City West Substation

Attachment 5 Appendix B

Project summaries

Revenue Proposal 2023-24 to 2027-28

31 JANUARY 2022

ElectraNet

Company Information

ElectraNet Pty Ltd (ElectraNet) is the principal electricity transmission network service provider (TNSP) in South Australia.

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Note

This attachment forms part of our Revenue Proposal for the 2023-24 to 2027-28 regulatory period. It should be read in conjunction with the other parts of the Revenue Proposal.

Our Revenue Proposal comprises the overview and attachments listed below, and the supporting documents that are listed in Attachment 14:

- Revenue Proposal Overview
- Attachment 1 – Maximum allowed revenue
- Attachment 2 – Regulatory asset base
- Attachment 3 – Rate of return
- Attachment 4 – Regulatory depreciation
- Attachment 5 – Capital expenditure (this document)
- Attachment 6 – Operating expenditure
- Attachment 7 – Corporate income tax
- Attachment 8 – Efficiency benefit sharing scheme
- Attachment 9 – Capital expenditure sharing scheme
- Attachment 10 – Service target performance incentive scheme
- Attachment 11 – Pricing methodology
- Attachment 12 – Pass through events
- Attachment 13 – Demand Management Innovation Allowance
- Attachment 14 – List of supporting documents

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Appendix B : Principal Network Projects and Programs

This Appendix provides summaries of the largest capital projects by value in the forthcoming regulatory period, other than work in progress projects, as summarised in Attachment 5, Table 5-3.

Capital costs in this Appendix are expressed in $2022-23 unless otherwise indicated.

B.1 Transmission network voltage control

B.1.1 Identified Need

Existing reactive power devices on the network are reaching the limits of their ability to maintain voltage stability as specified in the National Electricity Rules (NER) s5.1a.4 and S5.1.8 beyond 2024-25 in order to preserve power system security.

This is driven by the ongoing growth in solar PV generation and falling minimum demand levels.

To ensure sufficient reactive power reserves for contingency events, ElectraNet operates the Para and South East Static Var Compensators (SVCs) within a predefined target range. Increasingly, the SVCs are operating beyond this target range and reaching their operating limits before system disturbances occur, leaving no capacity to respond when disturbances do occur. Additional voltage control devices are required to ensure that the existing SVCs can be kept within the target range, making their dynamic capability available to respond to system disturbances and maintain system security as was originally intended.

The safe and reliable provision of adequate levels of voltage control is necessary to meet the Rules capital expenditure objectives to:

- maintain the quality, reliability, and security of supply of prescribed transmission services; and
- comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services.

B.1.2 Options Considered

ElectraNet has undertaken a range of detailed network studies to identify the most economically feasible options to address this need. A variety of network options were considered as were non-network options involving the use of Virtual Power Plants (VPPs). However, the current and likely future capacity of VPPs meant that this solution is not expected to be economically viable in the timeframe required.

Therefore, the options analysed were to:

1. Install four x 60MVar and one x 50MVar 275 kV reactor at four locations and upgrade control systems to allow coordinated automated switching operation at 32 connection points with the distribution network;
2. Install SVCs equivalent to 250 Mvar reactive power absorb range, one 50 Mvar 275 kV reactor and automate the switching at 32 connection points with the distribution network, or;
3. Install eight x 30 Mvar 66 kV reactors in the metropolitan region as well as eight x 7.5 Mvar 33 kV reactors at South East substation on the distribution network. Install a reactive plant control scheme and upgrade control systems to automate switching at 32 connection points with the distribution network.

A ‘do nothing’ option was not considered viable as it would not meet the voltage stability requirements of the Rules.

The benefits of this project to customers are that it will:

- Prevent potentially widespread outages caused by ineffective management of voltages;
- Reduce the risk of damage to and failure of equipment used to maintain the safe and reliable operation of the grid if the dynamic reactive power reserves are not maintained at their optimal levels, with associated costs and outage consequences; and
- Maintain customers' ability to use and export solar power under a wide range of operating conditions.

An economic analysis of the above options was conducted to determine the most efficient option considering the relative up front and ongoing costs of each, including maintenance costs. This analysis focused on identifying the least cost option but did not attempt to quantify the benefits above of achieving the mandatory voltage standards, which are expected to be consistent across each option.

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Install five 275 kV reactors	-46	1
Option 2	Install SVC and one 275 kV reactor	-61	3
Option 3	Install eight 66 kV reactors and eight 33 kV reactors	-57	2

The analysis has identified that the best economic solution to provide this essential network function is by installing additional reactive plant in line with Option 1.

B.1.3 Project Description

We plan to install five 275 kV reactors at four locations and upgrade control systems to allow coordinated automated switching of respective plant during the 2024-2028 regulatory period. The estimated capital cost is $52m.

B.1.4 Project details

Project ID no	EC.11645	**Completion Date**	30 June 2026
Project Estimate	$52m	**Capital Expenditure Category**	Security/ Compliance
Capital Expenditure Objectives	• maintain the quality, reliability, and security of supply of prescribed transmission services; and • comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services.		

B.2 Isolator Unit Asset Replacement 2024-2028

B.2.1 Identified Need

Isolators are mechanically operated switches that isolate a part of an electrical circuit under no-load conditions, allowing for work to be performed safely. They are a major component of our substations and are essential to the safe and reliable operation of the network.

The safe and reliable operation of this equipment is necessary to meet the National Electricity Rules capital expenditure objective to:

- maintain the quality, reliability and security of supply of prescribed transmission services[1]

If an isolator fails, this could lead to potential large-scale damage of assets or harm to personnel on site.

We have identified 80 isolators, representing about five per cent of the population of approximately 1,467 isolators on the network, that are at an increasing risk of failure based on their assessed condition.

B.2.2 Options Considered

The available options analysed were to:

- Replace on failure (base case);
- Option 1: Replace identified isolators in the 2024-2028 period; or
- Option 2: Replace identified isolators in the 2029-2033 period.

