Jemena Electricity Networks (Vic) Ltd

2026-31 Electricity Distribution Price Review - Revised Regulatory Proposal

Supporting justification document

Underground Cable Replacement - Business Case

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1. Executive Summary

Key highlights

- This program is required to mitigate risk of underground cable failure on the Jemena Electricity Network (JEN).
- Risks include: HV XLPE type cables are deteriorating due to water treeing, paper insulated (MI Type HV Cable) cables are deteriorating due to paper insulation failure and moisture ingress, some LV pillars and cabinets need replacing due to containing asbestos, and terminations are suffering the effects of corrosion and moisture ingress.
- Our approach has identified a prudent, cost-effective program of replacements to ensure that we maintain network performance and also address JEN compliance requirements.
- The program involves replacing 1km of LV (low voltage) and 1.6km of HV (high voltage) underground cables, and the replacement of LV pillars and LV and HV terminations upon asset failure.
- The replacement program recommends completion by 30 June 2031, with an estimated total capital expenditure of $9.0M ($2024).

1.1 Purpose

This document provides the business case to implement underground cable replacement activities during the 2026-31 regulatory control period. The proposed program, with a total capital expenditure of $9.0M, is part of our forecast replacement capital expenditure.

1.2 Identified need

The main function of the underground distribution system is to distribute electricity to customers in a more aesthetically pleasing and more reliable manner as compared to overhead distribution networks. However, the construction of underground distribution systems is more expensive than an overhead network but potentially less costly in terms of maintenance.

Overall, the underground distribution system now comprises approximately 45% of JEN’s total network length.

The key issues associated with underground cables are focussed on age, condition, type and the sometimes-onerous maintenance and repair works required to manage defects and faults. These considerations present a significant safety, environmental and security of supply risk.

Several underground cable replacement projects have been identified to ensure that we address asset risks upon failure, to ultimately maintain network performance and address JEN compliance requirements. The proposed expenditure is critical to restoring parts of the network impacted by an underground cable system fault to a secure operating state.

The known issues with underground cables are described below:

Issue	Description of Issues
1	**Asset risk** - The key issues associated with the underground cables are age, condition, type and the onerous maintenance and repair works required to manage defects and faults. Underground cables are subject to a variety of failure modes, including insulation failures, general ageing, exceeding the cyclic and emergency ratings of cables or poor thermally conductive bedding materials, and catastrophic rupture.

2	**Regulatory risk** – JEN has a duty to minimise safety risks are to design, construct, operate, maintain and decommission the network to minimise hazards and risks to the safety of any person and damage to the property. JEN also must meet reliability of supply obligations. This replacement program identifies likely programs of work to maintain network performance and meet compliance obligations upon asset failure.

The failure of an underground cable can pose a severe safety risk in some cases, particularly where cable insulation has completely broken down or in the event of the failure of an outdoor cast iron cable termination box. Underground cables most commonly fail due to the breakdown of their insulation, caused by factors such as water ingress or physical damage. Cable failure can also cause the loss of supply to customers in a varying degree depending on the cable's voltage.

As per our Asset Class Strategy, underground cables have an asset criticality score of AC3 (Significant) due to the consequence of underground cable failure and JEN's limited ability to respond to some types of faults due to the availability of skilled technicians.

This business case forms the rationale to initiate replacement programs to address the issues and risks associated with maintaining underground cables, particularly replacement upon failure.

JEN also recognises its responsibility to act prudently and efficiently when investing in the distribution network to meet customer and community needs. One way we do this is by adopting asset management practices that put controls in place to test the investment need. Our best practice asset management activities involve balancing costs, opportunities and risks against performance.

In preparing our proposed expenditure, we followed capital expenditure objectives that reflect our customers' expectations, the capital expenditure drivers and capital expenditure objectives and criteria contained in the NER. Our objectives are to:

- Meet customers' expectations that we should maintain our current levels of network reliability at the most efficient cost over the long term;
- Meet our customers' expectations that our network and communities are able to withstand and recover from extreme weather events;
- Manage safety, environmental, electrical system and security risks to as low as practicable and comply with all applicable regulatory obligations efficiently over the long term;
- Connect new customers to the electricity network and meet the changing energy needs of existing customers, ensuring we can meet or manage expected demand for all customers; and
- Optimise exports and imports from distributed energy resources and CER to the distribution network.

1.3 Credible options considered

Table 1 sets out the credible replacement options we have considered.

Table 1: Credible options and summary of economic analysis, $2024, million

Option	Total capital expenditure ($m)	Value of Customer Reliability ($m over 5 years)	Ranking
Option 1 – Do nothing	-	-	3
Option 2 - Replacement levels to maintain network performance and reliability and meet compliance obligations	9.00	9.40	1

Option	Total capital expenditure ($m)	Value of Customer Reliability ($m over 5 years)	Ranking
Option 3 - Replacement levels to increase network performance and reliability	10.80	11.28	2

1.4 Recommendation

It is recommended that Option 2 is adopted. This option provides the most financially and operationally viable option to mitigate the risks of underground cable failure due to associated risks.

Based on this, a forecast investment of $9.00M is required. Both Options 2 and 3 yield similar Values of Customer Reliability, and as such Option 2 offers the most prudent choice for our customers. This option best meets the long-term interests of our customers and is consistent with the National Electricity Objective and other regulatory obligations.

1.5 Regulatory considerations

The objective of the replacement program is to undertake replacement activities to ensure network performance and to meet compliance obligations, to maintain customer supply reliability across the JEN network given the current condition and future risks associated with underground cables.

JEN's investment decisions are ultimately guided by the National Electricity Objective (NEO). Additionally, JEN is required to meet the requirements of the National Electricity Rules (NER), Victorian Electricity Distribution Code of Practice (EDCoP), and public and industry expectations for distribution system performance, which require capital expenditure objectives to be achieved.

1.6 Financial information

This business case proposes a total capital investment of $9.00M.

This project proposed to be completed by 2031. Table provides the project budget by calendar year.

Table 2: Proposed expenditure by regulatory year, $2024

Regulatory Year	Proposed Expenditure ($M)
2027	$1.13
2028	$2.34
2029	$1.99
2030	$2.01
2031	$1.53
Total proposed expenditure	**$9.00**

2. Identified need

2.1 Business and socio-economic context

The JEN underground distribution system includes Sub-transmission (ST) cables, High Voltage (HV) distribution cables and Low Voltage (LV) cables and their ancillary equipment such as LV pillars and pits.

- The sub-transmission underground systems consist of 66kV and 22kV cables installed primarily as exit cables at terminal and zone substations.
- The HV underground systems consist of 22kV, 11kV and 6.6kV cables.
- The LV cable network distributes electricity to customers via pole and non-pole type substations.

There is approximately 2,461km of underground distribution cable (ST, HV and LV) in service on the network with some cables installed as early as the 1920's and 1930's still in service.

In addition, there is approximately 1,475.95km of underground service cable installed. This group of cables are those that are run from the service tee joints on the LV mains cables to the service pits, pillars or customers service and metering cubicles.

Underground cable systems provide a reliable and aesthetically pleasing means of energy distribution however, the construction of underground distribution systems is far more expensive than an overhead network but potentially less costly in terms of maintenance.

Overall, the underground distribution system now comprises approximately 45% of JEN's total network length.

In the event of failure, the cost of asset replacement and unserved energy at risk is dependent on the nature of the failure and load profile of the network on which the failure occurred. Typically this would result in unserved energy in excess of $400,000 per outage.

