

Appendix 5.28: Supply to Kingston PJR

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

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

Project Justification Report

Project name	Supply to Kingston
Expenditure type	Capital Expenditure
Business Group	Asset Strategy
Regulatory Period	1 July 2019 to 30 June 2024
Total Project Cost Estimate	\$712,950 excluding corporate overheads, excluding contingency, and excluding GST
Five year total spend 2019-24	\$712,950 excluding corporate overheads, excluding contingency, and excluding GST
CAPEX category	ENAA Distribution
Primary driver	Load growth in Kingston Foreshore area
Project Number	20001375

Contents

Reference documents	3
1. Executive Summary.....	4
2. Strategic Context and Expenditure Need.....	5
2.1. Existing infrastructure in the Kingston Foreshore area	5
2.2. Driving need for infrastructure investment	6
2.3. The Kingston Foreshore development.....	7
2.4. Other investments associated with the Kingston Foreshore development.....	9
3. Objectives.....	11
3.1. Corporate, asset management and key project objectives	11
3.2. Regulatory Compliance	12
3.2.1. National Electricity Law and National Electricity Rules.....	12
3.2.2. Capital Expenditure Objectives and Criteria.....	12
3.2.3. Regulatory Investment Test	13
3.2.4. Utilities Act 2000 (ACT).....	13
3.2.5. Evoenergy’s Distribution Network Augmentation Standards	13
3.2.6. Cost compliance.....	14
4. Options Assessment.....	15
4.1. Options analysis	15
4.1.1. Do Nothing Option	15
4.1.2. Option 1: Construct three new 11 kV cable feeders from Telopea Park Zone Substation	15
4.1.3. Option 2: Construct three new 11 kV cable feeders from East Lake Zone Substation	16
4.1.4. Option 3: Demand Management	17
4.1.5. Option 4: Grid battery to defer Option 2	18
4.1.6. Option 5: Grid battery only.....	18
4.1.7. Summary of Options Analysis.....	18
4.2. Recommendation	19
Appendix A – Preliminary Cost Estimates	20
A.1 Cost Estimate – Option 1: 11 kV Feeders from Telopea Park Zone Substation to Kingston Foreshore.....	20
A.2 Cost Estimate – Option 2: 11 kV Feeders from East Lake Zone Substation to Kingston Foreshore.....	21
Appendix B – Financial Analysis	22
B.1 Capital Expenditure Cash Flow for Each Option.....	22
B.2 NPC Analysis	23

Reference documents

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

1. Executive Summary

The ACT Government's Suburban Land Agency (SLA) is developing the area of land at the eastern end of Lake Burley-Griffin between Kingston and Fyshwick, including commercial and residential developments.

The development will comprise approximately 3,850 residential dwellings, a commercial area and a school. The residential dwellings will be primarily multi-storey apartments.

The load forecast for this development is estimated to be 9.7 MVA, comprising 7.7 MVA of residential load and 2.0 MVA of commercial and community use (school) load.

There are three existing 11 kV feeders to this area from Telopea Zone Substation and one from East Lake Zone Substation. Together have approximately 4.4 MVA of spare firm capacity available only. Telopea Park Zone Substation has a continuous summer rating of 100 MVA and is approaching this maximum demand level, so has little spare capacity available for this development. There are no spare 11 kV feeder circuit breakers at Telopea Park.

East Lake Zone Substation, located on the eastern side of Dairy Road, Fyshwick was commissioned in 2013. It currently has one 132/11 kV 30/55 MVA transformer and one 11 kV switchboard. This switchboard has 6 spare feeder circuit breakers available. A second transformer and switchboard are proposed to be installed by 30 June 2019. This will provide ample capacity, security and spare 11 kV feeder circuits for the connection of new feeders. It is a strategic objective of Evoenergy to supply load to proposed and future developments in the Kingston area from East Lake Zone Substation and off-load Telopea Park and Fyshwick zone substations.

This project proposes three new 11 kV cable feeders to be installed from East Lake Zone Substation to the Kingston Foreshore area from existing spare feeder circuit breakers. The length of each feeder will be approximately 2.0 km and each will have a firm summer capacity of 5.5 MVA. Spare conduits will be installed for future feeders to supply future stages of development in the Kingston / East Lake area.

The proposed feeders will inter-tie with existing feeders emanating from Telopea Park, and thus enable load to be transferred from Telopea Park to East Lake.

Under a separate SLA-funded proposal, sections of Evoenergy's overhead transmission network between East Lake Zone Substation and Kingston are proposed to be converted to underground cables and the Causeway Switching Station decommissioned and removed by December 2020. Spare 150mm diameter conduits will be installed with these cables for the proposed East Lake to Kingston 11 kV feeders thus reducing the cost of this project.

Other options considered include the installation of additional feeders from Telopea Park, demand management, and a grid battery. The additional feeders from Telopea Park was excluded due to the high net present cost (compared with the preferred option). Demand management was not considered feasible due to insufficient existing capacity such that there is a requirement for greater than 40% of new demand to be offset. The grid battery was excluded due to its 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 feeders from East Lake to Kingston Foreshore is **\$712,950 excluding corporate overheads, excluding contingency, and excluding GST**. Feeder installations will be carried out to coordinate with the 132 kV overhead to underground conversion project (conduits will be provided and installed by this project). These works will be carried out during the 2019-24 Regulatory Control Period with proposed completion by December 2020.

