

# Appendix 5.34: Supply to Mitchell 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

<b>Project name</b>	<b>Supply to Mitchell</b>
Expenditure type	Capital Expenditure
Business Group	Asset Strategy
Regulatory Period	1 July 2019 to 30 June 2024
Total Project Cost Estimate	\$3,993,350 excluding corporate overheads, excluding contingency, and excluding GST
Five year total spend 2019-24	\$3,993,350 excluding corporate overheads, excluding contingency, and excluding GST
CAPEX category	ENAA Distribution
Primary driver	Load growth in Mitchell area
Project Number	PN 20001757

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### 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 2017		22.12.17
Australian Power Generation Technology Report, EPRI	2015	2015
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 Mobile Substation Deployment PR1191	1.0	8.5.15
Evoenergy Peak Demand Reduction Strategy	2.0	22.8.17
Evoenergy Electrical Data Manual SM1183	5.0	22.6.17
Augmentation NPV Model Methodology	1.0	29.9.17

## 1. Executive Summary

This project justification report examines options for supplying forecast load developments in the Mitchell area.

The maximum demand in the Mitchell area in the ACT is forecast to increase by approximately 12.3 MVA to 2022 with the development of a number of new light industrial and commercial customers including data centres.

This project proposes three new 11 kV cable feeders to be installed from Gold Creek Zone Substation to the Mitchell area. Spare conduits will be installed along the feeder route to provide for future developments and load growth.

The proposed feeders will inter-tie with existing feeders emanating from Gold Creek, Belconnen and City East zone substations, and thus enable load to be transferred off highly-loaded feeders.

Other options considered include installations of feeders from Belconnen Zone Substation, construction of a new zone substation at Mitchell, demand management, and a grid battery. Feeders from Belconnen were excluded due to a high net present cost (compared to the preferred option). Demand management was not considered feasible due to the existing assets already exceeding their firm ratings so that there is a requirement for greater than 100% 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 of installing three new 11 kV feeders from Gold Creek Zone Substation to Mitchell is **\$3,993,350 excluding corporate overheads, excluding contingency, and excluding GST**.

These works will be carried out during the 2019-24 Regulatory Control Period in three stages, ie first cable by June 2021, second cable by June 2023, third cable by 2024.

## 2. Strategic Context and Expenditure Need

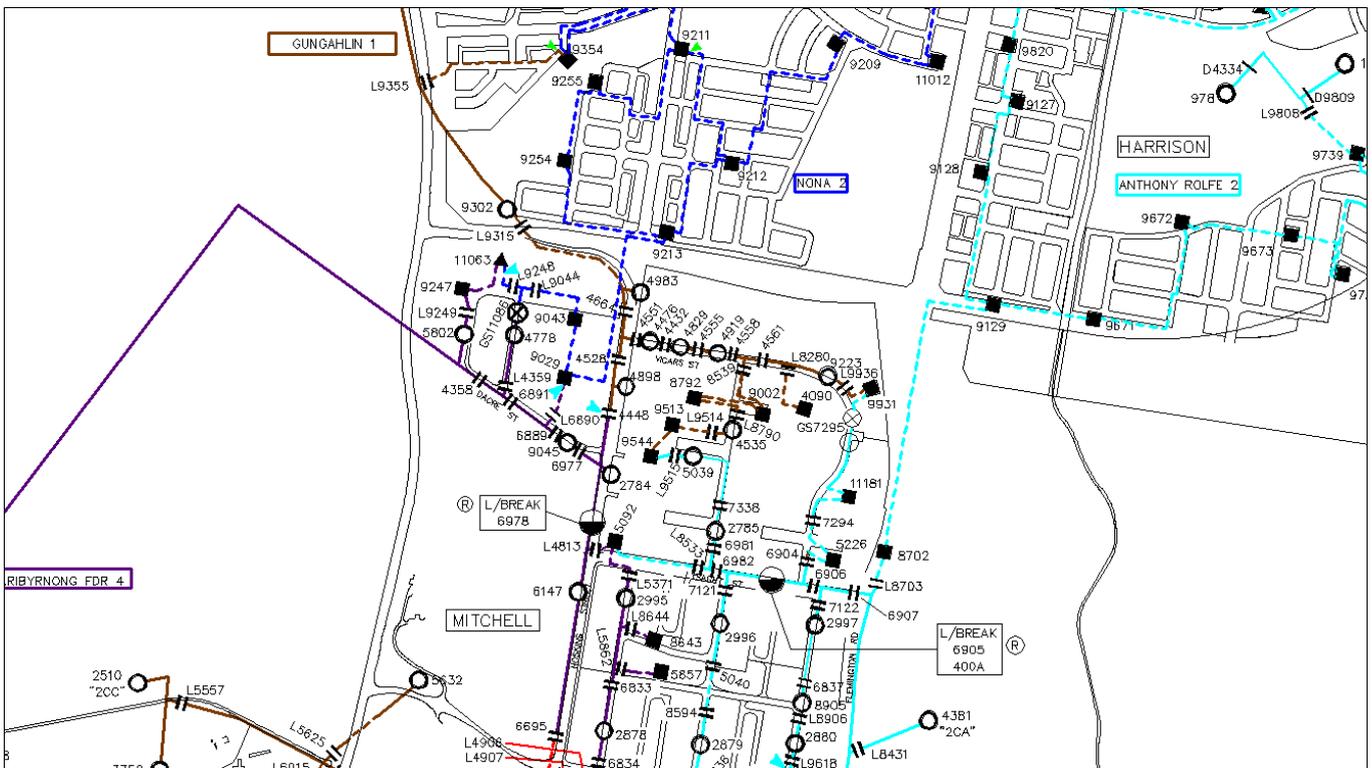
There is significant development planned for the Mitchell area. Existing infrastructure has insufficient capacity to cater for the additional demand associated with these developments.

### 2.1. Existing infrastructure in the Mitchell area

There are currently five 11 kV feeders supplying the Mitchell area. These are Maribyrnong and Swinden feeders from Belconnen Zone Substation, and Anthony Rolfe, Gungahlin and Nona feeders from Gold Creek Zone Substation.

The existing feeder network is illustrated in Figure 1.

**Figure 1: Mitchell area 11 kV Feeders.**



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: Mitchell Area 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	
Maribyrmong	BN	4.3	5.7	4.8	6.4	67%	65%	66%	71%	122%	-0.9
Swinden	BN	4.3	5.7	5.2	7.0	92%	89%	101%	90%	110%	-0.4
Anthony Rolfe	GC	5.9	7.8	6.6	8.8	92%	100%	111%	110%	132%	-1.9
Gungahlin	GC	5.0	6.7	5.6	7.5	41%	35%	38%	36%	81%	0.9
Nona	GC	5.5	7.3	6.2	8.2	70%	90%	85%	94%	105%	-0.3
<b>Total</b>											<b>-2.6</b>

### 2.1.1. Driving need for infrastructure investment

Forecast additional maximum demand in the Mitchell 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 currently being designed. There is a high degree of certainty (> 80%) that these developments will proceed. There will be other smaller load increases.