2.2 The identified need and key drivers

2.2.1 Identified need

2.2.1.1 Life Expectancy

As set out in JEN's *Network Asset Useful Lives Procedure*,[1] the applicable useful lives for the major elements of JEN's underground distribution systems are as follows in Table 3:

Table 3: Useful life of underground cable types

Description	Useful Life
Underground Cables and their Terminations	
ST, HV and LV Paper Impregnated Cable	70
ST and HV Cross linked polyethylene (**XLPE**)	40
LV XLPE	55
Pillars and Pits	
LV Pillars	30
LV Pits	40

[1] JEN - RP - Support - ELE-999-PR-IN-012 Network Asset Useful Lives Procedure - 20251201 – Public.

The *Network Asset Useful Lives Procedure* considers asset lives based on good industry practice and specific JEN experience and represents the age of assets at which end-of-life replacement will be considered. JEN has referenced several reviews of asset useful lives from consulting agencies and discussions with other Distribution Businesses to arrive at these asset lives.

Factors which have a detrimental effect on the life expectancy of underground cable distribution systems include:

- Water ingress in cables;
- Partial discharge within cable insulation systems;
- Overload;
- Third party intervention (dig up of assets); and
- Workmanship.

2.2.1.2 Age Profile

The population of JEN's underground cables is shown in Table 4.[2]

Table 4: Useful life of underground cable types

Description	Length (km) / No. of Assets
66kV Sub-transmission Cable (total length)	**27.45 km**
Sub-transmission XLPE	20.08 km
22kV, 11k and 6.6kV High Voltage cable (total length)	**929.55 km**
High Voltage Paper insulated	98.61 km
High Voltage XLPE insulated	830.94 km
Low Voltage Mains Cable (total length)	**1,497.77 km**
Low Voltage Service Cable (total length)	**1,475.95 km**
Pillars and Pits	**90,053 assets**
Low Voltage Pillars	2,373 assets
Low Voltage Pits	87,680 assets

[2] JEN – RIN – Support – Electricity Distribution Asset Class Strategy – 20250131 – Public.

Figure 1 shows Underground Service Cables Age Profile.

Figure 1: Underground Service Cables Age Profile

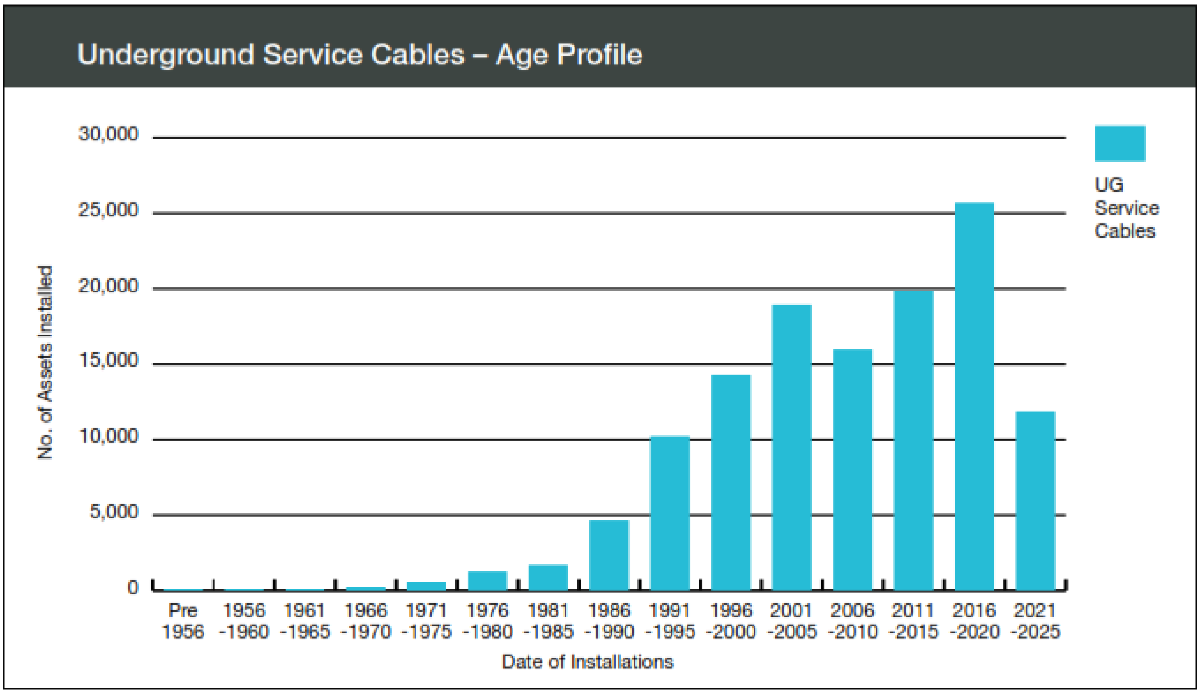


Figure 2 shows LV cables age profile.