Due to the specific function performed by these particular assets, the above represent the only technically and economically feasible options available. There are no non-network options available that can address the underlying need in the absence of full replacement of the relevant substations, which is not considered economically feasible.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Avoidance of emergency replacement cost (15%);
- Creation of spare parts that are then available to economically repair other isolators (1%);
- Reduced customer outage cost due to isolator failure (51%);
- Avoidance of generation support or temporary bypass for extended outages when no spares are available (5%);
- Avoidance of additional outages due to isolator failure during transformer or line maintenance (25%); and
- Reduction in safety risk due to isolator failure causing electrocution (3%).

1 Refer to NER capital expenditure objective 6A.6.7-point a.3.iii.

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace during the 2024-2028 regulatory period	5.3	1
Option 2	Replace during the 2029-2033 regulatory period.	3.5	2

The analysis has identified that benefits to customers are maximised by replacing the 80 identified isolators in the forthcoming regulatory period consistent with Option 1.

B.2.3 Project description

We plan to replace 80 isolators that have been identified as being at the end of their useful life and select others as a source of spare parts for future replacements. The estimated capital cost of doing so is $40.6m.

These assets represent approximately five per cent of the fleet of isolators – at this rate it would take about 90 years to replace the entire fleet of these assets.

B.2.4 Project specifics

Project ID no	EC.15397	**Completion Date**	30 June 2028
Project Estimate	$40.6m	**Capital Expenditure Category**	Replacement
Capital Expenditure Objective	• maintain the quality, reliability and security of supply of prescribed transmission services		

B.3 Transmission line insulation system replacement

B.3.1 Identified Need

Transmission line insulators attach overhead conductors to, and electrically isolate them from, transmission structures. They are a major component on the transmission lines system ensuring conductors remain suspended allowing for continuation of customer supply. If an insulator string fails a conductor can potentially fall to the ground. This could cause large-scale damage resulting in harm to the public or livestock, property damage, fire start and loss of supply for customers.

The safe and reliable operation of this equipment is necessary to meet the Rules capital expenditure objectives to:

- meet or manage the expected demand for prescribed transmission services; and
- maintain the quality, reliability and security of supply of prescribed transmission services.

We have identified approximately 2,775 insulator strings on 779 structures on 14 transmission lines across the network at an increasing risk of failure based on their assessed condition.

B.3.2 Options considered

The available options analysed were to:

- Replace on failure (base case);
- Option 1: Replace identified insulators during the 2024-2028 regulatory period; or
- Option 2: Replace identified insulators during the 2029-2033 regulatory period.

These are the only technically and economically feasible options available. Short of abandoning transmission lines and pursuing distributed generation solutions, which would be much more costly, there are no available non-network options that can address the underlying need.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Reduced risk to public safety in the event of a conductor drop due to insulator failure (4%);
- Reduced potential cost of unplanned outages to reactively replace / repair failed assets (1%);
- Reduced cost of bushfire risk in the event of a dropped conductor due to asset failure (1%); and
- Reduced outages for customers as a result of unplanned asset failure (94%).

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace during the 2024-2028 regulatory period	73	1
Option 2	Replace during the 2029-2033 regulatory period.	46	2

The analysis has identified that benefits to customers are maximised by replacing the 2,775 identified line insulators during the 2024-2028 regulatory period consistent with Option 1.

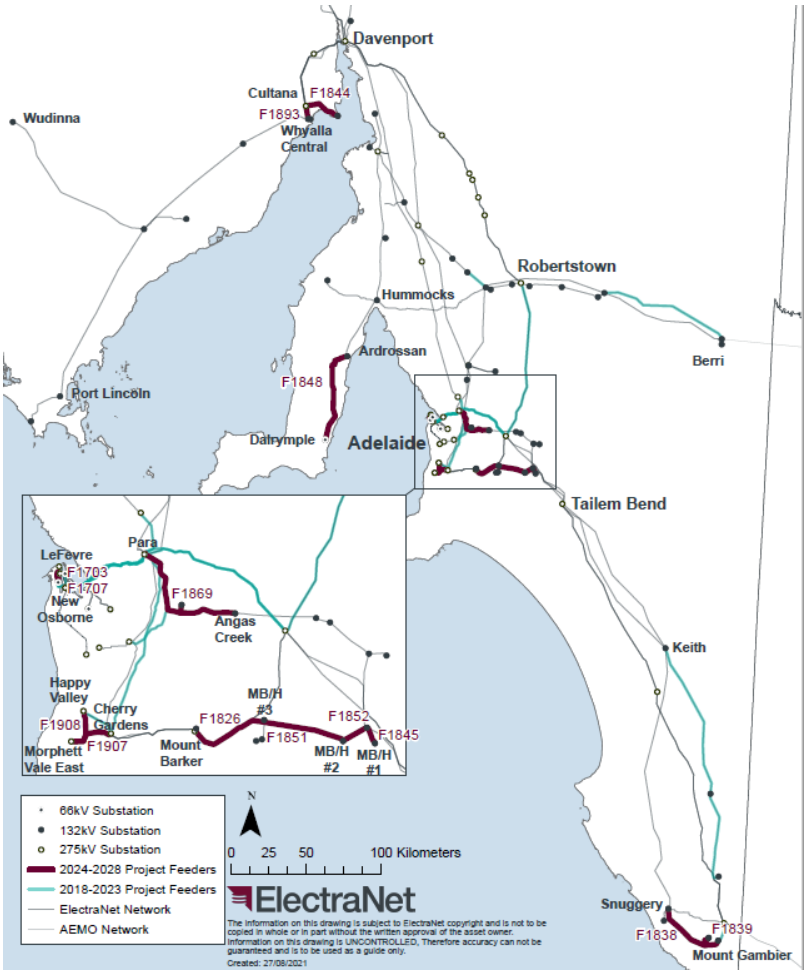
B.3.3 Project description

We plan to replace 2,775 insulator strings identified for replacement during the 2024-2028 regulatory period. The estimated cost is $31.5m. These replacements are shown on the map below.

