Appendix 5.21: Decommission Fyshwick zone substation PJR

Regulatory proposal for the ACT electricity distribution network 2019-24
January 2018

Disclaimer: On 1 January 2018, the part of ActewAGL that looks after the electricity network changed its name to Evoenergy. This change has been brought about from a decision by the Australian Energy Regulator. Unless otherwise stated, ActewAGL Distribution branded documents provided with this regulatory proposal are Evoenergy documents.

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Project Justification Report

Project name	**Decommission Fyshwick Zone Substation**
Expenditure type	Capital Expenditure
Business Group	Asset Strategy
Regulatory Period	1 July 2019 to 30 June 2024
Total Project Cost Estimate	$3,821,000 excluding corporate overheads, excluding contingency, and excluding GST
Five year total spend 2019-24	$3,821,000 excluding corporate overheads, excluding contingency, and excluding GST
CAPEX category	ENAA Distribution
Primary driver	Decommission Aging 66 kV Assets at Fyshwick Zone Substation and fully utilise East Lake Zone Substation
Project Number	20004614

Contents

Reference documents

Document	Version	Date
National Electricity Rules	102	
National Electricity Law		19.12.13
Utilities Act (ACT)		2000
Utilities (Management of Electricity Network Assets Code) Determination		2013
Evoenergy Maximum Demand Forecast		2017
ActewAGL Annual Planning Report		22.12.17
Distribution Network Augmentation Standard SM1197	1.1	12.5.15
Evoenergy Risk Assessment Tables PR4660.2	1.0	12.1.17
Evoenergy Quality of Supply Strategy SM11150	1.0	8.10.15
Evoenergy Asset Management Strategy SM1192	2.12	22.6.15
Evoenergy Peak Demand Reduction Strategy	2.0	22.8.17
Project Justification Report Fyshwick Secondary Systems Asset Renewal Program	0.1	12.7.17
Augmentation NPV Model Methodology	1.0	29.9.17

1. Executive Summary

Fyshwick Zone Substation was constructed and commissioned in 1959 and originally deemed to be a "temporary substation". It is connected radially to TransGrid's Queanbeyan 132/66 kV Substation via two single circuit wooden pole 66 kV transmission lines. Evoenergy pays TransGrid approximately $1.8m per annum for the Fyshwick 66 kV connection which is Evoenergy's only connection to TransGrid's Queanbeyan 132/66 kV Substation grid exit point.

Fyshwick Zone Substation is the only zone substation on Evoenergy's network that comprises 66 kV assets with Evoenergy's other 12 zone substations are connected to Evoenergy's 132 kV meshed network.

Primary assets supplying and at Fyshwick Zone Substation are approaching the end of their economic lives. The two 66 kV transmission lines from Queanbeyan to Fyshwick (3.6 km) are in poor condition. These lines were constructed in 1959 with wooden poles and Lemon 30/7/3.00 ACSR/GZ conductor. Most of the 52 66 kV poles have been nailed and will require replacement within the next 5-10 years. The steel core of the ACSR conductor is expected to corrode over time so the Lemon conductor will also require replacement in the near future. The 66 kV circuit breakers at Fyshwick are ASEA type; four are 1971 vintage and one 1985 and will require replacement within the next 5-10 years. The 66 kV protection relays are also approaching the end of their economic lives.

In 2013 the East Lake Zone Substation in 2013 was established in part to enable transfer of the Fyshwick load and retirement of the Fyshwick Zone Substation and decommissioning of the 66 kV assets, although this is yet to be achieved.

The preferred option to address the ageing assets is to construct three new express 11 kV cable feeders from East Lake to Fyshwick and decommission Fyshwick 66 kV assets, consistent with the original strategic intent of the East Lake Zone Substation.

This project is proposed to be implemented in the 2019-24 Regulatory Control period.

Other options considered included, upgrading of existing assets and demand management. These options were either not viable or higher cost compared to the preferred option.

A preliminary cost estimate for the selected option is **$3,821,000 excluding corporate overheads, excluding contingency, and excluding GST**. Additional feeders from East Lake to supply existing and new customers will be installed under separate projects as development and load increases.

Evoenergy will save the ongoing $1.8m pa connection fee to TransGrid's Queanbeyan Substation.

2. Strategic Context and Expenditure Need

Fyshwick Zone Substation was constructed and commissioned in 1982 and originally deemed to be a "temporary substation". It is connected radially to TransGrid's Queanbeyan 132/66 kV Substation via two single circuit wooden pole 66 kV transmission lines. Evoenergy pays TransGrid approximately $1.8m per annum for the Fyshwick 66 kV connection which is Evoenergy's only connection to TransGrid's Queanbeyan 132/66 kV Substation grid exit point.

Fyshwick Zone Substation is the only zone substation on Evoenergy's network that comprises 66 kV assets with Evoenergy's other 12 zone substations all connected to Evoenergy's 132 kV meshed network.

Primary assets supplying and at Fyshwick Zone Substation are approaching the end of their economic lives. The two 66 kV transmission lines from Queanbeyan to Fyshwick (3.6 km) are in poor condition. These lines were constructed in 1982 with wooden poles and Lemon 30/7/3.00 ACSR/GZ conductor. Most of the 52 66 kV poles have been nailed and will require replacement within the next 5-10 years. The steel core of the ACSR conductor is expected to corrode over time so the Lemon conductor will also require replacement in the near future. The 66 kV circuit breakers at Fyshwick are ASEA type; four are 1971 vintage and one 1985 and will require replacement within the next 5-10 years. The 66 kV protection relays are also approaching the end of their economic lives.