Figure 2: LV cables age profile

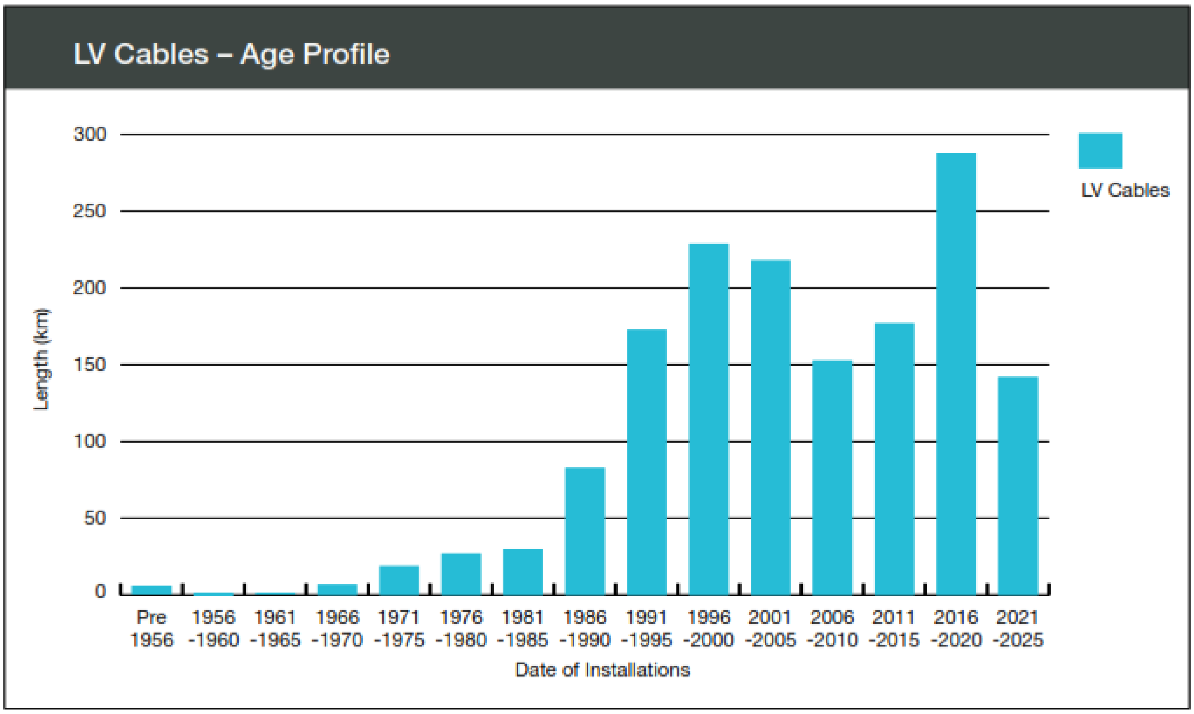


Figure 3 shows HV cables age profile

Figure 3: HV cables age profile

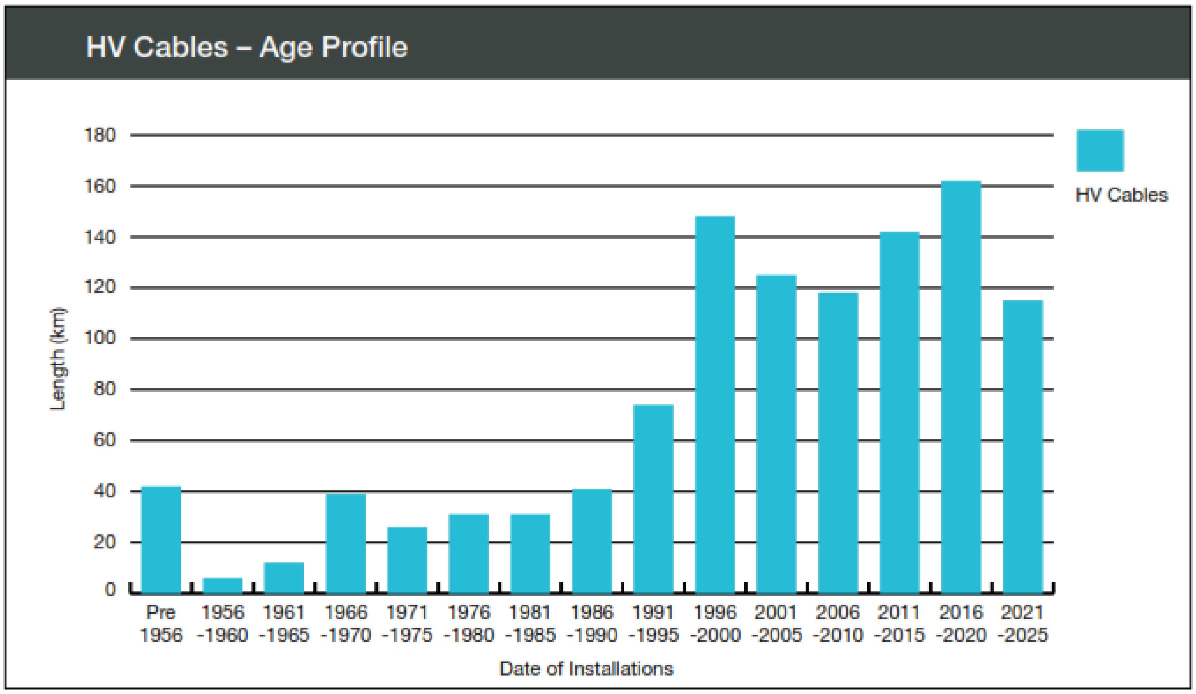
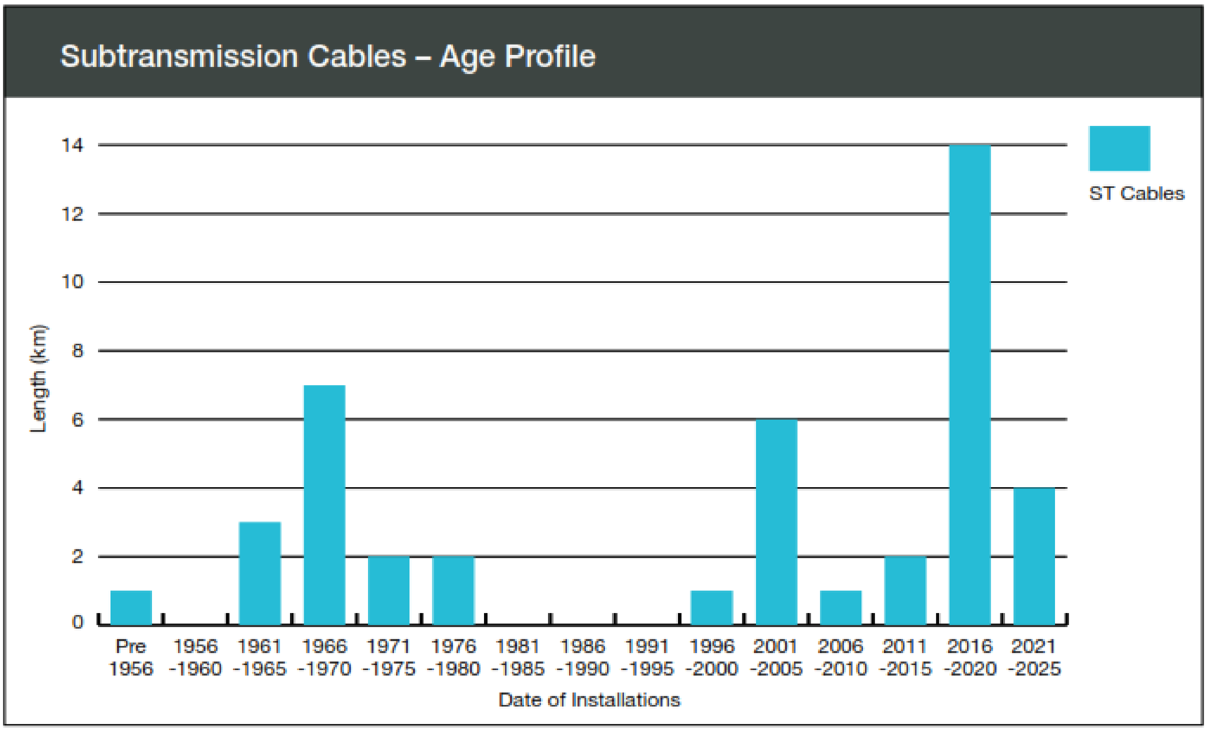


Figure 4 shows ST Cable Age Profile.

Figure 4: ST Cable Age Profile



N.B. The ST cable lengths reported above are the total lengths of single phase cable. (not the three phase circuit route length)

Note, the increase in the rate of installation of underground cables is due primarily to new residential estates installed within the JEN area of supply. All new estates are developed using Underground Residential Distribution (URD) systems.

2.2.2 Key drivers

The key issues associated with the underground cables stem from age, condition, type and the onerous maintenance and repair works required to manage defects and faults. These considerations present a significant safety, environmental and security of supply risk.