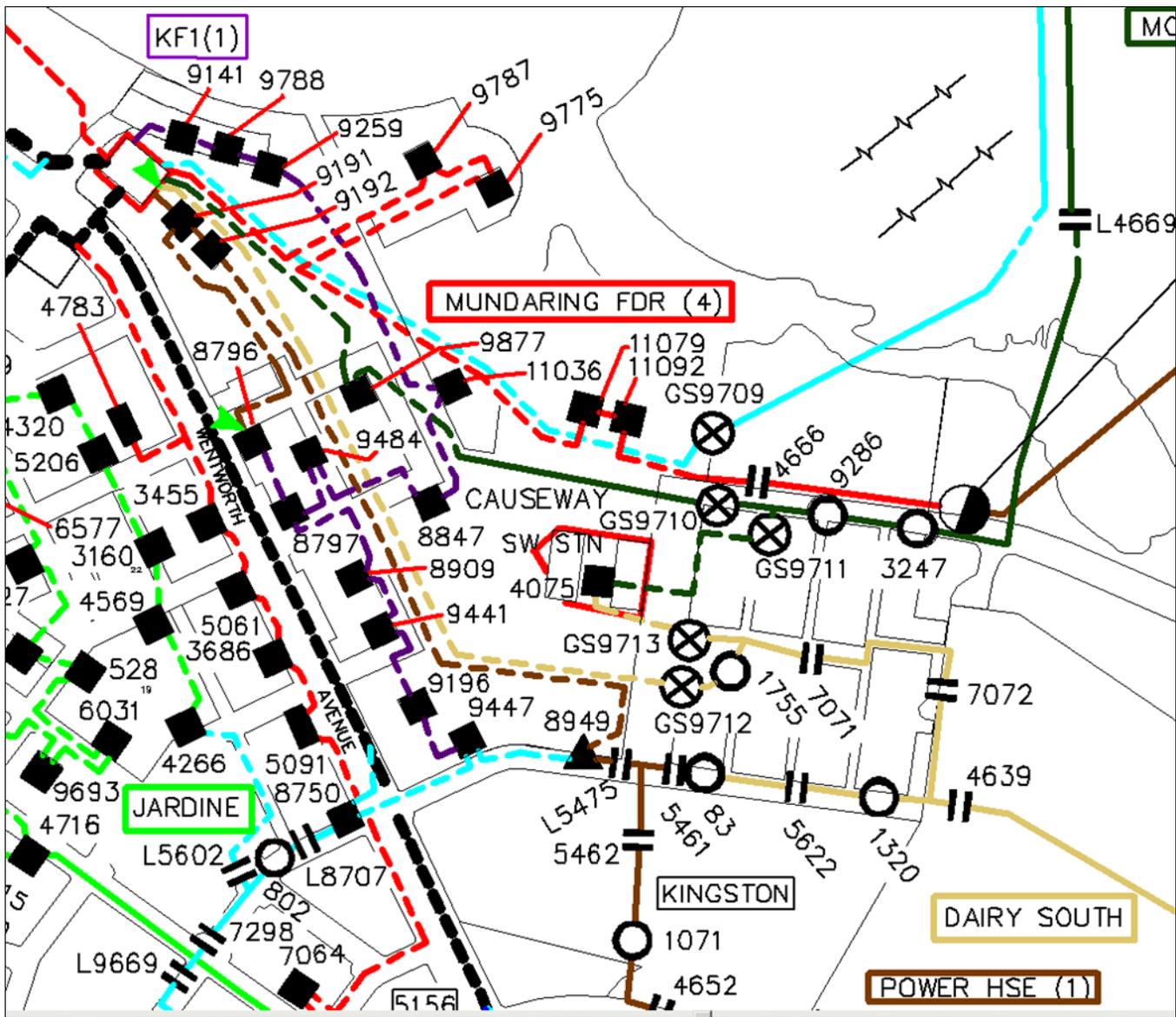
2. Strategic Context and Expenditure Need

There is significant development planned for the Kingston Foreshore area which is at the eastern end of Lake Burley-Griffin. Existing infrastructure has insufficient capacity to cater for the additional demand associated with the development.

2.1. Existing infrastructure in the Kingston Foreshore area

There are currently four 11 kV feeders supplying the Kingston area. These are Mundaring, Power House and KF1 feeders from Telopea Park Zone Substation and Dairy South feeder from East Lake Zone Substation. The existing feeder network is illustrated in Figure 1.

Figure 1: Existing 11 kV Feeders supplying Kingston Foreshore



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.

Table 1: Kingston Foreshore Feeder Loadings

Feeder Name	Zone	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	
Mundaring	TP	5.0	6.8	5.7	7.6	47%	60%	58%	64%	58%	2.1
Power House	TP	4.1	4.6	5.4	6.1	84%	68%	80%	68%	75%	1.0
KF1	TP	4.9	6.5	5.4	7.2	68%	72%	68%	47%	69%	1.5
Dairy South	EL	6.1	8.1	6.8	9.1	94%	98%	103%	134%	103%	-0.2
Total											4.4

2.2. Driving need for infrastructure investment

Forecast additional maximum demand in the Kingston area is indicated in Table 2. This has been based on an assessment of known developments (either at application or Preliminary Network Advice stage) proposed for the area. Some of these developments are either under construction or currently being designed. There is a high degree of certainty (> 80%) that these developments will proceed. In addition there are several potential smaller load increases. Some will be supplied from Telopea Park or Fyshwick zone substations but as load increases on Telopea Park and Fyshwick feeders, there will be the need to offload onto East Lake feeders.

Table 2: Proposed Developments in the Kingston area.

Proposed Development and Net Additional Diversified Load in MVA	2018	2019	2020	2021	2022	2023
Kingston Foreshore Development, Causeway	1.0	2.0	2.0	2.0	2.0	2.0
Kingston Arts Centre Precinct			0.5	0.5	0.5	
Additional Load (MVA)	1.0	2.0	2.5	2.5	2.5	2.0
Cumulative Additional Forecast Load (MVA)	1.0	3.0	5.5	8.0	10.5	12.5
Spare capacity of existing feeders to Kingston Foreshore area	3.4	1.4	-1.1	-3.6	-6.1	-8.1

The 11 kV feeders that currently supply the Kingston Foreshore area are Mundaring, Power House and KF1 from Telopea Park, and Dairy South from East Lake. Between them these feeders have approximately 4.4 MVA spare firm capacity during summer. The proposed developments shown in Table 2 indicate there will be no spare capacity available from summer 2020 onwards so additional feeders will be required unless demand side management initiatives can avoid this.

With Telopea Park Zone Substation approaching its firm rating, it is preferred that any new feeders emanate from East Lake Zone Substation which will have ample spare capacity following the proposed installation of a second transformer by June 2019. These new feeders would inter-tie with feeders from Telopea Park thus providing backup security in the event of a contingency at Telopea Park.

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.

Project Justification Report – Supply to Kingston

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.”

2.3. The Kingston Foreshore development

The vision for the Kingston Foreshore is stated on the SLA’s website as follows:

“The Kingston Foreshore area at the eastern end of Lake Burley-Griffin is being developed by the ACT Government’s Suburban Land Agency (SLA) as a mixed use waterfront precinct with a strong arts, cultural, tourism and leisure theme. The overall vision for Kingston Foreshore is to rejuvenate an under-utilized industrial area and to create a mix of retail, commercial, residential and recreational areas while preserving its overall historical significance. Kingston Foreshore will be the leading arts, recreation, cultural and community location in Canberra.”