In 2013 the East Lake Zone Substation in 2013 was established in part to enable transfer of the Fyshwick load and retirement of the Fyshwick Zone Substation and decommissioning of the 66 kV assets, although this is yet to be achieved.

Forecast load growth at Fyshwick and East Lake zone substations is shown in Table 1.These figures include normal organic growth plus identified new point loads such as CDC data centres in Fyshwick.

Table 1: Zone Substations Load Growth

Zone Substation	**Fyshwick**		**East Lake**	
Rating	**Summer MVA**	**Winter MVA**	**Summer MVA**	**Winter MVA**
Continuous firm rating	28	28	55*	55*
2-hour emergency rating (max 10 times per year)	28	28	63*	76*
Load forecast per year 50% POE	**Summer MVA**	**Winter MVA**	**Summer MVA**	**Winter MVA**
2017	27	22	19	19
2018	31.2	25.2	20	20
2019	33.8	27.8	21	22
2020	37	29	23	23
2021	38.4	31.4	24	24
2022	38	32	25	26
2023	39	33	26	27
2024	40	33	27	27
2025	41	34	27	28
2026	38	31	28	28

* Note East Lake Zone Substation has one 132/11 kV 30/55 MVA transformer at present, but a second is proposed to be installed by June 2019 under a separate project. When the second transformer is installed East Lake will have a continuous firm rating summer/winter of 55/55 MVA and a 2-hour emergency rating summer/winter of 63/76 MVA.

The main factor limiting the firm rating of Fyshwick to 28 MVA is the rating of the 66 kV transformer differential protection CTs and associated protection relays. It is assumed that upgrade of the 66 kV transformer differential protection CTs and associated protection relays can be done to increase the substation continuous firm rating summer/winter to 46.7/46.7 MVA and 2-hour emergency rating summer/winter to 54.2/57.9 MVA. Works associated with such upgrade works have not been investigated in detail however a provisional sum of $750,000 has been included in the cost estimate for Option 1.

There are ten existing 11 kV feeders supplied from Fyshwick Zone Substation. Loads on these feeders for the last three years are shown in Table 2.

Table 2: Loading of existing Fyshwick Zone Substation feeders

Fyshwick Zone Substation	Feeder Rating (MVA)				2014		2015		2016		2017
Feeder	Firm Summer Rating	Firm Winter Rating	Thermal Summer Rating	Thermal Winter Rating	% Load Summer	% Load Winter	% Load Summer	% Load Winter	% Load Summer	% Load Winter	% Load Summer
Abattoir	5.0	6.8	5.7	7.6	83%	48%	80%	68%	109%	83%	118%
Airport	5.0	6.7	5.6	7.5	84%	54%	80%	44%	79%	53%	84%
Barrier	4.5	5.9	5.0	6.6	56%	59%	1%	1%	1%	1%	1%
Collie	4.5	5.9	5.0	6.6	107%	67%	1%	1%	1%	1%	1%
Domayne	5.7	7.6	6.5	8.6	68%	56%	1%	1%	1%	1%	1%
Gladstone	5.0	6.7	5.6	7.5	100%	55%	61%	54%	69%	63%	71%
Newcastle	4.8	6.3	5.3	7.0	65%	18%	56%	54%	80%	63%	87%
Pialligo	4.5	5.9	5.0	6.6	79%	73%	65%	68%	69%	88%	72%
Tennant	5.2	7.0	5.9	7.8	75%	37%	44%	39%	56%	61%	66%
Whyalla	4.8	6.3	5.3	7.0	106%	67%	69%	71%	76%	61%	66%