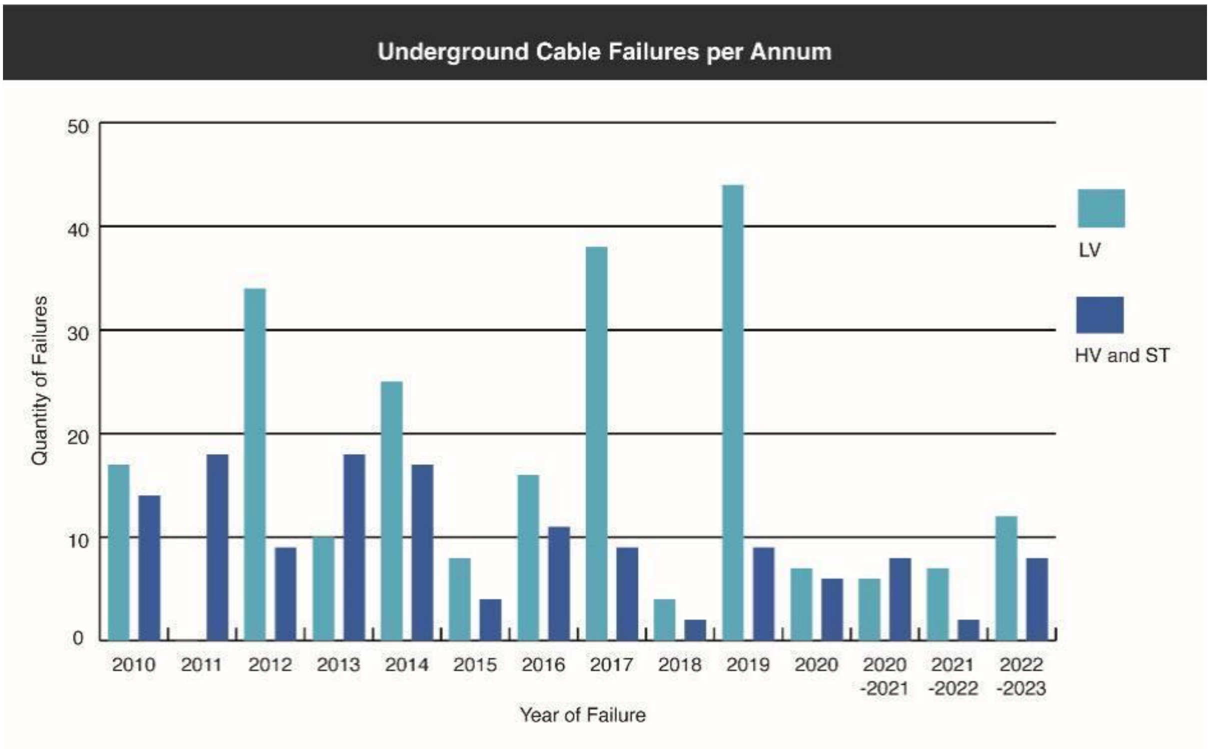
2.2.2.1 Asset condition and performance

The principal method of assessment of the performance of the underground distribution system and underground cables is based on the monitoring of asset failures and maintenance notifications. The on-line or in-service monitoring of the condition and performance of underground cables is limited to the inspection of the visible parts of these systems.

There is some ability to monitor cable condition on-line, but this is limited, and comprehensive diagnostic condition assessment generally involves taking cables out of service and often the physical disconnection of the cable. For this reason, these types of tests are generally only performed at the time of commissioning or following a cable fault or incident. They are not suited to the routine assessment of cable condition.

Assets that cannot be efficiently inspected based on their supply criticality and risk profile are run to failure. This is an appropriate lifecycle management strategy when the consequences of failure do not include any risk of injury or harm and where the failure rate is low. We consider this approach to be more efficient compared to proactive replacement and therefore helps reduce our forecast underground cable replacement expenditure in the next regulatory period. The number of underground cable failures that have occurred per year since 2010 for LV, HV and ST is set out in Figure 5.

Figure 5: Underground Cable Failure Data[3]



2.2.2.2 Asset deterioration

Underground cables are subject to a variety of failure modes:

[3] JEN – RIN – Support – Electricity Distribution Asset Class Strategy – 20250131 – Public.

- **Insulation failures** - which can be caused by partial discharge associated with voids in insulating material and the ingress of moisture. "Water treeing" leads to insulation breakdown and puncture.
- **General ageing** – for example, in oil impregnated paper insulated lead sheathed cables, the ageing of the insulation system is due to the presence of oxygen, moisture and heat. This leads to the failure of the lead sheath and consequently moisture ingress and insulation failure. Physical damage also results in cable failure either immediately or after moisture enters the damaged cable.
- **Exceeding the cyclic and emergency ratings of cables or poor thermally conductive bedding materials** - can cause severe overheating of cable insulation systems. This can result in insulation system failures.
- **Catastrophic rupture** – for example, pitch filled metal enclosed cable terminations have a history of catastrophic rupture resulting in the projection of pieces of metal, porcelain and pitch. These are age related failures associated with the failure of the sealing systems on these cable boxes.

Cable failures most commonly occur at joints and terminations as they are areas where the control of the electrical stresses can be problematic.

2.2.2.3 Regulatory compliance

Safety and reliability

Consistent with obligations under National Electricity Objective and JEN's commitment to continuous improvement, JEN is recommending the replacement of underground cables upon failure to ensure network performance, reliability, and to meet compliance obligations.

The Electricity Safety Act, s98

The general duty of major electricity companies, including Jemena, is to minimise safety risks. Duties of the *Electricity Safety Act 1998* (ESA) which requires a Major Electricity Company (MEC) to design, construct, operate, maintain and decommission its supply network to minimise As Far As Practicable (AFAP) the hazards and risks to the safety of any person, damage to the property and the bushfire danger arising from the supply network.

Victorian Service & Installation Rules

The Service & Installation Rules form the requirements for the connection of electrical installations to the Victorian Electricity Distribution Networks. Relevant sections include:

- Section 7.3 Underground Service Cables

Investment decisions

In line with the NEO, JEN's investment decisions aim to maximise the NPV to electricity consumers. The objective of this project is to maintain the reliability of supply to customers, given the current condition of the assets. This strategy must align with other JEN strategies and plans, and the project must comply with associated regulatory requirements.

JEN's investment decisions are ultimately guided by the NEO. Additionally, considerations such as the capital expenditure objectives set out in the NER (clause 6.5.7) are particularly relevant to JEN's investment decisions:

> *a) A building block proposal must include the total forecast capital expenditure for the relevant regulatory control period which the Distribution Network Service Provider considers is required in order to achieve each of the following (the capital expenditure objectives):*
>
> > *(1) Meet or manage the expected demand for standard control services over that period*
> >
> > *(2) Comply with all applicable regulatory obligations or requirements associated with the provision of standard control services*

(3) To the extent that there is no applicable regulatory obligation or requirement in relation to:

(i) The quality, reliability or security of supply of standard control services; or

(ii) The reliability or security of the distribution system through the supply of standard control services,

to the relevant extent:

(iii) Maintain the quality, reliability and security of supply of standard control services

(iv) Maintain the reliability and security of the distribution system through the supply of standard control services.

(4) Maintain the safety of the distribution system through the supply of standard control services.[4]

Additionally, the EDCoP sets out provisions relevant to JEN's planning, design, maintenance, and operation of its network, most notably section 19.2 (Good Asset Management) and section 13.3 (Reliability of Supply):

Section 19.2 – Good Asset Management

A distributor must use best endeavours to:

a) Assess and record the nature, location, condition and performance of its distribution system assets

b) Develop and implement plans for the acquisition, creation, maintenance, operation, refurbishment, repair and disposal of its distribution system assets and plans for the establishment and augmentation of transmission connections:

- *To comply with the laws and other performance obligations which apply to the provision of distribution services including those contained in this Code*
- *To minimise the risks associated with the failure or reduced performance of assets*
- *In a way which minimises costs to customers taking into account distribution losses.*

c) Develop, test or simulate and implement contingency plans (including where relevant plans to strengthen the security of supply) to deal with events which have a low probability of occurring, but are realistic and would have a substantial impact on customers.

Section 13.3 – Reliability of Supply

A distributor must use best endeavours to meet targets determined by the AER in the current distribution determination and targets published under clause 13.2.1 and otherwise meet reasonable customer expectations of reliability of supply.