These assets represent approximately five per cent of the fleet of insulators. At this rate it would take about 86 years to replace the entire fleet of these assets. This builds on an ongoing staged program of replacement on a risk basis of:

- 5,885 insulator strings in the current 2019-2023 regulatory period; and
- 6,747 insulator strings in the prior 2014-2018 regulatory period.

Figure 1: Transmission line insulation replacements 2024-2028



B.3.4 Project specifics

Project ID #	EC.15233	**Completion date**	30 June 2028
Project Estimate	$31.5m	**Capital Expenditure Category**	Refurbishment
Capital Expenditure Objective	• meet or manage the expected demand for prescribed transmission services; and • maintain the quality, reliability and security of supply of prescribed transmission services.		

B.4 Hummocks to Ardrossan West line rebuild

B.4.1 Identified Need

The Hummocks to Ardrossan West 132kV transmission line provides the only transmission supply to the Yorke Peninsula region. As such, continual operation of this radial line is crucial to providing ongoing customer supply.

The safe, reliable and continual operation of this transmission line is necessary to meet the Rules capital expenditure objectives[1] to:

- meet or manage the expected demand for prescribed transmission services; and
- maintain the quality, reliability and security of supply of prescribed transmission services.

A transmission line consists of four key elements, namely transmission structures, conductors, insulators and earthwires. If any of these elements were to fail, this would potentially cause unpredictable large-scale damage resulting in harm to the public or livestock, property damage, fire start, and loss of supply for customers.

Built in 1973, the Hummocks to Ardrossan West 132kV transmission line elements are now at or past their technical life based on their condition. The earthwire and conductors on this line, which is in a high corrosion zone, would normally be expected to last 35 years. These assets will have been in place for over 50 years by the start of the coming regulatory period. The assessed condition of this line indicates an increased risk of failure.

The photos below illustrate existing asset condition, showing the presence of corrosion. This asset deterioration gives rise to increased risk of asset failure resulting in potential impacts outlined above.

Figure 2: Conductor Strand Breakage Due to Corrosion

Figure 3: Line Insulator Pin Metal Loss Due To Corrosion

B.4.2 Options considered

The available options analysed were to:

- Replace individual line components on failure (base case);
- Option 1: Replace the line conductor and insulators during the 2024-2028 regulatory period;
- Option 2: Replace the line conductor and insulators during the 2029-2033 regulatory period;
- Option 3: Replace the entire line during the 2024-2028 regulatory period; or
- Option 4: Replace the entire line during the 2029-2033 regulatory period.

These are the only technically and economically feasible options available. Short of abandoning this transmission line and pursuing distributed generation solutions, which would be much more costly, the ongoing need to ensure continued supply to the region means that there are no non-network options that can address the underlying need to mitigate asset failure risks identified.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Reduced risk to public safety in the event of a dropped conductor due to asset failure;
- Reduced potential for unplanned outages resulting in loss of customer supply; and
- Avoided incremental costs to replace these assets in a reactive fashion.

The outcomes of this analysis are as follows.

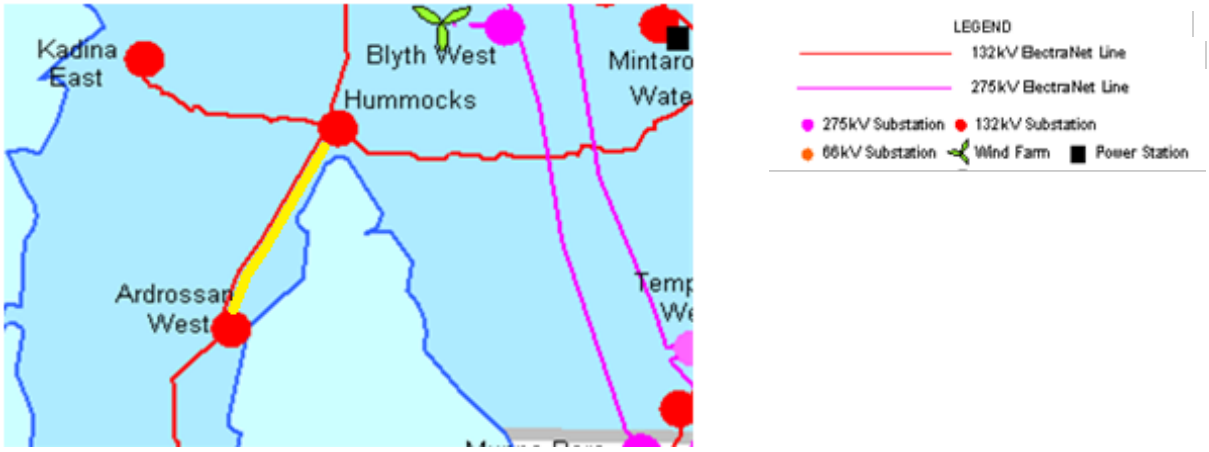
Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace the line conductor and insulators during the 2024-2028 regulatory period	42	2
Option 2	Replace the line conductor and insulators during the 2029-2033 regulatory period	34	4
Option 3	Replace the entire line during the 2024-2028 regulatory period	50	1
Option 4	Replace the entire line during the 2029-2033 regulatory period.	40	3

The analysis has identified that benefits to customers are maximised by replacing the entire line during the 2024-2028 regulatory period, consistent with Option 3. Options 1 and 2 were found to be uneconomic due to the requirement for substantial levels of network support during the outage of the single circuit line, which is avoided under full line rebuild Options 3 and 4.

B.4.3 Project description

We plan to replace the Hummocks to Ardrossan West transmission line during the 2024-2028 regulatory period. The estimated cost is $30.3m. The new line will run parallel to the existing line as illustrated in the figure below.

Figure 4: Hummocks - Ardrossan West Line



B.4.4 Project specifics

Project ID no	EC.15239	**Completion Date**	30 June 2028
Project Estimate	$30.3 m	**Capital Expenditure Category**	Replacement
Capital Expenditure Objective	• meet or manage the expected demand for prescribed transmission services; and • maintain the quality, reliability and security of supply of prescribed transmission services.		