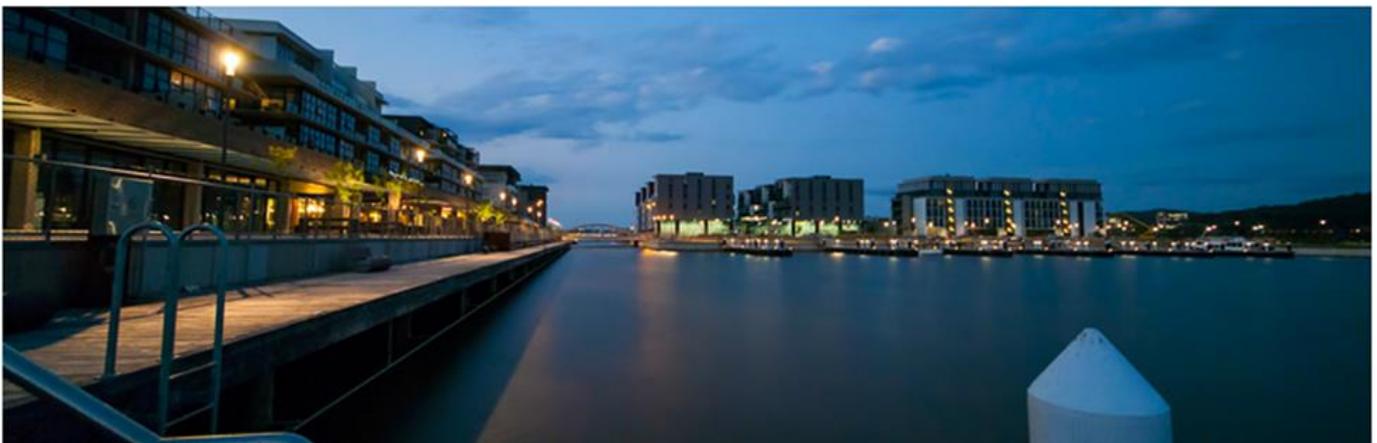
Redevelopment of the Kingston Foreshore area commenced 5 years ago and is continuing with the construction of multi-storey apartment buildings, commercial and retail. More apartment buildings are proposed and the carpark area near the Glassworks is to be redeveloped as an Arts Precinct. The area is planned to include 20 apartment buildings, 50 shops and restaurants, and recreational facilities such as gyms.

Modern apartment buildings are trending to be all-electric and feature instantaneous electric hot-water heating systems in each unit. In future they are expected to include electric vehicle charging facilities in their basement carparks. Typical maximum demand of an apartment building is approximately 0.5 MVA, and these maximum demands are coincident (eg all residents would require heating, cooling or cooking power demand at the same time). Apartment buildings do not currently feature any rooftop solar photovoltaic (PV) generation facilities or battery energy storage systems, though this could change in the future as advancements are made in technology (such as solar roofs) and prices decrease (particularly for battery systems).

Load to this area is currently supplied from Telopea Park Zone Substation which has a continuous firm rating of 100 MVA. There is load increase forecast in other areas supplied by Telopea Park Zone Substation, eg residential redevelopments proposed for Griffith, Forrest, Narrabundah and Red Hill suburbs.

Figure 2 shows typical residential / retail developments along the Kingston Foreshore.

Figure 2: Kingston Foreshore Boat Harbour



The maximum demand at Telopea Park Zone Substation is forecast to exceed its continuous rating of 100 MVA by 2022. It is desired to transfer some load from Telopea Park to East Lake.

Figure 3 shows the Kingston Foreshore development master plan (source SLA).

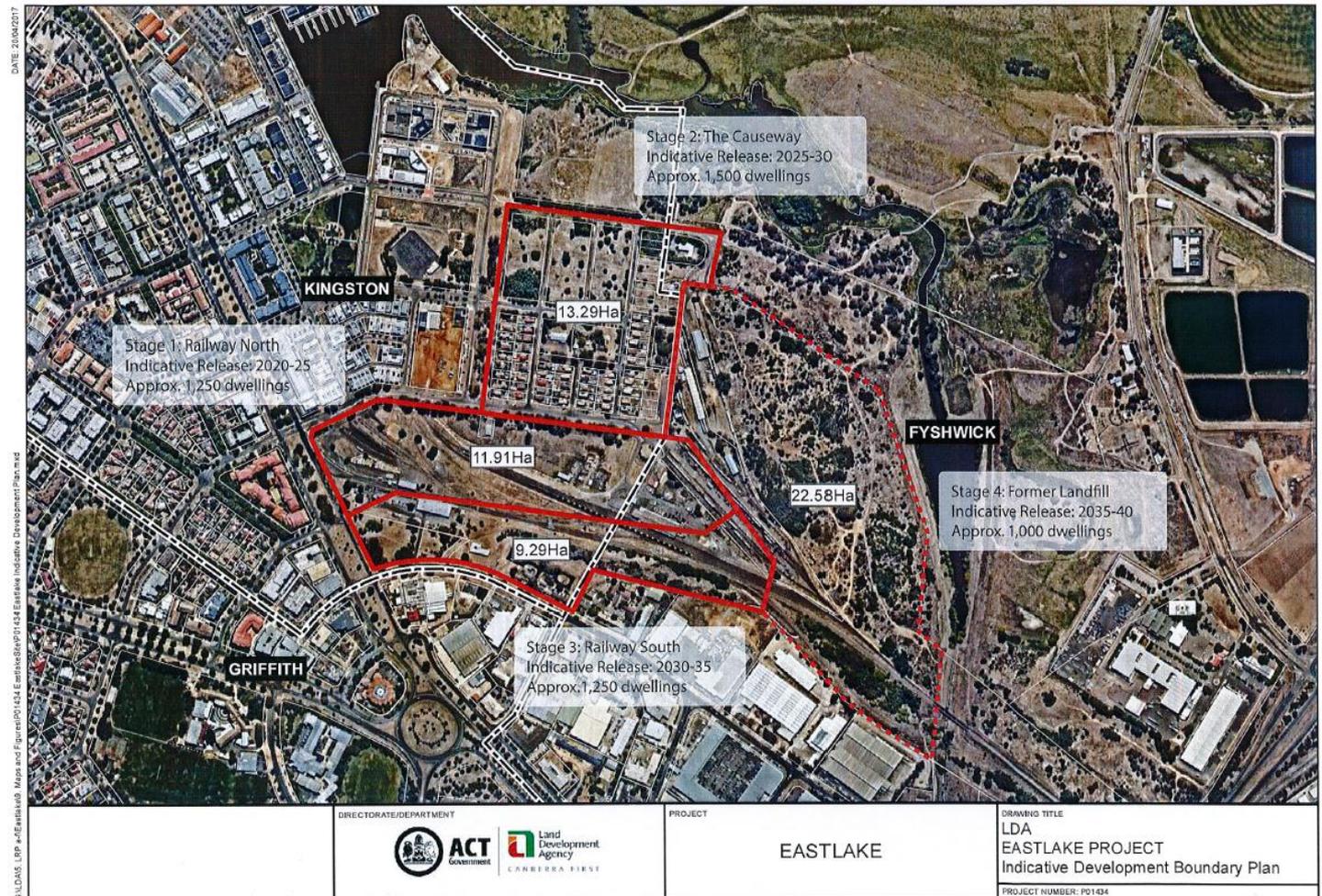
Figure 3: Kingston Foreshore master plan (source SLA)