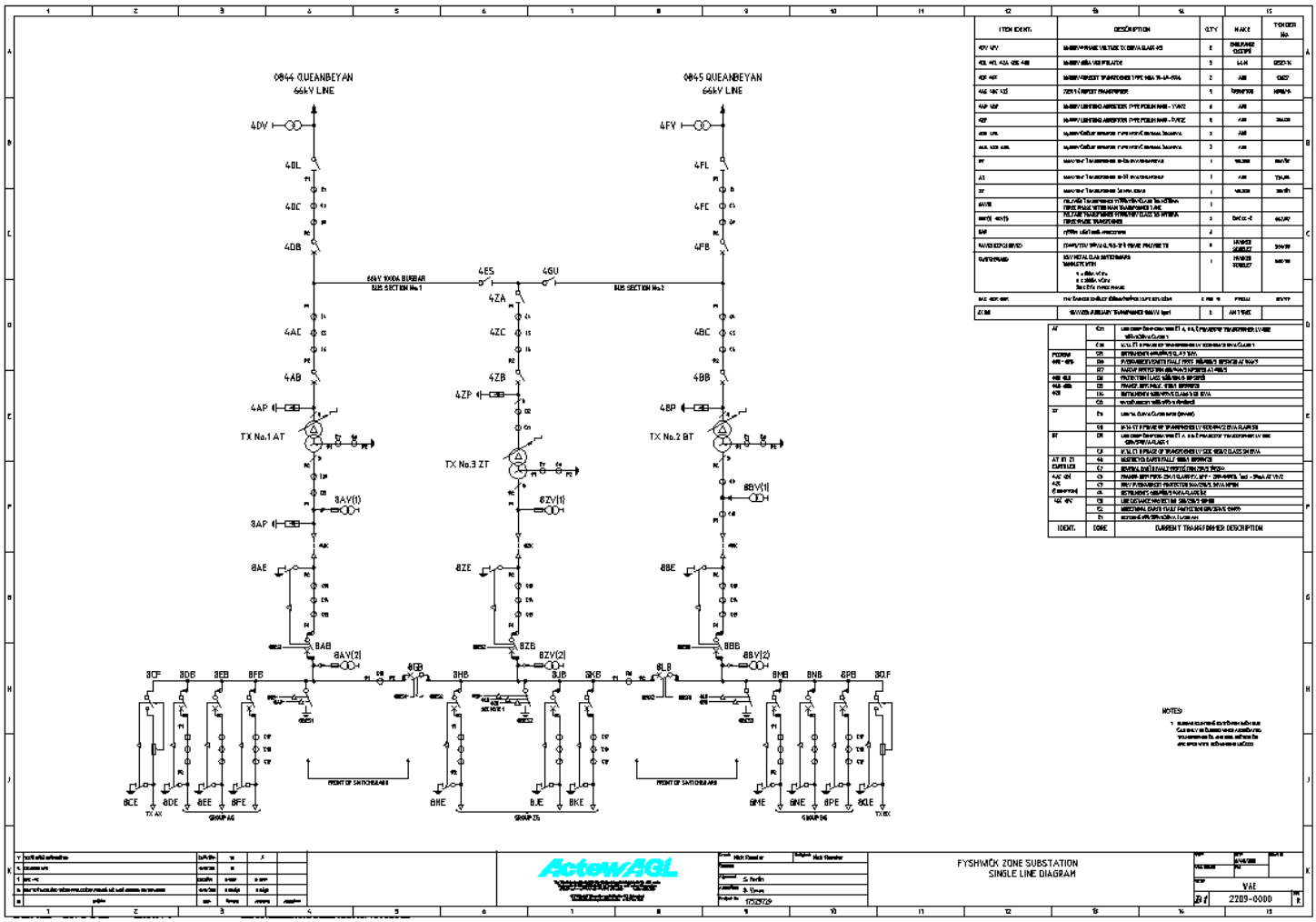
Note yellow denotes load above 80% of the firm rating, red denotes load above firm rating.

Note load previously supplied by Fyshwick feeders Barrier, Collie and Domayne has been transferred to East Lake feeders Cessnock, Lyell and Isa.

Load in the Fyshwick area is growing steadily due to commercial and light industrial development. The CDC (Canberra Data Centres) Fyshwick 1 and Fyshwick 2 data centres present large new block loads. The nature of data centres is that their load profile is relatively constant 24/7/365. New dedicated 11 kV feeders from East Lake Zone Substation to the CDC data centres have been proposed under a separate project.

Figure 1 shows the existing Fyshwick Zone Substation single line diagram.

Figure 1: Fyshwick 66/11 kV Zone Substation Existing Single Line Diagram:



3. Objectives

3.1. Corporate, asset management and key project objectives

The corporate, asset management and related key project objectives are shown in Table 3 below.

Table 3: Corporate, asset management and key project objectives

Corporate objectives	Asset management objectives	Key project objectives
Responsible	• Achieve zero deaths or injuries to employees or the public. • Maintain a good reputation within the community. • Minimise environmental impacts, for example bushfire mitigation. • Meet all requirements of regulatory authorities, such as the AER as outlined in the NER, and the ACT Utilities (Technical Regulations) Act 2014.	The selected option must ensure environment and safety standards will be met.
Reliable	• Tailor maintenance and renewal programs for each asset class based on real time modelling of asset health and risk. • Meet network SAIDI and SAIFI KPIs. • Record failure modes of the most common asset failures in the network. • Successfully deliver the asset class Program of Work (PoW) to ensure that the protection operates correctly to disconnect faulty sections in accordance with the NER.	Options evaluations to consider the value of customer reliability (VCR). In accordance with regulated requirements, the selected option must ensure access to an electricity supply.
Sustainable	• Enhance asset condition and risk modelling to optimise and implement maintenance and renewal programs tailored to the assets' needs. • Make prudent commercial investment decisions to manage assets at the lowest lifecycle cost. • Integrate primary assets with protection and automation systems in accordance with current and future best practice industry standards • Deliver the asset class PoW within budget.	Options evaluations to consider the cost effectiveness of the solution. In accordance with regulated requirements, the selected option must be the most prudent and efficient. Non-network options will be evaluated on equal merit with network solutions.
People	• Proactively seek continual improvement in asset management capability and competencies of maintenance personnel.	A post implementation review to incorporate learnings through the asset management system.

The project objectives are consistent with Evoenergy's regulatory requirements described below

3.2. Regulatory Compliance

3.2.1. National Electricity Law and National Electricity Rules

Evoenergy is subject to the National Electricity Law (NEL) and the National Electricity Regulations (NER) which regulate the National Electricity Market (NEM). Evoenergy operates in the NEM as both a Transmission Network Service Provider (TNSP) and a Distribution Network Service Provider (DNSP).

The National Electricity Objective (NEO), as stated in the NEL is to:

"…promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:

a) *price, quality, safety, reliability and security of supply of electricity; and*
b) *the reliability, safety and security of the national electricity system."*

This objective requires Registered NEM participants to balance the costs and risks associated with electricity supply.

The planning and development process for distribution and transmission networks, is carried out in accordance with the National Electricity Rules (NER) Chapter 5 Part B Network Planning and Expansion.

