthetics and environmental outcomes.

4. Resilience & Climate Change

4.1 Climate Modelling

Following on from a spate of large impact environmental events and given the current widely documented climactic changes occurring within Australia, Essential Energy commissioned modelling for the impact and probability of these events occurring in the future. Third party peer reviewed climate change modelling has been performed to predict the effects of future environmental conditions on the network, refer Climate Impact Assessment (**Attachment 6.01**).

This modelling shows the change in impacts from three perils: floods, windstorms, and bushfires and captures the predicted probabilities of network asset impacts from these perils under climate change scenarios RCP4.5 and RCP8.5 (two Representative Concentration Pathways (RCPs) accepted by the Intergovernmental Panel on Climate Change (IPCC)).

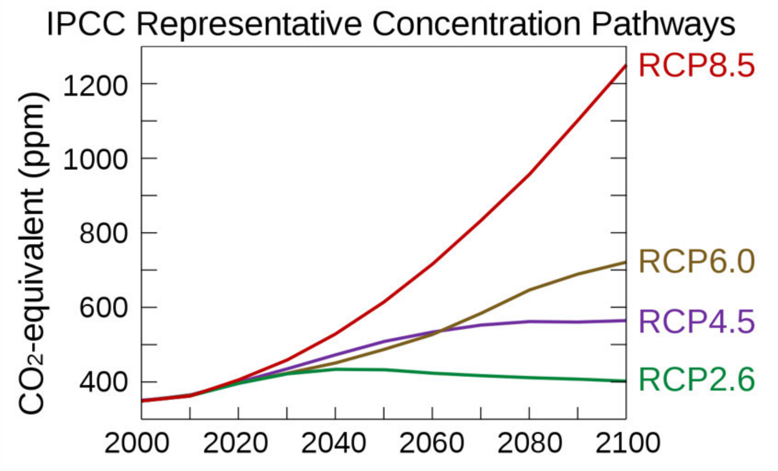

Figure 1 - RCP CO_2 ppm

As undergrounding the network involves the removal of all associated OH assets the impact of climate change for all these asset types is required to be assessed. Through the climate change modelling OH conductor and poles failures were forecasted utilising the RCP scenarios. Although an overhead asset as well pole top equipment was omitted from the analysis.

Over the period of 2013 through to 2022, Essential Energy experienced 3,064 asset failures due to fire, averaging 306.4 per annum. This average has been skewed with the performance during the 2019/20 bushfires however as shown in Figure 2 this average value has been met in other years during the period. From climate change modelling under RCP4.5, it has been projected that probabilistically Essential Energy will experience 234 asset failures in 2022 increasing to 290 by 2070. Methods of forecasting and projecting asset functional failures is covered in Section 7.17.1