**Table 2: Proposed Developments in the Mitchell area.**

Proposed Development and Net Additional Diversified Load in MVA	2018	2019	2020	2021	2022
Metronode Data Centre		1.8	0.6	0.6	0.3
Australian Data Centre		1.0	2.5	2.5	1.0
Capital Metro TPS3 (Depot)	1.2				
War memorial warehouse		0.3			
National archives warehouse			0.5		
<b>Additional Load (MVA)</b>	<b>1.2</b>	<b>3.1</b>	<b>3.6</b>	<b>3.1</b>	<b>1.3</b>
<b>Cumulative Additional Forecast Load (MVA)</b>	<b>1.2</b>	<b>4.3</b>	<b>7.9</b>	<b>11.0</b>	<b>12.3</b>
Spare capacity of existing feeders to Mitchell area	<b>-3.8</b>	<b>-6.9</b>	<b>-10.5</b>	<b>-13.6</b>	<b>-14.9</b>

The existing 11 kV feeders that currently supply the Mitchell area are heavily loaded and have no spare firm capacity during summer. The proposed developments shown in Table 2 indicate there will be a shortfall of approximately 14.9 MVA capacity by summer 2022 onwards so additional feeders will be required unless significant demand side management initiatives can avoid this. The proposed Hamer feeder which is scheduled to be installed by December 2017 will enable some load to be transferred off Antony Rolfe feeder, but there is little capacity in other feeder ties to enable sufficient load transfers from other feeders.

### 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
<b>Responsible</b>	<ul style="list-style-type: none"> <li>Achieve zero deaths or injuries to employees or the public.</li> <li>Maintain a good reputation within the community.</li> <li>Minimise environmental impacts, for example bushfire mitigation.</li> <li>Meet all requirements of regulatory authorities, such as the AER as outlined in the NER, and the ACT Utilities (Technical Regulations) Act 2014.</li> </ul>	The selected option must ensure environment and safety standards will be met.
<b>Reliable</b>	<ul style="list-style-type: none"> <li>Tailor maintenance and renewal programs for each asset class based on real time modelling of asset health and risk.</li> <li>Meet network SAIDI and SAIFI KPIs.</li> <li>Record failure modes of the most common asset failures in the network.</li> <li>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.</li> </ul>	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.
<b>Sustainable</b>	<ul style="list-style-type: none"> <li>Enhance asset condition and risk modelling to optimise and implement maintenance and renewal programs tailored to the assets' needs.</li> <li>Make prudent commercial investment decisions to manage assets at the lowest lifecycle cost.</li> <li>Integrate primary assets with protection and automation systems in accordance with current and future best practice industry standards</li> <li>Deliver the asset class PoW within budget.</li> </ul>	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.
<b>People</b>	<ul style="list-style-type: none"> <li>Proactively seek continual improvement in asset management capability and competencies of maintenance personnel.</li> </ul>	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.

### 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.

For high voltage (11 kV) 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	$\{(N-1)/N\}\%$ <sup>1</sup>
Partial feeder tie	100% or less <sup>2</sup>
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).

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<sup>1</sup> “N” represents the number of feeders operating in parallel.

<sup>2</sup> 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 six options to provide additional capacity and security of supply to the Mitchell area as listed in Table 5.

**Table 5: Options considered for provision of additional capacity and security to Mitchell.**

Option	Option type	Description	Evaluation
0	Network	Do nothing	Not selected as does not meet minimum requirements
1	<b>Network</b>	<b>Three 11 kV feeders Gold Creek Zone Substation to Mitchell</b>	<b>Selected due to higher NPC</b>
2	Network	Three 11 kV feeders Belconnen Zone Substation to Mitchell	Not selected due to lower NPC
3	Network	New Mitchell Zone Substation	Not selected due to lower NPC
4	Non-network	Demand side management	Not selected as does not meet minimum requirements and lower NPC
5	Mixed	Grid battery to defer option 1	Not selected as cost of delay exceeded benefits
6	Non-network	Grid battery only	Not selected due to lower NPC

### 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 during a contingency event.

The value of energy at risk is estimated to be approximately \$449m over a five year period based on the probability of a contingency event at the same time as demand exceeding firm capacity. The feeders in the Mitchell area will exceed their thermal ratings by 2020 resulting in very large unserved energy costs.

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 three new 11 kV cable feeders from Gold Creek Zone Substation to Mitchell

Option 1 proposes to install three new underground 11 kV cable feeders to the Mitchell area from Gold Creek Zone Substation to meet the growing load demand. Each new feeder would provide up to 5.5 MVA firm capacity (summer).

The works proposed under this option are:

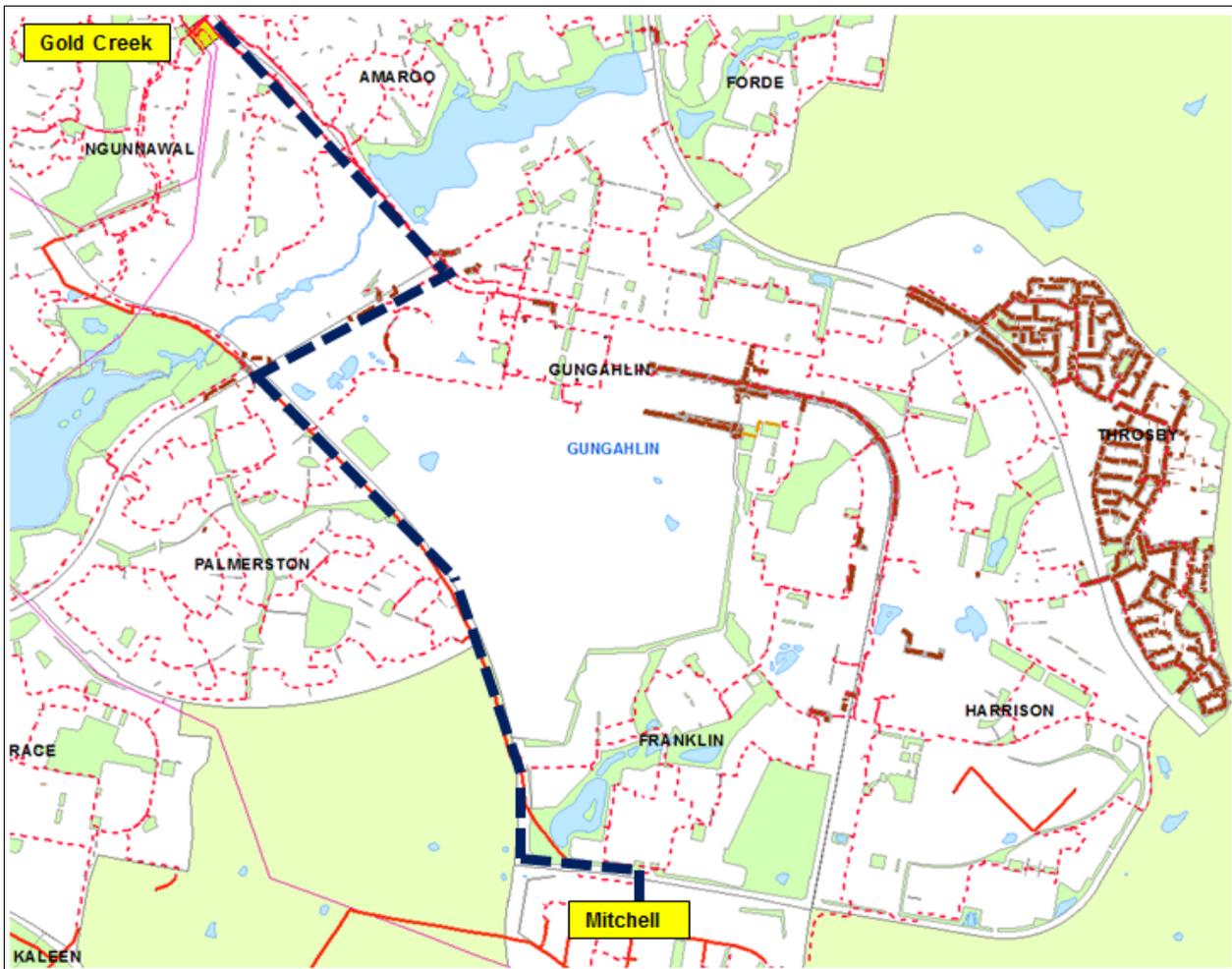
- Civil works including trenching and directional drilling approximately 6.3 km from Gold Creek Zone Substation to Mitchell.