Project Justification Report – Supply to Kingston

The above master plan covers Stage 1 of the overall Kingston / East Lake development plan. Figure 4 illustrates the SLA's long term development plan for the area.

Figure 4: Kingston – East Lake long term development plan (source SLA)



2.4. Other investments associated with the Kingston Foreshore development

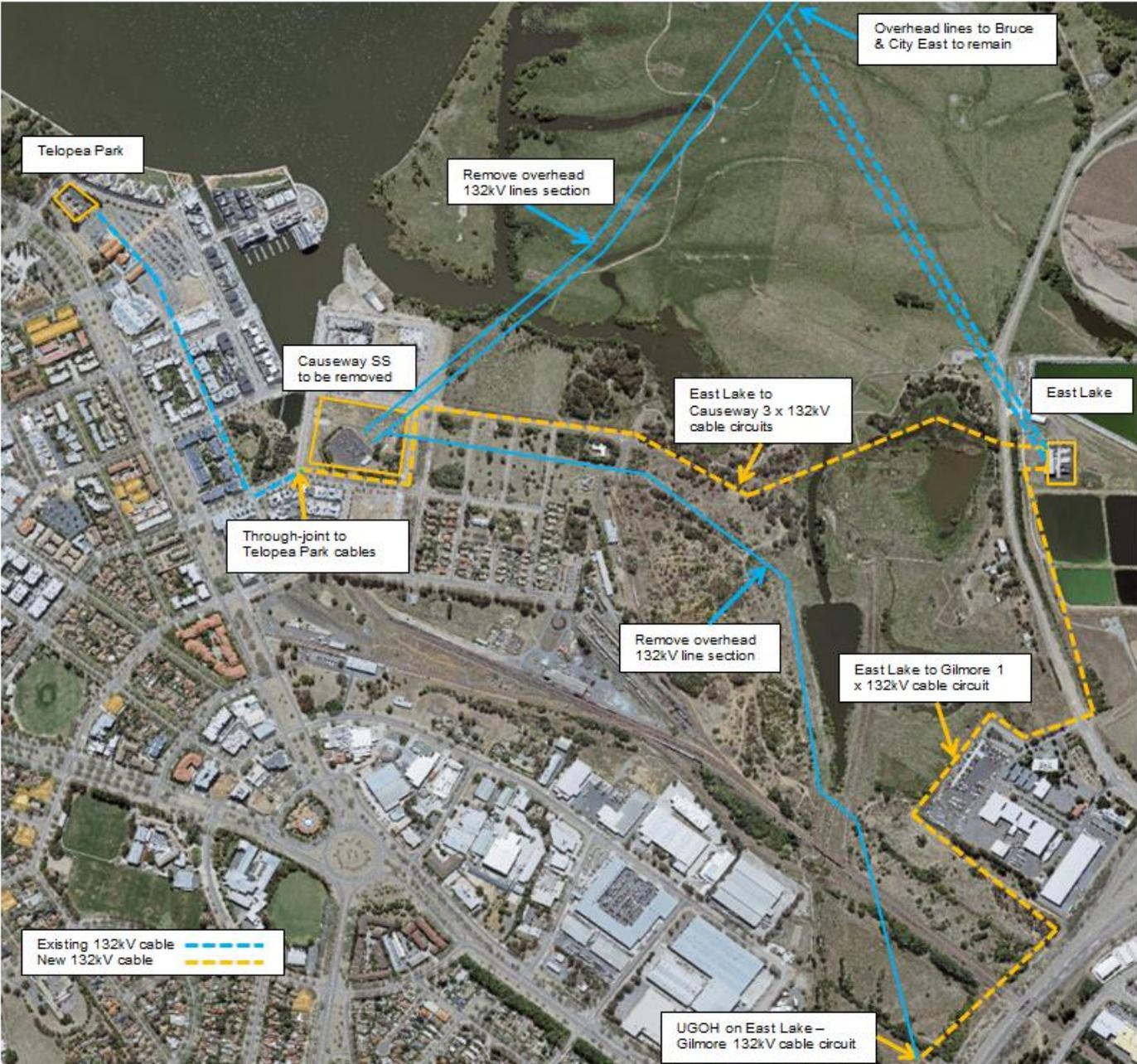
The Causeway Switching Station located in the Kingston suburb at the eastern end of Lake Burley-Griffin, provides a point of 132 kV interconnection between City East, East Lake, Telopea Park and Gilmore zone substations.

Connections to Causeway Switching Station comprise three 132 kV underground cable circuits to Telopea Park Zone Substation, a single circuit 132 kV overhead line to Gilmore Zone Substation, a single circuit 132 kV overhead line to City East Zone Substation, and a single circuit 132 kV overhead line to East Lake Zone Substation. Sections of these latter two lines traverse the Jerrabomberra wetlands nature reserve.

The SLA has requested Evoenergy to convert the 132 kV overhead lines in the vicinity of Causeway Switching Station to underground cables and decommission the switching station. The switching station site will then be redeveloped for residential use. The proposed scope of works is illustrated in Figure 5. These works are proposed to be carried out by December 2020.

Trenching and directional drilling will be undertaken from East Lake Zone Substation to Causeway Switching to enable the installation of 132 kV power cables. It is proposed to install spare 150mm diameter conduits in these trenches for the installation of 11 kV feeder cables as proposed in this Project Justification Report. This will significantly reduce the works and costs associated with this 11 kV feeder project.

