

Appendix 5.32: Supply to Pialligo 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.

Project Justification Report

Project name	Supply to Pialligo
Expenditure type	Capital Expenditure
Business Group	Asset Strategy
Regulatory Period	1 July 2019 to 30 June 2024
Total Project Cost Estimate	\$2,992,500 excluding corporate overheads, excluding contingency, and excluding GST
Five year total spend 2019-24	\$2,992,500 excluding corporate overheads, excluding contingency, and excluding GST
CAPEX category	ENAA Distribution
Primary driver	Load growth in Pialligo area
Project Number	20001380

Contents

Reference documents	3
1. Executive Summary	4
2. Strategic Context and Expenditure Need	5
2.1. Existing infrastructure in the Pialligo area	5
2.3. Driving need for infrastructure investment	6
3. Objectives	8
3.1. Corporate, asset management and key project objectives	8
3.2. Regulatory Compliance	9
3.2.1. National Electricity Law and National Electricity Rules	9
3.2.2. Capital Expenditure Objectives and Criteria	9
3.2.3. Regulatory Investment Test	10
3.2.4. Utilities Act 2000 (ACT)	10
3.2.5. Evoenergy's Distribution Network Augmentation Standards	10
3.2.6. Cost compliance	11
4. Options Assessment	12
4.1. Options analysis	12
4.1.1. Do Nothing Option	12
4.1.2. Option 1: Construct two new 11 kV cable feeders from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder	12
4.1.3. Option 2: Construct new 11 kV cable feeder from Fyshwick Zone Substation, new 11 kV cable feeder from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder	15
4.1.4. Option 3: Demand management	17
4.1.5. Option 4: Grid battery to defer Option 1	17
4.1.6. Option 5: Grid battery only	17
4.1.7. Summary of Options Analysis	18
4.2. Recommendation	18
Appendix A – Preliminary Cost Estimates	19
A.1 Cost Estimate – Option 1:	19
A.2 Cost Estimate – Option 2:	20
Appendix B – Financial Analysis	21
B.1 Capital Expenditure Cash Flow for Each Option	21
B.2 NPC Analysis	22

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
Augmentation NPV Model Methodology	1.0	29.9.17

1. Executive Summary

The electricity demand in the Pialligo area near Canberra Airport is forecast to increase due to commercial development in the area including the Brindabella Business Park, Macquarie Telecom Data Centre, Australian Defence Force expansion and light industrial development in the Beard Industrial Estate. The maximum demand of the area is forecast to increase by 8 MVA over the next 5 years.

The Pialligo area is currently supplied by the Aero Park feeder from City East Zone Substation, the Airport and Pialligo 11 kV feeders from Fyshwick Zone Substation, and the Dairy North 11 kV feeder from East Lake Zone Substation.

East Lake Zone Substation, located on the eastern side of Dairy Road, Fyshwick was commissioned in 2013. It currently has one 132/11 kV 30/55 MVA transformer and one 11 kV switchboard. This switchboard has 6 spare feeder circuit breakers available. A second transformer and switchboard are proposed to be installed by 30 June 2019. This will provide ample capacity, security and spare 11 kV feeder circuits for the connection of new feeders.

It is a strategic objective of Evoenergy to supply load to proposed and future developments in the Pialligo area from East Lake Zone Substation and off-load Fyshwick Zone Substation. It is also proposed to convert Fyshwick Zone Substation to an 11 kV switching station supplied by three express 11 kV feeders from East Lake Zone Substation. This is the subject of a separate Project Justification Report

This project proposes two new 11 kV cable feeders to be installed from East Lake Zone Substation. One feeder from East Lake is proposed to the Brindabella Business Park to meet the growing customer demand. The length of the feeder is approximately 3.2 km. The second feeder from East Lake will enable the overloaded Dairy North feeder to be split into two separate feeders – Dairy North and Dairy East. The proposed Dairy East feeder will supply the forecast demand of the Fairbairn Business Park. Additionally it is proposed to link the Dairy North and Abbatoir feeders via a new 1.2 km long cable feeder tie. This will improve backup security to these two feeders and enable some load transfer from Dairy North to Abbatoir feeder. Spare conduits will be installed along all new feeder routes to provide for future developments and load growth.

The proposed feeders will inter-tie with existing feeders emanating from Fyshwick and City East, and thus enhance the security of this meshed part of the network.

Other options considered include the installation of additional feeders from Fyshwick, demand management, and a grid battery. The feeders from Fyshwick were excluded due to a high net present cost (compared to the preferred option). Demand management was not considered feasible due to the insufficient existing capacity such that there is a requirement for 60% of new demand to be offset. The grid battery was excluded due to a higher net present cost and the relative certainty of the demand increase (noting grid batteries and other modular solutions deliver a higher options value in the context of uncertain demand).

A preliminary cost estimate for the selected option is **\$2,992,500 excluding corporate overheads, excluding contingency, and excluding GST.**

These works will be carried out during the 2019-24 Regulatory Control Period, with project completion scheduled by June 2021.

