Appendix 4.4: Molonglo Valley 11 kV Feeders PJR

Revised regulatory proposal for the ACT electricity distribution network 2019–24

November 2018

evoenergy

Project Justification Report

Project name	Molonglo Valley 11 kV Feeders
Expenditure type	Capital Expenditure
Business Group	Asset Strategy
Regulatory Period	1 July 2019 to 30 June 2024
Total Project Cost Estimate	$4,694,000 excluding corporate overheads, excluding contingency, and excluding GST
Five year total spend 2019-24	$4,694,000 excluding corporate overheads, excluding contingency, and excluding GST
CAPEX category	ENAA Distribution
Primary driver	Load growth in Molonglo Valley (Greenfield)
Project Number	20001374

Contents

1. Executive Summary

A new zone substation is proposed to be constructed to supply the growing demand of the Molonglo Valley. The proposed Molonglo Zone Substation project is described in the Project Justification Report for project PN 17519206. It is proposed that the new zone substation will be equipped initially with Evoenergy's 132/11 kV 15 MVA mobile substation by June 2021. A permanent 132/11 kV 30/55 MVA transformer and 11 kV switchboard is scheduled to be installed by June 2025 and a second transformer and switchboard by June 2030.

This Project Justification Report describes the proposed 11 kV feeder network to be installed from the new Molonglo Zone Substation to supply the Molonglo Valley and should be considered in conjunction with the Project Justification Report for the Molonglo Valley Zone Substation.

The maximum demand in the Molonglo Valley is forecast to increase steadily to 50 MVA over the next 20 years as load grows in the new and developing suburbs of Weston, Coombs, Wright, Denman Prospect and Whitlam. The development of this area will include 21,000 residential dwellings, plus commercial and community facilities. Existing 11 kV feeders to the area have insufficient thermal capacity to meet the forecast load beyond winter 2021.

The proposed 11 kV feeders from Molonglo Zone Substation will inter-tie with Civic, Woden, Belconnen and Latham zone substations, with the opportunity to offload these zone substations onto Molonglo Zone Substation, and to provide backup security of supply in the event of an outage at Molonglo Zone Substation (whether it be planned or unplanned).

The proposed Molonglo Zone Substation site is on the northern side of William Hovell Drive approximately 500m to the east of Coulter Drive.

The preferred option is to install 11 kV feeders from the new zone substation progressively to serve the residential areas as they develop. As part of the Molonglo Zone Substation project, spare 150mm diameter conduits will be installed to the switchyard fence boundary. Spare conduits will also be installed as part of the proposed 132 kV underground cable installation works, and as part of the ACT Government's developments in the area (eg across Coulter Drive and William Hovell Drive, and down John Gorton Drive). A staged approach to this project is selected to minimise the initial capital expenditure and construct only what is required to meet the forecasted load.

Other options have been considered and evaluated including the installation of feeders from existing zone substations, demand management, and a grid battery. The proposed installation of new 11 kV feeders from the proposed new Molonglo Zone Substation is the preferred option as it has the highest (ie least negative) net present cost of the credible options considered.

A preliminary cost estimate for the selected option is $4,694,000 excluding corporate overheads, contingency and GST. Feeder installations will be carried out in stages as development and load increases. Installation of new feeders will commence during the 2019-24 Regulatory Control Period and continue in the future as demand increases.

This project is coupled with the proposed Molonglo Zone Substation project, reference PN 17519206 which is estimated to cost $6,178,600 excluding corporate overheads, contingency and GST during the 2019-24 Regulatory Control Period.

The proposed expenditure for the 2019-24 Regulatory Control Period is:

PN 20001374 (Molonglo Valley 11 kV Feeders = $4,694,000 excluding corporate overheads, contingency and GST; plus
PN 17519206 (Molonglo Zone Substation) = $6,178,600 excluding corporate overheads, contingency and GST.

The capital expenditure will add to Evoenergy's regulated asset base and is expected to accrue returns in Evoenergy's regulated income.

2. Strategic Context and Expenditure Need

2.1. Strategic context

The Molonglo Valley District is situated in Canberra's west, approximately 10 km from the Canberra Central Business District (CBD). It lies to the north of the urban area of Weston Creek and south of Belconnen. Land servicing has commenced for the initial developments and when fully developed over the next 20 years, the Molonglo Valley District including the new suburbs of North Weston, Coombs, Wright, Denman Prospect and Whitlam will include an estimated 21,000 dwellings plus shopping centres, schools and community facilities. Development is proceeding rapidly and in some cases, eg Whitlam suburb, the development program has recently been accelerated (refer to Developer's program attached as Appendix C).

Coombs and Wright suburbs are mostly developed and are continuing to fill at a steady rate. North Wright and North Coombs will comprise approximately 600 dwellings each plus a school, hotel and restaurants, and are due to commence construction in late 2018.

North Weston suburb is mostly developed and is continuing to fill at a steady rate.

Denman Prospect suburb is being developed in five stages. Denman Prospect Stage 1A has been completed recently with 390 dwellings currently under construction. Stage 1B is under construction and will comprise 2,530 dwellings. Stages 2A, 2B and 3 will follow in the next three years and will include dwellings, a commercial centre (supermarkets, shops and service buildings), schools and community facilities.

Whitlam suburb is being developed in four stages. Whitlam Stage 1 is due to commence construction in November 2018 and will comprise 619 dwellings. Stages 2, 3 and 4 will each comprise approximately 620 dwellings and be developed by the end of 2021.

Mt Stromlo recreation area is being developed and will include a new aquatic centre plus holiday accommodation, scheduled to be completed by 2023.

A population of approximately 55,000 people is expected to ultimately live in the Molonglo Valley. Maximum demand of the Molonglo Valley is expected to grow steadily to approximately 50 MVA over the next 20 years.

Rooftop solar PV generation is installed on approximately 10% of all dwellings in Coombs, Wright and North Weston suburbs to date, whereas battery storage penetration to date is minimal (< 0.5%). This is typical for residential areas in the ACT where PV is not mandatory. The developer of Denman Prospect has mandated the installation of 3 kW rooftop PV generation systems on all detached dwellings in Stage 1A (390 dwellings), but has not mandated rooftop PV for multi-unit or commercial buildings. Battery storage systems are voluntary. It is unlikely that multi-unit developments (apartment buildings) will have rooftop PV or battery storage installed. Modern apartment buildings tend to be all-electric with no gas connected. Detached dwellings comprise approximately 30% of all dwellings in Denman Prospect, so this is the maximum likely penetration rate.

On its own rooftop PV will decrease summer maximum demand but without associated battery storage will have no impact on winter maximum demand which occurs in the evening after the sun has set. However as prices of batteries are anticipated to fall over coming years, it is expected that the rate of uptake will increase and ultimately many customers who have a rooftop PV installation may opt to install a battery storage system also. Thus a penetration rate of 30% has been assumed for rooftop PV and 20% for associated residential level battery storage systems throughout the Molonglo Valley. This is based on 100% rooftop PV on all detached or terraced dwellings, but minimal rooftop PV on apartment buildings. Fewer residential customers are connecting to gas, and coupled with the likely uptake of electric vehicles and instantaneous hot water heating systems, it is anticipated that future after diversity maximum demand (ADMD) levels will be approximately 2.5 kVA per dwelling.

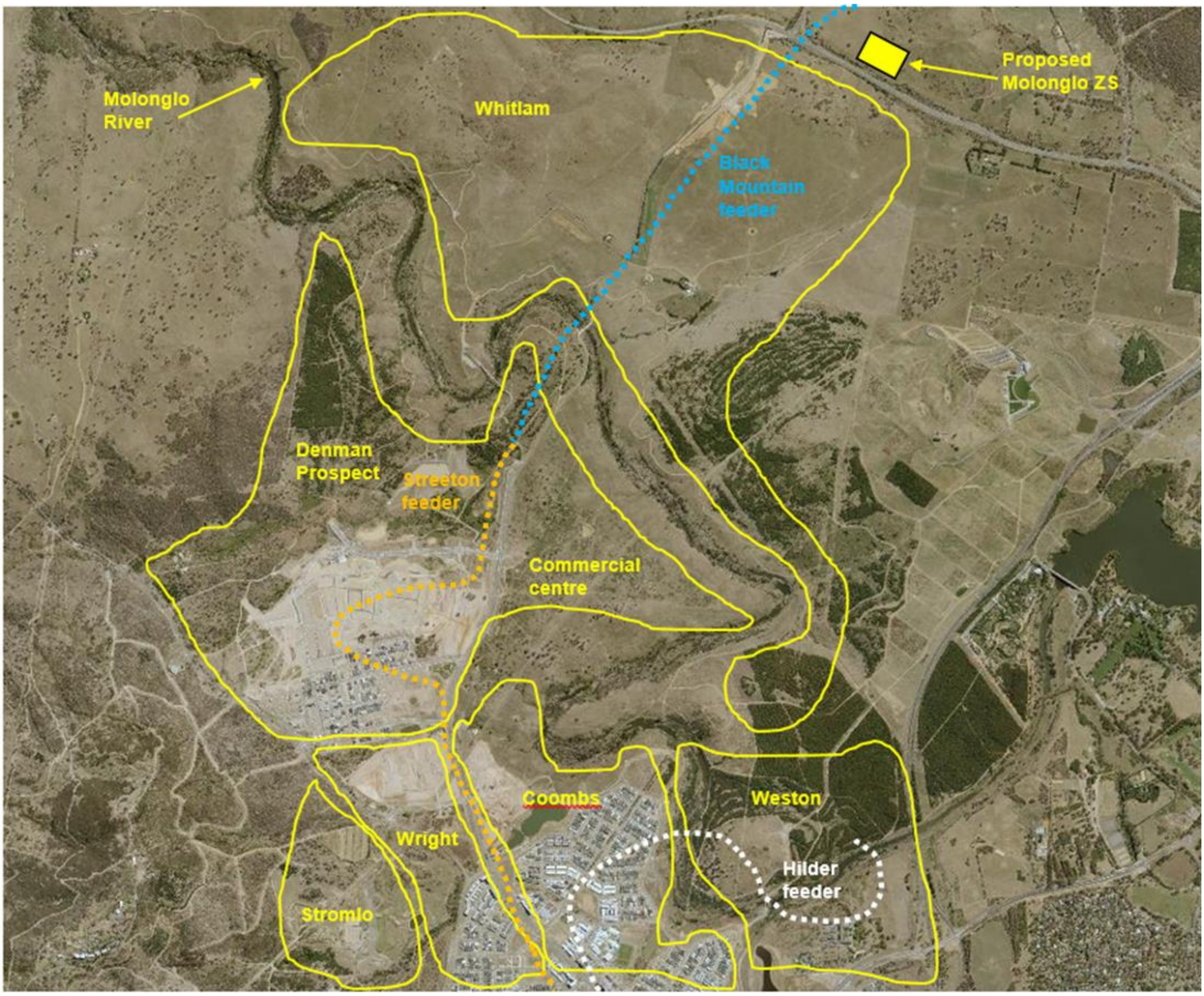
Supply is being provided to Wright and Denman Prospect through one 11 kV feeder from Woden Zone Substation (Streeton feeder), with an inter-tie connection to one 11 kV feeder from Civic Zone Substation (Black Mountain feeder).