When making decisions to invest, JEN must comply with these obligations.

2.2.3 Proposed replacement programs and activities

Our proposed expenditure is informed by specific activities, each assigned to service codes (in brackets):

Program & Service Code	Activities

[4] NER, cll 6.5.6(a), 6.5.7(a).

HV U/G Cable Replacement (RUA)	Replacement of HV underground cable and pre-activation tests. This activity includes: • Civil works including directional boring and excavation if required, regardless of terrain and earth types such as rock, clay or sand • Labels and signage • Fault locating and proving • Cable brackets and support fittings • Pre-activation testing, clearance and condition monitoring cable tests • Reinstatement of roads, pathways and grounds This activity excludes: • All cables lengths less than 10 meters that are captured through separate activities • All sub transmission cables
LV U/G Cable Replacement (RUC)	Replacement of LV underground cable and pre-activation tests. This activity includes: • Civil works including directional boring and excavation if required, regardless of terrain and earth types such as rock, clay or sand • Physical connection to assets including re-lugging of cables. • Labels and signage • Fault locating and proving • Cable brackets and support fittings • Pre-activation testing and clearance • Reinstatement of roads, pathways and grounds The activity excludes: • All cables lengths less than 10 meters that are captured through separate activities.
Pillar to Pillar (RUF)	Replacement of an existing LV pillar due to defects, age replacement and fault works. The activity also shall include: • The replacement of existing pillars • Fault works to make safe and planned follow up work to complete replacement • Earth connections, damaged or cracked LV switch housings, installation or replacement of padlocks and wire seal. • REC works including Certificates of Electrical Safety (CES) if required • All cable lengths including mains extensions • Cable terminations, joints, connections and minor alterations such as new lugging of the termination or lengthening of termination tails. • Civil works including directional boring and excavation if required, regardless of terrain and earth types such as rock, clay or sand • Reinstatement of roads, pathways and grounds • De-commissioning and disposal of defective equipment • Waste disposal generated from the replacement The activity excludes: • Relocation of the asset or any associated works with the relocation
HV U/G Termination Replacement (RUH)	Replacement of a HV termination and shall include but is not limited to cable terminations, transition joints, straight joints, pre activation tests and replacement cable lengths up to 10m. The activity includes: • Cable up to 22kV • Associated HV ABC terminations and connections • Cable lengths where the cable length is less than 10m. • Civil works if required • Cable brackets and support fittings • Pre-activation testing, clearance and condition monitoring cable tests • Reinstatement of roads, pathways and grounds • De-commissioning and disposal of defective equipment • Waste disposal generated from the replacement

LV U/G Termination Replacement (RUL)	Replacement of a LV termination and shall include but is not limited to cable terminations, straight joints, pre activation tests and replacement cable lengths up to 10m. This activity includes: • All terminations to greater than 16mm^2 cables in size • Cable lengths where the cable length is less than 10m • Civil works if required • Cable brackets and support fittings • Pre-activation testing, clearance • Reinstatement of roads, pathways and grounds • De-commissioning and disposal of defective equipment • Waste disposal generated from the replacement The activity excludes: • All cables less than or equal to 16mm2 in size.

2.3 Asset risk (or opportunity) analysis

2.3.1 Affected assets proposed for replacement

As mentioned, the principal method of assessment of the performance of the underground distribution system and underground cables is based on the monitoring of asset failures and maintenance notifications. The monitoring of the condition and performance of underground cables is performed via inspection of the visible parts of these systems. There is some ability to monitor cable condition on-line, but this is limited, and comprehensive diagnostic condition assessment generally involves taking cables out of service and often the physical disconnection of the cable. For this reason, these types of tests are generally only performed at the time of commissioning or following a cable fault or incident.

When an underground cable fails it is repaired by two straight joints and a section of cable to return it to service. An assessment of the cable condition is made to determine the suitability to remain in service taking the probability of failure into consideration. Failure probability is a function of age, condition of the cable such as water ingress and sheath damage, recent fault history including the number of joints that have been made to the cable and REFCL voltage stress exposure. This is an appropriate lifecycle management strategy when the likely consequences of failure do not include any risk of injury or harm and where the failure rate is low. We consider this approach to be more efficient compared to proactive replacement and therefore helps reduce our forecast underground cable replacement expenditure in the next regulatory period.

The failure history and risks associated with individual sections of cable is a key indicator of condition.

Current risks to our underground cable assets include:

Underground Cable		Current Risks & Controls
HV XLPE Cable	**Risk**	HV XLPE cable installation began in the mid 1970's. Worldwide research has shown that many of the cable faults experienced on cables after 10 - 15 years in service are attributed to insulation degradation through water treeing. The presence of water trees in cable insulation is known to decrease the residual life of the cable.
	Control	The JEN cable specification was changed in 2008 and consequently all new HV cable is supplied with water tree retardant XLPE insulation. The performance of this modified XLPE insulation has been documented overseas and found to impede the formation of water treeing in the insulation.

Paper Insulated (MI Type HV Cable)	**Risk**	This cable type was predominantly installed on the 11kV and 22kV networks prior to the 1970's, however, was still used up to the 1990s. There appear to be two main causes of MI type cable failure namely: Failure of paper insulation due to oil migration over the life of the cable, leaving paper dry and brittle. Due to the condition of the insulation in these cables, the risk of failure is significantly increased when cables are physically disturbed or handled. Failure due to moisture ingress resulting from lead sheath fatigue and corrosion. This problem is particularly evident in the inner suburban areas that are prone to electrolytic corrosion due to the proximity of tram and rail systems. Some sections of this type of cable have been identified as having excessive failure rates. For instance, some cable has experienced failures attributed to moisture ingress as a result of lead sheath fatigue and electrolytic corrosion.
	Control	Proactive replacement has been undertaken to address MI type HV cable failure issues based on failure rates.
HV CABUS Type Outdoor Cable Terminations	**Risk**	These terminations were installed on the 6.6kV, 11kV and 22kV networks. They are a pitch filled terminations housed in a cast iron cable box and many have failed catastrophically which can result in personnel injury and damage to public property. They are particularly hazardous when failure occurs as the cast iron can shatter and is often expelled over a wide area. The root cause of failure of these boxes is the ingress of moisture in the pitch filled cable boxes resulting in the deterioration of the ageing paper insulation.
	Control	These types of cable terminations have a history of catastrophic failure. JEN has implemented a prioritised proactive replacement program to manage the risk associated with the in-service failures of these terminations. There is approximately 50 terminations to replace in the PV, ES, FT and NS supply areas. This program will continue until all of these terminations have been retired.
HV and LV Pitch Filled Fabricated Metal Outdoor Cable Terminations	**Risk**	These terminations are of similar vintage to the CABUS type HV terminations. These terminations are also pitch filled but housed in a fabricated metal box. Failure of this type of termination is not as hazardous as the metal box does not shatter but can split expelling pitch and other debris. Failure is often associated with the effects of corrosion and moisture ingress. The consequences of failure are far less severe compared with CABUS terminations in terms of risk of injury to the general public however the potential for injury is still present. With LV terminations the impact on reliability of supply is minimal.
	Control	These types of cable terminations have a history of catastrophic failure. JEN has implemented a prioritised proactive replacement program to manage the risk associated with the in-service failures of these terminations. There is approximately 50 terminations to replace in the PV, ES, FT and NS supply areas. This program will continue until all of these terminations have been retired.
LV Outdoor Terminations with Exposed Conductor Insulation	**Risk**	There have been a number of reports of LV PVC and LV XLPE cable terminations deteriorating in service as the result of the effects of UV radiation. This is a potential safety hazard (especially on concrete poles) and also a potential cause of LV faults due to short circuits between the LV phases of the cable.
	Control	These terminations are to be rectified as they are found.
LV Pillars and Cabinets	**Risk**	A variety of LV pillars have been installed on the underground distribution system. These are generally installed in Underground Residential Distribution (URD) estates. In addition, there are LV cabinets used to provide multiple LV feeders in industrial and commercial areas. These require ongoing inspection to ensure they remain secure and if damaged are repaired.
	Control	Replacement programs have been completed which targeted some types that were made of materials containing asbestos.
Cable Sheath Voltage Limiters (SVL's)	**Risk**	In order to manage the voltages induced on the screens of single core 66kV cables, special cable screen earthing arrangements are used in conjunction with SVL's. The condition of the SVL's needs to be monitored.