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- Installation of three 11 kV 3c/400mm<sup>2</sup> AL XLPE cable feeders in three stages, ie first cable by June 2021, second cable by June 2023, third cable by 2024.
- Installation of feeder protection, SCADA and commissioning.

Figure 2 illustrates the proposed cable route.

**Figure 2: Proposed 11 kV feeder cables route Gold Creek Zone Substation to Mitchell**



A preliminary cost estimate for Option 1 is **\$3,993,350 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

Costs for each stage are estimated at: Stage 1 (2021) \$2,853,450; Stage 2 (2023) \$569,950; Stage 3 (2024) \$569,950 excluding corporate overheads, contingency and GST.

Option 1 is selected due to its higher (ie least negative) net present cost (NPC).

### 4.1.3. Option 2: Construct three new 11 kV cable feeders from Belconnen Zone Substation to Mitchell

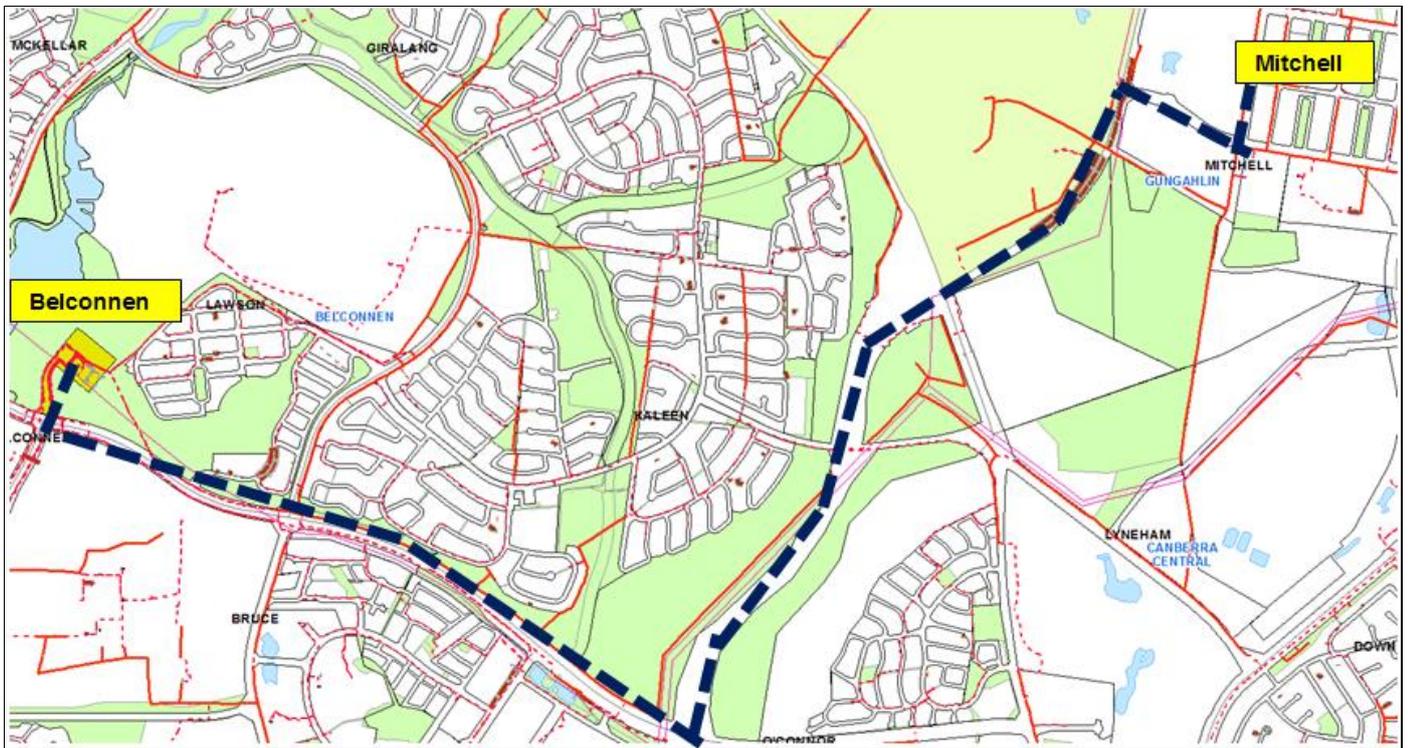
Option 2 proposes to install three new underground 11 kV cable feeders to the Mitchell area from Belconnen Zone Substation to meet the growing load demand. Each new feeder would provide up to 5.5 MVA firm capacity (summer).

The works proposed under this option are:

- Civil works including trenching and directional drilling approximately 8.1 km from Belconnen Zone Substation to Mitchell
- Installation of three 11 kV 3c/400mm<sup>2</sup> AL XLPE cable feeders in three stages, ie first cable by June 2021, second cable by June 2023, third cable by 2024.
- Installation of feeder protection, SCADA and commissioning.

Figure 3 illustrates the proposed cable route.