The primary objective of planning is to ensure that customers are able to receive a sufficient and reliable supply of electricity now and into the future.

3.2.2. Capital Expenditure Objectives and Criteria

The NER provides further guidance in terms of allowable capital expenditure via the capital expenditure objectives and criteria for standard control services. These capital expenditure objectives, specified in clause 6.5.6(a) and 6.5.7(a) of the NER describe the outcomes or outputs to be achieved by the expenditure. The objectives include:

1) *Meet or manage the expected demand for standard control services*
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 the quality, reliability or security of supply of standard control services; or the reliability or security of the distribution system through the supply of standard control services, to the relevant extent:*
    a) *Maintain the quality, reliability and security of supply of standard control services*
    b) *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.*

The expenditure criteria, set out in Section 6.5.6(c) and Section 6.5.7(c) of the NER, further outline requirements for the way in which expenditure must be set to achieve the objectives above. These include:

1) *The efficient costs of achieving the expenditure objectives*
2) *The costs that a prudent operator would require to achieve the expenditure objectives; and*
3) *A realistic expectation of the demand forecast and cost inputs required to achieve the expenditure objectives.*

The above criteria therefore imply that the capital expenditure, determined in line with the expenditure objectives, must be met via prudent and efficient expenditure, is to be achieved at least cost.

3.2.3. Regulatory Investment Test

Section 5.16 of the NER describes the Regulatory Investment Test for Transmission (RIT-T) and Section 5.17 describes the Regulatory Investment Test for Distribution (RIT-D). These tests must be carried out for any proposed investment where the augmentation or replacement cost of the most expensive credible option exceeds $5 million.

The regulatory investment tests provide the opportunity for external parties to submit alternative proposals to the Network Service Provider, who is obliged to consider any credible proposal objectively.

Since the required investment is greater than $5million the project is subject to the RIT-D.

3.2.4. Utilities Act 2000 (ACT)

Evoenergy has an obligation to comply with the Utilities Act 2000 (ACT) which imposes specific technical, safety and reliability obligations via the Management of Electricity Network Assets Code and the Electricity Distribution Supply Standards Code.

The Electricity Distribution Supply Standards Code (August 2013) sets out performance standards for Evoenergy's distribution network. Evoenergy is required to take all reasonable steps to ensure that its Electricity Network will have sufficient capacity to make an agreed level of supply available.

This local jurisdictional code specifies reliability standards that Evoenergy must endeavour to meet when planning, operating and maintaining the distribution network. It also specifies power quality parameters that must be met including limits on voltage flicker, voltage dips, switching transients, earth potential rise voltage unbalance, harmonics and direct current content.

The Management of Electricity Network Assets Code requires electricity distributors to protect integrity and reliability of the electricity network and to ensure the safe management of the electricity network without injury to any person or damage to property and the environment.

3.2.5. Evoenergy's Distribution Network Augmentation Standards

Evoenergy's distribution network augmentation standards are set to ensure compliance with the relevant regulatory instruments as described above.

Evoenergy's planning standards are determined on an economic basis but expressed deterministically so that peak demand can be met with an appropriate level of backup should a credible contingency event occur. A credible contingency event is the loss of a single network element, which occurs sufficiently frequently, and has such consequences, as to justify Evoenergy to take prudent precautions to mitigate. This is commonly referred to as an N-1 event.

Zone substation capacity must be augmented if the forecast zone substation maximum demand based on 50% PoE under N-1 conditions exceeds the two-hour emergency rating.

Major zone substation augmentation such as the installation of an additional transformer will not be considered until all other options such as load transfer to adjacent zone substations and non-network options have been fully explored and implemented.

For high voltage (11kV) distribution feeders in urban areas Evoenergy specifies that there should be a minimum of two effective feeder ties to meet two-for-three arrangement where it is economically viable, i.e. two feeders able to supply the load normally supplied by three feeders. A firm rating is assigned to each feeder based on its thermal rating and the number of feeder ties available.

Distribution high voltage feeder capacity must be augmented or demand management solutions provided if the forecast 50% PoE feeder maximum demand exceeds the firm ratings as given in Table 4.

Table 4: Feeder Firm Rating standard

Feeder configuration	Firm rating as percentage of thermal capacity
Two or more feeder ties	75%
One feeder tie	50%
Feeders operating in parallel	{(N-1)/N}%[1]
Partial feeder tie	100% or less[2]
No feeder tie	100%

3.2.6. Cost compliance

Cost compliance is achieved by proactively pursuing the philosophy of compliance with the national electricity objective by fully exploring and evaluating all options technically and commercially so as to seek approval for a solution that provides sound grounds for an efficient investment while meeting the long term interests of the consumers.

The investment value has been determined using 2016-17 market prices. The methodology and estimated costs used for this project are developed through the application of industry knowledge and Good Engineering Operating Practices based on historical similar projects. This approach complies with paragraphs 6 & 7 of the National Electricity Law (NEL).

[1] "N" represents the number of feeders operating in parallel.

[2] A partial feeder tie refers to a tie with limited back feeding capacity. The firm capacity of a feeder with a partial feeder tie may be set below 100% its thermal capacity.

4. Options Assessment

Evoenergy has considered three options regarding the future of Fyshwick Zone Substation as listed in Table 5.