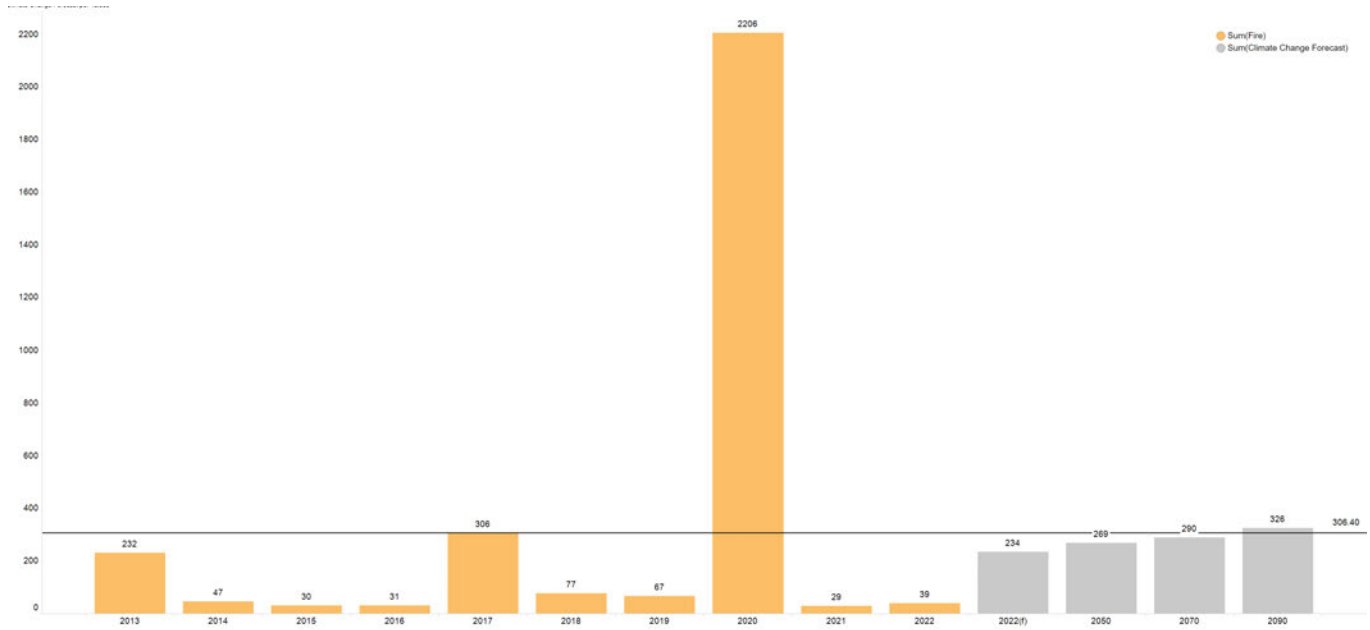

Figure 2 – Pole failures due to fire; experienced and forecast

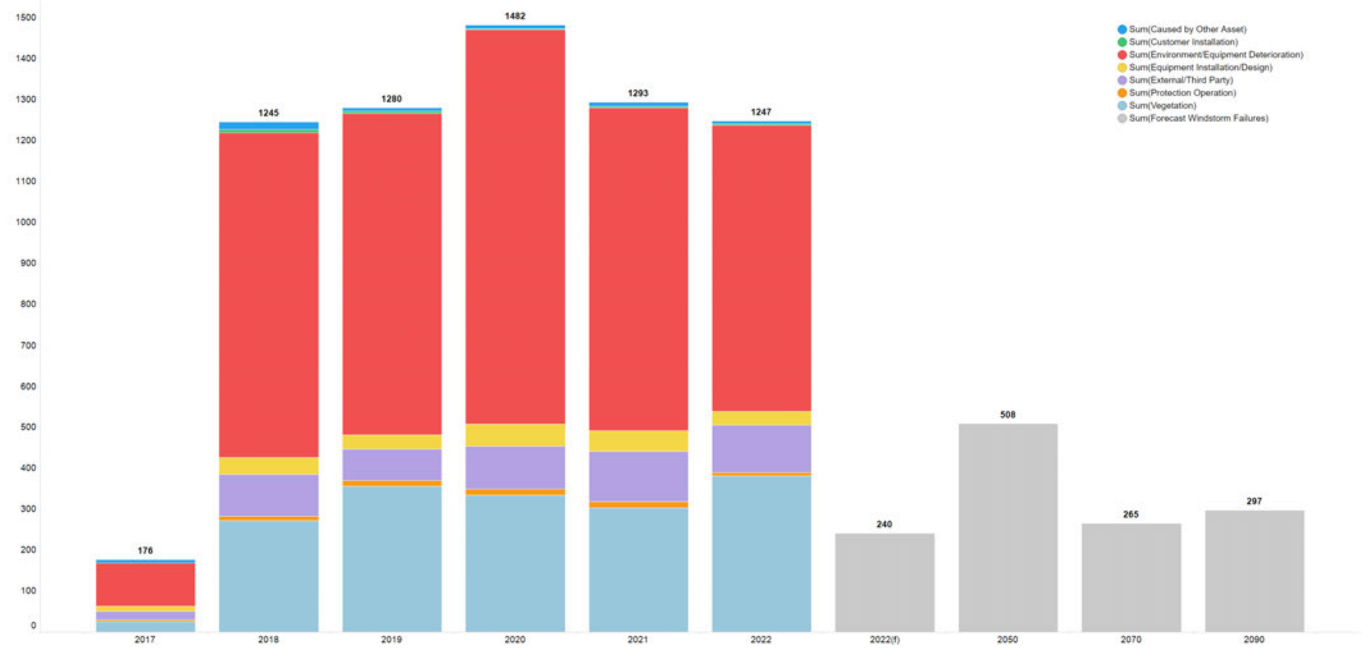

Figure 3 - Conductor failures historic causes and windstorm forecast

Windstorm failures have been calibrated to vegetation impact failures in Figure 3, further details on calibration can be found in Section 7. It is noted that unlike the projected forecast of failures due to bushfires, the increasing risk for conductor failure due to windstorm increases exponentially to 2050 before reducing to a linear increase. For details on windstorm and bushfire probabilistic modelling refer to Climate Impact Assessment (**Attachment 6.01**).

As referenced in Section 3 there are a number of benefits for undergrounding the network that relate to the failure modes in Figure 3. Failures resulting from vegetation impact and environmental impact will be significantly reduced in an underground network. These failures make up the predominate failure modes that have occurred and are modelled to continue into the future.

5. Customer Appetite for Addressing Resilience

In preparing the 2024-2029 regulatory proposal we engaged with customers over four phases. During the first phase conducted in October/November 2021 customers were polled on risks in operating the distribution network and how these are valued. Customers supported Essential Energy's risk metrics and placed a high level of importance on reliability, bushfire and safety.

During the second phase of engagement in February 2022 the concept of resilience was introduced to customers and how it differs from 'standard' reliability. Customers were offered a variety of scenarios to understand their appetite for investment in resilience across four options from a 'change nothing' to large scale expenditure across many assets. Included in options several investment methods were introduced, undergrounding the network being one of the interventions identified. The outcome of this phase of engagement resulted in broad support across the two options representing higher intervention levels, 47% and 44% respectively. In relation to undergrounding specifically this outcome related to an option of undergrounding areas of medium to high risk. It must be noted that this was a directional decision process to understand a willingness to pay with a number of intervention types equating to total expenditure for options.

The third phase of engagement specifically addressed individual intervention types with high level numbers to understand customer willingness to pay per intervention type. For undergrounding the network customers were presented the slide in Figure 4.