	Control	SVL's are installed to protect the cable sheath from damage that may occur due to high screen voltages being induced in the screens by fault currents passing through the cables.
22kV XLPE Cable Joints	**Risk**	JEN has experienced elevated failure rates on 22kV XLPE cables that were installed in the 1990's. These are relatively new cables, and the cause of the underground cable faults has been attributed to joint failure. All of the recent joint failures occurred on cables that were installed between the years 1993 and 1999. The cable failures also all occurred at below rated current and before their expected engineering end of life. It has been concluded that poor workmanship, issues with the size of the conductor crimp sleeve, and the cross-sectional area of the associated conductor contributed to the failures.
	Control	Asset replacement projects are being implemented in both a reactive and proactive manner to manage this issue.
Third Party Intervention	**Risk**	Another risk for cables is accidental third party intervention (i.e., third party damaged or dig in of JEN underground assets) or deliberate third party intervention (i.e., copper theft, primarily of public lighting cables in new URD estates).
	Control	Accidental dig ups occur from time to time and are mitigated via "Before You Dig Australia" campaigns and warning signs that declare there are underground assets in the area. Copper theft has become an increasingly common occurrence, particularly for public lighting cables in new estates. The same location is often targeted multiple times. All copper theft incidents are being reported to the Police.
Voltage Stress from REFCL System Operation	**Risk**	The use of Rapid Earth Fault Current Limiter (REFCL) technology to mitigate bushfire risk has further implications on the life expectancy of HV cables, cable joints and cable terminations under fault conditions.
	Control	In preparation for the implementation of REFCL systems, all HV paper insulated cables and pitch filled outdoor cable terminations will be replaced. This control will lower the probability of HV cable system assets failures after REFCL systems are put in service and reduce the risk on network reliability and STPIS.

2.3.2 Asset condition and risk assessment

Within our Asset Class Strategy, underground cables have an asset criticality score of AC3 (Significant) due to the consequence of underground cable failure and JEN's limited ability to respond to some types of faults due to the availability of skilled technicians.[5]

Good underground network design ensures that customer outages are typically minimised through HV switching and the isolation of damaged cable sections. JEN has access to appropriately skilled technicians so that the maintenance and repair of modern cable systems can be undertaken without delay. LV cable faults cause limited customer outages and like the modern HV cable systems there are maintenance crews readily available to repair the faults in a timely manner.

2.4 Consistency with Jemena strategy and plans

This section describes how this project is consistent with JEN's objectives and strategies:

- **Provision of Service Levels and Reliability:** Ensuring service levels and reliability meet customer expectations.
- **Modern Capabilities:** Deployment of modern equivalent capabilities in the network to remain relevant to customers in the longer term.

[5] JEN – RIN – Support – Electricity Distribution Asset Class Strategy – 20250131 – Public.

- **Prudent and Efficient Expenditure:** Ensuring expenditure is prudent and efficient, aligning with customer expectations regarding affordability.

JEN seeks to ensure that lifecycle costs are both efficient and effective. This business case is consistent with this requirement and aligns with the long term vision of the network, as set out in the Asset Management Plan (AMP) and annual planning reports.

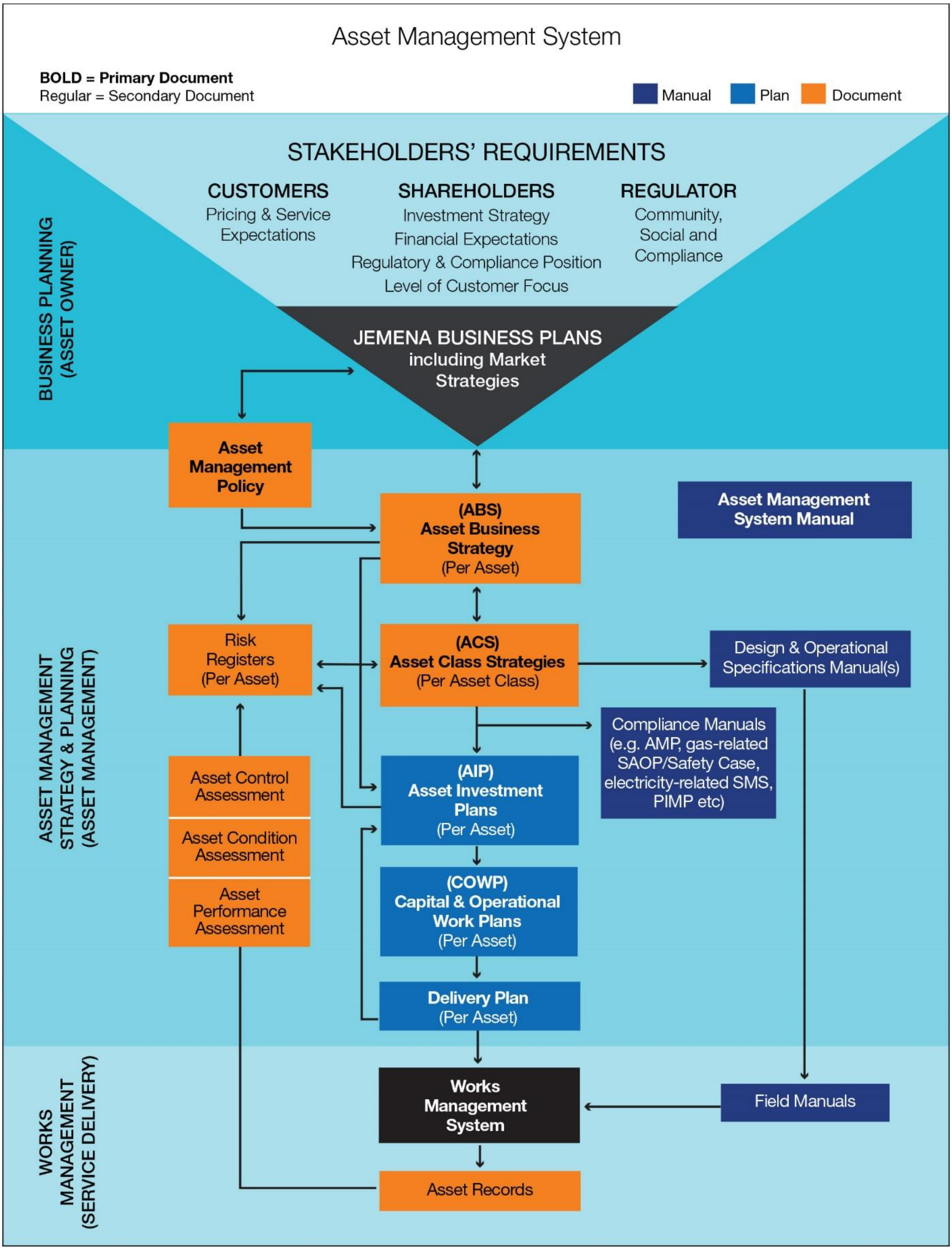
This proposal aligns with Asset Management Strategies, Plans and Policies contributing to a safe workplace for JEN employees and contractors. By addressing identified issues, JEN can reduce the risk of injury or environmental incident.