Figure 5: Decommissioning of Causeway Switching Station – Proposed Works



3. Objectives

3.1. Corporate, asset management and key project objectives

The corporate, asset management and related key project objectives are shown in Table 3 below. These objectives are used to assess the relative risk of options.

Table 3: Corporate, asset management and key project objectives

Corporate objectives	Asset management objectives	Key project objectives
Responsible	<ul style="list-style-type: none"> Achieve zero deaths or injuries to employees or the public. Maintain a good reputation within the community. Minimise environmental impacts, for example bushfire mitigation. Meet all requirements of regulatory authorities, such as the AER as outlined in the NER, and the ACT Utilities (Technical Regulations) Act 2014. 	The selected option must ensure environment and safety standards will be met.
Reliable	<ul style="list-style-type: none"> Tailor maintenance and renewal programs for each asset class based on real time modelling of asset health and risk. Meet network SAIDI and SAIFI KPIs. Record failure modes of the most common asset failures in the network. Successfully deliver the asset class Program of Work (PoW) to ensure that the protection operates correctly to disconnect faulty sections in accordance with the NER. 	<p>Options evaluations to consider the value of customer reliability (VCR).</p> <p>In accordance with regulated requirements, the selected option must ensure access to an electricity supply.</p>
Sustainable	<ul style="list-style-type: none"> Enhance asset condition and risk modelling to optimise and implement maintenance and renewal programs tailored to the assets' needs. Make prudent commercial investment decisions to manage assets at the lowest lifecycle cost. Integrate primary assets with protection and automation systems in accordance with current and future best practice industry standards Deliver the asset class PoW within budget. 	<p>Options evaluations to consider the cost effectiveness of the solution.</p> <p>In accordance with regulated requirements, the selected option must be the most prudent and efficient.</p> <p>Non-network options will be evaluated on equal merit with network solutions.</p>
People	<ul style="list-style-type: none"> Proactively seek continual improvement in asset management capability and competencies of maintenance personnel. 	A post implementation review to incorporate learnings through the asset management system.

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

3.2. Regulatory Compliance

3.2.1. National Electricity Law and National Electricity Rules

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

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

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

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

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

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

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

3.2.2. Capital Expenditure Objectives and Criteria

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

- 1) Meet or manage the expected demand for standard control services*
- 2) Comply with all applicable regulatory obligations or requirements associated with the provision of standard control services*
- 3) To the extent that there is no applicable regulatory obligation or requirement in relation to the quality, reliability or security of supply of standard control services; or the reliability or security of the distribution system through the supply of standard control services, to the relevant extent:*
 - a) Maintain the quality, reliability and security of supply of standard control services*
 - b) Maintain the reliability and security of the distribution system through the supply of standard control services*
- 4) Maintain the safety of the distribution system through the supply of standard control services.*

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

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

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

3.2.3. Regulatory Investment Test

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

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

Since the required investment is greater than \$5million the project is subject to the RIT-D. Evoenergy commenced RIT-D process in 2014 with publication of a Project Specification Consultation Report, but has yet to complete the RIT-D process (ie publication of Draft Project Assessment Report and Final Project Assessment Report). These reports will need to be prepared as part of the development of this project. The initial RIT-D consultation paper published in 2014 recommended establishing a new zone substation at the Arboretum site (comprising two transformers and two switchboards) by 2017-18, but lower load growth rate has enabled this to be deferred to 2021-22.

3.2.4. Utilities Act 2000 (ACT)

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

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

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

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

3.2.5. Evoenergy's Distribution Network Augmentation Standards

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

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

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

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

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

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

Table 4: Feeder Firm Rating standard

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

3.2.6. Cost compliance

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

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

¹ “N” represents the number of feeders operating in parallel.

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

4. Options Assessment

Evoenergy has considered five options to provide additional capacity to the Kingston Foreshore area as listed in Table 5.

Table 5: Options considered for provision of additional capacity to the Kingston Foreshore area

Option	Option type	Description	Evaluation
0	Network	Do nothing	Not selected as does not meet minimum requirements
1	Network	Construct three new 11 kV cable feeders from Telopea Park Zone Substation	Not selected due to lower NPC
2	Network	Construct three new 11 kV cable feeders from East Lake Zone Substation	Selected as higher NPC
3	Non-network	Demand side management and embedded generation	Not selected as does not meet minimum requirements and lower NPC
4	Mixed	Grid battery to defer option 2	Not selected as cost of delay exceeded benefits
5	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 \$878 over a five year period based on the probability of a contingency event at the same time as demand exceeding firm capacity.

Despite, the relatively low value of energy at risk, the Do Nothing option would result in ActewAGL 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 Telopea Park Zone Substation

Option 1 considers the installation of three new underground 11 kV cable feeders to the Kingston Foreshore area from Telopea Park Zone Substation to meet the growing load demand. Each feeder would provide up to 3.5 MVA firm capacity (summer).

Telopea Park Zone Substation has three 132/11 kV 50 MVA power transformers providing a continuous firm summer/winter rating of 100 MVA. The substation has three 11 kV switchboards comprising a total of 36 feeder circuit breakers each rated at 800 Amps. The switchboards are GEC double bus type 1985 vintage.

There are no spare feeder circuit breakers available. There are three feeders that are lightly loaded (< 10% of their firm rating). These feeders are Mundaring, Power House and Sandalwood. Under this option these three feeder cables would be disconnected and doubled-up with other lightly loaded feeders (eg York No1, York No 2 and Mildura) to the