Table 5: Options considered for the future of Fyshwick 66/11 kV Zone Substation

Option	Option type	Description	Evaluation
0	Do nothing	Do nothing	Not selected as does not meet minimum requirements
1	Network	Continue to operate and maintain Fyshwick Zone Substation and Queanbeyan–Fyshwick 66 kV lines as at present. Upgrade, replace and refurbish 66 kV assets supplying and at Fyshwick Zone Substation.	Not selected as lower NPC
2	**Network**	**Construct three new express 11 kV cable feeders from East Lake to Fyshwick and decommission Fyshwick 66 kV assets.**	**Selected as higher NPC**
3	Non-network	Demand side management and decommission Fyshwick 66kV assets	Not selected as does not meet need

Other options such as converting Fyshwick to 132/11 kV and connecting it to Evoenergy's 132 kV network have been discounted as would be prohibitively expensive and uneconomic.

4.1. Options analysis

4.1.1. Do Nothing Option

The 'Do Nothing' option would result in insufficient network capacity in the area to meet demand. In addition, it is likely that the 66 kV assets will fail in the next five to ten years. Assuming the 66 kV assets fail by 2024, the value of energy at risk is estimated to be approximately $677m over a five year period.

The Do Nothing option would subsequently result in Evoenergy breaching its Distribution Network Augmentation Standards and also imposing a large economic cost on the customers it serves.

4.1.2. Option 1: Maintain and Upgrade Fyshwick 66/11 kV Zone Substation

Under this option Fyshwick Zone Substation would be maintained, upgraded and operated as is for the foreseeable future.

Existing 66 kV assets are as follows:

Fyshwick Zone Substation 66 kV Assets

66/11 kV Power Transformers:

- TX1: ABB, 2005, Dyn1, 16/20 MVA ONAN/ONAF, 26.2/29.9 MVA summer/winter 2-hour emergency rating.
- TX2: Wilson, 2007, Dyn1, 15/25 MVA ONAN/ODAN, 30/30 MVA summer/winter 2-hour emergency rating.
- TX3: Wilson, 2013, Dyn1, 25 MVA ONAN, 30/34 MVA summer/winter 2-hour emergency rating.

Note TX3 was purchased as mining specification ex-stock to replace failed transformer in 2013. Vector group was changed by manufacturer inside tank from Dyn11 to Dyn1.

These transformers are in good condition with routine inspection and maintenance only proposed for the next 10 years.

66 kV Circuit Breakers:

4DB, 4FB: Line breakers, ABB, 1971, 800 Amps.
4AB, 4ZB, 4BB: Transformer breakers, 1971 and 1985, ABB, 800 Amps.

These circuit breakers are nearing their end of life and are scheduled for replacement during the 2019-24 Regulatory Control Period.

66 kV Busbars:

Copper, 1000 Amps.
Strung busbars are in serviceable condition.

66 kV Voltage Transformers:

4DV, 4FV: Endurance Electric 3-phase, 200 VA, Class 0.5.

These voltage transformers are nearing their end of life and are scheduled for replacement during the 2019-24 Regulatory Control Period.

66 kV Isolators:

4DL, 4FL, 4ZA, 4ES, 4GU: ALM 600 Amps, vertical single break.

These isolators are nearing their end of life and are scheduled for replacement during the 2019-24 Regulatory Control Period.

66 kV Current Transformers:

4DC, 4FC, 4AC, 4BC, 4ZC: ABB 600 Amps.

These current transformers are nearing their end of life and are scheduled for replacement during the 2019-24 Regulatory Control Period.

66 kV Transmission Lines Queanbeyan–Fyshwick:

Wooden poles, 26 per line, Lemon conductor 30/7/3.00 ACSR/GZ, conductor constructed 1959.

These lines are nearing their end of life and poles are scheduled for replacement during the 2019-24 Regulatory Control Period.

66 kV Secondary Systems:

The 66 kV protection CTs and associated protection relays are nearing their end of economic life and are scheduled for replacement during the 2019-24 Regulatory Control Period.

With reference to the draft Project Justification Report Fyshwick Secondary Systems Asset Renewal Program: Option 2 Complete In-Situ Replacement of Assets:

“This option replaces all secondary system assets at Fyshwick Zone Substation with current designs and architecture. This option also replaces the DC batteries, the control room and the SCADA automation system. The expected capital cost for this option is $3.7 million. An additional $3 million capital investment is required to replace CTs, rearrange switchyard layout and provide 66 kV busbar protection”.

A preliminary cost estimate for this option is $6,700,000 excluding corporate overheads, excluding contingency, and excluding GST.

4.1.3. Option 2: Construct three new express 11 kV cable feeders from East Lake to Fyshwick and decommission Fyshwick 66 kV assets.

Option 2 considers the installation of three new underground 11 kV express cable feeders from East Lake Zone Substation 11 kV switchboard(s) to Fyshwick Zone Substation 11 kV switchboard. These cables would connect to the 11 kV incomer circuit breakers at Fyshwick, 8AB, 8ZB and 8BB, following disconnection of the incomer cables from TX1, TX2 and TX3. Proposed cables would be 11 kV 3c/400mm^2 Cu XLPE. They would be installed in conduit full length (approx 2.7 km) providing approximately 10.5 MVA firm capacity each, ie 31.5 MVA capacity (21 MVA firm) at Fyshwick Switching Station.

The 11 kV switchboard at Fyshwick is Hawker Siddeley, 2000, 12 kV, metal clad, single bus 2000 Amps, 25 kA fault rating, 3 incomer and 2 bus-coupler vacuum circuit breakers 2000 Amps, 9 feeder vacuum circuit breakers. This switchgear is in good serviceable condition.