Supply is being provided to Coombs and Weston through one 11 kV feeder from Woden Zone Substation (Hilder feeder). Hilder feeder has a limited backup connection to the Streeton feeder.

Initial supply to Whitlam will be provided via connection to the Black Mountain feeder, with backup supply from the Streeton feeder.

Figure 1 shows the proposed areas of development of the Molonglo Valley and the routes of existing 11 kV feeders. It also shows the site of the proposed Molonglo Zone Substation.

Figure 1: Development of Molonglo Valley



2.2. Existing infrastructure in Molonglo Valley

There are two existing feeders that cross the Molonglo Valley – Streeton feeder from the south and Black Mountain feeder from the north. There is one other feeder in the vicinity that could be extended to the Molonglo Valley – Hilder feeder.

Supply is being provided to Wright and Denman Prospect through by the Streeton and Black Mountain feeders. Supply is being provided to Coombs and Weston through the Hilder feeder.

Initial supply will be provided to Whitlam through a cable connection to the Black Mountain feeder.

The existing feeders in the Molonglo Valley vicinity have the following attributes:
Streeton – firm rating 5.5 MVA, thermal rating 7.3 MVA, 2018 demand 3.6 MVA.
Black Mountain – firm rating 5.0 MVA, thermal rating 6.5 MVA, 2018 demand 3.2 MVA.
Hilder – firm rating 5.2 MVA, thermal rating 7.0 MVA, 2018 demand 5.6 MVA.

2.3. Driving need for infrastructure investment

At an expected fill rate of approximately 1,000 dwellings pa, the Molonglo Valley load is forecast to grow steadily at approximately 3.0 MVA pa on average. The majority of demand of Molonglo Valley developments will be residential dwellings with some commercial facilities (proposed Denman Prospect group shopping centre) and community facilities (schools, churches, streetlights, and the proposed Stromlo Forest Park Aquatic Centre and Leisure Centre).

Table 1 shows a summary of the forecast load growth in the Molonglo Valley for the next 10 years. These forecast loads make allowance for predicted penetration of rooftop solar PV and battery storage systems.

Table 1: Forecast Load Growth for Molonglo Valley

Molonglo Valley Development - Load Forecast @ 29.8.18									
Year	2018	2019	2020	2021	2022	2023	2024	2025	2026
Residential Loads (MVA)									
Coombs	0.5	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Wright	0.4	0.7	0.5	0.5	0.2	0.1	0.1	0.1	0.1
Weston	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Denman Prospect	1.8	0.6	1.0	1.0	1.0	1.0	0.5	0.4	0.5
Whitlam		1.9	1.5	1.5	1.5	0.2	0.2	0.2	
Additional Residential Load (MVA) @ 2.5 kVA ADMD	2.9	3.7	3.3	3.3	3.0	1.5	1.0	0.9	0.8
Block Loads (MVA)									
Wright - hotel etc				0.5	0.7				
Denman Prospect Commercial centre						0.5	0.5	0.5	0.5
Stromlo Aquatic Park				0.5					
Stromlo Leisure Centre					1.0	1.0			
North Wright School				0.2					
Additional Non-residential Load (MVA) ADMD	0.0	0.0	0.0	1.2	1.7	1.5	0.5	0.5	0.5
Total Additional Load (MVA) ADMD	2.9	3.7	3.3	4.5	4.7	3.0	1.5	1.4	1.3
Cumulative Additional Load (MVA) ADMD	2.9	6.6	9.9	14.4	19.1	22.1	23.6	25.0	26.3

Load growth forecasts for the Molonglo Valley are **very dynamic** as development is proceeding at a rapid pace and the size of developments is increasing due to intense mixed use developments (eg apartment buildings coupled with commercial development) becoming commonplace.

The Load Forecasting Process:

- Evoenergy's original load forecasts for the Molonglo Valley were based on the ACT Government's Indicative Land Development Program. This document is updated every year by the ACT Govt.
- As individual estates/suburbs are developed, Evoenergy then receives an Estate Development Plan which includes "Dwelling Yield" figures (refer to Appendix D for Whitlam Stage 1 as an example). Evoenergy updates its load forecast using 2.5 kVA ADMD per dwelling based on the expected uptake of rooftop solar PV generation and residential battery storage systems, coupled with the expected uptake of electric vehicles and the current trend away from gas. ADMD figures for commercial building and community facilities are calculated using typical VA rates per m^2 of building space being developed.
- As individual multi-use blocks are sold to individual developers, the expected number of units/apartments often changes. For example, the number of apartments to be constructed at two blocks in Wright have doubled from the original EDP, and one block also includes a hotel and restaurant and will also be all-electric. Evoenergy updates its load forecast accordingly.
- Evoenergy bases its load forecasts on hard facts and does not speculate re unknowns such as possible larger buildings, hotels, all-electric developments etc. Thus load forecasts require constant revision and updating.

The *Electricity Distribution (Supply Standards) Code* issued by the ACT Independent Competition and Regulatory Commission (ICRC) sets out certain performance standards for the distribution network in the ACT. A Distribution Network Service Provider (DNSP) 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". The processes defined in these criteria serve to limit network augmentation expenditure to instances where the increase in demand is clear and above the secure or firm capacity.

Evoenergy's Asset Management Strategy states: "The strategic intent for asset management is to ensure that all assets must be of sufficient capacity to meet expected peak demands. For the electricity network, this means that zone substations, transmission and distribution networks must, at all times, be adequately rated to ensure customers are not interrupted because of peak demand requirements".

Evoenergy's Demand Management Strategy states: "Evoenergy is working to reduce peak demand relative to average demand as this will lead to reduce capital expenditure and better asset utilisation.'

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The key business and regulatory compliance drivers for this expenditure are to provide new and existing customers in the Molonglo Valley with a safe, secure, reliable, quality and cost effective electricity service.

Evoenergy (formerly ActewAGL Distribution) originally proposed to construct the Molonglo Zone Substation in its 2014-19 Regulatory Submission with proposed construction by late 2015. This proposal was not approved by the AER so Evoenergy had to uprate its Black Mountain 11 kV feeder (by reconductoring) in 2017 to meet the growing demand and connect new customers.

3. Objectives

3.1. Corporate, asset management and key project objectives

The corporate, asset management and related key project objectives are shown in Table 2 below. These objectives are used to assess the relative risk of options.

Table 2: Corporate, asset management and key project objectives

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

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

3.2. Regulatory Compliance

3.2.1. National Electricity Law and National Electricity Rules

Evoenergy is subject to the National Electricity Law (NEL) and the National Electricity Rules (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.

The most expensive credible option exceeds $5 million so this project will be subject to the RIT-D.

3.2.4. Utilities Act 2000 (ACT)

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

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

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

The Management of Electricity Network Assets Code requires electricity distributors to protect the 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. System planning studies are undertaken to assess the adequacy of the distribution network to meet current and forecast demands whilst meeting the quality of supply criteria stipulated in the NER. The key performance criteria that are addressed are: thermal overloading, voltage performance, supply security, and supply reliability. Studies are conducted using Evoenergy's medium growth, 50% PoE demand forecast, coupled with known customer-initiated point load requests and applications.

Evoenergy applies deterministic planning as a **first step** to identify where existing or emerging constraints exist on the network.

Evoenergy then applies probabilistic planning as a **second step** to determine the economic justification for network investment.

The probabilistic planning approach is an extension of the deterministic planning approach in the sense that it provides a method of assessing the economic value of network reliability to customers. Probabilistic planning also provides scope for non-network demand management alternatives to reduce load by introducing the economic value of supply for customers, which is the basis for all demand management projects.

Both elements of the planning criteria have risk parameters built into the process, whether they are deterministic or probabilistic in nature.

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.

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. Feeders are loaded up to 75% of their thermal rating depending on the number of inter-feeder ties available. Feeder alarm and protection settings are set accordingly.

Operating an 11 kV distribution feeder at or above its thermal rating is extremely risky as overheating can lead to conductor annealing and failure, or cause failure of jumpers, clamps, connectors, conductor joints, or other hardware. On overhead lines the conductors may sag below their statutory ground clearance (resulting from a combination of ambient and conductor temperature) – this could create a safety hazard to the public or a bushfire risk.

These proposed new feeders to the Molonglo Valley have been identified deterministically based on the forecast load growth (refer Table 1), and justified probabilistically based on the value of energy at risk (refer Appendix B2).

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 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).

It is noted that the National Electricity Law, Rules, Objectives, Criteria, and the ACT Distribution Code, do not require an assessment of unserved energy to be included in the cost evaluation of major augmentation projects.