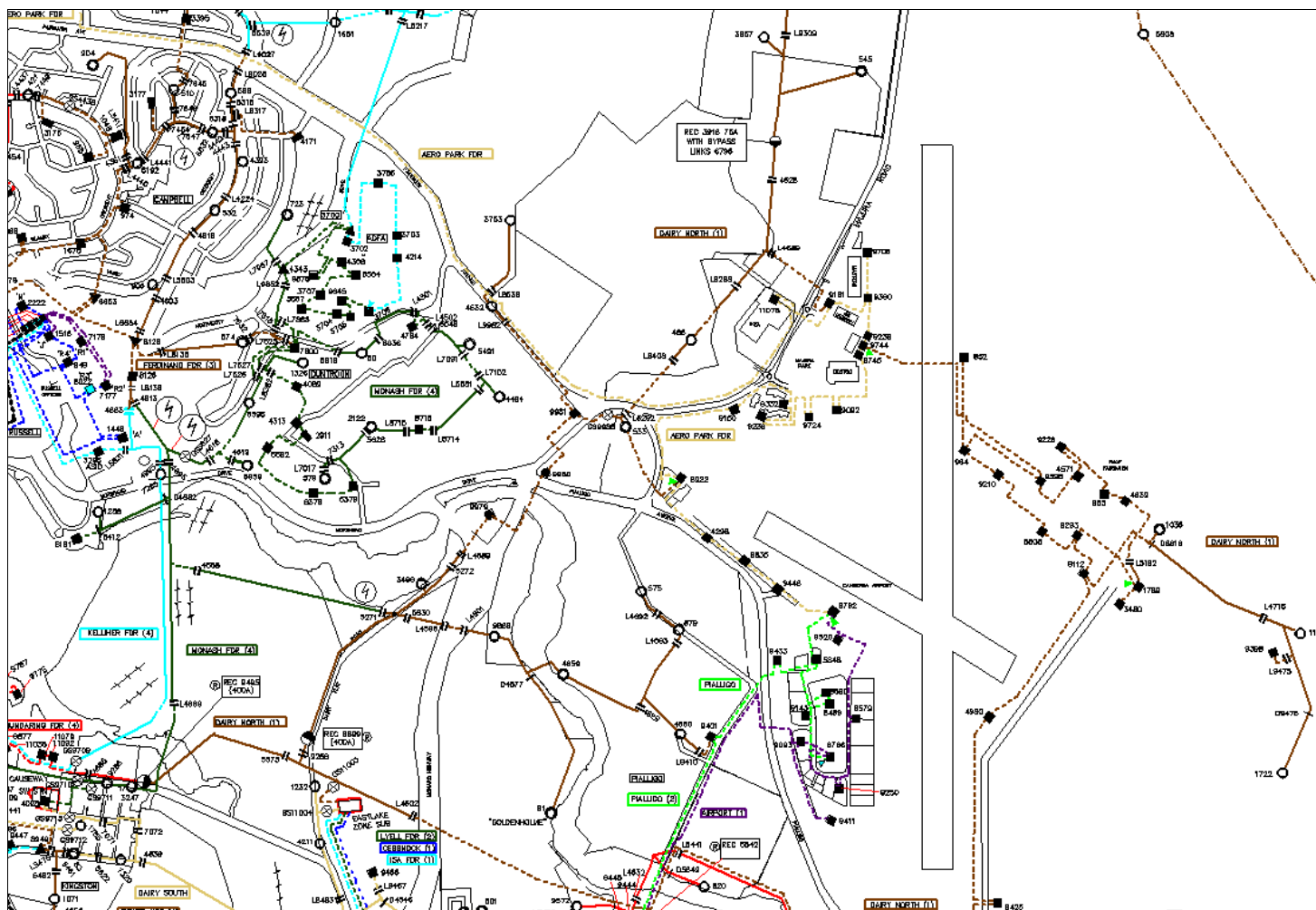
2. Strategic Context and Expenditure Need

There is significant development planned for the Pialligo / Brindabella Park area which is located near Canberra Airport. Existing infrastructure has insufficient capacity to cater for the additional demand associated with the development.

2.1. Existing infrastructure in the Pialligo area

There are currently four 11 kV feeders supplying the Pialligo area. These are Aero Park feeder from City East Zone Substation, Airport and Pialligo feeders from Fyshwick Zone Substation, and Dairy North feeder from East Lake Zone Substation. The existing feeder network is illustrated in Figure 1.

Figure 1: 11 kV feeders supplying the Pialligo area.



The maximum load supplied by each feeder as a percentage of its firm rating, is shown in Table 1 for summer and winter. Yellow denotes load above 80% of the firm rating, red denotes load above firm rating. Firm rating of an 11 kV feeder is dictated by the number of inter-connections it has to other 11 kV feeders in order to provide full back-up capacity in the event of a contingency. Thus a feeder that is inter-connected to one other feeder may be loaded to 50% of its thermal capacity and a feeder that is inter-connected to two other feeders may be loaded to 75% of its thermal capacity. 100% firm rating should not be exceeded as this places load at risk in the event of a contingency.

Table 1: Pialligo Feeder Loadings

Feeder Name	Zone	Feeder Rating (MVA)				2015		2016		2017	Spare capacity MVA
		Firm Summer Rating	Thermal Summer Rating	Firm Winter Rating	Thermal Winter Rating	Percent Loaded Summer	Percent Loaded Winter	Percent Loaded Summer	Percent Loaded Winter	Percent Loaded Summer	
Aero Park	CE	5.0	6.6	5.6	7.5	79%	53%	93%	61%	95%	0.2
Airport	FW	5.0	6.7	5.6	7.5	80%	44%	79%	53%	84%	0.8
Pialligo	FW	5.2	6.9	5.9	7.8	44%	39%	56%	61%	66%	1.7
Dairy North	EL	5.3	7.1	5.9	7.9	61%	55%	84%	73%	90%	0.5
Total											3.2

2.3. Driving need for infrastructure investment

The 66 kV infrastructure (both primary and secondary) at Fyshwick Zone Station is ageing and is nearing the end of its economic life. Fyshwick is the only zone substation on Evoenergy's network that operates at a transmission voltage of 66 kV. Evoenergy proposes to retire the 66 kV assets at Fyshwick Zone Substation and convert it to an 11 kV switching station only. To assist this, it is desirable to transfer load from Fyshwick to East Lake Zone Substation which is modern and has ample spare capacity.

Forecast additional maximum demand in the Pialligo area is indicated in Table 2. This has been based on an assessment of known developments (either at application or Preliminary Network Advice stage) proposed for the area. Some of these developments are either under construction or currently being designed. There is a high degree of certainty (> 80%) that these developments will proceed. In addition there are several potential smaller load increases. Some will be supplied from the Pialligo feeder but as this is nearing its firm capacity, there is the need to provide additional capacity to the area or to reduce demand.