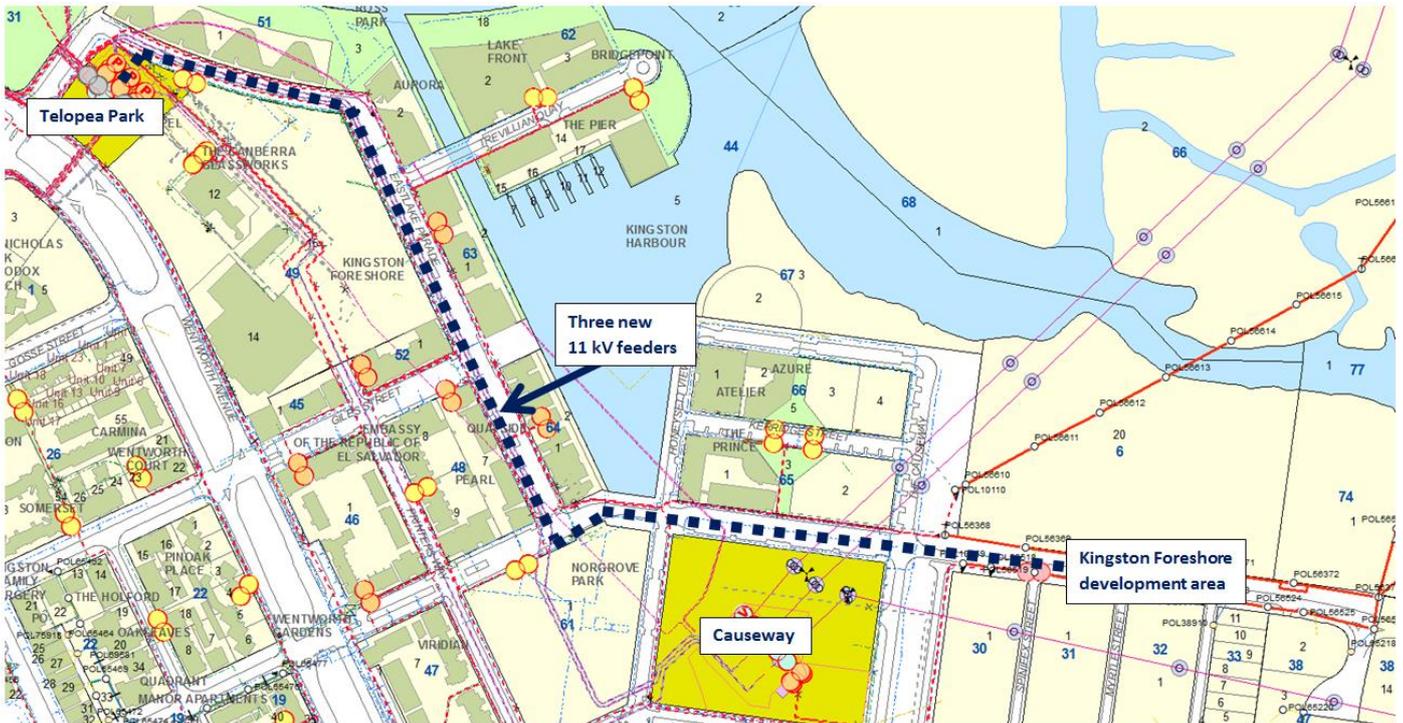
Project Justification Report – Supply to Kingston

same circuit breakers, thus freeing-up three circuit breakers for connection of proposed new Kingston Foreshore feeders.

The cable route length would be approximately 2.0 km and due to the heavily built up nature of the area, these cables would need to be installed full length via directional drilling. Three 150mm conduits would be installed via directional drilling to accommodate three 11 kV 3c/400mm² AL XLPE feeder cables.

Figure 6 illustrates the proposed cable route.

Figure 6: Proposed 11 kV feeder cable route Telopea Park Zone Substation to Kingston Foreshore



A preliminary cost estimate for Option 1 is **\$2,196,250 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

Option 1 is not selected due to its lower NPC, and constructability issues (ie directional drilling and excavation of cable haulage pits through built up area). It is also not good industry practice to connect two feeder cables to one circuit breaker.

4.1.3. Option 2: Construct three new 11 kV cable feeders from East Lake Zone Substation

Option 2 proposes to install three new underground 11 kV cable feeders from East Lake Zone Substation to supply new loads in the Kingston Foreshore area and offload Telopea Park Zone Substation. Each feeder would provide up to 5.5 MVA firm capacity (summer).

It is proposed that the new feeders to Kingston would be installed in association with the proposed East Lake – Causeway 132 kV underground cabling project. This is a customer-driven project (SLA), currently scheduled for completion by June 2020. Cable route is approximately 1.4 km. Spare 150mm conduits for 11 kV feeder cables will be installed by the SLA as part of this project.

Figure 7 illustrates the proposed cable route.

Figure 7: Proposed 11 kV feeder cable route East Lake Zone Substation to Kingston Foreshore



The preliminary estimated cost of this option is **\$712,950 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B. Timing of additional feeder cables will depend on the rate of load growth in the Kingston – East Lake area, which will be monitored and forecast carefully.

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

4.1.4. Option 3: Demand Management

Option 3 considers non-network initiatives including:

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

These options are further discussed within the Demand Management Paper.

To defer the Kingston feeders to the next Regulatory Control Period (beyond 2024), it is estimated that non-network solutions would need to provide a maximum demand of approximately 7.1 MVA.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 0.777 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	0.7 MVA
Customer – owned energy storage	0.07 MVA
Load curtailment	0.007 MVA
Totals	0.777 MVA

Project Justification Report – Supply to Kingston

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 Kingston it was determined that more than 40% of demand growth would need to be offset by demand management to enable the project to be deferred, implying that new demand management is unlikely to defer investment.

4.1.5. Option 4: Grid battery to defer Option 2

This option utilises a grid battery to enable Option 2 to be deferred. This option has the advantage of deferring the investment until greater certainty in future demand is known. However, given the relatively high certainty of future demand for this area and the relatively high cost of the grid battery, this option was assessed as higher cost than the network Option 2 with a preliminary cost estimate of **\$1,575,179 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPV comparison in Appendices A and B.

4.1.6. Option 5: Grid battery only

This option utilises a grid battery only. A grid battery, although more expensive than a traditional network solution on a per MVA basis, has advantages over a traditional network solution. A grid battery is modular and is 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 Kingston Foreshore however, the grid battery is not economic due to the relative certainty of demand with a preliminary cost estimate of **\$20,241,155 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPV comparison in Appendices A and B.

4.1.7. Summary of Options Analysis

Table 7: Summary of Options

Option	Description	Total Capital Cost 2019-2039	Capital Cost 2019-24	20 year Net Present Cost	Outcome
0	Do nothing	\$0	\$0	\$0	Not selected as does not meet need
1	Construct 3 new 11 kV cable feeders from Telopea Park to Kingston Foreshore	\$2,196,250	\$2,196,250	-\$2,088,001	Not selected due to lower NPC
2	Construct 3 new 11 kV cable feeders from East Lake to Kingston Foreshore	\$712,950	\$712,950	-\$677,810	Selected due to higher NPC
3	Demand side management	N/A	N/A	N/A	Not selected as does not meet need
4	Grid battery to defer Option 2	\$1,575,179	\$1,575,179	-\$1,352,096	Not selected as deferral not economic
5	Grid battery only	\$20,241,155	\$4,092,050	-\$10,128,822	Not selected due to lower NPC

4.2. Recommendation

The selected option is Option 2, the construction of three new 11 kV underground feeders from East Lake Zone Substation to the Kingston Foreshore area. Cables are to be installed in conjunction with the proposed 132 kV overhead to underground conversion project by December 2020. Spare conduits for 11 kV feeders will be installed as part of this project, significantly reducing the risks and costs to Evoenergy associated with civil works.