4. Options Assessment

Table 3 lists the options that Evoenergy has considered to provide 11 kV supply capacity to the Molonglo Valley District.

Table 3: Options considered for 11 kV supply to Molonglo Valley District

Option	Option type	Description
0	Network	Do nothing – connect all new loads to existing Streeton and Black Mountain feeders and operate to their thermal ratings
1	Network	Extend Hilder 11 kV feeder and operate Streeton, Black Mountain and Hilder feeders to their thermal ratings
2	Network	Construct new 11 kV feeders from existing zone substations in stages: Five feeders from Latham Zone Substation and Five feeders from Civic Zone Substation
3	**Network**	**Construct new 11 kV feeders from proposed Molonglo Zone Substation in stages. This is part of the overall project:** **Construct new Molonglo Zone Substation (PN17519206); and** **Construct 11 kV feeders from Molonglo Zone Substation (PN20001374)**
4	Non-network	Demand side management and embedded generation
5	Mixed - Option 3 plus batteries	Delayed preferred network option using non-network options

4.1. Options Description

4.1.1. Do Nothing Option

The 'Do Nothing' option requires connecting all new loads to existing feeders in the Molonglo Valley and operating these feeders up to their thermal limits. The Streeton and Black Mountain feeders are the only feeders adjacent to proposed new developments.

The 'Do Nothing' option would result in insufficient network capacity in the area and thus would result in Evoenergy breaching its obligations to provide a reliable and secure power supply. This option is not a prudent or acceptable solution and would place considerable load at risk in the event of a feeder contingency.

4.1.2. Option 1: Extend Hilder feeder and operate Streeton, Black Mountain and Hilder feeders to thermal limits

Option 1 considers extending the 11 kV Hilder feeder to the Molonglo Valley load centre, and operating the extended Hilder feeder, Streeton feeder and Black Mountain feeders up to their thermal limits.

The Hilder feeder is the only existing feeder near Molonglo Valley other than Streeton and Black Mountain feeders. Hilder feeder emanates from Woden Zone Substation and currently supplies part of Coombs and Weston (refer Figure 1).

The works required to extend the Hilder feeder would include directional drilling beneath the Molonglo River. Removal of the overhead Black Mountain feeder section between William Hovell Drive and Molonglo River is currently timed to coincide with the development of Whitlam Estate (and proposed new Molonglo Valley feeders). Under this option it would be necessary to underground the Black Mountain feeder as a separate exercise prior to the estate development works.

A preliminary cost estimate for this option is $4,055,000 excluding corporate overheads, contingency and GST. Refer to Appendix A1.

The effectiveness of this option is similar to the Do Nothing Option in that it would defer construction of the Molonglo Zone Substation and associated 11 kV feeders until winter 2021 only. This option would result in insufficient network capacity in the area and thus would result in Evoenergy breaching its obligations to provide a reliable and secure power supply. This option is not a prudent or acceptable solution and would place considerable load at risk in the event of a feeder contingency.

4.1.3. Option 2: Install new 11 kV feeders from existing zone substations

Option 2 considers the installation of ten new underground 11 kV cable feeders in stages to Molonglo Valley from existing zone substations to meet the growing load demand. Due to the de-rating effect of installing multiple cable feeders in common trenches a thermal capacity of 5 MVA per feeder has been assumed.

Typically an urban zone substation supplies an area of radius approximately 5 km. There are four zone substations within 10 km of the Molonglo Valley load centre. These are Latham (8.5 km), Belconnen (7.2 km), Civic (5.3 km) and Woden (5 km).

Woden Zone Substation has firm ratings of 95 MVA summer and winter. It has a two-hour emergency rating of 95 MVA summer and 114 MVA winter. Forecast load growth at Woden Zone Substation without and with the proposed Molonglo Zone Substation is shown in Table 4. The two-hour emergency cyclic rating is the maximum short time load that a transformer can carry nominally once or twice in its operating life under fault conditions, while still maintaining an acceptable loss of life. Evoenergy uses the two-hour rating on the assumption that remote and manual switching can be done to either transfer or shed load within this duration.

Table 4: Woden Zone Substation Load Forecast

	Woden Zone Substation Load Forecast without Molonglo Zone Substation		**Woden Zone Substation Load Forecast with Molonglo Zone Substation (June 2021 commissioning)**	
Year	Summer POE 50	Winter POE 50	Summer POE 50	Winter POE 50
2019	75.4	85.7	75.4	85.7
2020	77.6	88.8	77.6	88.8
2021	79.5	91.1	79.5	83.3
2022	81.3	93.4	74.4	83.3
2023	83.0	95.6	74.4	83.3
2024	84.0	96.0	74.4	83.3
2025	84.3	96.4	74.4	83.3
2026	84.6	96.8	74.4	83.3
2027	84.9	97.2	74.4	83.3
2028	85.2	97.6	74.4	83.3

Load is growing steadily at Woden, Latham, Civic and Belconnen zone substations. The ability of these zone substations to supply up to 50 MVA additional load at Molonglo Valley, either individually or collectively without significant augmentation (eg additional transformer capacity) would be difficult to achieve.

Load transfer capability from Latham, Belconnen, Civic and Woden zone substations to neighbouring zone substations is shown in Table 5. Load transfer capacity is based on the spare capacity of zone substation transformers and the spare capacity of interconnecting 11 kV feeders between substations. This load transfer capacity will decrease as load increases on zone substations and interconnecting feeders. The 2026 figures are estimated based on expected load growth of interconnecting feeders.

Table 5: Load transfer capacity between zone substations (MVA)

		From							
		Latham		Belconnen		Civic		Woden	
	Year	2017	2026	2017	2026	2017	2026	2017	2026
To	Latham			9.97	3.00				
	Belconnen								
	Civic			5.93	2.00				
	Woden								
	City East			5.93	2.00	7.99	2.50		
	Telopea Park							5.88	2.00
	Wanniassa							18.97	11.00

There are no spare feeder circuit breakers at Woden Zone Substation. There are three spare feeder circuit breakers at Latham Zone Substation and six spare feeder circuit breakers at Civic Zone Substation (although five of these are proposed to be used for other projects – three new feeders to ANU plus two new feeders to Canberra CBD).

Under this option it is proposed to install 5 new 11 kV cable feeders from Latham Zone Substation and a further 5 new 11 kV cable feeders from Civic Zone Substation to Molonglo Valley. It is preferred not to install feeders from Belconnen due to the lack of spare transformer capacity, or from Woden due to the lack of spare feeder circuit breakers and the difficulty of installing cables beneath the Molonglo River. Some doubling up of feeders (ie two per circuit breaker) would be required, although this is not preferred due to diminished security and reliability (ie a feeder fault would trip its twin healthy feeder).

Route length from Latham is assumed to be 9.0 km and from Civic to be 8.0 km. The project would be implemented in stages:

Stage 1 (2021) – all civil works (trenching and directional drilling and installation of conduits) for the Latham–Molonglo feeders and installation of two feeder cables Latham–Molonglo.
Stage 2 (2023) – installation of third feeder cable Latham–Molonglo.
Stage 3 (2025) – installation of fourth feeder cable Latham–Molonglo.
Stage 4 (2027) – installation of fifth feeder cable Latham–Molonglo.
Stage 5 (2029) – all civil works (trenching and directional drilling and installation of conduits) for the Civic–Molonglo feeders and installation of two feeder cables Civic–Molonglo.
Stage 6 (2031) – installation of third feeder cable Civic–Molonglo.
Stage 7 (2033) – installation of fourth feeder cable Civic–Molonglo.
Stage 8 (2035) – installation of fifth feeder cable Civic–Molonglo.

A preliminary cost estimate for Option 2 is $28,880,500 excluding corporate overheads, contingency and GST. Refer to cost estimates, cash flows and NPC comparison in Appendices A2 and B.

Installing new 11 kV feeders from Civic to Molonglo Valley would be problematic due to Black Mountain lying between the two sites. Cables would need to be installed around the northern perimeter of Black Mountain so feeder lengths to Molonglo Valley would be approximately 8.0 km.

In addition to de-rating, the long lengths of cable feeders from Latham and Civic would create issues with voltage drop and network losses, so voltage regulators or similar devices would be required at the Molonglo Valley end of feeders.

The quality, reliability and security of supply may be reduced under this option due to the length of underground feeders with multiple joints in close proximity to each other. A 9.0 km feeder would require 17 joints plus two terminations, ie a joint approximately every 500 m. Experience shows that the majority of cable faults occur at joints.

Option 2 is not selected due to its lower net present cost (NPC), constructability issues, the distance from Latham and Civic zone substations to Molonglo Valley, future reliability concerns, potential voltage drop and network loss issues.

11 kV voltage regulators would be required which would add to the estimated cost. Extending the 11 kV switchboards at Latham and Civic would also be difficult to achieve as there is limited space available in each switchroom.