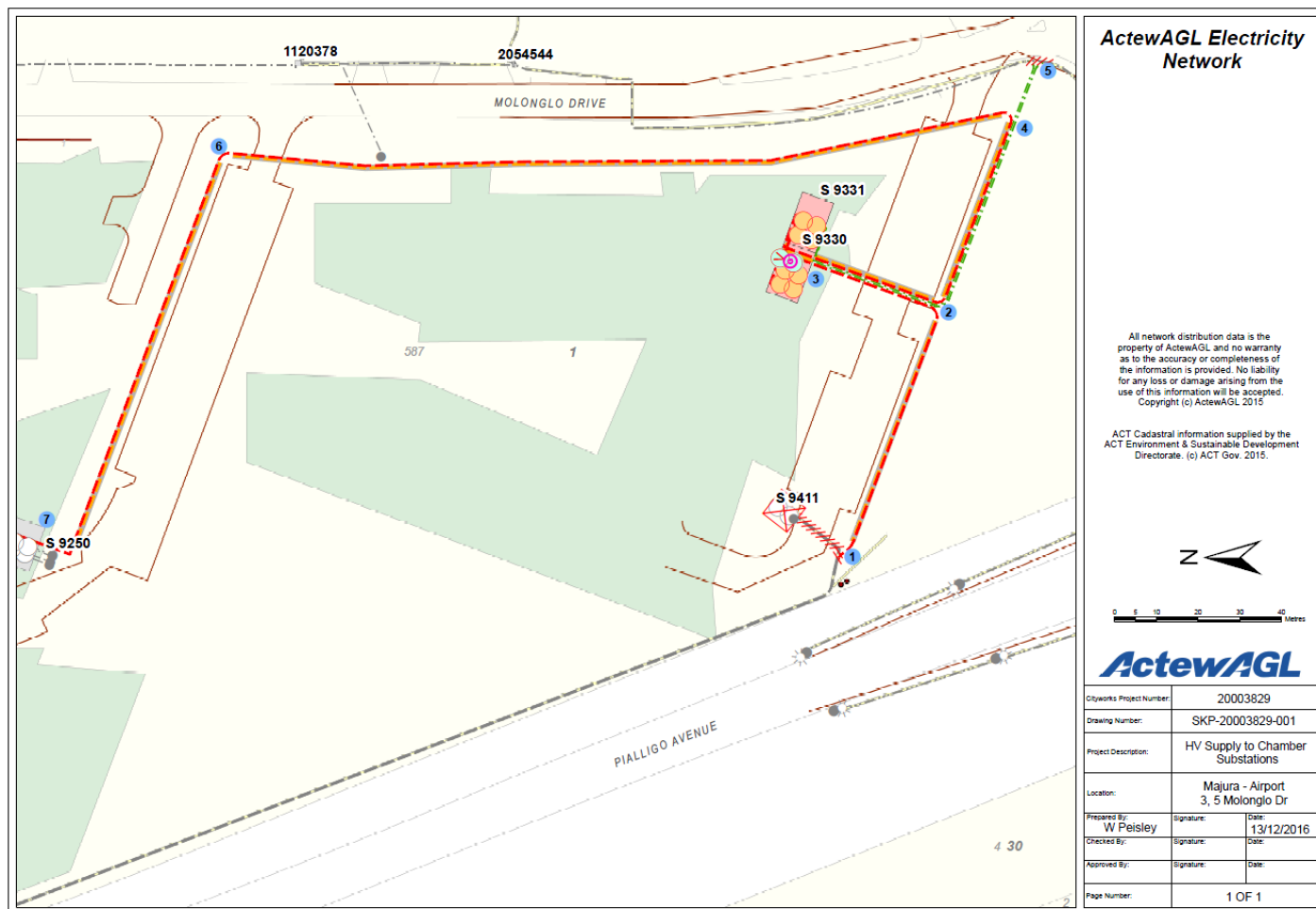
Table 2: Proposed Developments in the Pialligo area.

Proposed Development and Net Additional Diversified Load in MVA	2016-17	2017-18	2018-19	2019-20	2020-21
Brindabella Business Park (PN20003829)		1.0	1.0	1.0	1.6
Fairbairn Macquarie Telecom Data Centre (PN20003913)		0.4	0.6	0.5	0.3
Majura Defence Facility (PN20003493)		0.8			
Pialligo Horticulture Expansion (PN20003770)		1.0			
Additional Load (MVA)		3.2	1.6	1.5	1.9
Cumulative Additional Forecast Load (MVA)		3.2	4.8	6.3	8.2

Project PN20003829 involves the fit-out of two new chamber substations S9330 and S9331 at Brindabella Business Park. Each will include 3 x 1500 kVA distribution transformers to provide N-1 security to the proposed 4.6 MVA load. There are two existing 11 kV feeders to Brindabella Park - Pialligo and Airport, both of which have insufficient spare capacity available (refer Table 1) to supply this new load. Additional 11 kV capacity is required to Brindabella Park.

Figure 2 shows the proposed connection of chamber substations S9330 and S9331.

Figure 2: Proposed Chamber Substations S9330 and S9331 (PN20003829) at Brindabella Park



The Macquarie Telecom Data Centre at Fairbairn Park is currently supplied via a 1000 kVA pad-mount distribution substation S9226 which is connected to the Dairy North feeder. It is proposed to install a new 1500 kVA pad-mount distribution substation in parallel with S9226 under project PN20003913 to provide the capacity requested by the data centre. This would overload the Dairy North feeder.

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. These objectives are used to assess the relative risk of options.

Table 3: Corporate, asset management and key project objectives

Corporate objectives	Asset management objectives	Key project objectives
Responsible	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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. 	<p>Options evaluations to consider the value of customer reliability (VCR).</p> <p>In accordance with regulated requirements, the selected option must ensure access to an electricity supply.</p>
Sustainable	<ul style="list-style-type: none"> 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. 	<p>Options evaluations to consider the cost effectiveness of the solution.</p> <p>In accordance with regulated requirements, the selected option must be the most prudent and efficient.</p> <p>Non-network options will be evaluated on equal merit with network solutions.</p>
People	<ul style="list-style-type: none"> 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. Evoenergy commenced RIT-D process in 2014 with publication of a Project Specification Consultation Report, but has yet to complete the RIT-D process (ie publication of Draft Project Assessment Report and Final Project Assessment Report). These reports will need to be prepared as part of the development of this project. The initial RIT-D consultation paper published in 2014 recommended establishing a new zone substation at the Arboretum site (comprising two transformers and two switchboards) by 2017-18, but lower load growth rate has enabled this to be deferred to 2021-22.

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 five options to provide additional capacity to the Pialligo, Brindabella Park and Fairbairn Park areas as listed in Table 5.

Table 5: Options considered for provision of additional capacity to the Pialligo, Brindabella Park and Fairbairn Park areas

Option	Option type	Description	Evaluation
0	Network	Do nothing	Not selected as does not meet minimum requirements
1	Network	Construct two new 11 kV cable feeders from East Lake Zone Substation, and link Dairy North to Abbatoir feeders	Selected as higher NPC
2	Network	Construct new 11 kV cable feeder from Fyshwick Zone Substation, new 11 kV cable feeder from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder	Not selected due to lower NPC
3	Non-network	Demand side management	Not selected as does not meet minimum requirements and lower NPC
4	Mixed	Grid battery to defer option 1	Not selected as cost of delay exceeded benefits
5	Non-network	Grid battery only	Not selected due to lower NPC

4.1. Options analysis

It is proposed to install a second 132/11 kV 30/55 MVA transformer and 11 kV switchboard at East Lake Zone Substation by the end of the 2014-19 Regulatory Control Period.

4.1.1. Do Nothing Option

The 'Do Nothing' option would result in insufficient network capacity in the area to meet demand during a contingency event.

The value of energy at risk is estimated to be approximately \$2,038 over a five year period based on the probability of a contingency event at the same time as demand exceeding firm capacity.