B.5 Line conductor and earthwire refurbishment

B.5.1 Identified Need

Transmission line conductors are used to transport electricity throughout the network. Earthwires are a cruical asset used for a range of functions including protecting conductors from direct lightning stikes protecting the network from outages.

If these assets were to fail it could potentially cause unpredictable large-scale damage resulting in harm to the public or livestock, property damage, fire start and loss of supply for customers.

The safe and reliable operation of these assets are critical to meet the Rules capital expenditure objectives to:

- meet or manage the expected demand for prescribed transmission services; and
- maintain the quality, reliability and security of supply of prescribed transmission services.

We have identified conductors on seven transmission lines across the network at increacing risk of failure due to their assessed condition.

B.5.2 Options considered

The available options analysed were to:

- Replace line components on failure (base case);
- Option 1: Replace the conductors and earthwires during the 2024-2028 regulatory period; or
- Option 2: Replace the conductors and earthwires during the 2029-2033 regulatory period.

These are the only technically and economically feasible options available. Short of abandoning transmission lines and pursuing distributed generation solutions, which would be much more costly, there are no available non-network options that can address the underlying need.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Reduced risk to public safety in the event of a dropped conductor or earthwire due to asset failure;
- Reduced cost to reactively replace / repair failed assets;
- Reduced cost of bushfire risk in the event of a dropped conductor due to asset failure; and
- Reduced risk of loss of customer supply.

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace the line conductors and earthwires in the 2024-2028 regulatory period	33	1
Option 2	Replace the line conductors and earthwires during the 2029-2033 regulatory period.	31	2

The analysis has identified that benefits to customers are maximised by replacing the identified conductors and earthwires during the 2024-2028 regulatory period consistent with Option 1.

B.5.3 Project description

We plan to replace the sections of conductor and earthwire on seven identified transmission lines during the 2024-2028 regulatory period. The estimated cost is $25.5m.

These assets represent approximately one and a half per cent of the fleet of conductor and earthwire assets. At this rate it would take over three hundred years to replace the entire fleet of these assets.

B.5.4 Project specifics

Project ID no	EC.14084	**Completion Date**	30 June 2028
Project Estimate	$25.5m	**Capital Expenditure Category**	Refurbishment
Capital Expenditure Objective	• meet or manage the expected demand for prescribed transmission services; and • maintain the quality, reliability and security of supply of prescribed transmission services.		

B.6 Transmission Tower Anti-Climb Installation

B.6.1 Identified Need

Transmission tower anticlimb devices are used to deter unauthorised climbing of transmission structures. Anticlimb devices play a crucial role in ensuring public safety as well as reducing risk of possible damage to transmission line assets.

If a member of the public accessed overhead conductor(s) or associated assets, it could lead to unpredictable damage causing potential harm to other members of the public and/or loss of supply.

We have a duty of care, including under WH&S and other legislation, to ensure that, so far as is reasonably practicable, the health and safety of workers, the public and others is not put at risk by our assets. While it has for many years been standard practice to install anti-climb measures on new transmission towers, a number of towers on older lines on our network do not have these safeguards. ElectraNet considers it a prudent public safety measure to install anti-climb measures on older transmission towers in high risk locations.

Safe and reliable operation of this equipment is necessary to meet the Rules capital expenditure objectives to:

- comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services; and
- maintain the reliability and security of the transmission system through the supply of prescribed transmission services;

Figure 5: Climbing Deterrent Device

B.6.2 Options considered

A detailed assessment has been undertaken across the network of the effectiveness of hazard controls against unauthorised access to transmission towers. The network consists of approximately 15,000 transmission line structures. About 8,700 of these are lattice tower structures.

Around 5,360 towers have been identified as not meeting current guidelines as set out in the Energy Networks Australia National Guidelines for Prevention of Unauthorised Access to Electricity Infrastructure NENS Doc 015-2006.

We conducted an analysis of towers not fitted with effective climbing deterrent devices and identified around 3,500 towers as being at greatest risk of unauthorised climbing. That risk assessment considered each tower's proximity to the following (listed in no particular order and with threshold distances shown in brackets):

- towns (6 km);
- dwellings (1,800 m);
- point of interest (1,800m);
- main road (600m); and
- access track (120m).

Each tower was assigned a score based on the number of these criteria it met.

We presented these options to our Consumer Advisory Panel Working Group for discussion. We received feedback including from Lifeline Adelaide, through Uniting Communities, which supported the need to restrict public access to transmission towers and the criteria used to prioritise towers for protection.

A number of options were considered based on the number of vulnerability criteria satisfied as follows, following adjustments to the total to allow for lines to be removed from service.

Option	Description	No. of towers	Estimated cost
	Take no action (do nothing)	0	0
1	Towers satisfying 1 or more criteria	3,163	$30m
2	Towers satisfying 2 or more criteria	2,924	$28m
3	Towers satisfying 3 or more criteria	1,835	$18m
4	Towers satisfying 4 or more criteria	704	$7m
5	Towers satisfying all 5 criteria	81	$1m

Unlike other projects a standard NPV analysis is not well suited to this project due to the lack of reliable data concerning the frequency with which tower climbing is attempted (i.e. this represents an unknown probabilty of failure). Threshold analysis indicates that the full project would provide net customer benefits if it reduces the (annual) risk of a fatal fall from a transmission tower by 5%.

Following review by the Working Group we reduced the project scope and cost by approximately 1,500 towers from the 3,500 proposed in the Preliminary Revenue Proposal to 1,981 towers at greatest risk based on the above criteria, and taking a staged approach to addressing the public safety risk. This represents a 44% reduction in the original scope and cost of the project as the most prudent and efficient solution on a risk basis, and most closely corresponds with Option 3.