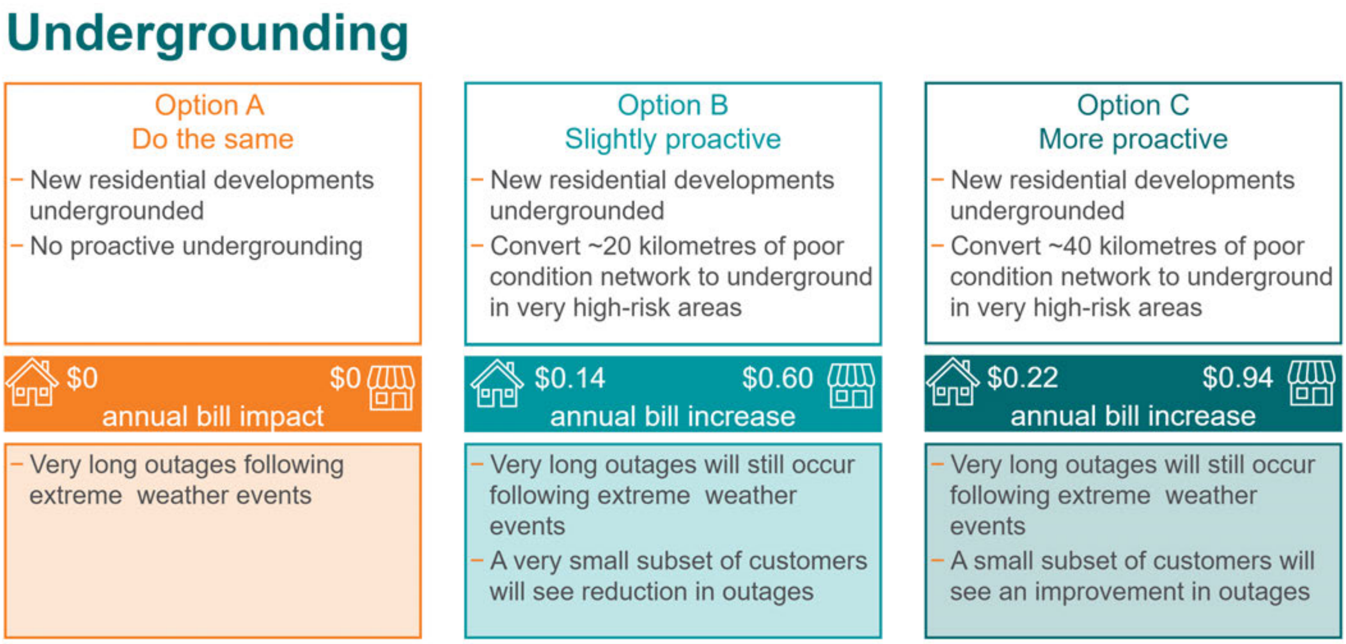

Figure 4 - Customer Engagement on Undergrounding the Network

Customers overwhelmingly supported Option C (66%) in the results of the third phase of engagement. This option included undergrounding 40kms of poor condition OH network in very high-risk areas.

During the fourth phase of engagement due to increases in the Consumer Price Index (CPI) all options were revisited due to the cost implications of all programs. Despite forecast increases in delivering the investment options, 86% of forum participants indicated their continued support for the investment proposals. Refer How engagement informed our Proposal (**Attachment 4.02**).

6. Options

6.1 Undergrounding

Of Essential Energy's 182,000 km of overhead network, approximately 350 km (0.19%) of assets meets the criteria for this program of work, being:

- Equivalent Annualised Cost (EAC) positive i.e. the in-year risk of the associated Overhead network assets exceeds the annualised cost to underground that portion of network
- The Net Present Value (NPV) of the section of line is positive for the option to underground
- There is an increasing probability of failure due to climate change modelling

This allows for the highest risk value portions of the network (up to 40km) to be selected for this program, in line with customer preferences.

Option 1 – underground up to 40km at cost of [redacted] with NPV of $37.3M

6.2 Composite Poles

As a large proportion of risk for the timber pole population results from the increasing age of the fleet one option would be to replace like for like with a newer timber pole or another material. Essential Energy has developed a composite pole transition business case (**Attachment 10.02.24**). Through analysis it has been determined that when replacing timber poles due to a variety of benefits over alternative materials composite poles provide the lowest life cycle cost.

One major aspect of the customer engagement was a willingness for expenditure to provide a more resilient network in the face of growing risk of natural perils, in this case bushfires. Whilst replacing these poles like for like (timber) would reduce risk, it would not meet the expectations of customers expressed through engagement for the regulatory proposal.

This program addresses the entirety of the OH asset types inclusive of poles, crossarms and conductor. Whilst replacing timber poles will negate the increasing risk of bushfires on the network, other perils such as windstorms and East Coast Lows are also forecasted to increase. This increase in windstorm activity will impact overhead conductor and to a lesser degree crossarms (unmodelled) and as such this option will only address a proportion of the risk in the network.

Option 2 - A separate Resilience Risk Based Pole Replacement Investment Case (**Attachment 10.06.01**) has been included in our Proposal where undergrounding is not feasible or not the highest value option.

6.3 Standalone Power Systems (SAPS)

Our current SAPS strategy is focused on high cost to serve single customer installations. Over the regulatory period it is forecast that Essential Energy will complete approximately 400 SAPS installations. This is expected to be at the upper limit of supplier and third-party construction companies availability for installation.