**Figure 3: Proposed 11 kV feeder cables route Belconnen Zone Substation to Mitchell**



A preliminary cost estimate for Option 2 is **\$5,710,950 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

Costs for each stage are estimated at: Stage 1 (2021) \$4,293,650; Stage 2 (2023) \$708,650; Stage 3 (2024) \$708,650 excluding corporate overheads, contingency and GST.

Option 2 is not selected due to its lower present cost (NPC).

#### 4.1.4. Option 3: Construct new Mitchell Zone Substation

A new zone substation has previously been proposed to supply the Mitchell and South Gungahlin area. This would reduce the load on both Belconnen and Gold Creek zone substations. Evoenergy is negotiating to purchase a site for a future Mitchell Zone Substation this Regulatory Control Period. This site is at the corner of Well Station Drive and Hoskins Street. A standard outdoor air-insulated 132 kV substation with indoor 11 kV switchboards would be constructed.

The works proposed under this option are:

- Construction of new 132/11 kV H-scheme zone substation. Switchyard to allow for three transformers, two 132 kV line connection bays and two bus zones.
- Construction of control building, switchyard and structures.
- Construction of two 132 kV underground cable circuits from substation to Bruce–Gold Creek line (to allow loop-in-loop-out connection).
- Installation of two 132 kV underground to overhead connections to Bruce–Gold Creek line.
- Installation of two 132/11 kV 30/55 MVA power transformers and neutral earthing transformers.
- Installation of auxiliary transformers.
- Installation of two 11 kV duplicate selectable bus switchboards in new building.
- Protection and control equipment associated with the above new assets.
- Construction would be carried out in two stages: Stage 1 (2021) Construction of zone substation with one 132/11 kV 30/55 MVA transformer and one 11 kV switchboard; Stage 2 (2030) installation of second 132/11 kV 30/55 MVA transformer and second 11 kV switchboard.

This would provide 55 MVA continuous firm capacity at Mitchell Zone Substation.

A preliminary cost estimate for Option 3 is **\$15,739,350 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

Costs for each stage are estimated at: Stage 1 (2021) \$12,226,350 and Stage 2 (2030) \$3,513,000 excluding corporate overheads, contingency and GST.

Option 3 is not selected due to its lower present cost (NPC).

#### 4.1.5. Option 4: 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 Mitchell 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 14.9 MVA pa.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 0.33 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	Total
Customer – owned embedded generation	0.09 MVA
Customer – owned energy storage	0.09 MVA
Load curtailment	0.15 MVA
<b>Totals</b>	<b>0.33 MVA</b>

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 Mitchell it was determined that more than 100% 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.

#### 4.1.6. Option 5: 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 is 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 **\$10,238,614 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

#### 4.1.7. Option 6: 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 grid 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 Mitchell however, the grid battery was not economic due to the relative certainty of demand with a preliminary cost estimate of **\$144,320,118 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

#### 4.1.8. Summary of Options Analysis

A summary of the options considered is presented in the Table 5.

**Table 5: 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	<b>Three 11 kV feeders Gold Creek to Mitchell</b>	\$3,993,350	\$3,993,350	-\$4,045,603	<b>Selected due to higher NPC</b>
2	Three 11 kV feeders Belconnen to Mitchell	\$5,710,950	\$5,710,950	-\$5,785,678	Not selected due to lower NPC
3	New Mitchell Zone Substation	\$35,313,654	\$144,320,118	-\$75,090,174	Not selected due to lower NPC
4	Demand side management	N/A	N/A	N/A	Not selected as does not meet need
5	Grid battery to defer Option 1	\$10,238,614	\$10,238,614	-\$9,315,150	Not selected as does not meet need
6	Grid battery only	\$12,226,350	\$12,226,350	-\$12,386,333	Not selected due to lower NPC

#### 4.2. Recommendation

The selected option is Option 1, the construction of a three new 11 kV underground cable feeders from Gold Creek Zone Substation to the Mitchell area. Cables to be 11 kV 3c/400mm<sup>2</sup> AL XLPE.

Financial analysis (refer Appendix B) 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 Mitchell area. Additional spare conduits will be installed for future feeders to meet future load growth.

Timing is scheduled for completion by June 2022.

The preliminary cost estimate for the selected option is **\$3,993,350 excluding overheads, contingency and GST**.

The proposed 11 kV feeders will provide ties to existing feeders from Gold Creek, Belconnen and City East zone substations, and thus provide some backup supply capability and load transfer capability in the future.

## Appendix A – Financial Analysis

### A.1 Cost Estimate – Option 1: 11 kV Feeders from Gold Creek to Mitchell

Gold Creek to Mitchell area: three new 11 kV feeders - route length approx 6.3 km. Assume spare conduits available from Gold Creek down Mirrabai Drive to Gundaroo Drive (approx 1.9 km). Stage 1 first cable (2019), Stage 2 second cable (2020), Stage 3 third cable (2022).									
Preliminary Estimate ± 30% Accuracy									
Description	Notes	Unit	\$/Unit	Stage 1 Quantity	Stage 1 Cost	Stage 2 Quantity	Stage 2 Cost	Stage 3 Quantity	Stage 3 Cost
<b>Trenching and drilling</b>					\$2,263,450		\$23,450		\$23,450
Clearing of route where required	Allowance	m2	\$10	5000	\$50,000	0	\$0	0	\$0
Directional drilling	Assume drilling with no rock. Assume three 150mm conduits and one 63mm conduit per drill. Assume drill 3.0 km.	m	\$600	3000	\$1,800,000	0	\$0	0	\$0
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume two 150mm conduits and one 63mm conduit per trench. Assume trench 1.4 km.	m	\$250	1400	\$350,000	0	\$0	0	\$0
Cable jointing and haulage pits	Assume every 500m	ea	\$1,000	14	\$14,000	14	\$14,000	14	\$14,000
Traffic management		m	\$2	6300	\$9,450	6300	\$9,450	6300	\$9,450
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Route is mostly flat.	m3	\$40	1000	\$40,000		\$0		\$0
<b>Cabling works</b>					\$473,000		\$473,000		\$473,000
11 kV 3c/400mm2 AI XLPE cable		m	\$55	6300	\$346,500	6300	\$346,500	6300	\$346,500
11 kV 3c/300mm2 AI XLPE cable		m	\$45	0	\$0		\$0		\$0
11 kV 3c/185mm2 AL XLPE cable		m	\$30	0	\$0		\$0		\$0
Throughjoints	Assume every 500m	ea	\$1,000	12	\$12,000	12	\$12,000	12	\$12,000
Terminations		ea	\$1,500	2	\$3,000	2	\$3,000	2	\$3,000
Conduit and marker tape	Assume conduit included in trenching and drilling rates	m	\$15	0	\$0	0	\$0		\$0
Cable installation labour and plant		m	\$15	6300	\$94,500	6300	\$94,500	6300	\$94,500
Cable jointing labour and plant		ea	\$1,000	14	\$14,000	14	\$14,000	14	\$14,000
HV Cables and connections Test & Commissioning	Allowance	ea	\$3,000	1	\$3,000	1	\$3,000	1	\$3,000
<b>Zone Substation Connection</b>					\$16,500	1	\$16,500		\$16,500
11 kV feeder CB at Gold Creek	Assume spare CBs available	ea	\$100,000	0	\$0	0	\$0	0	\$0
11 kV Test & Commissioning	per CB	lot	\$2,000	1	\$2,000	1	\$2,000	1	\$2,000
P&C equipment and cabling	per feeder panel	ea	\$5,000	1	\$5,000	1	\$5,000	1	\$5,000
P&C Test & Commission	Allowance	ea	\$2,500	1	\$2,500	1	\$2,500	1	\$2,500
DC Cabling	per switchgear panel/bay	ea	\$5,000	1	\$5,000	1	\$5,000	1	\$5,000
DC Test & Commission	Allowance	ea	\$2,000	1	\$2,000	1	\$2,000	1	\$2,000
<b>SCADA</b>					\$35,500		\$2,000		\$2,000
SCADA connections	per feeder CB and TPS	ea	\$2,000	1	\$2,000	1	\$2,000	1	\$2,000
Fibre optic cable		m	\$5	6300	\$31,500	0	\$0	0	\$0
SCADA Test & Commission	Allowance	ea	\$2,000	1	\$2,000	0	\$0	0	\$0
<b>Indirect Costs</b>					\$65,000		\$55,000		\$55,000
Development Application	Allowance	ea	\$10,000	1	\$10,000	0	\$0	0	\$0
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	\$5,000	1	\$5,000	1	\$5,000	1	\$5,000
Project management and administration	Allowance	ea	\$50,000	1	\$50,000	1	\$50,000	1	\$50,000
<b>Stage Sub Total without overheads</b>					\$2,853,450		\$569,950		\$569,950
<b>Project Sub Total without overheads</b>									\$3,993,350
<b>Overheads</b>									
Overheads at average rate 33%	Allowance	27%			\$770,432		\$153,887		\$153,887
<b>Stage Sub Total with overheads</b>					\$3,623,882		\$723,837		\$723,837
<b>Project Sub Total with overheads</b>									\$5,071,555
<b>Contingency</b>									
Contingency at 10%	Allowance	10%			\$362,388		\$72,384		\$72,384
<b>Stage total with all overheads and contingency</b>					\$3,986,270		\$796,220		\$796,220
<b>Project total with all overheads and contingency</b>									\$5,578,710