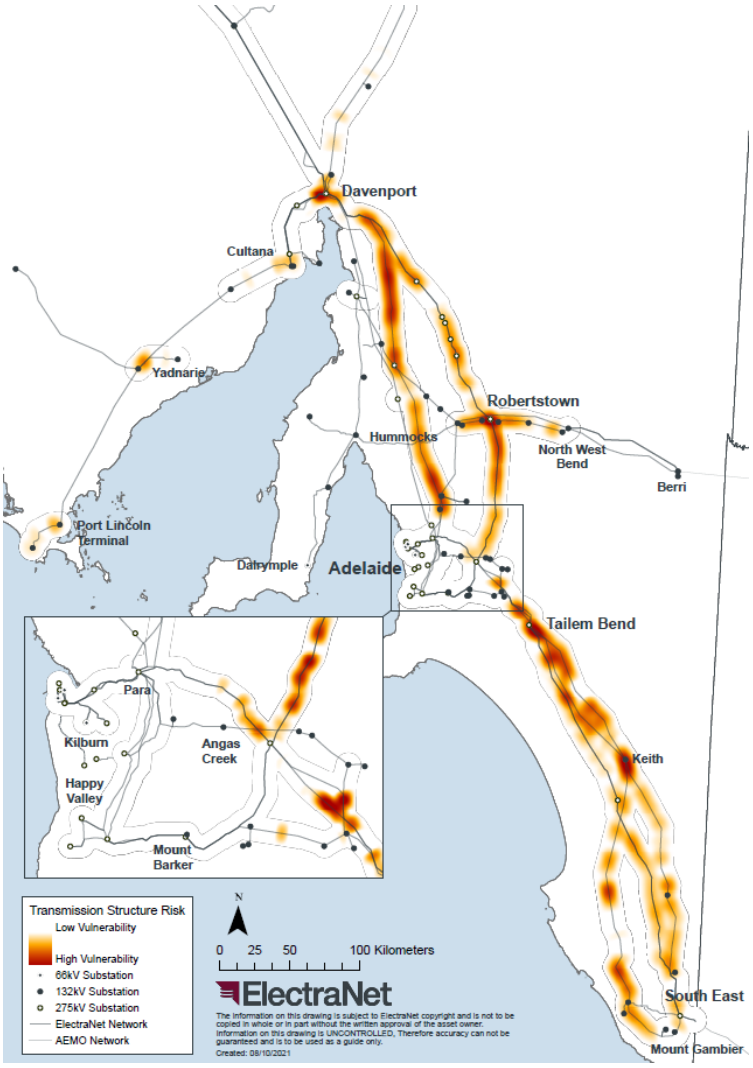
Therefore, we propose to install anti-climb devices on highest risk towers in the forthcoming regulatory period, with other towers to be addressed on a staged basis in future periods.

B.6.3 Project description

We plan to install anticlimb equipment on 1,981 lattice towers at highest risk across the transmission network based on proximity to populated areas at an estimated cost of $20.4m.

This represents a staged program, with additional towers to be addressed in future periods on a risk basis.

Figure 6: Transmission Tower Anti-climb Priority Locations



B.6.4 Project specifics

Project ID no	EC.15235	**Completion Date**	June 2028
Project Estimate	$20.4m	**Capital Expenditure Category**	Security/ Compliance
Capital Expenditure Objective	• comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services; and • maintain the reliability and security of the transmission system through the supply of prescribed transmission services;		

B.7 EC.15120 Instrument Transformer Unit Asset Replacement 2024-2028

B.7.1 Identified Need

Instrument transformers are electrical devices used to measure system voltage and current levels on the transmission network. Instrument transformers are a major component of the electrical protection system that ensures electrical faults are cleared within designated times, as specified in the National Electricity Rules (NER).[2]

The safe and reliable operation of this equipment is necessary to meet the Rules capital expenditure objectives[3] to:

- meet or manage the expected demand for prescribed transmission services; and
- maintain the quality, reliability and security of supply of prescribed transmission services.

In addition, if an instrument transformer fails explosively, it can cause unpredictable damage resulting in harm to people, potential substation failure and consequential loss of supply for customers.

We have identified 101 instrument transformers of the population of approximately 3,113 on the network at an increasing risk of failure based on their assessed condition.

The photo below shows the impact of an explosive failure of an instrument transformer.

Figure 7: Instrument Transformer Explosive Failure

2 S5.1a.8 of the NER outlines the requirements regarding fault clearance times, including the specific maximum permitted fault clearance times.

3 Refer to NER capital expenditure objectives: 6A.6.7 point a.1. & 6A.6.7 point a.3.ii,

B.7.2 Options considered

The available options analysed were to:

- Replace instrument transformers on failure (base case);
- Option 1: Replace identified instrument transformers during the 2024-2028 regulatory period, or;
- Option 2: Replace identified instrument transformers during the 2029-2033 regulatory period

Due to the specific function performed by instrument transformers, these represent the only technically and economically feasible options available. There are no non-network options available that can address the underlying need in the absence of full replacement of the relevant substations, which is not an economically viable option.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Reduced risk to safety of personnel and the wider community from explosive failure (13%);
- Reduced potential for unplanned outages from failed instrument transformers resulting in loss of customer supply (84%);
- Avoiding damage to other substation assets from catastrophic failure (2%); and
- Avoided incremental costs to replace failed assets in a reactive fashion (1%).

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace during the 2024-2028 regulatory period	1.8	1
Option 2	Replace during the 2029-2033 regulatory period	1.1	2