Despite, the relatively low value of energy at risk, the Do Nothing option would result in Evoenergy breaching its Distribution Network Augmentation Standards and thus its obligation to provide a reliable and secure power supply.

4.1.2. Option 1: Construct two new 11 kV cable feeders from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder

Option 1 includes three components. It considers the installation of a new underground 11 kV cable feeder to Brindabella Park and alterations to the existing Dairy North and Abbatoir feeders as follows:

Part 1: New 11 kV feeder to Brindabella Park:

It is proposed to install a new 11 kV 3c/400mm² AL XLPE cable feeder from a spare circuit breaker at East Lake Zone Substation to distribution substation S9411 at Pialligo Ave, Brindabella Park. This cable would be through-jointed to

Project Justification Report – Supply to Pialligo

the proposed cable to be installed between S9411 and S9330. Note S9411 is temporary only and will be removed. This would provide 5.5 MVA firm capacity (summer) to meet the growing load demand of the Brindabella Business Park.

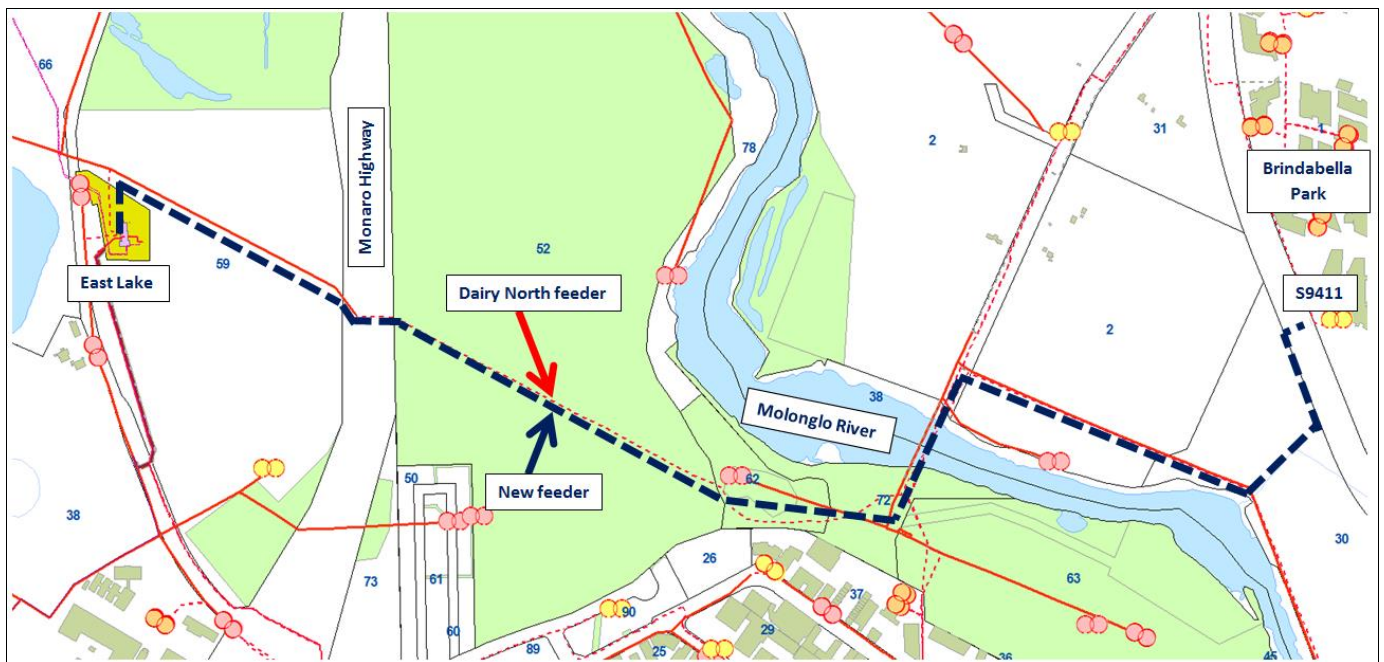
The cable route length would be approximately 3.2 km and would follow the same route as the existing Dairy North feeder from East Lake Zone Substation south-eastwards to Monaro Highway and across the farmland to the east (alongside the Dairy North feeder cable) to near pole 56484 on the southern side of the Molonglo River. At this point the cable would be directional drilled beneath the Molonglo River (approx 100m wide) to a point near pole 25174. From there the cable route would be eastwards alongside the existing overhead Gladstone feeder to near pole 38338 then northwards across farmland to Pialligo Ave and S9411.

The cable would be installed full length in 150mm diameter PVC conduit. Two spare conduits would be installed full length for future use.

Sections of this feeder would cross private property so would be subject to obtaining the appropriate approvals and/or easements. It is noted that 11 kV cables or overhead lines currently occupy most of this route, so it is assumed that approvals would be granted.

Figure 3 illustrates this feeder route.

Figure 3: Proposed new 11 kV feeder from East Lake Zone Substation to Brindabella Park