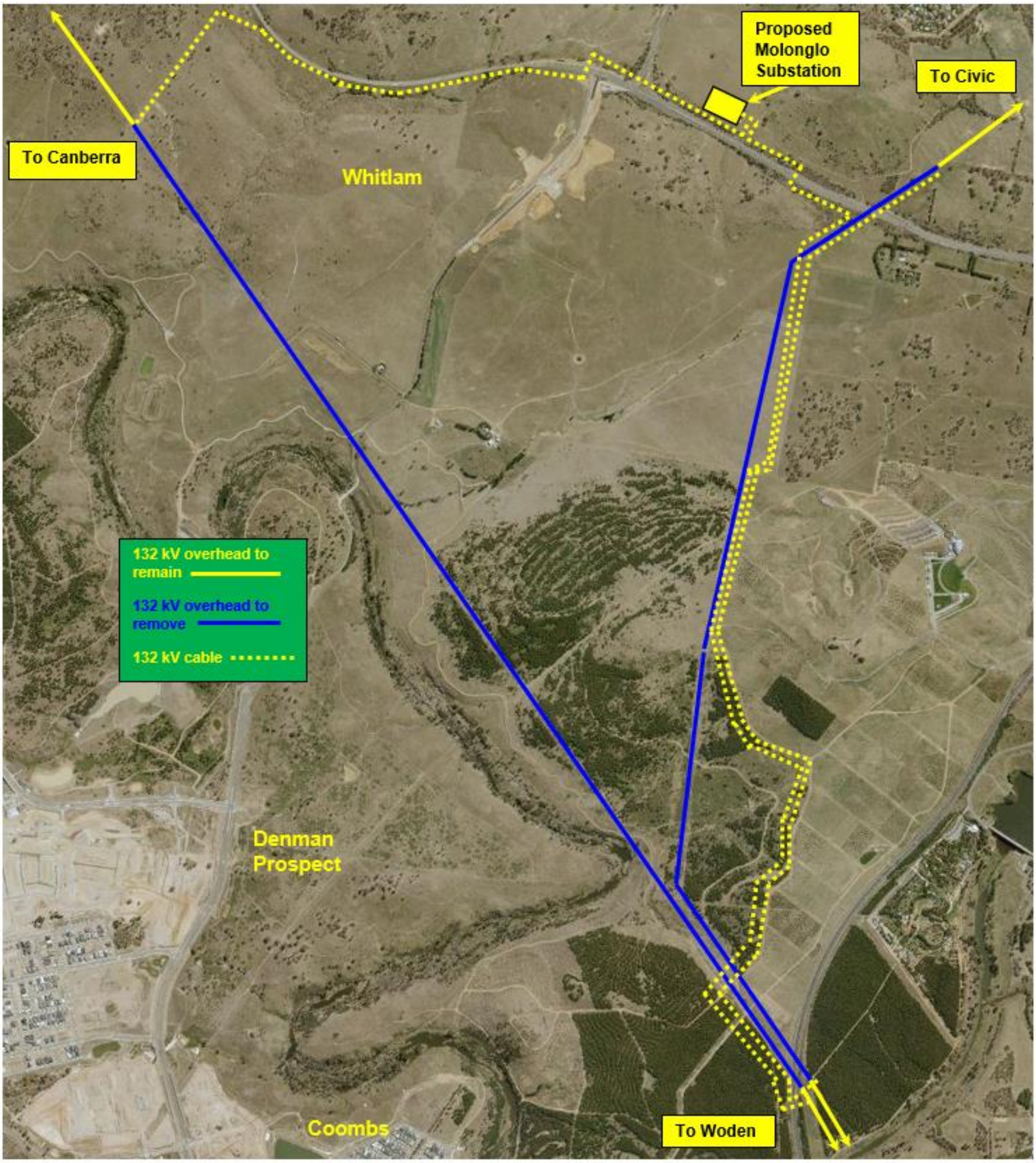
4.1.4. Option 3: Construct new 11 kV feeders from proposed Molonglo Zone Substation

Option 3 considers the installation of new underground 11 kV cable feeders from the proposed Molonglo Zone Substation to supply existing and new loads in the Molonglo Valley.

Evoenergy proposes to construct the new 132/11 kV Molonglo Zone Substation by June 2021 to meet the load forecast provided in Table 1. Until June 2021 the increasing load of new developments in the area will be met by connections to the Streeton feeder (supplied from Woden Zone Substation) and the Black Mountain feeder (supplied from Civic Zone Substation). The Streeton and Black Mountain feeders will be operated up to their thermal limits until the Molonglo Zone Substation and feeders are available.

The proposed site for the Molonglo Zone Substation is on the northern side of William Hovell Drive approximately 500m east of Coulter Drive. The 132 kV Canberra–Woden and Civic–Woden transmission lines that traverse the Molonglo Valley are proposed to be relocated (replaced with underground cables) as part of a separate project that will be fully funded by the Suburban Land Agency. Figure 2 shows the location of the proposed substation site and the proposed 132 kV transmission lines relocation works.

Figure 2: Proposed site of Molonglo Zone Substation and 132 kV Transmission Line Relocations



The overhead Civic–Black Mountain feeder traverses the Molonglo Valley from William Hovell Drive to Uriarra Road, and continues north-westwards to supply some small rural loads in the Stromlo area. It is proposed that a new cable feeder from Molonglo Zone Substation will connect to the Black Mountain feeder at Holborrow Ave (the new east-west arterial road that traverses Denman Prospect Estate). The overhead section of the Black Mountain feeder from Molonglo Zone Substation to Holborrow Ave will subsequently be decommissioned and removed. This will allow development of the Whitlam Estate to the east of John Gorton Drive to proceed unimpeded. There is one pole mounted distribution transformer S159 at “Glenloch Farm” on the southern side of William Hovell Drive which is currently connected to the Black Mountain feeder via an overhead 11 kV spur line. Supply to this will be arranged either from a new radial underground 11 kV spur off a new feeder or by connecting S159 to S3313, a pole mounted distribution transformer located approximately 900m to the east. Ultimately supply to Glenloch will be provided from the new underground reticulation network in Whitlam.

Another feeder from Molonglo Zone Substation will be installed to Coulter Drive and be connected to the Civic Zone Substation end of the Black Mountain feeder (nominally at pole POL 30965). Recloser 6846 and its associated bypass links will be removed from POL 25142, three spans north of POL 30965. This will provide a strong 11 kV tie between Civic and Molonglo zone substations.

Future feeders northwards up Coulter Drive will enable 11 kV inter-ties to Latham Zone Substation (via Bowley, Weir and Elkington feeders) and to Belconnen Zone Substation (via Benjamin and Cameron South feeders).

All feeder cables emanating from Molonglo Zone Substation will be 11 kV 3c/400mm^2 AL XLPE as far as the first connection point to an existing or new pole-mounted or ground-mounted structure such as an overhead gas switch or a ground-mounted distribution substation. Spare 150mm conduits will be installed with all new feeder cables, especially where installed in dedicated or shared trenches. These will be used for future new or replacement cables. Spare 63mm conduits will be installed with all feeders for future possible fibre optic cables for communications purposes.

11 kV feeders will be reticulated through the suburbs of North Weston, North Wright, North Coombs, Denman Prospect and Whitlam under separate projects as demand grows and as these suburbs are developed.

Load would be transferred from Civic Zone Substation (approx 5.4 MVA) by reconnecting the Black Mountain feeder to Molonglo Zone Substation and from Woden Zone Substation (approx 3.2 MVA) by reconnecting the Streeton feeder to Molonglo Zone Substation. Future 11 kV feeders will inter-tie with Woden, Civic, Belconnen and Latham zone substations strengthening the security of the meshed network. Maximum demand of Molonglo Zone Substation is forecast to reach 50 MVA by 2036 based on the 20-year development plan for the Molonglo Valley.

11 kV feeders are proposed to be installed from Molonglo Zone Substation as follows:

2018-21: Prior to Molonglo Zone Substation and not part of this project:

Connect new loads in the Molonglo Valley to Streeton and Black Mountain feeders. Feeder extensions will be mainly spurs from the main trunk feeders.

2021-24: Following commissioning of Molonglo Zone Substation – all cables to be 11 kV 3c/400mm^2 AL XLPE:

1. Install feeder to POL 30965 and connect to Black Mountain feeder via an 11 kV pole-mounted gas switch. Remove aerial recloser 6846 and associated bypass link. Cable length approximately 1.2 km.
2. Install feeder down John Gorton Drive, across proposed new Coppins Crossing bridge to Holborrow Ave and throughjoint to underground cable that runs westwards to Denman Prospect Stage 1B community centre distribution substation. This will provide a link to Streeton feeder. This will replace the existing overhead section of Black Mountain feeder. Cable length approximately 4.0 km.
3. Install feeder down John Gorton Drive, across proposed new Coppins Crossing bridge to North Coombs and connect to a suitable distribution substation to provide a link to Woden-Hilder feeder. Cable length approximately 5.0 km.
4. Install feeder down John Gorton Drive, across proposed new Coppins Crossing bridge to North Wright and connect to a suitable distribution substation to provide a link to Streeton feeder. Cable length approximately 5.0 km.
5. Install feeder down John Gorton Drive, across proposed new Coppins Crossing bridge to North Coombs and connect to North Weston and connect to a suitable distribution substation. Cable length approximately 5.0 km.
6. Install feeder down western side of John Gorton Drive to proposed distribution substation located at the north-west corner of the Road 1 / John Gorton Drive intersection (for supply to streetlights and traffic lights). This feeder will continue westwards as Road 1 develops. Cable length approximately 1.4 km.
7. Install feeder down eastern side of John Gorton Drive to Road 1 / John Gorton Drive intersection. This feeder will continue westwards as Road 1 develops. Cable length approximately 1.4 km.

Note the replacement Coppins Crossing bridge over the Molonglo River is currently at preliminary design stage. Evoenergy will specify its requirements for power cable conduits through the decking on either side.

The Molonglo Zone Substation mobile substation transformer will provide approximately 15 MVA capacity to the Molonglo Valley until the first 55 MVA permanent transformer and 11 kV switchboard is installed around 2025-26.

2025-30: All cables to be 11 kV 3c/400mm^2 AL XLPE:

Install additional feeders to Denman Prospect Stages 2 and 3, and to Whitlam suburb as these areas are developed. Electrical Master Plans will be prepared as part of the Estate Development Plan (EDP) process. Cables throughout these estates will be installed in common services trenches.

All new feeders installed during this period will be connected to the new Molonglo Zone Substation switchboard and will be tied to feeders from other zone substations, to provide backup security in the event of an outage of the Molonglo Zone Substation transformer.

2030 onwards: All cables to be 11 kV 3c/400mm^2 AL XLPE:

Following installation of the second 55 MVA transformer and second 11 kV switchboard at Molonglo Zone Substation, install feeders from Molonglo Zone Substation switchboard No 2 with inter-ties to switchboard No 1 feeders and feeders from Latham, Belconnen, Civic and Woden zone substations. Transformer No 2 will operate in parallel with Transformer No 1 providing 55 MVA firm capacity.