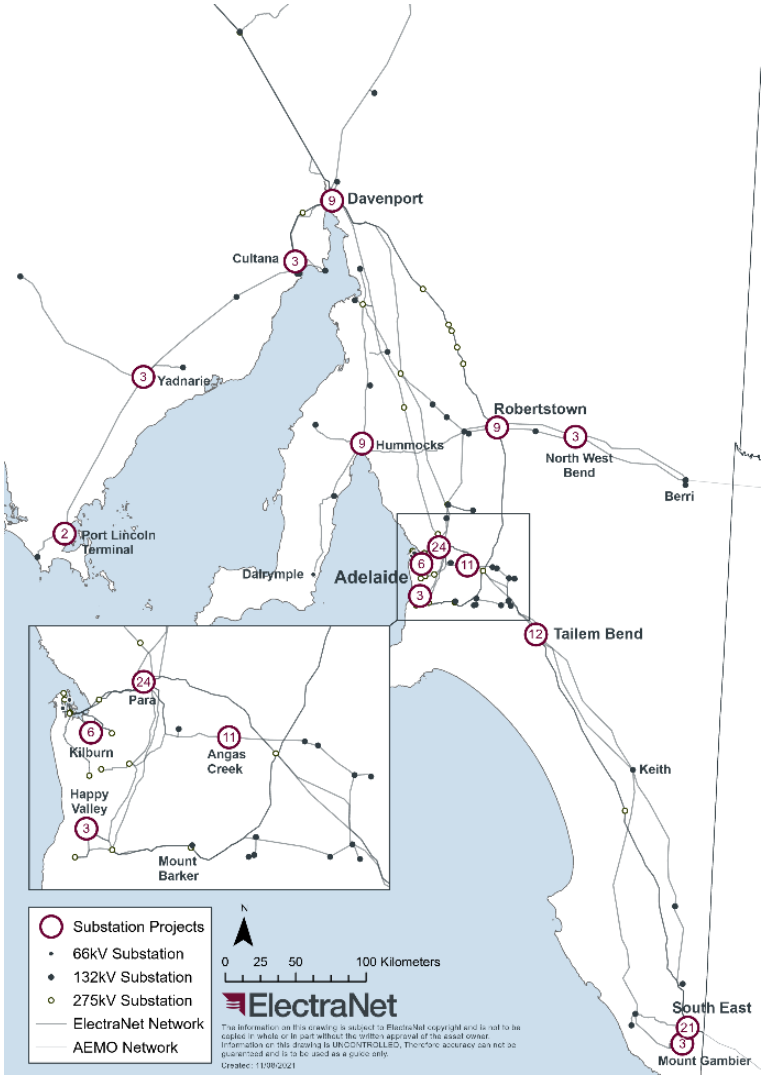
The analysis has identified that benefits to customers are maximised by replacing the 101 identified instrument transformers during the 2024-2028 regulatory period, consistent with Option 1.

B.7.3 Project description

We plan to replace 101 instrument transformers identified as being at the highest risk of failure across the network progressively during the 2024-2028 regulatory period. The estimated cost is $16.7m. The location of these assets across the network is shown below.

These assets represent less than three per cent of the fleet of instrument transformers. At this rate it would take over 150 years to replace the entire fleet of these assets.

Figure 8: Instrument Transformer Replacements 2024-2028



B.7.4 Project specifics

Project ID no	EC.15120	**Completion Date**	June 2028
Project Estimate	$16.7m	**Capital Expenditure Category**	Replacement
Capital Expenditure Objective	• meet or manage the expected demand for prescribed transmission services; and • maintain the quality, reliability and security of supply of prescribed transmission services.		

B.8 Substation Technology System Cyber Security uplift

B.8.1 Identified Need

Substation technology systems consist of computing and communications in the form of Local Area Network (LAN) equipment located at substations. They provide essential functions to support a secure and reliable ongoing network operation.

Some of this equipment is now well beyond its service life, which makes it increasingly difficult to keep it running safely. If substation Local Area Networks were breached by local or remote means this could lead to unpredictable damage resulting in potential substation failure and/or consequential supply interruption for customers.

The safe and reliable operation of this equipment is necessary to meet the Rules capital expenditure objectives to:

- maintain the quality, reliability, and security of supply of prescribed transmission services; and
- maintain the safety of the transmission system through the supply of prescribed transmission services.

B.8.2 Options considered

The options analysed were to:

- Take no specific action (base case);
- Option 1: Replace high-risk substation LAN assets and undertake cyber uplift of networks and intelligent devices during the 2024-2028 regulatory period; or
- Option 2: Replace high-risk substation LAN assets and undertake cyber uplift of networks and intelligent devices during the 2029-2033 regulatory period.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Reductions in future outages caused by failure of system components (2%);
- Reductions in the risk of cyber-attack causing system black event (35%);
- Reductions in the risk of cyber-attack causing ongoing service interruptions (40%); and
- Reductions in damage to other substation assets during attempted break ins (23%).

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace and upgrade assets during the 2024-2028 regulatory period	+0.80	1
Option 2	Replace and upgrade assets during the 2029-2033 regulatory period	-1.06	2

In line with the rising importance of protecting Australia's critical network infrastructure, ElectraNet must take proactive steps to minimise potential threats posed to system security. Given this, and in line with a prudent risk-based approach, benefits to customers are maximised by replacing and upgrading the relevant equipment during the 2024-2028 regulatory period, consistent with Option 1.

B.8.3 Project description

We plan to replace and upgrade substation technology assets identified as being susceptible to cyberattack at identified substations by replacing relevant equipment as well as uplifting cyber security of networks and intelligent devices. This work will be carried out progressively during the 2024-2028 regulatory period. The estimated project cost is $14.8m.

B.8.4 Project specifics

Project ID #	EC.15399	**Completion date**	30 June 2026
Project Estimate	$14.8m	**Capital Expenditure Category**	Security/ compliance
Capital Expenditure Objective	• maintain the quality, reliability and security of supply of prescribed transmission services; and • maintain the safety of the transmission system through the supply of prescribed transmission services.		

B.9 Circuit Breaker Unit Asset Replacement

B.9.1 Identified Need

Circuit breakers are switching devices used to interrupt supply in the event of a fault or to de-energise plant to allow safe access for asset maintenance. Circuit breakers are a major component of the electrical protection system that ensures electrical faults are cleared within designated times, as specified in the National Electricity Rules (NER).[4]

The safe, reliable and continued operation of this equipment is necessary to meet the Rules capital expenditure objectives[5] to:

- meet or manage the expected demand for prescribed transmission services; and
- maintain the quality, reliability and security of supply of prescribed transmission services.

We have identified 24 circuit breakers across the network that are at an increased risk of failure based on their assessed condition. These circuit breakers are located at 13 substations across the network and are between 40 and 66 years old. One of the identified circuit breakers is 66kV, twelve are 132 kV and eleven are 275 kV. The circuit breakers in question are oil filled and are the last of the oil filled circuit breakers on South Australia's transmission network. They represent approximately four per cent of the total 'fleet' of circuit breakers in the network.