An additional hurdle for the usage of SAPS is that the current strategy requires customer agreement to transition. Therefore, where large customer bases are involved, it is unlikely that all customers would agree to replacement of traditional 'poles and wires' with SAPS. Customer engagement research identified 43% of customers would be 'interested to very interested' in transitioning to SAPS.

SAPS will be considered on site-by-site basis where it is feasible to do so but does not part of this business case.

Option 3 – not a feasible option given estimated cost and supply constraints

7. Value Justification

7.1 Climate Data Usage and Probability of Failure Impact

The initial analysis used all failure data from 2013 – 2021 across all failure modes. In relation to bushfire probabilities of failure, the data was skewed to extremely high values for all locations that experienced a fire during this observation period. For example, Bega and Moruya Depot areas had very high failure rates due to the widespread fires within those regions in the 2019/2020 bushfire season.

To reduce the impact of the observation period limits on the model outputs, a location-based probabilistic approach was taken for this failure mode. This utilised climate modelling data (**Attachment 6.01**) under climate change scenarios (RCP4.5 and RCP8.5) to give the probability of each pole being within the footprint of a fire. This data contained probabilities for current conditions as a baseline and then for the years 2050, 2070 and 2090 under the two climate change scenarios.

From this data, the number of functional failures within each depot / BFP subset of the population was calculated by summing their probabilities and multiplying by a scalar burn rate which captures the likelihood of a pole functionally failing given that it lays within a fire footprint. This scalar burn rate was calibrated such that the total number of functional failures matched the quantity seen on the network between 2013 – 2021.

This depot based PoF was utilised to 'localise' the network wide PoF Weibull model. This was achieved by removing fire related asset failures from the functional failure Weibull task data set and calibrating to the expected number of failures. These failures were then brought back into the overall PoF calculation utilising the climate change calibrated failures for the baseline scenario, to give a PoF at the reference year of 2022. This achieved an increased accuracy of the PoF at a depot level for functional failures compared to the original network wide values. As per Table 1 this has reduced the randomness of the shape parameter which is expected given the 'random' nature of the bushfire probability in this modelling.

Table 1 - Weibull Parameters

Timber Type	Functional Failure (Incl Bushfire related)		Functional Failure (Excl Bushfire related)	
	Alpha	Beta	Alpha	Beta
Timber Natural Round	237.8	2.89	301.3	2.59
Timber Other	545.7	1.84	303.1	2.95

Overhead conductors utilise a hazard rate probability function and due to no conditional replacement programs existing only one set of Weibull parameters is utilised to represent the failure of this asset type. These parameters are delineated by conductor type and proximity to the coast[1]. To smooth the climate change modelling for windstorm which has a pronounced increase of risk between 2022 and 2050, a linear increase has been adopted between 2022 and 2070. Including the 2050 exponential increase, would increase the value of this program of works.

In addition to windstorm an escalator was used for bushfire risk increase for conductor damage however this rate was far lower than that of windstorm due to the nature of the asset being 23 additional failures versus 73 across all depots between 2022 and 2070 respectively.

There has been no change to the standard functional failure curves for pole top equipment as this has been excluded from climate change modelling. Figure 5 below shows the resulting assessment of depot level risk (darker shade of red the higher the risk) overlayed with identified economically viable locations (grey icon) and assets selected through optimisation (green icon).

[1] We bull parameters can be found in 10.02.03 - Overhead Conductor Investment Case