Project Justification Report – Supply to Mitchell

**A.2 Cost Estimate – Option 2: 11 kV Feeders from Belconnen to Mitchell**

Belconnen to Mitchell area: three new 11 kV feeders - route length approx 8.1 km. Assume 50-50 directional drilling and open trenching. Stage 1 first cable (2019), Stage 2 second cable (2020), Stage 3 third cable (2022).									
Preliminary Estimate ± 30% Accuracy									
Description	Notes	Unit	\$/Unit	Stage 1 Quantity	Stage 1 Cost	Stage 2 Quantity	Stage 2 Cost	Stage 3 Quantity	Stage 3 Cost
<b>Trenching and drilling</b>									
Clearing of route where required	Allowance	m2	\$10	5000	\$50,000	0	\$0	0	\$0
Directional drilling	Assume drilling with no rock. Assume three 150mm conduits and one 63mm conduit per drill. Assume drill 3.0 km.	m	\$600	4050	\$2,430,000	0	\$0	0	\$0
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume two 150mm conduits and one 63mm conduit per trench. Assume trench 1.4 km.	m	\$250	4050	\$1,012,500	0	\$0	0	\$0
Cable jointing and haulage pits	Assume every 500m	ea	\$1,000	18	\$18,000	18	\$18,000	18	\$18,000
Traffic management		m	\$2	8100	\$12,150	8100	\$12,150	8100	\$12,150
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Route is mostly flat.	m3	\$40	1000	\$40,000		\$0		\$0
<b>Cabling works</b>									
11 kV 3c/400mm2 AI XLPE cable		m	\$55	8100	\$445,500	8100	\$445,500	8100	\$445,500
11 kV 3c/300mm2 AI XLPE cable		m	\$45	0	\$0		\$0		\$0
11 kV 3c/185mm2 AL XLPE cable		m	\$30	0	\$0		\$0		\$0
Throughjoints	Assume every 500m	ea	\$1,000	16	\$16,000	16	\$16,000	16	\$16,000
Terminations		ea	\$1,500	2	\$3,000	2	\$3,000	2	\$3,000
Conduit and marker tape	Assume conduit included in trenching and drilling rates	m	\$15	0	\$0	0	\$0		\$0
Cable installation labour and plant		m	\$15	8100	\$121,500	8100	\$121,500	8100	\$121,500
Cable jointing labour and plant		ea	\$1,000	16	\$16,000	16	\$16,000	16	\$16,000
HV Cables and connections Test & Commissioning	Allowance	ea	\$3,000	1	\$3,000	1	\$3,000	1	\$3,000
<b>Zone Substation Connection</b>									
11 kV feeder CB at Belconnen	Assume spare CBs available	ea	\$100,000	0	\$0	0	\$0	0	\$0
11 kV Test & Commissioning	per CB	lot	\$2,000	1	\$2,000	1	\$2,000	1	\$2,000
P&C equipment and cabling	per feeder panel	ea	\$5,000	1	\$5,000	1	\$5,000	1	\$5,000
P&C Test & Commission	Allowance	ea	\$2,500	1	\$2,500	1	\$2,500	1	\$2,500
DC Cabling	per switchgear panel/bay	ea	\$5,000	1	\$5,000	1	\$5,000	1	\$5,000
DC Test & Commission	Allowance	ea	\$2,000	1	\$2,000	1	\$2,000	1	\$2,000
<b>SCADA</b>									
SCADA connections	per feeder CB and TPS	ea	\$2,000	1	\$2,000	1	\$2,000	1	\$2,000
Fibre optic cable		m	\$5	8100	\$40,500	0	\$0	0	\$0
SCADA Test & Commission	Allowance	ea	\$2,000	1	\$2,000	0	\$0	0	\$0
<b>Indirect Costs</b>									
Development Application	Allowance	ea	\$10,000	1	\$10,000	0	\$0	0	\$0
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	\$5,000	1	\$5,000	1	\$5,000	1	\$5,000
Project management and administration	Allowance	ea	\$50,000	1	\$50,000	1	\$50,000	1	\$50,000
<b>Stage Sub Total without overheads</b>					<b>\$4,293,650</b>		<b>\$708,650</b>		<b>\$708,650</b>
<b>Project Sub Total without overheads</b>									<b>\$5,710,950</b>
<b>Overheads</b>									
Overheads at average rate 33%	Allowance	27%			\$1,159,286		\$191,336		\$191,336
<b>Stage Sub Total with overheads</b>					<b>\$5,452,936</b>		<b>\$899,986</b>		<b>\$899,986</b>
<b>Project Sub Total with overheads</b>									<b>\$7,252,907</b>
<b>Contingency</b>									
Contingency at 10%	Allowance	10%			\$545,294		\$89,999		\$89,999
<b>Stage total with all overheads and contingency</b>					<b>\$5,998,229</b>		<b>\$989,984</b>		<b>\$989,984</b>
<b>Project total with all overheads and contingency</b>									<b>\$7,978,197</b>