If a circuit breaker fails explosively, it can cause unpredictable damage resulting in harm to people, potential substation failure and consequential loss of supply for customers.

The photo below shows the impact of an explosive failure of a circuit breaker.

Figure 9: Porcelain Circuit Breaker Explosive Failure

4 S5.1a.8 of the NER outlines the requirements regarding fault clearance times, including the specific maximum permitted fault clearance times.

5 Refer to NER capital expenditure objectives: 6A.6.7, point a.1. & 6A.6.7, point a.3.ii,

B.9.2 Options considered

The available options analysed were to

- Replace on failure (do nothing);
- Option 1: Replace identified circuit breakers in the 2024-2028 regulatory period, or;
- Option 2: Replace identified circuit breakers in the 2029-2033 regulatory period.

Due to the specific function performed by these particular assets, these are the only technically and economically feasible options available. There are no non-network options available that can address the underlying need in the absence of full replacement of the relevant substations, which is not considered an economically viable option.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Reduced ongoing maintenance costs for increased repairs (2%);
- Reduced costs associated with emergency replacement in the event of failure (26%);
- Reduced risk of damage caused to other assets in the event of catastrophic failure (1%);
- Reduced risk to safety of personnel and the wider community in the event of catastrophic failure (4%); and
- Reduced potential for unplanned outages from failed circuit breakers leading to loss of supply for affected customers (68%).

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace during the 2024-2028 regulatory period	24.4	1
Option 2	Replace during the 2029-2033 regulatory period	23.9	2

The analysis has identified that the benefits to customers are maximised by replacing the 24 identified circuit breakers during the 2024-2028 regulatory period, consistent with Option 1.

B.9.3 Project description

We plan to replace 24 circuit breakers located at 13 substations across the network identified as being at the highest risk of failure during the 2024-2028 regulatory period at an estimated cost of $14.1m.

These assets are the last of our oil filled circuit breakers, and this project concludes the replacement of this type of circuit breaker on the network.

B.9.4 Project specifics

Project ID no	EC.15060	**Completion Date**	30 June 2028
Project Estimate	$14.1 m	**Capital Expenditure Category**	Replacement
Capital Expenditure Objective	• meet or manage the expected demand for prescribed transmission services; and • maintain the quality, reliability and security of supply of prescribed transmission services.		

B.10 Wide Area Monitoring Scheme

B.10.1 Identified Need

Phasor Measurement Units (PMUs) are electronic measuring devices used to provide high-speed voltage and current phase measurements on the power system in the order of one microsecond intervals. These high-speed sensors improve real time visibility of network performance to enhance and improve system operation in a rapidly changing power system that is becoming more complex and challenging to operate.

In a notice issued on 27 January 2022, under clauses 4.11.1 (d) & (e) of the National Electricity Rules, AEMO identified critical locations in the South Australian network at which high-speed streaming of power system data is required. It therefore directed ElectraNet to install PMUs at major 275 kV transmission substations, key generation connection points as well as selected regional and metro substations across the transmission network. These devices will enable AEMO and ElectraNet to monitor the performance and response of the transmission network, generators and batteries at these locations.

This equipment is necessary to meet the Rules capital expenditure objective to :

- comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services; and
- maintain the quality, reliability, and security of supply of prescribed transmission services.

B.10.2 Options

ElectraNet has been directed by AEMO to install approximately 2 PMUs per site at 27 locations in the network, including upgrades to a small number of sites. Under clause 4.11.1 (d) and (e) of the Rules, ElectraNet must complete these works.

There is no available technical alternative other than to install measurement devices of the required capabilities at the specified locations.

B.10.3 Project Description

We plan to comply with AEMO's direction to install PMUs at major 275 kV transmission substations, key generation connection points, selected regional and metro substations during the 2024-2028 regulatory period. Our estimated cost of doing so is $12.9m.

B.10.4 Project specifics

Project ID no	EC.15272	**Completion Date**	31 Dec 2023
Project Estimate	$12.9m	**Capital Expenditure Category**	Security / Compliance
Capital Expenditure Objective	• comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services; and • maintain the quality, reliability, and security of supply of prescribed transmission services.		

B.11 AC Board Unit Asset Replacement

B.11.1 Identified Need

AC switchboards are electrical devices used to provide a safe and reliable substation power supply. AC switchboards are a major component of substations ensuring essential assets including control equipment remain operable.

If an AC switchboard fails causing a substation fire, it can cause unpredictable damage resulting in harm to site personnel and other substation assets, and/or consequential involuntary load curtailment for customers. The AC Boards in question are old and do not accord with current standards, increasing the personal safety risk associated with them.

Safe and reliable operation of this equipment is necessary to meet the Rules capital expenditure objectives to:

- meet or manage the expected demand for prescribed transmission services; and
- maintain the quality, reliability, and security of supply of prescribed transmission services.

We have identified six AC Switchboards and associated AC auxiliary equipment having an increased risk of failure based on their assessed condition.

B.11.2 Options considered

The available options analysed were to:

- Replace AC Switchboards on failure (base case);
- Option 1: Replace the identified AC Switchboards during the 2024-2028 regulatory period, or;
- Option 2: Replace the identified AC Switchboards during the 2029-2033 regulatory period.

Due to the specific function performed by AC Switchboards, replacement is the only technically and economically feasible option available. There are no available non-network options that can address the underlying need in the absence of full replacement of the relevant substations, which is not an economically viable option.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Reduced risk to safety of personnel from exposed terminals, missing Residual Current Device (RCD) protection as well as non-compliant cable colour coding (9%);
- Reduced risk of AC switchboard asset damage in the event of asset failure causing fire (32%);
- Reduced risk of associated asset damage in the event of asset failure causing fire spreading to the entire switchboard and adjacent cable trays (40%); and
- Reduced cost to customers by avoiding loss of supply (19%).