Under this option existing 11 kV feeders to remain connected and supplied via the Fyshwick 11 kV Switching Station would include: Abbatoir, Barrier, Collie, Domayne, Newcastle, Tennant and Whyalla.

New feeders are proposed under a separate project to be installed from East Lake Zone Substation directly to CDC data centres.

New feeders are proposed under a separate project to be installed from East Lake Zone Substation that will connect to the following feeders and effectively unload them from Fyshwick Switching Station: Airport, Gladstone and Pialligo.

Load supplied via the Fyshwick Switching Station would be keep below its (new) firm rating of 21 MVA.

The proposed cable route length from East Lake to Fyshwick is approximately 2.7 km. Three spare 150mm diameter PVC conduits exist from East Lake Zone Substation down Dairy North Rd, across Monaro Highway, and down Newcastle St as far as Lyell St, a distance of approximately 1.8 km. Thus only 900m would be required to be directional drilled and have conduits installed, from Newcastle St / Lyell St intersection along Newcastle St, Collie St and Tennant St to Fyshwick Zone Substation.

A preliminary cost estimate for this option is **$3,821,000 excluding corporate overheads, excluding contingency, and excluding GST**.

Option 2 is selected because it has the higher (ie least negative) Net Present Cost (NPC).

4.1.4. Option 3: Demand management

Option 3 considers non-network initiatives including:

- Incentives to realise the potential of latent demand management within the customer base
- Incentives to encourage the uptake of additional demand management within the customer base

These options are further discussed within the Demand Management Paper.

To enable the decommissioning of Fyshwick 66 kV assets without any further investment in network solutions all load currently supplied by the Fyshwick Zone Substation (approximately 30 MVA) would need to be supplied by the two existing feeders from East Lake and Telopea Park. Demand management as a stand-alone solution is therefore not considered feasible.

Notwithstanding, there may be opportunities for demand management to reduce the extent of investment required in the network option (Option 2). This will be explored as part of the RIT-D process for this project.

It should also be noted that the CDC data centres include back-up diesel generators on site, but these are deemed to be used for emergency purposes only and not for daily load management and so are unlikely to be made available to

Evoenergy. Further, the data centres have no rooftop solar PV and do not intend to install any. Demand management is therefore likely to be sourced from smaller customers.

Third party non-network proposals will be requested via the RIT-D process and via Evoenergy's website demand management portal and may identify additional opportunities.

4.1.5. Summary of Options Analysis

Table 6: Summary of Options

Option	Description	Total Capital Cost 2019-2039	Capital Cost 2019-24	20 year Net Present Cost	Outcome
0	Do nothing	$0	$0	$0	Not selected as does not meet need
1	Upgrade, replace and refurbish 66 kV assets supplying and at Fyshwick Zone Substation.	$6,700,000	$6,700,000	-$5,253,909	Not selected due to lower NPC
2	**Construct three new express 11 kV cable feeders from East Lake to Fyshwick and decommission Fyshwick 66 kV assets.**	**$3,821,000**	**$3,821,000**	**-$2,996,296**	**Selected due to higher NPC**
3	Demand side management and decommission Fyshwick 66kV assets	N/A	N/A	N/A	Not selected as does not meet need

4.2. Recommendation

The selected option is Option 2, the construction of three new 11 kV underground express feeders from East Lake Zone Substation to Fyshwick Zone Substation, decommissioning of all 66 kV assets and conversion of Fyshwick to an 11 kV switching station.

Financial analysis (refer Appendix B) shows Option 2 to have the higher net present cost.

Timing is proposed for completion by June 2024.

Preliminary cost estimate is **$3,821,000 excluding overheads, contingency and GST**.

The project can be implemented in time to meet the project needs as identified and will add to Evoenergy's regulated asset base. The major assets will have an economic life of 50 years.

The augmentation cost of the most expensive option exceeds $5 million so this project will be subject to the Regulatory Investment Test for Distribution (RIT-D).

Appendix A – Preliminary Cost Estimates

A.1 Cost Estimate – Option 1: Upgrade and Retain Fyshwick 66/11 kV Zone Substation

Replace, and upgrade assets to continue operation of Fyshwick Zone Substation at 66/11 kV.					
Preliminary Estimate ± 30% Accuracy					
Description	**Notes**	**Unit**	**$/Unit**	**Quantity**	**Cost**
Replace 66 kV Primary Assets					$1,700,000
66 kV circuit breakers	Allowance	ea	$100,000	5	$500,000
66 kV Voltage Transformers	Allowance	ea	$50,000	2	$100,000
66 kV Isolators	Allowance	ea	$50,000	5	$250,000
66 kV Current Transformers	Allowance	ea	$50,000	5	$250,000
66 kV post insulators and misc hardware	Allowance	lot	$100,000	1	$100,000
Labour and plant	Allowance	lot	$500,000	1	$500,000
Queanbeyan–Fyshwick 66 kV Lines					$2,585,600
Poles	Replace wooden poles with concrete	ea	$15,000	56	$840,000
Conductor	AAAC Sulphur 3.6 km x 6	m	$16	21600	$345,600
Pole earthing		ea	$2,500	56	$140,000
Insulators and line hardware	Allowance	ea	$7,500	56	$420,000
Labour and plant	Allowance	lot	$15,000	56	$840,000
Electrical (Secondary System)					$1,675,000
Protection & Control					$1,525,000
Upgrade of 66 kV differential CTs and relays	Allowance	ea	$750,000	1	$750,000
Install 66 kV busbar protection system	Allowance	ea	$750,000	1	$750,000
P&C Test & Commission	Allowance	ea	$5,000	5	$25,000
DC Supply System					$150,000
DC Batteries	Allowance	ea	$50,000	2	$100,000
DC Cabling	per switchgear panel/bay	ea	$5,000	5	$25,000
DC Test & Commission	Allowance	ea	$5,000	5	$25,000
SCADA					$40,000
SCADA connections for new 66 kV equipment		ea	$6,000	5	$30,000
Test & Commissioning	Allowance	ea	$2,000	5	$10,000
Indirect Costs					$700,000
Development Application	Allowance	ea	$100,000	1.00	$100,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	$100,000	1	$100,000
Project management and administration	Allowance	ea	$500,000	1	$500,000
Project Sub Total without overheads					**$6,700,600**
Overheads					
Overall average overhead rate	Allowance	27%		1	$1,809,162
Project Sub Total with overheads					**$8,509,762**
Contingency					
All project works	Preliminary allowance	15%		1	$1,276,464
Project total with all overheads and contingency					**$9,786,226**