The preliminary estimated cost of this option for the 2019-24 Regulatory Control Period is **$4,694,000 excluding corporate overheads, contingency and GST** (refer cost estimate Appendix A3). Note this is dependent on the Molonglo Zone Substation being constructed during the 2019-14 Regulatory Control Period (PN 17519206 @ $6,178,600). Timing of additional feeder cables will depend on the rate of load growth in the Molonglo Valley, which will be monitored and forecast carefully.

Option 2 is selected due to its higher (ie least negative) NPC.

4.1.5. Option 4: Non-network solution

Option 4 considers non-network initiatives including demand side management and alternative supply measures such as embedded generation. The developer of Denman Prospect proposes to make this suburb energy efficient by requiring the mandatory installation of 3 kW rooftop solar PV generation on every detached dwelling. This will reduce energy demand but will require significant uptake of energy storage, e.g. battery storage installations, to have a major impact on the overall maximum demand of the network. In particular winter maximum demand usually occurs around 6:00pm throughout the month of July when there is no PV generation, so peak shaving would require the use of battery storage devices. To date just one residential battery has been installed in Coombs, Wright and Denman Prospect suburbs. System maximum demand over the last two years occurred at 5:00pm on 10 February 2017. At that time output from solar farms in the ACT was less than half their rated capacity so the same could be assumed for rooftop PV.

As prices of battery storage systems are anticipated to fall over coming years, it is expected that the rate of uptake will increase and many customers who have a PV installation may opt to install a battery storage system also. Thus a penetration rate of 30% has been assumed for rooftop PV and 20% for associated residential level battery storage systems throughout the Molonglo Valley. It is not expected that customers will install a battery system on its own to take advantage of energy arbitrage (ie purchasing energy at low demand, low tariff times to charge their battery, then discharge the battery at high demand, high tariff times).

Stage 1B of Denman Prospect Estate includes 34 apartment buildings comprising 1,547 units. North Wright and North Coombs developments include 7 proposed apartment buildings, plus a hotel, school and restaurant. Installation of solar PV or battery energy storage is not mandatory for apartment buildings so standard demand levels and load profiles are expected for these buildings. Based on the expected penetration levels of rooftop PV and battery storage systems, coupled with smaller dwelling sizes and energy efficient appliances, Evoenergy has calculated for the Molonglo Valley an After Diversity Maximum Demand (ADMD) of 2.5 kVA per dwelling. There is a recent trend towards the installation of instantaneous electric hot water systems in apartment buildings and it is anticipated that new apartment buildings will include electric vehicle (EV) charging facilities. Most new apartment buildings are also all-electric with no connection to the gas network. These factors will potentially increase the ADMD per apartment unit.

Evoenergy is undertaking a Smart Network trial in Stage 1A of Denman Prospect Estate (comprising 390 dwellings) to assess the viability and effectiveness of network-controlled load demand of customer appliances beyond the meter (eg solar PV generation systems, battery storage systems, hot water heating systems, heat pumps / air conditioners, swimming pool pumps and EV charging stations). Connection and usage by customers of gas to meet their energy needs will also be monitored in real time.

The outcome of this project will enable load forecast calculations to be refined with a higher degree of accuracy and thus help confirm the timing requirement for capacity augmentation to the Molonglo Valley. At this stage timing is based on forecast dwellings, commercial and community facilities construction rate, estimated uptake rate of rooftop PV, estimated uptake rate of battery storage, estimated uptake rate of EVs, and estimated uptake rate of instantaneous hot water heating systems. These forecasts are updated as details of individual developments (eg multi-unit developments) are advised by individual developers.

The trial will also help determine what additional facilities may be required to maintain power quality. This could include distribution transformers with on-load-tap-changers (OLTC), voltage regulators or dynamic VAR compensators (DVARs) to manage voltage regulation.

Modern light-emitting diode (LED) streetlight luminaires (typically 22 W each) have replaced compact fluorescent (CFL) streetlight luminaires (typically 42 W) in all new residential streets and alongside open space footpaths. High pressure sodium (HPS) streetlight luminaires (typically 150 W or 250 W) continue to be installed along main arterial roads and to illuminate pedestrian crossings, to meet the requirements of AS/NZS 1158: Lighting for Roads and Public Spaces. The overall reduced power consumption of streetlights has been accounted for in load forecasts.

Viable proposals from third parties that can significantly reduce maximum demand of the Molonglo Valley developments and enable Evoenergy to defer capacity augmentation have to date not been forthcoming. No third party non-network proposals have been received in response to the initial RIT-D public consultation report or the Annual Planning Report or to Evoenergy’s website demand management portal. It is estimated that such proposals would be required to provide an increasing reduction in maximum demand of approximately 3.0 MVA pa to enable the deferral of any network augmentation. This would be in addition to currently proposed rooftop PV installations on all detached dwellings in Denman Prospect.

Any embedded generation must be fuelled by a renewable energy source to comply with the ACT Government’s mandate that all electricity supplied to ACT consumers by 2020 must be generated from renewable sources. The ACT Government also has a target of achieving zero net carbon emissions by 2050. There is no viable hydro, wind, bio-mass or geothermal resource in the Molonglo Valley or surrounding vicinity, which leaves large scale solar generation with associated large scale battery storage as the main possible alternative to network augmentation. Demand reduction measures such as on-site generation, co-generation and tri-generation[1] which are associated with commercial and industrial businesses are unlikely to be applicable in the immediate future and are therefore not considered further.

Establishment of a micro-grid in the Molonglo Valley is not considered viable due to the absence of a reliable and sustainable generation resource. During winter months it is common to have several consecutive days of cloud cover which significantly reduces the output and effectiveness of solar generation.

Evoenergy’s Customer Engagement Strategy is published on our external website and a Demand Management Engagement Strategy is being prepared that will meet the requirements of the NER Section 5.13.1.

All known possible customer and network initiated demand reduction, embedded generation and energy storage solutions have been investigated, with maximum theoretical contribution each could provide estimated (in MVA) and implementation costs estimated. The maximum estimated capacity achievable using non-network and demand management options is 1.06 MVA. This does not meet the minimum capacity required of 4.5 MVA by 2021 to enable the new zone substation and associated 11 kV feeders to be deferred. These are summarised in Table 6.

[1] Tri-generation is the production of electricity, heat and cooling in the one process. Typically this means a gas fired generator producing electricity and heat with the exhaust heat going to an absorption chiller which produces chilled water and hot water for air conditioning or alternatively the heat is used to heat a swimming pool.

Table 6: Summary of non-network options

Non-network Option		Streeton Feeder	Hilder Feeder	Black Mountain Feeder	Total
Controllable load	Capacity	0.03 MVA	0.03 MVA	0.03 MVA	**0.09 MVA**
	Cost	$45,000	$45,000	$45,000	**$135,000**
Energy efficiency	Capacity	0.03 MVA	0.03 MVA	0.03 MVA	**0.09 MVA**
	Cost	$15,000	$15,000	$15,000	**$45,000**
Customer – owned embedded generation	Capacity	0.1 MVA	0.1 MVA	0.1 MVA	**0.3 MVA**
	Cost	$210,000	$210,000	$210,000	**$630,000**
Customer – owned energy storage	Capacity	0.02 MVA	0.02 MVA	0.02 MVA	**0.06 MVA**
	Cost	$84,000	$84,000	$84,000	**$252,000**
Network – owned embedded generation	Capacity				
	Cost				
Power Factor Improvement	Capacity				
	Cost				
Load curtailment	Capacity	0.01 MVA	0.01 MVA	0.01 MVA	**0.03 MVA**
	Cost	$400,000	$400,000	$400,000	**$1,200,000**
Fuel switching	Capacity	0.1 MVA	0.1 MVA	0.1 MVA	**0.3 MVA**
	Cost	$5,000	$5,000	$5,000	**$15,000**
Demand aggregators	Capacity	0.1 MVA	0.1 MVA	0.1 MVA	**0.3 MVA**
	Cost	$100,000	$100,000	$100,000	**$300,000**
Automated feeder load sharing	Capacity				
	Cost				
Totals	Capacity	**0.36 MVA**	**0.36 MVA**	**0.36 MVA**	**1.06 MVA**
	Cost	**$859,000**	**$859,000**	**$859,000**	**$2,577,000**
Network – owned energy storage	Capacity	0.25 MWh	0.25 MWh	0.25 MWh	0.75 MWh
	Cost	$910,000	$910,000	$910,000	$2,730,000

In summary, a maximum demand reduction of 1.06 MVA could be achieved if all the above non-network options were implemented simultaneously, at an estimated cost of $2,577,000.

Notes:

The rates ($/MVA) used to calculate the costs in Table 5 are taken from the "Australian Generation Technology Report" produced by the CO2CRC reference group of the Electric Power Research Institute (EPRI)[2].

A brief description of each of the above non-network options is as follows:

Controllable Load:

Demand reduction achieved by controlling non-essential customer loads such as electric resistance water heaters.

Energy Efficiency:

Demand reduction achieved by replacing inefficient appliances with efficient appliances, eg replacing fluorescent lighting with LED luminaires.

Customer-owned Embedded Generation:

Embedded supply achieved by an increased uptake by customers of solar photovoltaic (PV) generation systems. The existing PV penetration in Molonglo Valley including the mandatory PV requirements in Denman Prospect is accounted for in the load forecast figures in Table 1.

Network-owned Embedded Generation:

Embedded supply achieved by network-owned medium or large-scale generation. There is limited potential for network-owned embedded generation in this area.

[2] http://www.co2crc.com.au/wp-content/uploads/2016/04/LCOE_Report_final_web.pdf

Customer-owned Energy Storage:

Demand reduction achieved by discharging customer-owned battery storage systems at times of peak demand. Estimate is based on a 1% battery uptake by June 2018.