Project Justification Report – Supply to Mitchell

**A.3 Cost Estimate – Option 3: Mitchell Zone Substation**

Mitchell Zone Substation - site corner Well Station Dr / Hoskin St. 132 kV cable in cable out. 132 kV AIS. Indoor 11 kV. Stage 1 One transformer and switchboard (2021). Stage Two second transformer and switchboard (2030).							
Preliminary Estimate ± 30% Accuracy							
Description	Notes	Unit	\$/Unit	Stage 1 Quantity	Stage 1 Cost	Stage 2 Quantity	Stage 2 Cost
<b>Civil &amp; Structural</b>					\$5,647,300		\$277,500
Earthworks					\$624,000		\$0
Clearing of site 180m x 180m		m2	\$10	32400	\$324,000		\$0
Landscaping/screening / plantings outside switchyard	Allowance	lot	\$100,000	1	\$100,000		\$0
Cut & Fill - benching of site		m3	\$40	5000	\$200,000		\$0
<b>Site Works</b>					\$1,052,000		\$0
Substation earthgrid		m2	\$50	6400	\$320,000		\$0
Supply, place, compact crushed gravel (blue metal)		m2	\$30	6000	\$180,000		\$0
Switchyard climbproof fence		m	\$1,500	320	\$480,000		\$0
Site Perimeter farm fence and gate		m	\$100	720	\$72,000		\$0
<b>Concrete Works</b>					\$1,055,000		\$180,000
Outdoor switchgear pier foundation (light)	Incl excavation, formwork, concrete, rebar & anchor bolts per 'footing'	ea	\$4,000	15	\$60,000	15	\$60,000
Outdoor switchgear pier foundation (medium)	Incl excavation, formwork, concrete, rebar & anchor bolts per 'footing'	ea	\$8,000	15	\$120,000	15	\$120,000
11kV Switchgear / control / secondary systems building basement	Excavation, no rock (minor boulders only).	m3	\$100	800	\$80,000		\$0
132/11kV transformer pad incl bund	Wall to 0.3m (higher walls are brick)	ea	\$225,000	3	\$675,000		\$0
11/0.4kV transformer pad incl bund		ea	\$12,000	2	\$24,000		\$0
Neutral earthing transformer pad incl bund		ea	\$12,000	2	\$24,000		\$0
Diesel Genset Pad incl Bund		ea	\$12,000	1	\$12,000		\$0
Transformer Runway	5m wide, heavy load reinforced concrete pad	m	\$1,000	60	\$60,000		\$0
<b>Roads &amp; Walkways</b>					\$408,400		\$0
Site Access Road - from Coulter Drive	Bitumen, 4m wide	m	\$660	500	\$330,000		\$0
Parking & Loading areas	Bitumen	m2	\$130	280	\$36,400		\$0
Light Vehicle / Walkway	Bitumen, 2.5m wide	m	\$210	200	\$42,000		\$0
<b>Ducts and Culverts</b>					\$195,200		\$0
HV Ducting HD PVC Conduit		m	\$200	200	\$40,000		\$0
HV Cable Duct	Transformers to 11 kV switchboards, under transformer runway	m	\$400	60	\$24,000		\$0
Secondary Cabling Culvert	Precast box culvert	m	\$600	160	\$96,000		\$0
Cable ladders & trays		m	\$220	160	\$35,200		\$0
<b>Buildings &amp; Structures</b>					\$1,677,500		\$97,500
132/11 kV Transformer Blast Wall 15m each	4.5m high	m	\$6,500	15	\$97,500	15	\$97,500
11 kV Switchgear / control / secondary systems building	In-situ construction, over basement. Loading and access 'platform'. Incl VESDA, Central A/C, Small Power & Light, Operator facilities and amenities.	m2	\$3,000	400	\$1,200,000		\$0
132 kV Gantry	Portal gantry, incl foundation	ea	\$90,000	2	\$180,000		\$0
132 kV Cable termination structures	Galvanised steel. Incl foundation	ea	\$100,000	2	\$200,000		\$0
<b>Oil Containment System</b>					\$184,000		\$0
Oil-water separation tank	Type Puraceptor Class 1, incl excavation/fill	ea	\$150,000	1	\$150,000		\$0
Ducting for oil-water		m	\$200	120	\$24,000		\$0
Secondary dam (sedimentation dam)	Earthworks + lining	lot	\$10,000	1	\$10,000		\$0