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace during the 2024-2028 regulatory period	2.9	1
Option 2	Replace during the 2029-2033 regulatory period	2.4	2

The analysis has identified that the benefits to customers are maximised by replacing the 6 AC switchboards identified during the 2024-2028 regulatory period, consistent with Option 1.

B.11.3 Project description

We plan to replace 6 AC switchboards identified as being at the highest risk of failure across the network during the 2024-2028 regulatory period. The estimated cost is $8.96m.

These assets represent approximately eight per cent of the fleet of AC switchboards in the network and the last of those which do not meet current standards, concluding a staged risk-based replacement program that has been carried out over multiple regulatory periods.

B.11.4 Project specifics

Project ID #	EC.15043	**Completion date**	30 June 2028
Project Estimate	$8.96m	**Capital Expenditure Category**	Replacement
Capital Expenditure Objective	• meet or manage the expected demand for prescribed transmission services; and • maintain the quality, reliability, and security of supply of prescribed transmission services.		

B.12 Substation Perimeter Intrusion and Motion Detection Security

B.12.1 Identified Need

Security systems are used to protect critical network infrastructure at ElectraNet's substations and to protect the public from that infrastructure. They play a crucial part in ensuring ongoing reliability of network assets as well as protecting public safety.

The reliable operation of this equipment is necessary to meet the Rules capital expenditure objectives to:

- Maintain the quality, reliability and security of supply of prescribed transmission services.

We have identified the need to improve the physical security at certain substations by installing perimeter intrusion detection equipment and Closed Circuit Television (CCTV) systems.

Without these protections there is an increasing risk of unauthorised public access which can cause unpredictable harm to people, substation assets or consequential loss of supply for customers.

B.12.2 Options considered

The available options analysed were to:

- Retain current systems (base case);
- Option 1: Install perimeter intrusion detection system and CCTV systems at certain substations during the 2024-2028 regulatory period, or
- Option 2: Install perimeter intrusion detection system and CCTV systems at certain substations during the 2029-2033 regulatory period.

A risk cost and economic analysis of the above options was conducted, which identified the following principal benefits:

- Reduced public safety risk from where unauthorised entry results in electrocution (14%);
- Reduced staff and contractor safety risk where equipment damage not detected results in electrocution (51%);
- Reduced repair costs where unauthorised entry results in equipment damage (9%);
- Reduced loss of supply risk where unauthorised entry results in an outage (10%);
- Reduced risk of loss of network control where unauthorised entry and access to networks/technology assets results in denial of use/services (13%); and
- Savings from reduced incident investigation from early detection and intervention (3%).

The outcomes of this analysis are summarised in the table below. This illustrates that the calculated net economic benefit to customers is slightly smaller than the overall project cost.

Notwithstanding this, and in line with the rising importance of protecting Australia's critical network infrastructure, ElectraNet must take proactive steps to minimise potential threats posed to system security. Given this, and in line with a prudent risk-based approach, Option 1 has been identified as the solution that maximises the expected benefits to customers.

Option	Description	NPV ($m 2022-23) Static Risk
Option 1	Install perimeter intrusion detection system and CCTV systems during 2024-2028 regulatory period	-1.4
Option 2	Install perimeter intrusion detection system and CCTV systems during 2029-2033 regulatory period	-0.9

B.12.3 Project description

We plan to upgrade substation security systems across certain substations by installing perimeter intrusion detection and CCTV systems during the 2024-2028 regulatory period. The cost of this project is estimated to be $11.7m.

B.12.4 Project specifics

Project ID #	EC.11828	**Completion date**	30 June 2028
Project Estimate	$11.7m	**Capital Expenditure Category**	Security /Compliance
Capital Expenditure Objective	• Maintain the quality, reliability and security of supply of prescribed transmission services		

B.13 Telecommunications Asset Replacement 2024-2028

B.13.1 Identified Need

ElectraNet's telecommunication network is used to carry critical protection, SCADA, operational and security data. It forms an essential part of the transmission system providing crucial asset interfacing required to maintain network operation.

The safe and reliable operation of this equipment is necessary to meet the Rules capital expenditure objectives to:

- meet or manage the expected demand for prescribed transmission services; and
- maintain the quality, reliability, and security of supply of prescribed transmission services.

Failure of network telecommunication interfaces could cause improper operation of assets which may cause prolonged outages, damage to equipment and/or consequential involuntary load curtailment for customers.

We have identified telecommunication assets across seven network locations that are at an increasing risk of failure based on their assessed condition. This includes assets that are no longer supported by the manufacturer, assets for which there is a shortage of spares as well as a shortage of the skills needed for operation and maintenance.

B.13.2 Options considered

The available options analysed were to:

- Replace communication assets on failure (base case);
- Option 1: Replace identified telecommunication assets during 2024-2028 regulatory period, or;
- Option 2: Replace identified telecommunication assets during 2029-2033 regulatory period.

Due to the range of specific communication functions performed these assets, these represent the only technically and economically feasible options available. There are no available non-network options that can address this underlying need.

A risk cost and economic analysis of the above options was conducted, which identified the principal benefit as being the avoided incremental costs of replacing these assets in a reactive fashion with and without spares.

The outcomes of this analysis are as follows.

Option	Description	NPV ($m 2022-23)	Ranking of Options
Option 1	Replace during the 2024-2028 regulatory period	3.4	1
Option 2	Replace during the 2029-2033 regulatory period	1.8	2

The analysis has identified that benefits to customers are maximised by replacing the telecommunication assets identified across seven sites during the 2024-2028 regulatory period, consistent with Option 1.

B.13.3 Project description

We plan to replace the telecommunication assets identified across seven network site locations as being at the highest risk of failure across the network during the 2024-2028 regulatory period. The estimated cost is $10.3m.

These represent approximately 12 per cent of the fleet of telecommunications assets. At this rate it would take about 42 years to replace the entire fleet of these assets.

Project ID #	EC.15288	**Completion date**	30 June 2028
Project Estimate	$10.3m	**Capital Expenditure Category**	Replacement
Capital Expenditure Objective	• meet or manage the expected demand for prescribed transmission services; and • maintain the quality, reliability, and security of supply of prescribed transmission services.		

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