Financial analysis shows Option 2 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 Evoenergy'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 Kingston Foreshore area. Additional spare conduits will be installed for future feeders as further stages of Kingston – East Lake are developed.

This project will enable load to be transferred from Telopea Park to East Lake Zone Substation thus releasing some capacity to enable Telopea Park to supply developments in the Griffith, Forrest, Red Hill and Narrabundah suburbs.

Timing is scheduled for completion by December 2020.

The preliminary cost estimate for the selected option is **\$712,950 excluding overheads, contingency and GST**.

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

Appendix A – Preliminary Cost Estimates

A.1 Cost Estimate – Option 1: 11 kV Feeders from Telopea Park Zone Substation to Kingston Foreshore

Kingston Foreshore supply from Telopea Park Zone Substation via 3 new 11 kV feeders @ 2km each. Assume directional drilling full length.					
Preliminary Estimate ± 30% Accuracy					
Description	Notes	Unit	\$/Unit	Quantity	Cost
Trenching and drilling					\$1,241,000
Clearing of route where required	Allowance	m2	\$10	200	\$2,000
Directional drilling	Assume drilling with no rock. Assume three 150mm conduits per drill.	m	\$600	2000	\$1,200,000
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume two or three cables per trench.	m	\$300	0	\$0
Cable jointing and haulage pits	Assume every 500m	ea	\$3,000	7	\$21,000
Traffic management		m	\$5	2000	\$10,000
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Site is mostly flat .	m3	\$40	200	\$8,000
Cabling works					\$549,000
11 kV 3c/400mm2 XLPE cable		m	\$56	6000	\$336,000
Throughjoints	Assume every 500m	ea	\$1,000	15	\$15,000
Terminations	Assume distribution substations at Molonglo established under estate reticulation works.	ea	\$1,500	6	\$9,000
Conduit and marker tape	Assume all cables installed in conduit	m	\$10	6000	\$60,000
Cable installation labour and plant		m	\$20	6000	\$120,000
HV Cables and connections Test & Commissioning	Allowance	ea	\$3,000	3	\$9,000
11 kV Switchgear					\$81,000
11 kV feeder CB double-ups	Assume CBs able to accommodate two cables	ea	\$25,000	3	\$75,000
11kV Test & Commissioning	per CB	lot	\$2,000	3	\$6,000
Electrical (Secondary System)					\$31,250
Protection & Control					\$14,250
P&C Secondary Cabling	per feeder panel	ea	\$2,250	3	\$6,750
P&C Test & Commission	Allowance	ea	\$2,500	3	\$7,500
DC Supply System					\$17,000
DC Cabling	per switchgear panel/bay	ea	\$5,000	3	\$15,000
DC Test & Commission	Allowance	ea	\$2,000	1	\$2,000
SCADA					\$4,000
SCADA connections for new feeder panels		ea	\$2,000	1	\$2,000
Test & Commissioning	Allowance	ea	\$2,000	1	\$2,000
Indirect Costs					\$290,000
Development Application	Allowance	ea	\$40,000	1	\$40,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	\$50,000	1	\$50,000
Project management and administration	Allowance	ea	\$200,000	1	\$200,000
Project Sub Total without overheads					\$2,196,250
Overheads					
Overall average overhead rate	Allowance	27%	\$592,988	1	\$592,988
Project Sub Total with overheads					\$2,789,238
Contingency					
All project works	Preliminary allowance	15%	\$418,386	1	\$418,386
Project budget total					\$3,207,623

Project Justification Report – Supply to Kingston

A.2 Cost Estimate – Option 2: 11 kV Feeders from East Lake Zone Substation to Kingston Foreshore

Kingston Foreshore supply from East Lake Zone Substation via 3 new 11 kV feeders @ 1.4km each. Assume conduits provided full length by SLA as part of 132 kV OHUG project.					
Preliminary Estimate ± 30% Accuracy					
Description	Notes	Unit	\$/Unit	Quantity	Cost
Trenching and drilling					\$29,500
Clearing of route where required	Allowance	m2	\$10	0	\$0
Directional drilling	Assume drilling with no rock. Assume three 150mm conduits per drill.	m	\$600	0	\$0
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume two or three cables per trench.	m	\$300	0	\$0
Cable jointing and haulage pits	Assume every 500m	ea	\$3,000	7	\$21,000
Traffic management		m	\$5	100	\$500
Reinstatement incl revegetation as required	Excavation, no rock (minor boulders only). Site is mostly flat .	m3	\$40	200	\$8,000
Cabling works					\$352,200
11 kV 3c/400mm2 XLPE cable		m	\$56	4200	\$235,200
Throughjoints	Assume every 500m	ea	\$1,000	15	\$15,000
Terminations	Assume distribution substations at Molonglo established under estate reticulation works.	ea	\$1,500	6	\$9,000
Conduit and marker tape	Assume all cables installed in conduit	m	\$10	0	\$0
Cable installation labour and plant		m	\$20	4200	\$84,000
HV Cables and connections Test & Commissioning	Allowance	ea	\$3,000	3	\$9,000
11 kV Switchgear					\$6,000
11 kV feeder CB double-ups	Assume CBs able to accommodate two cables	ea	\$25,000	0	\$0
11kV Test & Commissioning	per CB	lot	\$2,000	3	\$6,000
Electrical (Secondary System)					\$31,250
Protection & Control					\$14,250
P&C Secondary Cabling	per feeder panel	ea	\$2,250	3	\$6,750
P&C Test & Commission	Allowance	ea	\$2,500	3	\$7,500
DC Supply System					\$17,000
DC Cabling	per switchgear panel/bay	ea	\$5,000	3	\$15,000
DC Test & Commission	Allowance	ea	\$2,000	1	\$2,000
SCADA					\$4,000
SCADA connections for new feeder panels		ea	\$2,000	1	\$2,000
Test & Commissioning	Allowance	ea	\$2,000	1	\$2,000
Indirect Costs					\$290,000
Development Application	Allowance	ea	\$40,000	1	\$40,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	\$50,000	1	\$50,000
Project management and administration	Allowance	ea	\$200,000	1	\$200,000
Project Sub Total without overheads					\$712,950
Overheads					
Overall average overhead rate	Allowance	27%	\$192,497	1	\$192,497
Project Sub Total with overheads					\$905,447
Contingency					
All project works	Preliminary allowance	15%	\$135,817	1	\$135,817
Project budget total					\$1,041,263