## Project Justification Report – Supply to Mitchell

Drainage, Water & Sewage					\$451,200		\$0
Drainage Ducts/culverts	Footprint related	m2	\$33	6400	\$211,200		\$0
Fresh water tank, and piping	Allowance	lot	\$140,000	1	\$140,000		\$0
Sewage tank, and piping	Allowance	lot	\$100,000	1	\$100,000		\$0
<b>Electrical (Primary System)</b>					<b>\$3,533,800</b>		<b>\$2,626,000</b>
132 kV Switchgear					\$1,085,800		\$238,000
145 kV Dead Tank CB, 3150 A, incl bushing CT & structure. SF6 excl.	Transformer CBs	ea	\$100,000	1	\$100,000	1	\$100,000
145 kV Live Tank CB, 3150 A, incl structure. SF6 excl.	Line CBs	ea	\$75,000	2	\$150,000		\$0
145 kV Horizontal Double Break Disconnecter (Motorised) 2000 A & Earth switch (Manual), incl structure.	With Earth Switch	ea	\$21,000	2	\$42,000		\$0
145 kV Horizontal Double Break Disconnecter (Motorised) 2000 A incl structure.	Without Earth Switch	ea	\$17,000	7	\$119,000	1	\$17,000
145 kV VT (post type). Incl structure. (1x3-ph)	Line VTs	ea	\$30,000	2	\$60,000		\$0
145 kV CT (post type). Incl structure. (1x3-ph)	Line CTs	ea	\$54,000	2	\$108,000		\$0
145 kV Surge Arrester, incl surge counter. Excl structure. (1x3-ph)	Cable Terminations. (Transformers to be c/w tank-mounted surge arrestors)	ea	\$6,900	2	\$13,800		\$0
132 kV Busbar, 2000 A	Rigid bus, tubular Al on post supports. 15m bay 3 phase	ea	\$65,000	2	\$130,000		\$0
132 kV jumpers/busbars	Twin Uranus per phase, incl post insulators and fittings	bay	\$150,000	1.5	\$225,000	0.5	\$75,000
SF6 Gas - estimate 10kg per single pole (LTCB) and 30kg per DTCTB	Allowance for first fill and levy	kg	\$1,200	90	\$108,000	30	\$36,000
132 kV switchgear Test & Commissioning	Allowance	bay	\$20,000	1.5	\$30,000	0.5	\$10,000
<b>132/11 kV Transformer</b>					<b>\$1,400,000</b>		<b>\$1,400,000</b>
132/11 kV 30/55MVA ONAN/ODAF, OLTC, YNd1	With 11 kV Bushing CT & 132 kV Neutral CT. 132 kV and 11 kV air bushings but consider 11 kV cable boxes. Including delivery and installation	ea	\$1,280,000	1	\$1,280,000	1	\$1,280,000
Transformer insulating oil		litre	\$1	20000	\$20,000	20000	\$20,000
Transformer Test & Commissioning	Allowance	ea	\$100,000	1	\$100,000	1.0	\$100,000
<b>11 kV Switchgear</b>					<b>\$790,000</b>		<b>\$790,000</b>
12 kV Switchboard air-insulated double bus, vacuum CBs (2 x Incomer 2500A, 10 x Feeders 12500 AR, 1 x Bus-coupler 2500A)	Incl Duplicate Protection & SCADA Interface and installation (swbd only \$680k)	ea	\$750,000	1	\$750,000	1	\$750,000
11 kV Switchboard Metering/Earthing Panel	Incl SCADA Interface	ea	\$20,000	1	\$20,000	1	\$20,000
11 kV Test & Commissioning	per switchboard - allowance	lot	\$20,000	1	\$20,000	1	\$20,000
<b>HV Connections</b>					<b>\$174,000</b>		<b>\$114,000</b>
132 kV Cable	Cables installed as part of 132 kV relocation project. Cable termination structures and 132 kV bus to be installed beforehand - 6 cables per circuit	m	\$500	0	\$0		\$0
132 kV Cable Termination - jointing per 3-phase circuit	Two x single core 1600mm2 Cu XLPE cables per phase	ea	\$30,000	2	\$60,000		\$0
11 kV Aerial Bus	At transformer 11 kV terminal (delete if cable boxes on transformers)	ea	\$20,000	1	\$20,000	1	\$20,000
11 kV Cable 1c/800mm2 Cu XLPE two per phase	For connection between transformers and 11kV switchboards - assume 60m	m	\$100	480	\$48,000	480	\$48,000
11 kV Cable 3c/35mm2 AL XLPE	For connections to 11/0.4 kV station services transformers and neutral earthing transformers - assume 50m each	m	\$100	100	\$10,000	100	\$10,000
11 kV Cable Termination 1c/800mm2 Cu XLPE		ea	\$750	16	\$12,000	16	\$12,000
11 kV Cable Termination 3c/35mm2 Al XLPE		ea	\$1,000	4	\$4,000	4	\$4,000
HV Cables and connections Test & Commissioning	Allowance	lot	\$20,000	1	\$20,000	1	\$20,000
<b>Primary (ancillary equipment)</b>					<b>\$84,000</b>		<b>\$84,000</b>
11/0.4 kV Auxiliary supply transformer 200 kVA	Cable-in cable-out	ea	\$40,000	1	\$40,000	1	\$40,000
11kV Earthing transformer 3000 Amps	Civil/Structure/Electric S&I	ea	\$40,000	1	\$40,000	1	\$40,000
Primary (ancillary) Test & Commissioning	Allowance	lot	\$2,000	2	\$4,000	2	\$4,000

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<b>Electrical (Secondary System)</b>								\$1,226,250		\$309,500
Protection & Control								\$556,250		\$309,500
132 kV Line Protection Panel	1 panel incl X and Y protection & SCADA Interface	ea	\$80,000	2				\$160,000		\$0
132 kV Busbar Protection Panel	1 panel incl X and Y protection & SCADA Interface	ea	\$80,000	1				\$80,000		\$0
132/11 kV Transformer Protection Panel	1 panel incl X and Y protection & SCADA Interface	ea	\$80,000	1				\$80,000	1	\$80,000
132 kV Transformer AVR Panel		ea	\$25,000	1				\$25,000	1	\$25,000
P&C Secondary Cabling	per P&C panel	ea	\$2,250	5				\$11,250	2	\$4,500
P&C Test & Commission	Allowance	lot	\$200,000	1				\$200,000	1	\$200,000
LV AC Supply								\$280,000		\$0
Diesel Genset - 200 kVA	Skid/kiosk mounted with integrated tank, noise reduction	ea	\$125,000	1				\$125,000		\$0
LV AC Main Distribution Board	Incl protection and SCADA interface, automatic changeover of incoming supply	ea	\$50,000	1				\$50,000		\$0
LV AC Cabling	Allowance	lot	\$100,000	1				\$100,000		\$0
LV AC Test & Commission	Allowance	lot	\$5,000	1				\$5,000		\$0
DC Supply System								\$390,000		\$0
125 V DC Battery bank	Duplicate DC systems	ea	\$85,000	2				\$170,000		\$0
AC/DC Converter - Charger	Duplicate DC systems	ea	\$40,000	2				\$80,000		\$0
DC Distribution Board	Duplicate DC systems	ea	\$30,000	2				\$60,000		\$0
DC Cabling	Allowance	lot	\$75,000	1				\$75,000		\$0
DC Test & Commission	Allowance	lot	\$5,000	1				\$5,000		\$0
<b>SCADA, Communication, Substation misc (lightning protection, lighting, security)</b>								\$1,019,000		\$0
SCADA RTU and HMI (incl commissioning)	Duplicate RTU, single HMI	lot	\$500,000	1				\$500,000		\$0
Communication End-Equipment Panel (incl commissioning)	Duplicate	lot	\$250,000	1				\$250,000		\$0
Fibre Optic Breakout Panel (FOBOT)	Duplicate	ea	\$20,000	2				\$40,000		\$0
Security - Intrusion Detection	Allowance	lot	\$10,000	1				\$10,000		\$0
Security - CCTV	Allowance	lot	\$50,000	1				\$50,000		\$0
Lightning Protection	15m pole with lightning arrester	ea	\$7,000	14				\$98,000		\$0
External Lighting	10m pole with floodlights	ea	\$1,500	14				\$21,000		\$0
SCADA, Comms, misc, Test & Commissioning	Allowance	lot	\$50,000	1				\$50,000		\$0
<b>Indirect Costs</b>								\$800,000		\$300,000
Construction Environmental Management Plan CEMP	Allowance	ea	\$100,000	1				\$100,000		\$0
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	\$100,000	1				\$100,000	0.5	\$50,000
Misc building approvals	Allowance	ea	\$100,000	1				\$100,000		\$0
Project management and administration	Allowance	ea	\$500,000	1				\$500,000	0.5	\$250,000
<b>Stage Sub Total without overheads</b>								\$12,226,350		\$3,513,000
<b>Project Sub Total without overheads</b>										\$15,739,350
<b>Overheads</b>										
Overheads at average rate 43%	Allowance	27%						\$3,301,115		\$948,510
<b>Stage Sub Total with overheads</b>								\$15,527,465		\$4,461,510
<b>Project Sub Total with overheads</b>										\$19,988,975
<b>Contingency</b>										
Contingency at 15%	Allowance	15%						\$2,329,120		\$669,227
<b>Stage total wth all overheads and contingency</b>								\$17,856,584		\$5,130,737
<b>Project total with all overheads and contingency</b>										\$22,987,321