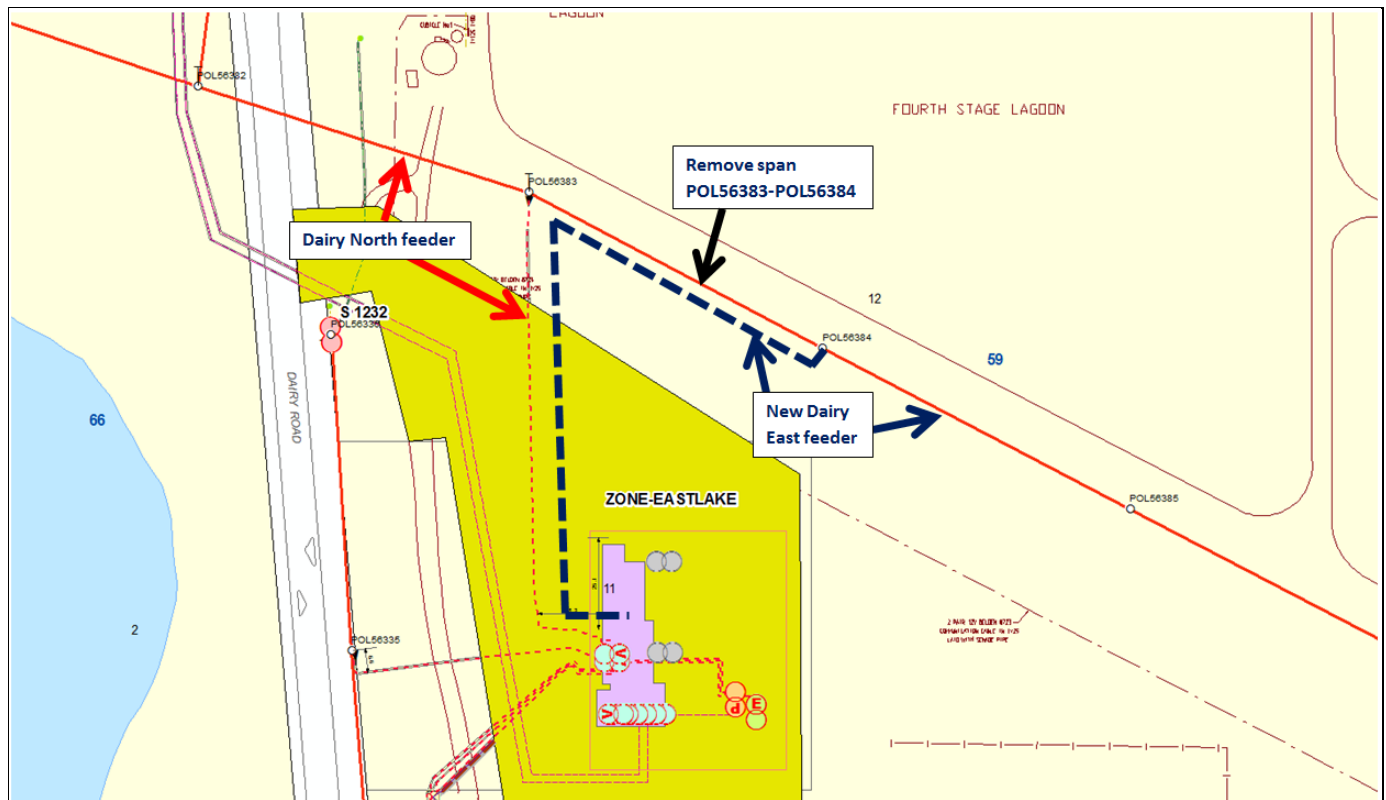
Part 2: New 11 kV Dairy East feeder:

It is proposed to run a new 11 kV feeder tail from East Lake Zone Substation to connect to the Dairy North feeder at a new pole-mounted gas switch on pole 56384, one span east of the existing connection point at gas switch GS11003. The Dairy North feeder will then be split between these two gas switches. The “new” feeder which will supply the Fairburn Park area will be named Dairy East.

Figure 4 illustrates this feeder route.

Project Justification Report – Supply to Pialligo

Figure 4: Proposed new 11 kV Dairy East feeder



Part 3: Construct link between Dairy North and Abbatoir feeders:

The existing Dairy North feeder supplies some small distribution substations (S839, S840 and S4988) via a long section of overhead two phase line. It is proposed to extend the Abbatoir feeder approximately 1.3 km north along Sutton Rd from pole 16394 to pole 15288 with 11 kV 3c/240mm² AL XLPE cable to link to the Dairy North feeder and transfer these distribution substations to the Abbatoir feeder. Note Abbatoir feeder will be offloaded by proposed new feeders to the CDC data centres at Fyshwick as proposed under a separate Project Justification Report. This link and load transfer will ease some of the voltage stability issues being experienced on the Dairy North feeder with the recent connection of the Mt Majura solar farm and improve the quality of supply to these remote rural customers.

It is anticipated that most of this cable route would be installed by open trenching along the Sutton Rd verge.

A preliminary cost estimate for Option 1 is **\$2,992,500 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

Option 1 is selected due to its higher (ie least negative) net present cost (NPC). It also aligns with Evoenergy's strategic objective to convert Fyshwick 66/11 kV Zone Substation to an 11 kV switching station.

4.1.3. Option 2: Construct new 11 kV cable feeder from Fyshwick Zone Substation, new 11 kV cable feeder from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder

Option 2 includes three components. It considers the installation of a new underground 11 kV cable feeder to Brindabella Park and alterations to the existing Dairy North and Abbatoir feeders as follows:

Part 1: New 11 kV feeder to Brindabella Park:

It is proposed to install a new 11 kV 3c/400mm² AL XLPE cable feeder from a circuit breaker at Fyshwick Zone Substation to distribution substation S9411 at Pialligo Ave, Brindabella Park. There is no spare 11 kV circuit breaker at Fyshwick Zone Substation so the switchboard would need to be extended to accommodate an additional feeder circuit breaker panel. This cable would be through-jointed to the proposed cable to be installed between S9411 and S9330. Note S9411 is temporary only and will be removed. This would provide 5.5 MVA firm capacity (summer) to meet the growing load demand of the Brindabella Business Park.