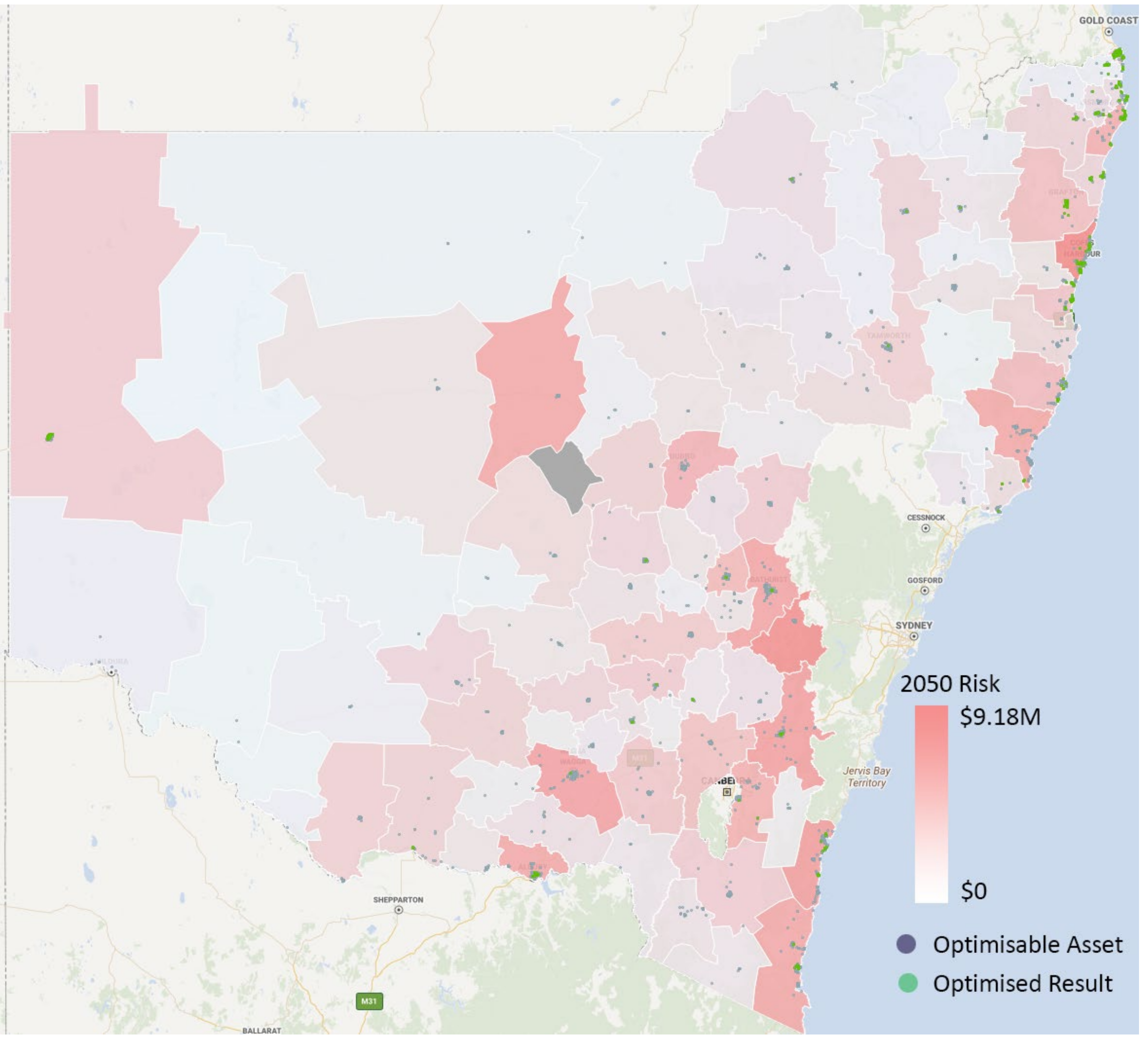

Figure 5 - 2050 Depot Risk and identified positive value sites

7.2 Risk Benefit

The value benefit of this program has utilised the PoF modelling as outlined in the previous section and consequence models that have been developed and calibrated to actual performance. These consequence models utilise the Appraisal Value Framework (Attachment 6.03.03) to quantify and value the risks posed by the failure of an asset. As per Figure 6 the value generated from this program of work is predominately through network (or reliability) benefit. These benefits equate to a positive NPV of $37.32M for the expenditure over the period.