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**A.4 Capital Expenditure Cash Flow for Each Credible Option**

Financial Year	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
2019/20	\$3,993,350	\$5,710,950	\$12,226,350		\$6,245,264	\$6,245,264
2020/21					\$3,993,350	\$7,267,098
2021/22						\$7,267,098
2022/23						\$7,267,098
2023/24						\$7,267,098
2024/25						\$7,267,098
2025/26						\$7,267,098
2026/27						\$7,267,098
2027/28						\$7,267,098
2028/29						\$7,267,098
2029/30			\$3,513,000			\$7,267,098
2030/31						\$7,267,098
2031/32						\$7,267,098
2032/33						\$7,267,098
2033/34						\$7,267,098
2034/35						\$7,267,098
2035/36						\$7,267,098
2036/37						\$7,267,098
2037/38						\$7,267,098
2038/39						\$7,267,098
<b>Total Cost (20 yr)</b>	<b>\$3,993,350</b>	<b>\$5,710,950</b>	<b>\$12,226,350</b>	<b>N/A</b>	<b>\$10,238,614</b>	<b>\$35,313,654</b>
<b>2019-24 Regulatory Control Period Cost</b>	<b>\$3,993,350</b>	<b>\$5,710,950</b>	<b>\$15,739,350</b>	<b>N/A</b>	<b>\$10,238,614</b>	<b>\$144,320,118</b>

## Appendix B: 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 Mitchell. 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 Mitchell

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

#### Options:

**One** – Three 11 kV feeders Gold Creek Zone Substation to Mitchell.

**Two** – Three 11 kV feeders Belconnen Zone Substation to Mitchell.

**Three** – Mitchell Zone Substation (AIS).

**Four** – Demand management.

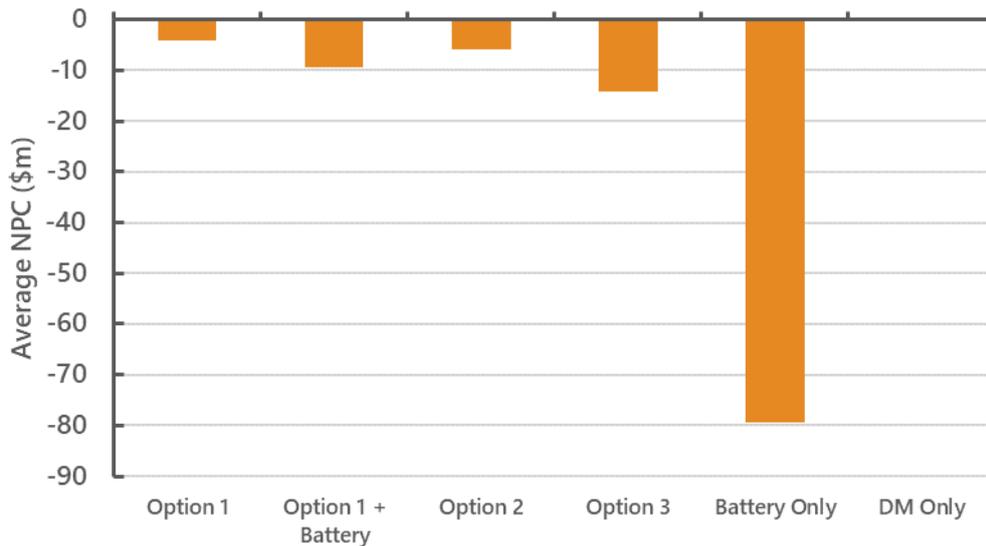
**Five** – Grid battery to defer Option 1

**Six** – Grid battery only

#### RESULTS (Average over 50 simulations):

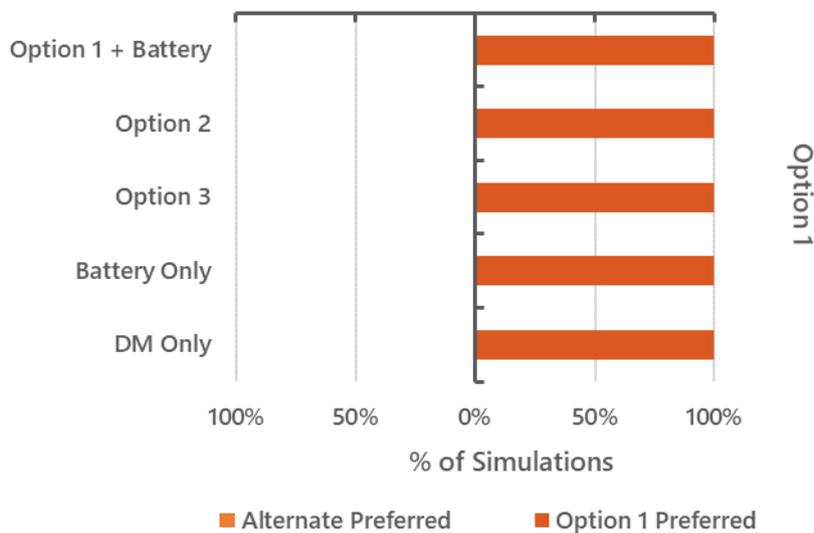
Option:	One	Two	Three	Four	Five	Six
NPC (2019-2024)	-\$3,701,161	-\$5,293,086	-\$11,331,761	N/A	-\$9,062,929	-\$31,841,822
NPC (2019-2039)	-\$4,045,603	-\$5,785,678	-\$14,238,878	N/A	-\$9,407,372	-\$78,887,359
Network Option total Capital Cost	\$3,993,350	\$5,710,950	\$15,739,350	N/A	\$3,993,350	-
Option Capital Cost (2019-2024)	\$3,993,350	\$5,710,950	\$12,226,350	N/A	\$10,342,979	\$39,675,011
Option Capital Cost (2019-2039)	\$3,993,350	\$5,710,950	\$15,739,350	N/A	\$10,342,979	\$147,610,361

**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.

**Project Justification Report – Supply to Mitchell**

**Value of Risk:**

Year	Volume of Energy at Risk (kWh)	Value of Energy at Risk (\$)
2020	1,486,177	8,447,406
2021	2,885,277	75,867,804
2022	3,601,600	121,500,456
2023	3,601,600	121,500,456
2024	3,601,600	121,500,456

**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:  $6\% * 8 / 24 / 365$

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.