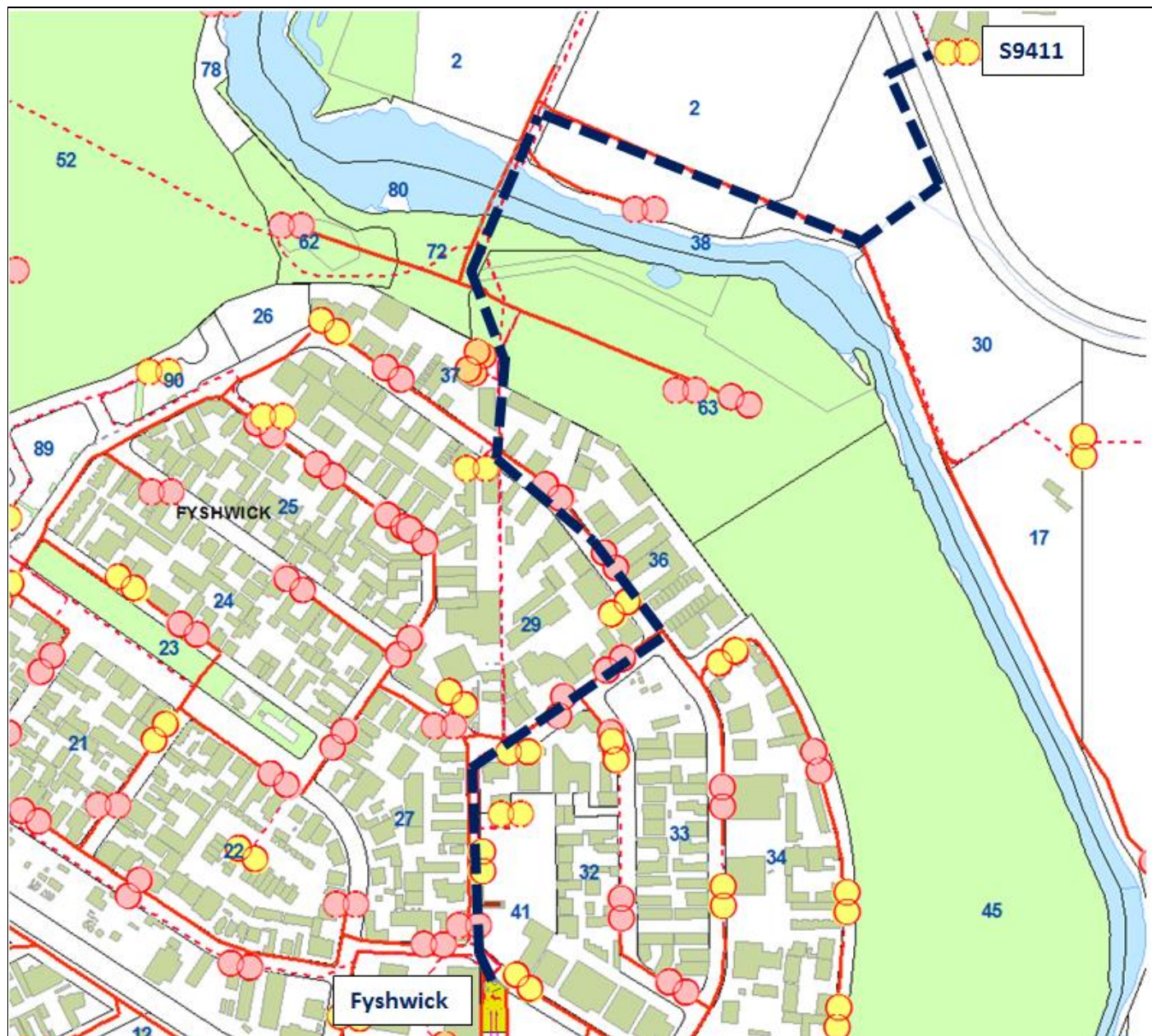
The cable route length would be approximately 3.1 km and would run from Fyshwick Zone Substation via Tennant St, Collie St, Albany St, Gladstone St, then northwards to near pole 56484 on the southern side of the Molonglo River. At this point the cable would be directional drilled beneath the Molonglo River (approx 100m wide) to a point near pole 25174. From there the cable route would be eastwards alongside the existing overhead Gladstone feeder to near pole 38338 then northwards across farmland to Pialligo Ave and S9411.

The cable would be installed full length in 150mm diameter PVC conduit. Two spare conduits would be installed full length for future use.

Sections of this feeder would cross private property so would be subject to obtaining the appropriate approvals and/or easements. It is noted that 11 kV cables or overhead lines currently occupy most of this route, so it is assumed that approvals would be granted.

Figure 5 illustrates this feeder route.

Figure 5: Proposed new 11 kV feeder from Fyshwick Zone Substation to Brindabella Park



Part 2: New 11 kV Dairy East feeder:

This is described under Option 1 above.

Part 3: Construct link between Dairy North and Abbatoir feeders:

This is described under Option 1 above.

A preliminary cost estimate for Option 2 is **\$3,053,900 excluding corporate overheads, contingency and GST**.

Option 2 is not selected due to its lower NPC. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

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 defer the Pialligo feeder to the next regulatory control period (beyond 2024), it is estimated that non-network solutions would need to provide a maximum demand of approximately 4.8 MVA pa.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 0.84 MVA. This does not meet the minimum capacity required to enable the new feeder to be deferred.

These non-network options are summarised in Table 6.

Table 6: Summary of latent demand management

Non-network Option	Airport Feeder	Pialligo Feeder	Dairy Nth Feeder	Total
Customer – owned embedded generation	0.2 MVA	0.15 MVA	0.2 MVA	0.55 MVA
Customer – owned energy storage	0.04 MVA	0.03 MVA	0.05 MVA	0.12 MVA
Load curtailment	0.06 MVA	0.04 MVA	0.08 MVA	0.017 MVA
Totals	0.3 MVA	0.22 MVA	0.33 MVA	0.84 MVA

Third party non-network proposals have been requested in ActewAGL's 2017 Annual Planning Report and via Evoenergy's website demand management portal and may identify additional opportunities.

Where there is insufficient latent demand management within the customer base, there is further opportunity to incentivise customers to adopt additional technologies to reduce demand. This includes opportunities to permanently reduce demand (such as energy efficiency technology or power factor correction) as well as opportunities to adopt technology to enable participation in demand response markets (such as embedded generation, battery storage, building management systems). For the purposes of the evaluation, it is assumed that no more than 30% of demand growth can be offset using additional demand management.

For Pialligo it was determined that 60% of demand growth would need to be offset by demand management to enable the project to be deferred, implying that new demand management is unlikely to defer investment.

4.1.5. Option 4: Grid battery to defer Option 1

This option utilises a grid battery to enable Option 1 to be deferred. This option has the advantage of deferring the investment until greater certainty in future demand is known. However, given the relatively high certainty of future demand for this project and the relatively high cost of the grid battery, this option was assessed as higher cost than the network Option 1 with a preliminary cost estimate of **\$4,124,880 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

4.1.6. Option 5: Grid battery only

This option utilises a grid battery only. A grid battery, although more expensive than a traditional network solution on a per MVA basis, has advantages over a traditional network solution. A network battery is modular and also able to be redeployed, meaning it can represent a more economic option in an environment of demand uncertainty or where demand is expected to increase for a short period and then decline.

In the case of Pialligo however, the grid battery was not economic due to the relative certainty of demand with a preliminary cost estimate of **\$16,149,106 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

4.1.7. Summary of Options Analysis

Table 7: 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	Construct two new 11 kV cable feeders from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder	\$2,992,500	\$2,992,500	-\$3,031,657	Selected due to higher NPC
2	Construct new 11 kV cable feeder from Fyshwick Zone Substation, new 11 kV cable feeder from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder	\$3,053,900	\$3,053,900	-\$3,093,861	Not selected due to lower NPC
3	Demand side management and network battery	N/A	N/A	N/A	Not selected as does not meet need
4	Grid battery to defer option 1	\$4,124,880	\$4,124,880	-\$3,845,700	Not selected as deferral not economic
5	Grid battery only	\$4,899,505	\$17,011,334	-\$9,254,197	Not selected due to lower NPC

4.2. Recommendation

The selected option is Option 1, the construction of two new 11 kV cable feeders from East Lake Zone Substation: one to Brindabella Park, and the other to enable the Dairy North feeder to be split into two (Dairy North and Dairy East feeders); and link Dairy North feeder to Abbatoir feeder. All new feeder sections to be underground cables.