Power Factor Improvement:

Demand reduction achieved by improving power factor. An average power factor of 0.95 has been observed in the Molonglo Valley so there is little scope for improvement.

Load Curtailment:

Demand reduction achieved by voluntary curtailment of load by customers at times of peak demand. Evoenergy is currently undertaking an SMS trial for residents connected to Weir feeder in Belconnen. This trial will indicate the potential effectiveness of this option.

Fuel Switching:

Demand reduction achieved by customers replacing electric appliances such as ovens and stove cooking tops with natural gas fuelled equivalents.

Demand Aggregators:

Demand reduction achieved by a third party Aggregator controlling customers' generation, storage and power usage.

Automated Feeder Load Sharing:

Demand reduction achieved by monitoring feeder loads in real time and automatically switching loads from heavily loaded to lightly loaded feeders.

Network-leased Energy Storage:

Demand reduction achieved by one or more mobile, container sized, network-owned battery energy storage systems at times of peak demand. Due to the size of these batteries site acquisition costs and development approval may be necessary. Batteries are redeployable when no longer needed due to either peak demand reduction or implementation of a network option.

4.1.6. Options Analysis

Table 7 shows a summary of the forecast load growth in the Molonglo Valley for the next 10 years and the ability of the options considered to supply this load growth. These forecast loads make allowance for predicted penetration of rooftop solar PV and battery storage systems. This shows that available thermal capacity of existing feeders (including the extended Hilder feeder) would be exceeded by mid-2021.

The bottom two rows of the table show the impact of the two credible options being considered (ie Option 2: Construction of feeders from existing zone substations, and Option 3: Construction of Molonglo Zone Substation and associated feeders).

Table 7: Forecast Load Growth and Impact of Augmentation Options

Molonglo Valley Development - Load Forecast @ 29.8.18									
Year	2018	2019	2020	2021	2022	2023	2024	2025	2026
Residential Loads (MVA)									
Coombs	0.5	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Wright	0.4	0.7	0.5	0.5	0.2	0.1	0.1	0.1	0.1
Weston	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Denman Prospect	1.8	0.6	1.0	1.0	1.0	1.0	0.5	0.4	0.5
Whitlam		1.9	1.5	1.5	1.5	0.2	0.2	0.2	
Additional Residential Load (MVA) @ 2.5 kVA ADMD	2.9	3.7	3.3	3.3	3.0	1.5	1.0	0.9	0.8
Block Loads (MVA)									
Wright - hotel etc				0.5	0.7				
Denman Prospect Commercial centre						0.5	0.5	0.5	0.5
Stromlo Aquatic Park				0.5					
Stromlo Leisure Centre					1.0	1.0			
North Wright School				0.2					
Additional Non-residential Load (MVA) ADMD	0.0	0.0	0.0	1.2	1.7	1.5	0.5	0.5	0.5
Total Additional Load (MVA) ADMD	2.9	3.7	3.3	4.5	4.7	3.0	1.5	1.4	1.3
Cumulative Additional Load (MVA) ADMD	2.9	6.6	9.9	14.4	19.1	22.1	23.6	25.0	26.3
Spare thermal capacity Streeton and Black Mountain feeders (MVA) - **Do Nothing Option**	7.0	3.3	0.0	-4.5	-9.2	-12.2	-13.7	-15.1	-16.4
Spare thermal capacity Streeton, Black Mountain and extended Hilder feeders (MVA) - **Option 1**	8.4	4.7	1.4	-3.1	-7.8	-10.8	-12.3	-13.7	-15.0
Spare thermal capacity Streeton and Black Mountain feeders and new feeders from Latham and Civic (10 MVA in 2021, 5 MVA in 2023, 5 MVA in 2025) - **Option 2**	7.0	3.3	0.0	5.5	0.8	2.8	1.3	4.9	3.6
Spare thermal capacity Streeton and Black Mountain feeders and Molonglo Zone Substation and feeders (15 MVA in 2021, 15+55 MVA in 2025) - **Option 3**	7.0	3.3	0.0	10.5	5.8	2.8	1.3	54.9	53.6

The forecast load growth for the Molonglo Valley shown in Table 7 above indicates:

- All available thermal capacity of the existing Streeton and Black Mountain feeders would be exhausted by the end of 2020. This is the Do Nothing Option and does not meet the minimum requirements.
- All available thermal capacity of the Streeton, Black Mountain and extended Hilder feeders would be exhausted by winter 2021. This is Option 1 and does not meet the minimum requirements.
- Construction of the new feeders from Latham and Civic zone substations commencing 2021 could provide the additional capacity required. This is Option 2 and meets the project requirements.
- Construction of Molonglo Zone Substation and associated 11 kV feeders commencing 2021 could provide the additional capacity required. This is Option 3 and meets the project requirements.

The Molonglo Valley load forecast is based on the rate of construction as indicated by developers. Evoenergy will continue to connect new customers to the Streeton and Black Mountain feeders until such time as all available spare thermal capacity has been utilised. Under the Do Nothing Option or Option 1, all available spare thermal capacity would be utilised by the end of 2020. Beyond this time the Do Nothing Option or Option 1 would mean that new customers would not be able to be supplied. This would place Evoenergy in breach of its obligation to make supply available to new customers in the ACT.

In addition, Evoenergy's Distribution Network Augmentation Standards require 11 kV feeders to be operated to their maximum firm rating only, not their maximum thermal rating. Loading feeders to their thermal capacity with no backup capacity available from other feeders would be an extremely risky approach that would result in considerable unserved energy in the event of an unplanned outage. It should also be noted that the Black Mountain feeder is an overhead 11 kV line so any cable connections being made to it (to supply Whitlam suburb) would require an outage. This would result in considerable planned unserved energy.

Loss of a feeder will result in unserved energy until repairs are made. Although 8 hours outage duration has been used for “Value of Energy at Risk” calculations (refer Appendix B2), it should be noted that Evoenergy’s maintenance staff do not normally repair cable faults after the hours of darkness. A feeder fault on the existing feeders supplying Molonglo Valley is most likely to occur in the early evening during winter months when the load is greatest. It would typically take 24 hours for such a fault to be located and repaired. Under normal firm-rating conditions, Evoenergy would be able to isolate the faulted section and back-feed from adjacent feeders to reduce customer outage time. This will not be the case when feeders are loaded to their maximum thermal rating.

Construction of new feeders (either from existing zone substations or new Molonglo Zone Substation) must commence by the end of 2020 to be available by winter 2021.

4.1.7. Summary of Options Analysis

Table 8: Summary of Options

Option	Description	Capital Cost 2019-39	Capital Cost 2019-24	20 year Net Present Cost	Outcome
0	Do nothing. Connect all new loads to Streeton and Black Mountain feeders and operate to their thermal ratings.	$0	$0	N/A	Not selected as does not meet need
1	Extend Hilder feeder. Operate Streeton, Black Mountain and Hilder feeders to their thermal ratings.	$4,055,000	$4,055,000	N/A	Not selected as does not meet need
2	Construct new 11 kV feeders from existing zone substations: Five feeders from Latham Zone Substation and Five feeders from Civic Zone Substation.	$28,880,500	$11,998,600	-$16,234,891	Not selected due to lower NPC
3	**Construct new 11 kV feeders from Molonglo Zone Substation (PN 20001374)**	**$4,694,000**	**$4,694,000**	**-$3,346,982**	**Selected due to higher NPC**
	Overall project: **Construct new 11 kV feeders from Molonglo Zone Substation (PN 20001374);** **Construct new Molonglo Zone Substation (PN 17519206)**	**$21,346,600**	**$10,872,600**	**-$10,336,712**	**Selected due to higher NPC**
4	Demand side management and embedded generation	$26,317,128	$6,130,746	-$13,570,947	Not selected as does not meet need
5	Delayed preferred network option using non-network options	$5,556,229	$5,556,229	-$3,552,502	Not selected as deferral not economic

4.2. Recommendation

The selected option is Option 3, the construction of new 11 kV cable feeders from the proposed 132/11 kV Molonglo Zone Substation (plus construction of new Molonglo Zone Substation). Cables are to be installed in stages from 2021-24.

Financial analysis (refer Appendix B) shows Option 3 to be the preferred option as it has the highest net present cost (ie least negative) of all credible options. It also has the lowest capital cost. The overall project, ie construction of new Molonglo Zone Substation and associated 11 kV feeders has the highest NPC of all credible options.

The new feeders will provide capacity and security of supply to the new suburbs being developed in the Molonglo Valley. Some load that is currently supplied by Civic and Woden zone substations via Streeton and Black Mountain feeders, will be transferred to the new Molonglo feeders, to reduce the load on these feeders below their maximum firm ratings.

Timing is scheduled for 2021-24. Future additional feeder cables will be installed as the load growth and demand increases with further development of the Molonglo Valley.

The preliminary estimated cost for the selected option of new 11 kV feeders from Molonglo Zone Substation to be constructed during the 2019-24 Regulatory Control Period is **$4,694,000 excluding overheads, contingency and GST**.

The major assets will add to Evoenergy's regulated asset base and will have an economic life of 50 years.

Proposed 11 kV feeders will provide ties to existing feeders from Latham, Civic and Woden zone substations, and thus provide some backup supply capability and load transfer capability in the future.

The Regulatory Investment Test for Distribution (RIT-D) will be completed in accordance with the National Electricity Rules.