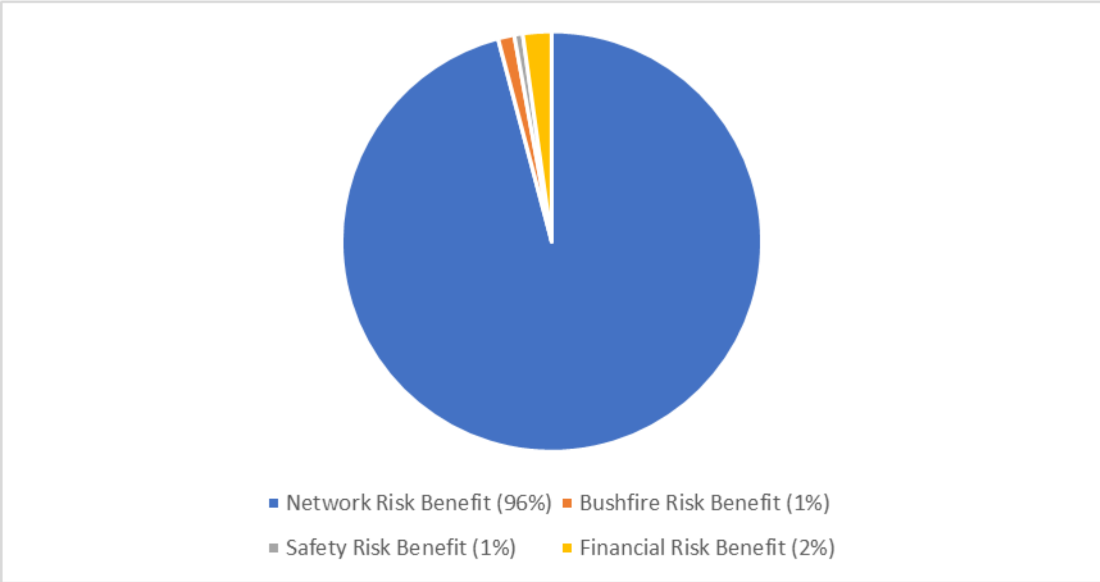

Figure 6 - Risk value benefit for program

Value for this investment case is driven heavily from network consequence as can be seen in Figure 6. This is due to the locations of sites requiring sufficient loading and VCR risk to overcome the large cost to underground the network. Importantly this also delineates this investment case from other programs, such as SAPS, as the value benefits for SAPS are weighted more heavily to other benefits such as bushfire initiation. Over the 2024-2029 regulatory period this is only has a minor reduction in risk due to the scale of the program. In Figure 7 the Baseline value represents the do-nothing scenario and Outcome illustrates the resulting risk profile following investment. This baseline/outcome is independent of other programs of work being completed.