Financial analysis shows Option 1 to be the best option due to its higher (ie least negative) NPC. It also has the lowest capital cost. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B. It can be implemented in time to meet the project needs as identified and will add to ActewAGL's regulated asset base. The major assets will have an economic life of 50 years.

The new feeders will provide capacity and security of supply to the new developments proposed for the Pialligo, Brindabella Park and Fairbairn Park areas. Spare conduits will be installed with all new cables for future feeders.

Timing is scheduled for completion by December 2020.

The preliminary cost estimate for the selected option is **\$2,992,500 excluding overheads, contingency and GST**.

Proposed 11 kV feeders will provide ties to existing feeders from City East and Fyshwick zone substations, and thus provide some backup supply capability and load transfer capability in the future. This project will also enable some load to be transferred from Fyshwick to East Lake Zone Substation.

Appendix A – Preliminary Cost Estimates

A.1 Cost Estimate – Option 1: Construct two new 11 kV cable feeders from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder

Construct two new 11 kV cable feeders from East Lake Zone Substation, and link Dairy North to Abbatoir feeders.					
Preliminary Estimate ± 30% Accuracy					
Description	Notes	Unit	\$/Unit	Quantity	Cost
Trenching and drilling					\$2,331,500
Clearing of route where required	Allowance	m2	\$10	6400	\$64,000
Directional drilling	Assume drilling with no rock. Assume three 150mm conduits per drill.	m	\$600	2500	\$1,500,000
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume three conduits per trench.	m	\$300	2200	\$660,000
Cable jointing and haulage pits	Assume every 500m	ea	\$3,000	20	\$60,000
Traffic management		m	\$5	1500	\$7,500
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Site is mostly flat .	m3	\$40	1000	\$40,000
Cabling works					\$369,000
11 kV 3c/400mm2 XLPE cable		m	\$56	3500	\$196,000
11 kV 3c/240mm2 XLPE cable		m	\$35	1200	\$42,000
Throughjoints	Assume every 500m	ea	\$1,000	13	\$13,000
Terminations		ea	\$2,500	6	\$15,000
Conduit and marker tape	Assume all cables installed in conduit	m	\$10		\$0
Cable installation labour and plant		m	\$20	4700	\$94,000
HV Cables and connections Test & Commissioning	Allowance	ea	\$3,000	3	\$9,000
11 kV Switchgear					\$2,000
11 kV feeder CB	Extend switchboard and add feeder CB panel	ea	\$120,000		\$0
11kV Test & Commissioning	per CB	lot	\$2,000	1	\$2,000
Electrical (Secondary System)					\$0
Protection & Control					\$0
P&C Secondary Cabling	per feeder panel	ea	\$2,250		\$0
P&C Test & Commission	Allowance	ea	\$2,500		\$0
DC Supply System					\$0
DC Cabling	per switchgear panel/bay	ea	\$5,000		\$0
DC Test & Commission	Allowance	ea	\$2,000		\$0
SCADA					\$0
SCADA connections for new feeder panels		ea	\$2,000		\$0
Test & Commissioning	Allowance	ea	\$2,000		\$0
Indirect Costs					\$290,000
Development Application	Allowance	ea	\$40,000	1	\$40,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	\$50,000	1	\$50,000
Project management and administration	Allowance	ea	\$200,000	1	\$200,000
Project Sub Total without overheads					\$2,992,500
Overheads					
Overall average overhead rate	Allowance	27%	\$807,975	1	\$807,975
Project Sub Total with overheads					\$3,800,475
Contingency					
All project works	Preliminary allowance	15%	\$570,071	1	\$570,071
Project budget total					\$4,370,546

A.2 Cost Estimate – Option 2:

Construct new 11 kV cable feeder from Fyshwick Zone Substation, new 11 kV cable feeder from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder

Construct new 11 kV cable feeder from Fyshwick Zone Substation, new 11 kV cable feeder from East Lake Zone Substation, and link Dairy North feeder to Abbatoir feeder.					
Preliminary Estimate ± 30% Accuracy					
Description	Notes	Unit	\$/Unit	Quantity	Cost
Trenching and drilling					\$2,271,000
Clearing of route where required	Allowance	m2	\$10	6400	\$64,000
Directional drilling	Assume drilling with no rock. Assume three 150mm conduits per drill.	m	\$600	2400	\$1,440,000
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume three conduits per trench.	m	\$300	2200	\$660,000
Cable jointing and haulage pits	Assume every 500m	ea	\$3,000	20	\$60,000
Traffic management		m	\$5	1400	\$7,000
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Site is mostly flat .	m3	\$40	1000	\$40,000
Cabling works					\$361,400
11 kV 3c/400mm2 XLPE cable		m	\$56	3400	\$190,400
11 kV 3c/240mm2 XLPE cable		m	\$35	1200	\$42,000
Throughjoints	Assume every 500m	ea	\$1,000	13	\$13,000
Terminations		ea	\$2,500	6	\$15,000
Conduit and marker tape	Assume all cables installed in conduit	m	\$10		\$0
Cable installation labour and plant		m	\$20	4600	\$92,000
HV Cables and connections Test & Commissioning	Allowance	ea	\$3,000	3	\$9,000
11 kV Switchgear					\$122,000
11 kV feeder CB	Extend switchboard and add feeder CB panel	ea	\$120,000	1	\$120,000
11kV Test & Commissioning	per CB	lot	\$2,000	1	\$2,000
Electrical (Secondary System)					\$9,500
Protection & Control				1	\$2,500
P&C Secondary Cabling	per feeder panel	ea	\$2,250		\$0
P&C Test & Commission	Allowance	ea	\$2,500	1	\$2,500
DC Supply System					\$7,000
DC Cabling	per switchgear panel/bay	ea	\$5,000	1	\$5,000
DC Test & Commission	Allowance	ea	\$2,000	1	\$2,000
SCADA					\$0
SCADA connections for new feeder panels		ea	\$2,000		\$0
Test & Commissioning	Allowance	ea	\$2,000		\$0
Indirect Costs					\$290,000
Development Application	Allowance	ea	\$40,000	1	\$40,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	\$50,000	1	\$50,000
Project management and administration	Allowance	ea	\$200,000	1	\$200,000
Project Sub Total without overheads					\$3,053,900
Overheads					
Overall average overhead rate	Allowance	27%	\$824,553	1	\$824,553
Project Sub Total with overheads					\$3,878,453
Contingency					
All project works	Preliminary allowance	15%	\$581,768	1	\$581,768
Project budget total					\$4,460,221