Appendix A: Preliminary Cost Estimates

A.1 Cost Estimate – Option 1: Extend Hilder Feeder

Molonglo Valley : Extend Hilder Feeder to Denman Prospect and Whitlam (requires directional drilling beneath Molonglo River to Whitlam); Overhead to Underground conversion of Black Mountain feeder to provide for Whitlam Estate development.					
Preliminary Estimate ± 30% Accuracy					
Description	**Notes**	**Unit**	**$/Unit**	**Quantity**	**Cost**
Trenching and drilling					$3,297,500
Clearing of route where required	Allowance	m2	$10	3000	$30,000
Directional drilling for Hilder feeder including beneath Molonglo River	Assume drilling with no rock. Assume three conduits per drill.	m	$600	4000	$2,400,000
Open trenching and backfilling for Black Mountain feeder conversion	Assume excavation with no rock.	m	$300	2500	$750,000
Cable jointing and haulage pits	Assume every 500m	ea	$3,000	15	$45,000
Traffic management		m	$5	6500	$32,500
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Site is mostly flat.	m3	$40	1000	$40,000
Cabling works					$624,500
11 kV 3c/400mm2 XLPE cable		m	$56	6500	$364,000
Throughjoints	Assume every 500m	ea	$1,000	15	$15,000
Terminations en route to existing distribiutin substations		ea	$1,500	12	$18,000
Conduit, cable cover and marker tape		m	$15	6500	$97,500
Cable installation labour and plant		m	$20	6500	$130,000
11 kV Switchgear					$8,000
11 kV feeder CBs		ea	$75,000		$0
11 kV Test & Commissioning		lot	$2,000	4	$8,000
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					$125,000
Development Application	Allowance	ea	$10,000	1	$10,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	$15,000	1	$15,000
Project management and administration	Allowance	ea	$100,000	1	$100,000
Project Sub Total without overheads					**$4,055,000**
Overheads					
Overall average overhead rate	Allowance	27%	$1,094,850	1	$1,094,850
Project Sub Total with overheads					**$5,149,850**
Contingency					
All project works	Preliminary allowance	15%	$772,478	1	$772,478
Project budget total					**$5,922,328**

A.2 Cost Estimate – Option 2: 11 kV Feeders to Molonglo Valley from existing zone substations

Molonglo Valley supply from existing substations via new 11 kV feeders. Assume five feeders from Latham @ 9 km each and five from Civic @ 8 km each. Assume two trenches from each substation. Total trenching/boring route length approx 2 x 9 km + 2 x 8 km = 34 km.					
Preliminary Estimate ± 30% Accuracy					
Description	**Notes**	**Unit**	**$/Unit**	**Quantity**	**Cost**
Trenching and drilling					$19,612,000
Clearing of route where required	Allowance	m2	$10	100000	$1,000,000
Directional drilling	Assume drilling with no rock. Assume two or three cables per trench. Assume 75% of 34 km total route	m	$600	25500	$15,300,000
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume two or three cables per trench. Assume 25% of 34 km total route.	m	$300	8500	$2,550,000
Cable jointing and haulage pits	Assume every 500m	ea	$3,000	64	$192,000
Traffic management		m	$5	34000	$170,000
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Site is mostly flat.	m3	$40	10000	$400,000
Cabling works					$7,680,000
11 kV 3c/400mm2 XLPE cable		m	$56	85000	$4,760,000
Throughjoints	Assume every 500m	ea	$1,000	340	$340,000
Terminations	Assume distribution substations at Molonglo established under estate reticulation works.	ea	$1,500	20	$30,000
Conduit and marker tape	Assume all cables installed in conduit	m	$10	85000	$850,000
Cable installation labour and plant		m	$20	85000	$1,700,000
11 kV Switchgear					$770,000
11 kV feeder CBs	Assume able to extend switchboards at Latham & Civic	ea	$75,000	10	$750,000
11kV Test & Commissioning	per CB	lot	$2,000	10	$20,000
Electrical (Secondary System)					$90,500
Protection & Control					$32,500
P&C Secondary Cabling	per feeder panel	ea	$2,250	10	$22,500
P&C Test & Commission	Allowance	ea	$2,500	4	$10,000
DC Supply System					$58,000
DC Cabling	per switchgear panel/bay	ea	$5,000	10	$50,000
DC Test & Commission	Allowance	ea	$2,000	4	$8,000
SCADA					$28,000
SCADA connections for new feeder panels		ea	$2,000	10	$20,000
Test & Commissioning	Allowance	ea	$2,000	4	$8,000
Indirect Costs					$700,000
Development Application	Allowance	ea	$100,000	1	$100,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	$100,000	1	$100,000
Project management and administration	Allowance	ea	$500,000	1	$500,000
Project Sub Total without overheads					**$28,880,500**
Overheads					
Overall average overhead rate	Allowance	27%	$7,797,735	1	$7,797,735
Project Sub Total with overheads					**$36,678,235**
Contingency					
All project works	Preliminary allowance	15%	$5,501,735	1	$5,501,735
Project budget total					**$42,179,970**

A.3 Cost Estimate – Option 3: 11 kV Feeders to Molonglo Valley from Molonglo Zone Substation

Molonglo Valley supply from Molonglo Zone Substation via new 11 kV feeders. Assume seven feeders 2021-24. Others will follow as demand and development requires.					
Preliminary Estimate ± 30% Accuracy					
Description	**Notes**	**Unit**	**$/Unit**	**Quantity**	**Cost**
Trenching and drilling					$2,075,000
Clearing of route where required	Allowance	m2	$10	6000	$60,000
Directional drilling	Assume drilling with no rock. Assume three conduits per drill. Assume drilling across Coulter Drive only (70m). Conduits across William Hovell Drive will be installed by others.	m	$600	1400	$840,000
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume three cables per trench. Assume shared trench down John Gorton Drive.	m	$300	2000	$600,000
Cable jointing and haulage pits	Assume every 500m	ea	$3,000	20	$60,000
Traffic management		m	$5	23000	$115,000
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Site is mostly flat.	m3	$40	10000	$400,000
Cabling works					$2,255,000
11 kV 3c/400mm2 XLPE cable		m	$56	23000	$1,288,000
Throughjoints	Assume every 500m	ea	$1,000	26	$26,000
Terminations	Assume distribution substations at Molonglo established under estate reticulation works.	ea	$1,500	14	$21,000
Conduit and marker tape	Assume all cables installed in conduit	m	$10	46000	$460,000
Cable installation labour and plant		m	$20	23000	$460,000
11 kV Switchgear					$14,000
11 kV feeder CBs	Assume all supplied and equipped at Molonglo ZS	ea	$75,000		$0
11kV Test & Commissioning	per CB	lot	$2,000	7	$14,000
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					$350,000
Development Application	Allowance	ea	$50,000	1	$50,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	$50,000	1	$50,000
Project management and administration	Allowance	ea	$250,000	1	$250,000
Project Sub Total without overheads					**$4,694,000**
Overheads					
Overall average overhead rate	Allowance	27%	$1,267,380	1	$1,267,380
Project Sub Total with overheads					**$5,961,380**
Contingency					
All project works	Preliminary allowance	15%	$894,207	1	$894,207
Project budget total					**$6,855,587**

Appendix B: Financial Analysis

B.1 Capital Expenditure Cash Flow for Each Option

Financial Year	Option 2	Option 3	Option 4*	Option 5**
2019-20				
2020-21	$10,777,910		$3,170,077	$862,229
2021-22		$1,341,143	$538,304	$1,341,143
2022-23	$1,220,780	$1,341,143	$1,076,607	$1,341,143
2023-24		$2,011,714	$1,345,759	$2,011,714
2024-25	$1,220,780		$1,345,759	
2025-26			$1,345,759	
2026-27	$1,220,780		$1,345,759	
2027-28			$1,345,759	
2028-29	$10,777,910		$1,345,759	
2029-30			$1,345,759	
2030-31	$1,220,780		$1,345,759	
2031-32			$1,345,759	
2032-33	$1,220,780		$1,345,759	
2033-34			$1,345,759	
2034-35	$1,220,780		$1,345,759	
2035-36			$1,345,759	
2036-37			$1,345,759	
2037-38			$1,345,759	
2038-39			$1,345,759	
Total Cost (20 years)	**$28,880,500**	**$4,694,000**	**$26,317,128**	**$5,556,229**
2019-24 Regulatory Control Period Cost	**$11,998,600**	**$4,694,000**	**$6,130,746**	**$5,556,229**

* Option 4 utilises a network owned battery which is modular and redeployable and has a 10 year lifetime. The battery is costed on a lease-like basis.

** Deferral in Option 5 is not exercised as it is not economic.

B.2 NPC Analysis

The Net Present Cost (NPC) was calculated using a Monte-Carlo simulation model. The simulation randomly selects a peak demand growth rate for each year that is within ± 10% of the forecasted loads expected in the Molonglo Valley. 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 11 kV Supply to Molonglo Valley

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

Options:

Two – new 11 kV feeders from Latham and Civic zone substations – credible option.
Three – new 11 kV feeders from Molonglo Zone Substation – credible part option.
Four – best non-network option (network battery) – non-credible option.
Five – best mixed network and non-network combination (option two plus network battery) – non-credible option.
Overall project – new Molonglo Zone Substation and 11 kV feeders from Molonglo Zone Substation – credible selected option.

RESULTS (Average over 50 simulations):

Option:	Two	Three	Four	Five	Overall
NPC (2019-2024)	-$8,911,396	-$3,043,324	-$4,772,354	-$3,552,502	-$8,151,917
NPC (2019-2039)	-$16,234,891	-$3,346,982	-$13,570,947	-$3,856,159	-$10,336,712
Network Option total Capital Cost	$28,880,500	$4,694,000	-	$4,694,000	$21,346,600
Option Capital Cost (2019-2024)	$11,998,600	$4,694,000	$6,130,746	$5,556,229	$10,872,600
Option Capital Cost (2019-2039)	$28,880,500	$4,694,000	$26,317,128	$5,556,229	$21,346,600

The overall project (Molonglo Zone Substation plus feeders) is the preferred option as it has a higher (ie less negative) net present cost than Option 2, the only other credible option. The overall project also has a lower total capital cost than Option 2.