Appendix B – Financial Analysis

B.1 Capital Expenditure Cash Flow for Each Option

Financial Year	Option 1	Option 2	Option 3	Option 4 *	Option 5 *
2019/20					
2020/21	\$2,196,250	\$712,950		\$862,229	\$862,229
2021/22				\$712,950	\$1,076,607
2022/23					\$1,076,607
2023/24					\$1,076,607
2024/25					\$1,076,607
2025/26					\$1,076,607
2026/27					\$1,076,607
2027/28					\$1,076,607
2028/29					\$1,076,607
2029/30					\$1,076,607
2030/31					\$1,076,607
2031/32					\$1,076,607
2032/33					\$1,076,607
2033/34					\$1,076,607
2034/35					\$1,076,607
2035/36					\$1,076,607
2036/37					\$1,076,607
2037/38					\$1,076,607
2038/39					\$1,076,607
Total Cost (20 yr)	\$2,196,250	\$712,950	N/A	\$1,575,179	\$4,092,050
2019-24 Regulatory Control Period Cost	\$2,196,250	\$712,950	N/A	\$1,575,179	\$20,241,155

* Options 4 and 5 utilise a network owned battery which is modular and redeployable and has a 10 year lifetime. The battery is costed on a lease-like basis.

B.2 NPC Analysis

The Net Present Cost (NPC) was calculated using a Monte-Carlo simulation model. The simulation randomly selects a peak demand growth rate for each year that is within $\pm 10\%$ of the forecasted spot loads expected in Kingston. 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 Kingston Foreshore

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

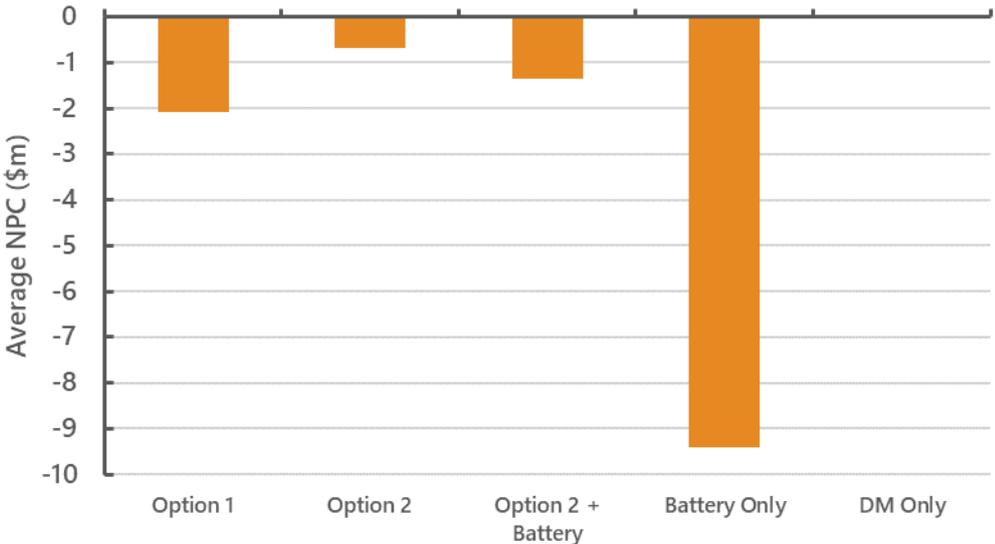
Options:

- One – three new 11 kV feeders from Telopea Park Zone Substation
- Two – three new 11 kV feeders from East Lake Zone Substation
- Three – demand management
- Four – grid battery to defer Option 2
- Five – grid battery only

RESULTS (Average over 50 simulations):

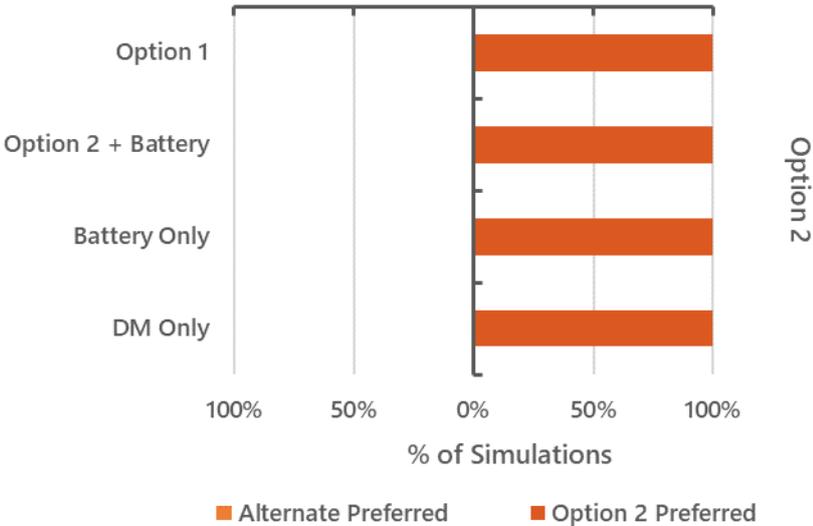
Option:	One	Two	Three	Four	Five
NPC (2019-2024)	-\$1,898,566	-\$616,315	N/A	-\$1,299,726	-\$2,921,699
NPC (2019-2039)	-\$2,088,001	-\$677,810	N/A	-\$1,361,221	-\$9,421,884
Network Option total Capital Cost	\$2,196,250	\$712,950	N/A	\$712,950	-
Option Capital Cost (2019-2024)	\$2,196,250	\$712,950	N/A	\$1,586,164	\$3,861,348
Option Capital Cost (2019-2039)	\$2,196,250	\$712,950	N/A	\$1,586,164	\$18,774,553

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



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

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



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

Value of Risk:

Year	Volume of Energy at Risk (kWh)	Value of Energy at Risk (\$)
2020	-	-
2021	808	3
2022	37,848	94
2023	193,436	391
2024	193,436	391

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.