JEN abides by Australian asset and risk management industry standards (ISO 55001 and ISO 31000:2018) which is part of JEN's internal risk and asset management framework documents (ELE PL 0004 and JAA PO 0050).

Figure outlines the Jemena asset management system and where the Asset Management Plan (AMP) is positioned within it. The AMP covers the creation, maintenance and disposal of assets including investment planned to augment network capacity to meet increasing demand and to replace degraded assets to maintain reliability of supply to meet Jemena Business Plan requirements.

This strategic framework facilitates the planning and identification of business needs that require network investment documented via business cases.

Figure 6: The Jemena Asset Management System



JEN also recognises its responsibility to act prudently and efficiently when investing in the distribution network to meet customer and community needs. One way we do this is by adopting asset management practices that put controls in place to test the investment need. Our best practice asset management activities involve balancing costs, opportunities and risks against performance.

In preparing our proposed expenditure, we followed capital expenditure objectives that reflect our customers' expectations, the capital expenditure drivers and capital expenditure objectives and criteria contained in the NER. Our objectives are to:

- Meet customers' expectations that we should maintain our current levels of network reliability at the most efficient cost over the long term;
- Meet our customers' expectations that our network and communities are able to withstand and recover from extreme weather events;
- Manage safety, environmental, electrical system and security risks to as low as practicable and comply with all applicable regulatory obligations efficiently over the long term;
- Connect new customers to the electricity network and meet the changing energy needs of existing customers, ensuring we can meet or manage expected demand for all customers; and
- Optimise exports and imports from distributed energy resources and CER to the distribution network.

3. Comparison of credible options

3.1 Identifying credible options

The following feasible options could be executed to address the business need, problem or opportunity.

1. **Option 1 is 'do nothing'**, assumes that as underground cables fail they are not replaced and as load distribution alternatives become unavailable customers will be left off supply indefinitely. This option does not address any of the identified condition issues in full nor does it allow us to maintain current levels of network reliability and is not considered a credible option.
2. **Option 2 is 'replacement levels to maintain network performance, reliability and to meet compliance obligations'**. This option optimises replacement levels to ensure current levels of network reliability whilst responding to our customers who have indicated they value a stable network. This is evidenced by our customer engagement, which highlights 'maintaining the network' being more important to customers than 'improving the network'. When assessing this option, we calculated a value of customer reliability (VCR) metric to determine the average value different types of our customers place on having reliable electricity supply.[6] The VCR calculated, applicable to the average customer was determined to be $9.40M over 5 years.
3. **Option 3 is 'replacement levels to increase network performance and reliability'**. This approach would focus on proactively replacing underground cable sections with the intention of improving network reliability. As with Option 2, when assessing this option we calculated a value for VCR to determine the average value different types of our customers place on having reliable electricity supply.[7] The VCR calculated, applicable to the average customer was determined to be $11.28M over 5 years.

3.2 Developing credible options

Table shows the extent to which each option addresses the identified issues.

Table 5: Credible Options Analysis

Issue	Option 1	Option 2	Option 3
Asset risk Key issues with underground cables include age, condition, type and the onerous maintenance and repair works required to manage defects and faults.	○	●	●
Regulatory risk JEN has a duty to minimise safety risks are to design, construct, operate, maintain and decommission the network to minimise hazards and risks to the safety of any person and damage to the property. JEN also must meet reliability of supply obligations.	○	●	●

●	Fully addressed the issue
◑	Partially addressed the issue
○	Did not address the issue

Each of these options are discussed in detail below.

[6] More detail on how this has been calculated can be found in 4.1.1.

[7] More detail on how this has been calculated can be found in 4.1.1.

3.2.1 Option 1: Do nothing

The 'do nothing' option assumes that as underground cables fail they are not replaced and as load distribution alternatives become unavailable customers will be left off supply indefinitely. This option does not address any of the identified condition issues, given it does not undertake underground cable replacement. The probability of failure for this equipment would continue to increase over time, potentially leading to catastrophic failure while in service. Given the criticality of these issues and the lack of risk mitigation, this option is not considered credible.

3.2.2 Option 2: Replacement levels to maintain network performance, reliability and to meet compliance obligations

The 'replacement levels to maintain network performance, reliability and meet compliance obligations' option is an approach which invests in the replacement of underground cables in areas of the network where asset failure has occurred.

Replacing underground cables as required assists in mitigating consequences associated with a failure of this type of asset, which are designed to 'run to failure'. This is the recommended option given their historically high reliability performance. Furthermore, underground cables cannot be readily inspected visually, and current testing techniques have network security risk as they require the cable to be taken out of service.

This option would maintain current levels of network reliability and optimises replacement levels to maintain this reliability whilst responding to our customers who have indicated they value a stable network more so than improvements to the network. This is evidenced by our customer engagement, which highlights 'maintaining the network' being more important to customers than 'improving the network'.[8]

Jemena's Peoples Panel noted 'Jemena needs to prioritise investing in reliability by assessing, building, and maintaining the network to meet changes in operating conditions and withstand network failures'.[9] This position was reiterated by the First Nations and Disability Customer Voice Groups.

When assessing this option, we calculated a value of customer reliability (VCR) metric to determine the average value different types of our customers place on having reliable electricity supply.[10] The VCR calculated, applicable to the average customer was determined to be $9.40M over 5 years.

This option is likely to resolve most identified issues while aligning with the JEN asset class and business strategies. The total capital cost of this option is forecasted at $9.00M based on activities commencing in FY2027. This option is preferred given historic failure rates and the age of assets proposed to be replaced.

As detailed in this business case, several individual programs of work have been identified to ensure that we maintain network performance, reliability and address our compliance requirements. Forecast replacement volumes and expenditure proposed under Option 2 is set out in Table.

Table 6: Option 2 Replacement Volumes and Expenditure – Underground Cables

Unique ID	Service Code	Activity	Forecast Replacement Volumes					Proposed Expenditure ($'000), $2024					
			FY27	FY28	FY29	FY30	FY31	FY27	FY28	FY29	FY30	FY31	Total
A208	RUA	HV U/G Cable Replacement (m)	328	321	328	321	328	162.5	159.2	162.5	159.2	162.5	**806**

[8] See JEN - Att 02-01 Customer engagement – 20250131.

[9] See JEN - Att 02-01 Customer engagement – 20250131, s.5.1.

[10] More detail on how this has been calculated can be found in 4.1.1.

Unique ID	Service Code	Activity	Forecast Replacement Volumes					Proposed Expenditure ($'000), $2024					
			FY27	FY28	FY29	FY30	FY31	FY27	FY28	FY29	FY30	FY31	Total
A209	RUA	Replace Metal Trifurcating Boxes	-	16	11	12	5	-	1,216.4	853.7	883.2	394.4	**3,348**
A210	RUC	LV U/G Cable Replacement (m)	200	200	200	200	200	124.2	124.2	124.2	124.2	124.2	**621**
A211	RUF	Pillar to Pillar	5	5	5	5	5	32.6	32.6	32.6	32.6	32.6	**163**
A239	RUH	HV U/G Termination Replacement	20	20	20	20	20	339.8	339.8	339.8	339.8	339.8	**1,699**
A 213	RUL	LV U/G Termination Replacement	45	45	45	45	45	469.9	467.8	466.1	468.3	469.7	**2,342**

N.B. Total figures have been rounded.