Appendix B – Financial Analysis

B.1 Capital Expenditure Cash Flow for Each Option

Financial Year	Option 1	Option 2	Option 3	Option 4	Option 5
2019/20	\$2,992,500	\$3,053,900		\$1,131,380	\$807,455
2020/21				\$2,992,500	\$807,455
2021/22					\$807,455
2022/23					\$807,455
2023/24					\$807,455
2024/25					\$807,455
2025/26					\$807,455
2026/27					\$807,455
2027/28					\$807,455
2028/29					\$807,455
2029/30					\$807,455
2030/31					\$807,455
2031/32					\$807,455
2032/33					\$807,455
2033/34					\$807,455
2034/35					\$807,455
2035/36					\$807,455
2036/37					\$807,455
2037/38					\$807,455
2038/39					\$807,455
Total Cost (20 yr)	\$2,992,500	\$3,053,900	N/A	\$4,123,880	\$4,037,276
2019-24 Regulatory Control Period Cost	\$2,992,500	\$3,053,900	N/A	\$4,123,880	\$16,149,106

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 $\pm 10\%$ of the forecasted spot loads expected in the Pialligo area. 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 Supply to Pialligo

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

Options:

One – two new 11 kV feeders from East Lake Zone Substation

Two – one new 11 kV feeder from East Lake Zone Substation and one new feeder from Fyshwick Zone Substation

Three – demand management

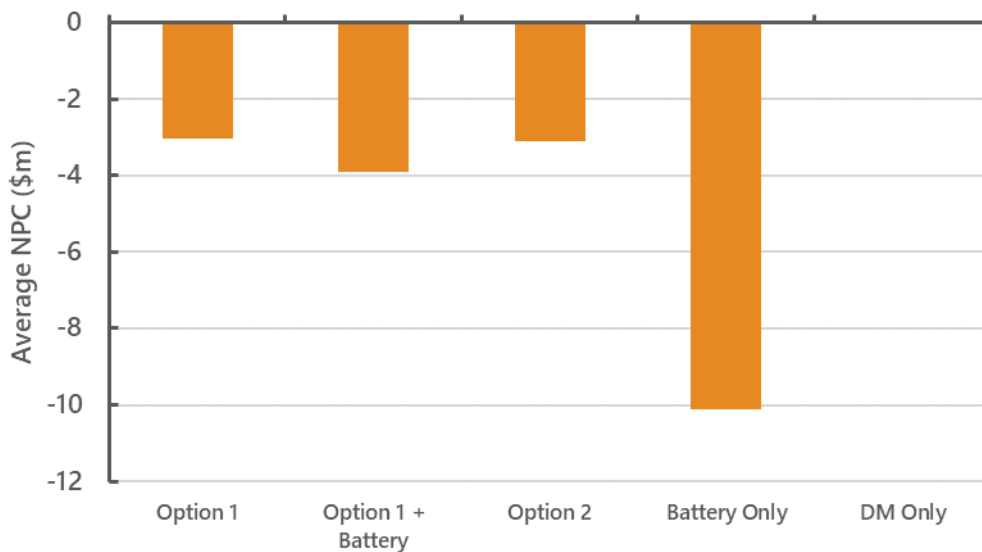
Four – grid battery to defer Option 1

Five – grid battery only

RESULTS (Average over 50 simulations):

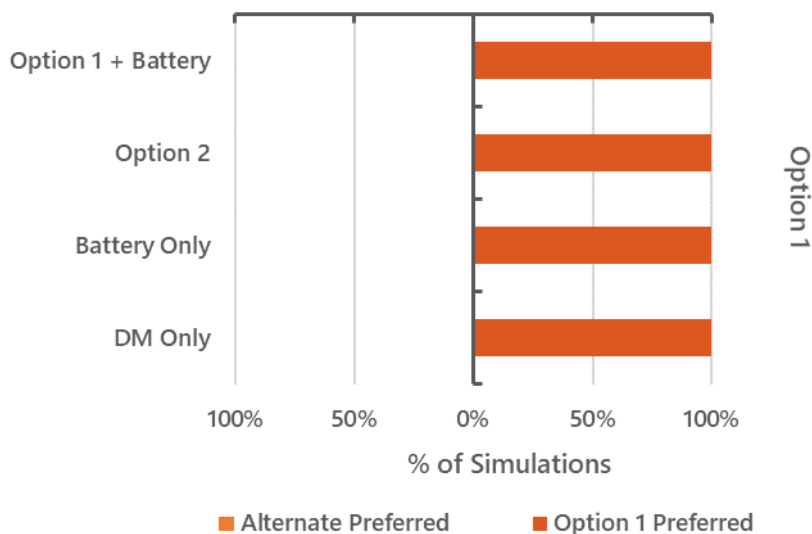
Option:	One	Two	Three	Four	Five
NPC (2019-2024)	-\$2,773,542	-\$2,830,449	N/A	-\$3,583,278	-\$4,338,425
NPC (2019-2039)	-\$3,031,657	-\$3,093,861	N/A	-\$3,846,690	-\$10,120,357
Network Option total Capital Cost	\$2,992,500	\$3,053,900	N/A	\$3,053,900	-
Option Capital Cost (2019-2024)	\$2,992,500	\$3,053,900	N/A	\$3,844,721	\$5,338,936
Option Capital Cost (2019-2039)	\$2,992,500	\$3,053,900	N/A	\$3,844,721	\$18,604,273

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 1 was the preferred option in 100% of simulations.

Value of Risk:

Year	Volume of Energy at Risk (kWh)	Value of Energy at Risk (\$)
2020	46,413	117
2021	237,964	480
2022	237,964	480
2023	237,964	480
2024	237,964	480

Notes:

Energy at risk is the volume of energy served above the firm rating each year. An indicative load duration curve has been used to determine the relationship between peak demand, firm rating and volume of energy in kWh.

Value at risk assumes:

Value of Customer Reliability = \$26.93/kWh

Probability of Failure = 6% (3% annual probability of transformer failure + 3% probability of feeder failure)

Outage duration = 8 hours

Probability of failure in any given hour: $6\% \times 8 / 24 / 365$

Value above firm rating = VCR * probability * volume of energy

All energy above the emergency rating is not served. This is equivalent to assuming a 100% outage probability for energy above this level.

In addition to the VCR cost, there are litigation, reputational and other financial risks that are included in the total:

Litigation costs = \$100,000 / event

Reputational risk cost = external consultations and communications costs = \$10,000 / event.

Financial risk cost = internal investigation costs = \$10,000 / event.

Total risk cost = Reliability risk cost + Litigation + Reputational risk cost + Financial risk cost
 = VCR / kWh + \$120,000 / event.