A.2 Cost Estimate – Option 2: Install 11 kV Express Feeders from East Lake to Fyshwick and Decommission all 66 kV Assets

Install three express 11 kV feeders from East Lake Zone Substation to Fyshwick Zone Substation. Convert Fyshwick to 11 kV Switching Station. Decommission and remove all 66 kV assets. Assume 900m to be directional drilled with 3 conduits. Total cable route length approx 2.7 km.					
Preliminary Estimate ± 30% Accuracy					
Description	**Notes**	**Unit**	**$/Unit**	**Quantity**	**Cost**
Trenching and drilling					$744,500
Clearing of route where required	Allowance	m2	$10	9000	$90,000
Directional drilling	Assume drilling with no rock. Assume three conduits per drill.	m	$600	900	$540,000
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil.	m	$300	0	$0
Cable jointing and haulage pits	Assume every 500m	ea	$3,000	7	$21,000
Traffic management		m	$5	2700	$13,500
Reinstatement incl revegetation as required	Allowance	m3	$40	2000	$80,000
Cabling works					$1,038,000
11 kV 3c/400mm2 Cu XLPE cable		m	$100	8100	$810,000
Throughjoints	Assume every 500m	ea	$1,000	15	$15,000
Terminations	Terminations at East Lake CB and CDC switchgear	ea	$1,500	6	$9,000
Conduit and marker tape	3 x 150mm plus 1 x 63mm	m	$10	3600	$36,000
HV Cables Test & Commissioning	Allowance	ea	$2,000	3	$6,000
Cable installation labour and plant		m	$20	8100	$162,000
11 kV Switchgear					$15,000
11 kV feeder CB panels	Assume connection to existing switchboards at East Lake and Fyshwick	ea	$75,000	0	$0
11kV Test & Commissioning	per CB	lot	$2,500	6	$15,000
Electrical (Secondary System)					$39,500
Protection & Control					$22,500
P&C Secondary Cabling	per feeder panel (assue Fyshwick replacment)	ea	$2,500	3	$7,500
P&C Test & Commission	Allowance	ea	$2,500	6	$15,000
DC Supply System					$17,000
DC Cabling	per switchgear panel/bay	ea	$5,000	3	$15,000
DC Test & Commission	Allowance	ea	$2,000	1	$2,000
SCADA					$24,000
SCADA connections for new feeder panels		ea	$2,000	6	$12,000
Test & Commissioning	Allowance	ea	$2,000	6	$12,000
Decommision and remove 66 kV assets Fyshwick					$1,260,000
Dismantle 66 kV lines Queanbeyan–Fyshwick	per pole	ea	$10,000	56	$560,000
Decommission and dismantle 66 kV assets	Allowance to remove transformers and 66 kV switchgear	ea	$500,000	1	$500,000
Decommission and remove 66 kV secondary	Allowance to remove 66 kV secondary systems	ea	$200,000	1	$200,000
Indirect Costs					$700,000
Development Application	Allowance	ea	$100,000	1	$100,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	$100,000	1	$100,000
Project management and administration	Allowance	ea	$500,000	1	$500,000
Project Sub Total without overheads					**$3,821,000**
Overheads					
Overall average overhead rate	Allowance	27%		1	$1,031,670
Project Sub Total with overheads					**$4,852,670**
Contingency					
All project works	Preliminary allowance	15%		1	$727,900.50
Project total with all overheads and contingency					**$5,580,571**

Appendix B – Financial Analysis

B.1 Capital Expenditure Cash Flow for Each Option

Financial Year	Option 1	Option 2	Option 3
2019-20			
2020-21			
2021-22			
2022-23		$1,910,500	
2023-24	$6,700,000	$1,910,500	
2024-25			
2025-26			
2026-27			
2027-28			
2028-29			
2029-30			
2030-31			
2031-32			
2032-33			
2033-34			
2034-35			
2035-36			
2036-37			
2037-38			
2038-39			
Total Cost (20 years)	**$6,700,000**	**$3,821,000**	**N/A**
2019-24 Regulatory Control Period Cost	**$6,700,000**	**$3,821,000**	**N/A**

* Option 3 (demand management only) is not able to meet the forecast demand.

B.2 NPC Analysis

The Net Present Cost (NPC) was calculated using a Monte-Carlo simulation model. The simulation randomly selects a peak demand growth rate for each year that is within ± 10% of the forecasted spot loads expected in Fyshwick. The use of a Monte-Carlo simulation results in selection of the best option that is robust to uncertain peak demand growth forecasts.