3.2.3 Option 3: Replacement levels to increase network reliability

The 'replacement levels to increase network performance and reliability' option is a proactive approach that invests in at-risk replacement of the underground network in affected areas over and above what is required to maintain current levels of reliability. This approach would focus on replacing the highest risk underground cables.

Generally, this option would include a variety of sub-options for determining when replacement occurs:

- **Replacing underground cables at a scheduled age**. Although the scheduled replacement age will be based on structured analysis of the functions and potential failures, for high reliable assets such as underground cables, age based replacement is not an optimal strategy and not cost effective.

- **Scheduled inspection of the underground cable system for defects**. This option is not viable because of large civil expenses required to expose the underground cables and that it's questionable whether cable conditions can be ascertained visually.

- **Scheduled testing of the underground cable systems to ascertain their conditions**. Current testing techniques have a network security risk as they require the cable to be taken out of service. Moreover, modern underground cables are highly reliable and it is considered the incremental improvement in network reliability does not outweigh the cost to test the cables.

This option is likely to resolve most identified issues in terms of age and condition. The total capital cost of this option is $9.40M.

This option would replace assets at a rate above historical trend forecasts, to improve network reliability above current levels. This option, however, is not recommended given it is not considered prudent in terms of JEN's current approach to high volume, low value assets – which are currently run to failure.

Likewise, this option does not respond to our customer's needs, who have indicated they value a stable network more so than improvements to the network. This is evidenced by our customer engagement, which highlights 'maintaining the network' being more important to customers than 'improving the network'.[11] Jemena's Peoples Panel noted 'Jemena needs to prioritise investing in reliability by assessing, building, and maintaining the network to meet changes in operating conditions and withstand network failures'.[12] This position was reiterated

[11] See JEN - Att 02-01 Customer engagement – 20250131.

[12] See JEN - Att 02-01 Customer engagement – 20250131, s.5.1.

by the First Nations and Disability Customer Voice Groups.

As with Option 2, when assessing this option we calculated a value for VCR to determine the average value different types of our customers place on having reliable electricity supply.[13] The VCR calculated, applicable to the average customer was determined to be $11.28M over 5 years.

Forecast replacement volumes and expenditure proposed under Option 2 is set out inTable Table 7.

Table 7: Option 3 Replacement Volumes and Expenditure – Underground Cables

Unique ID	Service Code	Activity	Forecast Replacement Volumes					Proposed Expenditure ($'000), $2024					
			FY27	FY28	FY29	FY30	FY31	FY27	FY28	FY29	FY30	FY31	Total
A208	RUA	HV U/G Cable Replacement (m)	393	386	393	386	393	195	191.1	195	191.1	195	**967**
A209	RUA	Replace Metal Trifurcating Boxes	-	19.2	13.2	14.4	6	-	1,459.8	1,024.4	1,059.8	473.3	**4,017**
A210	RUC	LV U/G Cable Replacement (m)	240	240	240	240	240	149	149	149	149	149	**745**
A211	RUF	Pillar to Pillar	6	6	6	6	6	39.1	39.1	39.1	39.1	39.1	**195**
A239	RUH	HV U/G Termination Replacement	24	24	24	24	24	407.8	407.8	407.8	407.8	407.8	**2,039**
A 213	RUL	LV U/G Termination Replacement	54	54	54	54	54	563.9	561.3	559.3	562	563.7	**2,810**

N.B. Total figures have been rounded.

[13] More detail on how this has been calculated can be found in 4.1.1.

4. Option analysis

4.1 Economic analysis

In line with the objective of the National Electricity Rules, JEN's capex investment decisions aim to maximise the present value of the net economic benefit to all those who produce, consume and transport electricity in the National Electricity Market.

To assess benefits against this objective, JEN has undertaken a probabilistic cost-benefit assessment of replacement options that considers the likelihood and severity of critical network outages. This methodology assesses the expected impact of asset failures and subsequent network outages on supply delivery and combines this with the value customers place on supply reliability (VCR) and compares the result with the costs required to reduce the likelihood and/or impact of these supply outages. The benefits considered in this economic analysis relate to mitigating the increasing risk of underground cable failure within the electricity distribution network. This includes the safety risks associated with Option 1 (do nothing) described earlier. The following table summarises the economic analysis undertaken.

Table 8 outlines the costs and VCR values associated with each option.

Table 8: Costs of Options[14], $2024

Option	Total capital expenditure ($m)	Value of Customer Reliability ($m)	Ranking
Option 1 – Do nothing	-	-	3
Option 2 - Replacement levels to maintain network performance and reliability and meet compliance obligations	9.00	9.40	1
Option 3 - Replacement levels to increase network performance and reliability	10.80	11.28	2

4.1.1 Assumptions and inputs used

Costs

In validating the prudency of expenditure, JEN engaged AECOM to provide benchmarking for underground cable replacement costs.[15]

Cost estimates for underground cable replacement, which inform proposed expenditure, have been prepared using general industry rates for recent similar works performed in Victoria, as well as the standards and practices of JEN. Costs, and unit rate costs, have been prepared using a mix of current and historical information from similar projects, adjusted to reflect the replacement program, location and market conditions. Labour, plant and overhead rates are based on the Jemena contractor's rate.

Underground cables operate with a higher level of reliability than overhead networks as they are less susceptible to environmental and other external interference. However, their construction is more expensive than overhead network assets and is likely to be less costly in terms of maintenance.

[14] JEN - RP - Support – Underground Cable Replacement Model - 20251201 - Public

[15] JEN - RP - Support - AECOM Benchmarking Unit Rates for Asset Replacement - 20251201 - Confidential

Value of unserved energy analysis

This business case determines the value of unserved energy based on the historical level of replacements for Option 2 and an increase in volumes from historical levels in Option 3. The value of unserved energy is determined by the average duration that customers experience an outage due to an underground cable fault converted to consumption and using the 2025 VCR in $/kWh to calculate the monetary value of the unserved energy.

Table 9: Estimate of customer unserved energy per hour

Sector	kW/h
Residential	0.70
Commercial	1.67
Industrial	16.67

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Sector	2025 VCR - $/kWh
Residential	54.41
Agricultural	22.25
Commercial	34.39
Industrial	33.49
>10MVA	70.88

4.1.2 Financial analysis

This business case proposes a total capital investment of $9.0M.

This project proposed to be completed by FY31. Table 11 provides the project budget by calendar year.

Table 11: Proposed expenditure by regulatory year, $2024

Regulatory Year	Proposed Expenditure ($M)
2027	$1.13M
2028	$2.34M
2029	$1.99M
2030	$2.01M
2031	$1.53M
Total proposed expenditure	**$9.00M**

5. Recommendation

It is recommended that Option 2. This option provides the most financially and operationally viable option to mitigate the risks of underground cable failure due to associated risks.

Based on this, a forecast investment of $9.00M is required. The VCR calculated was determined to be $9.40M over 5 years. This option best meets the long-term interests of JEN customers and is consistent with the National Electricity Objective and other regulatory and compliance obligations.