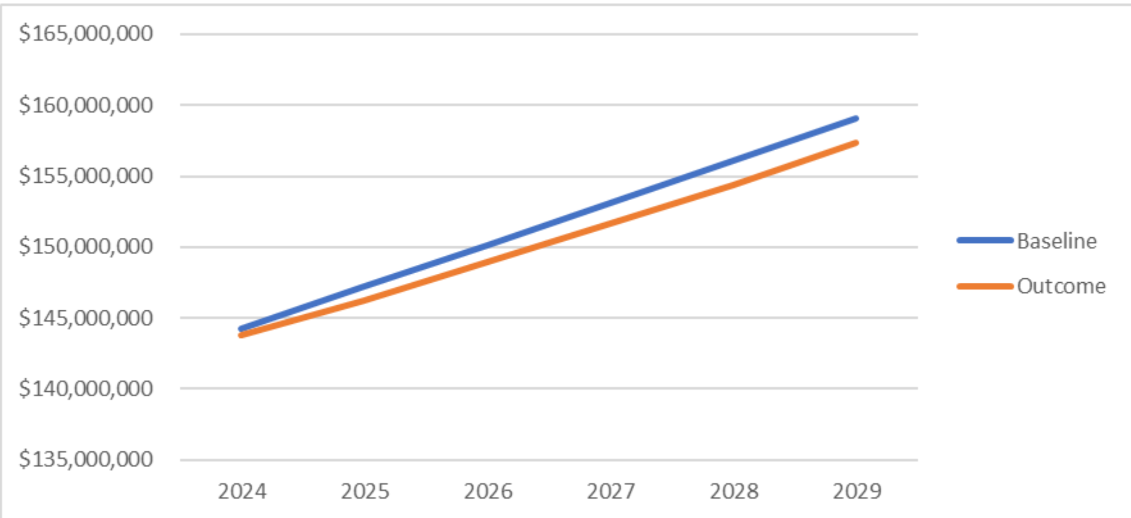

Figure 7 - Risk outcome following investment

Due to the relatively small volume of this program a step change in Opex for a reduction in vegetation management has not been accounted for in either the valuation of this option or any base/step/trend forecasts for the period.

7.3 Sensitivity Analysis

To understand the impact of certain variables and their implication on the total value of the program, sensitivity analysis was undertaken. This has identified that the selected NPV period has the largest implication on value derived from the program. Even under the worst case scenario (Case 1) the program has a total value ratio above one. Case 4 has been established as the basis of this business case. Regarding the sensitivity on unit cost there are varying unit costs associated with different pole construction types, for sensitivity a +/- 10% factor has been applied to these unit costs.

Table 2 - Sensitivity Analysis

Metric	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
NPV Period	**60**	**60**	**60**	**60**	**60**	**60**
Unit Cost	Vars (+10%)	Vars (+10%)	Vars	Vars	Vars (-10%)	Vars
WACC Rate[2]	3.75%	3.54%	3.75%	3.54%	3.54%	3.27%
NPV (M)	+$35.57	+$38.03	+$34.78	+$37.32	+$40.97	+$40.88
Value Ratio	1.94	2.08	1.90	2.04	2.24	2.23

8. Recommendation

This analysis has demonstrated that undergrounding the network in select locations Option 1 can deliver positive risk value outcomes in line with customer expectations. Positive value is demonstrated for this accelerated replacement program of 40km at cost of [redacted] and NPV $37.3M. Additional benefits include resilience to weather related events, reduced long term maintenance and safety improvements.

Table 3 – Undergrounding costs

2024/25	2025/26	2026/27	2027/28	2028/29
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Essential Energy's risk and value-based work approach aims to target investment in the highest value locations to provide the best possible value for the network with the resources available. Utilising undergrounding in locations where appropriate will complement other options such as composite poles and SAPS such that locations where undergrounding is the most suitable alternative are utilised to reduce network risk and deliver on customer expectations.

[2] WACC rate used is Pre-tax real which is equivalent to a 5.58% Nominal Vanilla WACC

References

Doc No.	Document Name	Relevance
1	4.02 How Engagement Informed our Proposal	Reference material, justification
2	6.01 Climate Impact Assessment	Reference material
3	6.02 Resilience Plan	Reference material
4	6.03.01 Corporate Risk Management Procedure	Reference material
5	6.03.02 Network Risk Management Manual	Reference material
7	6.03.03 Appraisal Value Framework	Risk valuation
7	6.03.05 Business Rules for PoF, CoF and asset risk models	Reference material
8	6.03.06 Network Risk Calibration Approach	Reference material
9	6.04.01 Bushfire Prevention Strategy	Reference material
10	10.06.01 Resilience Risk Based Pole Replacement Investment Case	Reference material
11	10.02.24 Composition Poles Transition Business Case	Reference material

Key Terms and Definitions

Term	Definition
$M	Dollars expressed in millions
CoF	Consequence of Failure
CCA	Copper Chrome Arsenic timber treatment
CML	Customer Minutes Lost
DNSP	Distribution Network Service Provider
FY	Financial Year
NPV	Net Present Value
PoF	Probability of Failure
VCR	Value of Customer Reliability
WACC	Weighted Average Cost of Capital