Investment within the simulation is dynamic – investment decisions change based on the randomly selected growth rates from previous years. Investment occurs automatically when the firm rating is breached so the value of energy at risk is always zero. In options where multiple investments are available the cheapest is selected.

Summary Financial Analysis Results for Decommissioning of Fyshwick Zone Substation

The summary below shows the average values for the selected characteristics after 50 simulations.

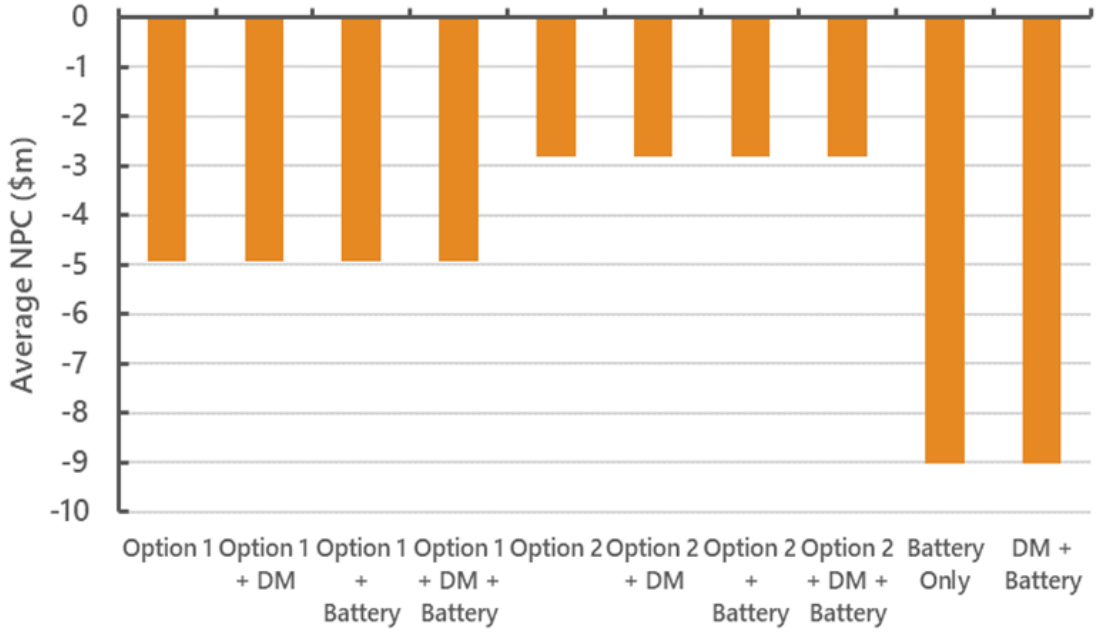
Options:

One – Upgrade, replace and refurbish 66 kV assets supplying and at Fyshwick Zone Substation.
Two – Construct three new express 11 kV cable feeders from East Lake to Fyshwick and decommission Fyshwick 66 kV assets.
Three – Demand side management

RESULTS (Average over 50 simulations):

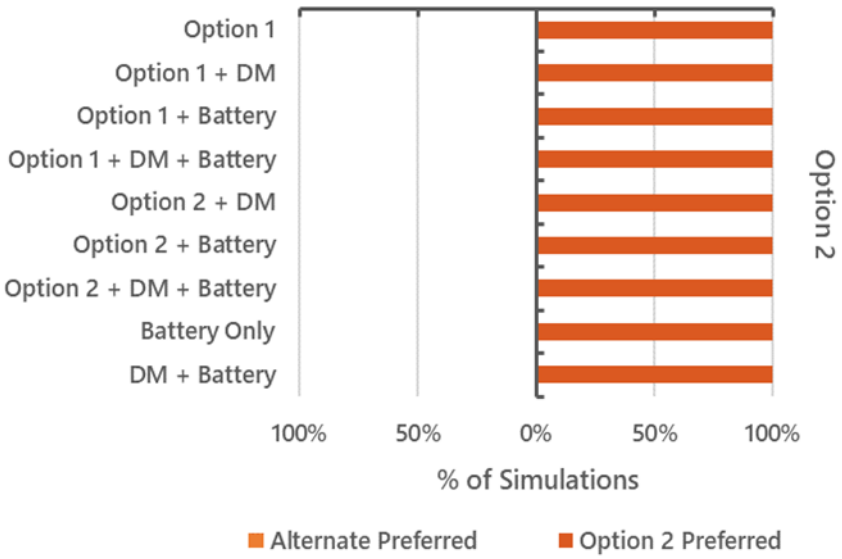
Option:	One	Two	Three
NPC (2019-2024)	-$4,676,007	-$2,666,720	-
NPC (2019-2039)	-$5,253,909	-$2,996,296	-
Network Option total Capital Cost	$6,700,000	$3,821,000	-
Option Capital Cost (2019-2024)	$6,700,000	$3,821,000	-
Option Capital Cost (2019-2039)	$6,700,000	$3,821,000	-

Average Net Present Cost for Each Network / Non-Network Combination:



Multiple combinations of network options, demand management and network batteries were tested using the Monte-Carlo model. The preferred option was selected on the basis of minimising the Net Present Cost.

Percentage of Simulations where the Selected Option had a Lower Cost than Other Options:



The random variation in peak demand growth in the Monte-Carlo model means that different options may be preferred in some simulations. The above chart shows that Option 2 was the preferred option in 100% of simulations.