Unserved Energy:

The volume of unserved energy in kWh under the Do Nothing option is shown in the following table:

Year	Volume of Unserved Energy (kWh)	Value of Unserved Energy
2019	270,151	$7,275,166
2020	4,609,263	$124,127,453
2021	14,033,828	$377,930,988
2022	26,082,962	$702,414,167
2023	33,927,252	$913,660,896
2024	37,205,482	$1,001,943,630

Notes:

The amount of load and duration above the firm rating of each existing feeder has been calculated using the actual historical load profile curve for each feeder plus the expected load profile curves of forecast new loads.

Unserved energy = (load above feeder firm rating x probability of an outage occurring at the time of such exceedance x outage duration) + all load above feeder thermal rating (ie when the load exceeds the thermal rating of the feeder, all such energy is assumed to be unserved).

Value of Unserved Energy assumes:

- Value of Customer Reliability = $26.93/kWh. This is the figure published by AEMO in 2014 for Residential Customers.
- CPI = 2% pa.
- Probability of failure of supply to a customer = 6% (= 3% probability of zone transformer failure + 3% probability of feeder failure).
- Probability of failure in any given hour = 6% / (24 x 365).
- Outage duration = 8 hours. This is a conservative figure as cable faults can often take longer than 8 hours to locate and repair.
- Value of unserved energy = Volume of unserved energy x VCR.
- All energy above the thermal rating is not served. This is equivalent to assuming a 100% outage probability for energy above this level.

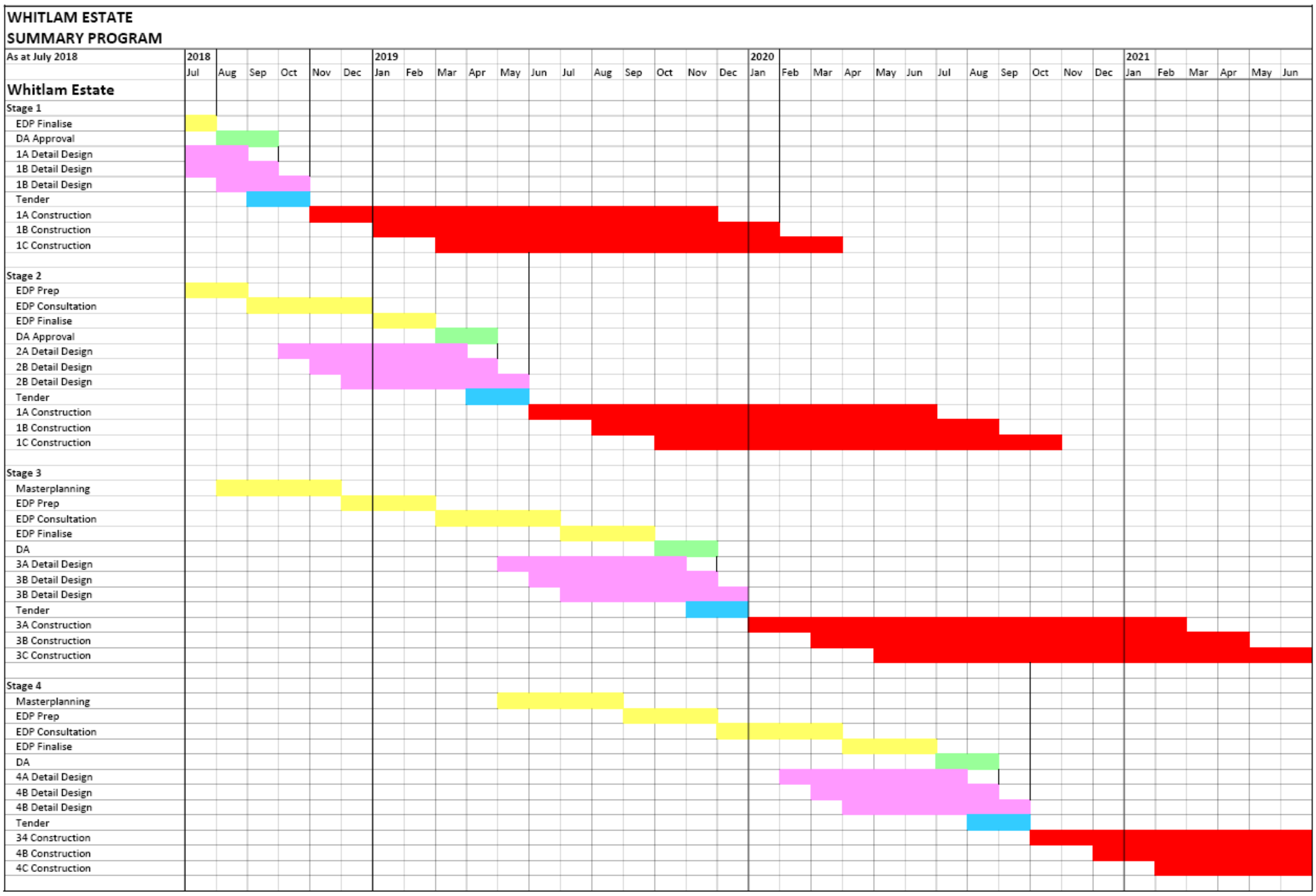
At the time of investment the value of unserved energy exceeds the annualised cost of this proposed augmentation, so the proposed new Molonglo Zone Substation and associated 11 kV feeders are considered to be economically justified.

In addition to the value of unserved energy, there are litigation, reputational and other financial risks to be added to the overall risk cost as follows:

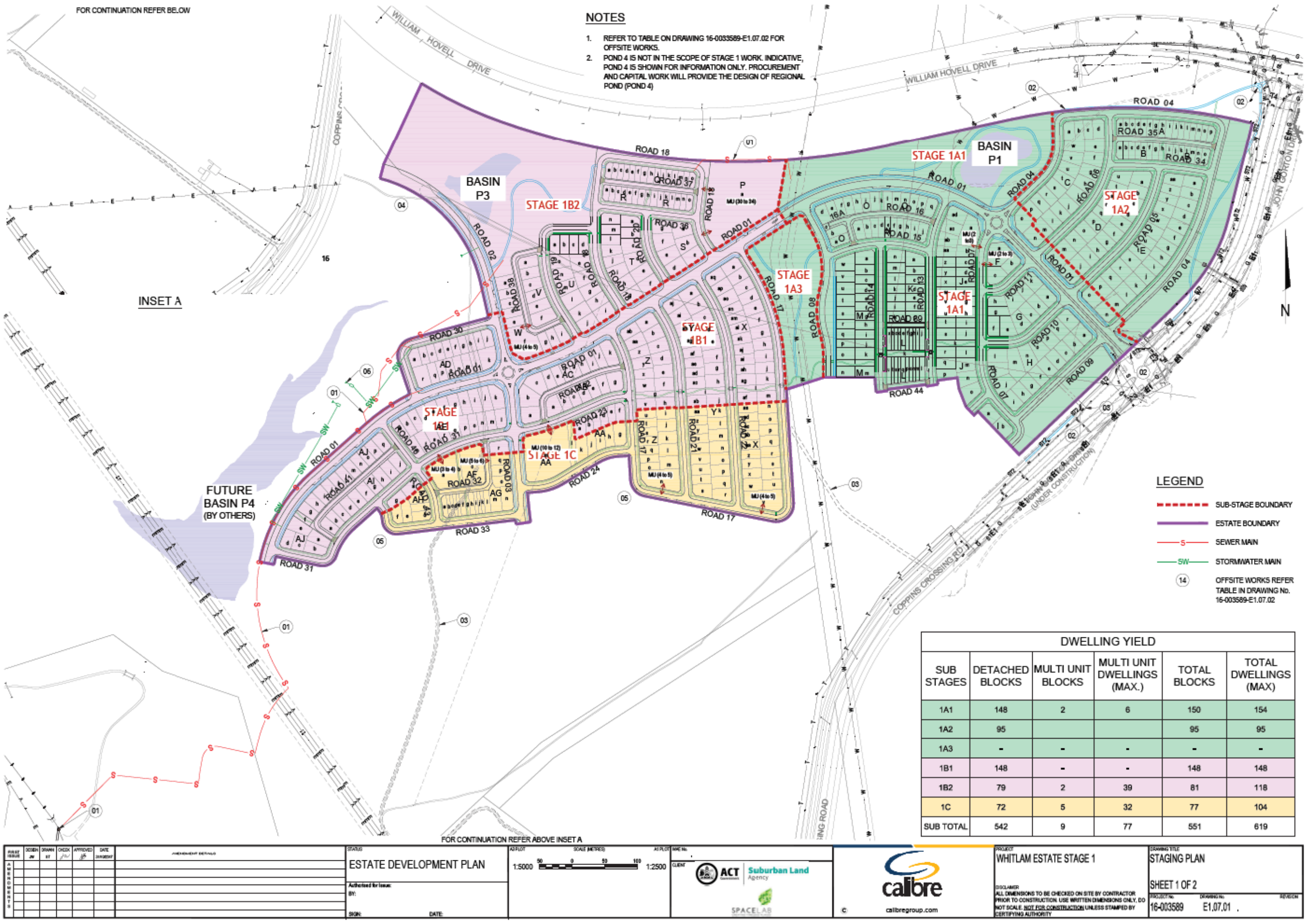
Litigation costs = $100,000 / event.
Reputational risk cost = external consultations and communications costs = $10,000 / event.
Financial risk cost = internal investigation costs = $10,000 / event.

Total risk cost = Reliability risk cost + Litigation + Reputational risk cost + Financial risk cost
= Value of unserved energy + $120,000 / event.

Appendix C: Whitlam Estate Development Program



Appendix D: Whitlam Estate Stage 1



DWELLING YIELD					
SUB STAGES	DETACHED BLOCKS	MULTI UNIT BLOCKS	MULTI UNIT DWELLINGS (MAX.)	TOTAL BLOCKS	TOTAL DWELLINGS (MAX)
1A1	148	2	6	150	154
1A2	95			95	95
1A3	-	-	-	-	-
1B1	148	-	-	148	148
1B2	79	2	39	81	118
1C	72	5	32	77	104
SUB TOTAL	542	9	77	551	619