Appendix 4.7: Canberra City North, Lyneham & Dickson PJR

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

November 2018

evoenergy

Project Justification Report

Project name	**Supply to Canberra City North, Lyneham and Dickson**
Expenditure type	Capital Expenditure
Business Group	Asset Strategy
Regulatory Period	1 July 2019 to 30 June 2024
Total Project Cost Estimate	$5,521,500 excluding corporate overheads, excluding contingency, and excluding GST
Five year total spend 2019-24	$5,521,500 excluding corporate overheads, excluding contingency, and excluding GST
CAPEX category	ENAA Distribution
Primary driver	Load growth in Canberra City North, Lyneham and Dickson
Project Number	20001382

Contents

1. Executive Summary

This Project Justification Report addresses the growth of electricity demand in the Canberra City North, Lyneham and Dickson areas and evaluates options re how Evoenergy can meet these needs.

The maximum demand in northern Canberra City, Lyneham and Dickson suburbs is forecast to increase steadily over the next ten years with major residential and commercial developments along with the ACT Government's light rail project and urban renewal program. The load in this area is typically summer peaking. The new developments are likely to include high energy efficiency and rooftop solar PV generation, and this has been accounted for within the demand forecast.

The forecast load growth will be supplied by existing feeders as much as possible, however these feeders cannot fully meet the forecast demand increase.

This Project Justification Report proposes the construction of two new 11 kV feeders and the extension of an existing 11 kV feeder as follows:

- New 11 kV feeder from City East Zone Substation to Donaldson St by June 2020 to supply new developments in the Canberra City North area.
- New 11 kV feeder from Civic Zone Substation to Dooring St by June 2021 to supply new developments in the Lyneham area.
- Extension of existing 11 kV Haig feeder to Dickson by June 2022 to supply new developments in the Dickson area.

The proposed new 11 kV feeders from City East and Civic zone substations will inter-tie with existing 11 kV feeders from City East, Civic and Telopea Park zone substations to provide backup security of supply in the event of a contingency.

The extension of the Haig feeder will provide interconnection with Wattle and Cowper feeders, which are planned to supply critical block loads such as the Canberra Metro Traction Power Station TPS4.

Other options considered and evaluated included non-network demand management, utilising a grid battery to defer a network upgrade and utilising a grid battery to avoid a network upgrade.

A preliminary cost estimate for the selected option of a new feeder from City East Zone Substation to Donaldson St, plus a new feeder from Civic Zone Substation to Dooring St, plus extension of the Haig feeder, is **$5,521,500 excluding corporate overheads, contingency and GST**.

This Project Justification Report includes the assessment of risk based on probabilistic principles. The conservatively estimated value of avoided risk exceeds cost of investment. Therefore, Evoenergy considers that proposed investment is prudent and economic.

These works will be carried out during the 2019-24 Regulatory Control Period, with proposed project completion by June 2022.

2. Strategic Context and Expenditure Need

There is significant development underway and proposed for the northern Canberra City area including the inner city suburbs of Lyneham and Dickson, comprising a mixture of multi-storey commercial and residential buildings.

2.1. Existing infrastructure in the Canberra City North, Lyneham and Dickson area

There are several 11 kV feeders supplying the northern Canberra City, Dickson and Lyneham area. These feeders emanate from City East and Civic zone substations.

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

Table 1: Loading of feeders supplying Canberra City North, Lyneham and Dickson areas

Feeder Name	Zone Sub	Firm Summer Rating MVA	Thermal Summer Rating MVA	Firm Winter Rating MVA	Thermal Winter Rating MVA	2015		2016		2017		2018
						Summer MD	Winter MD	Summer MD	Winter MD	Summer MD	Winter MD	Summer MD
Braddon	CE	4.9	6.5	5.4	7.2	92%	62%	75%	64%	73%	57%	65%
Cowper	CE	4.1	5.4	4.8	6.5	105%	100%	103%	107%	89%	102%	97%
Ebden	CE	5.1	6.9	5.8	7.7	65%	67%	41%	69%	34%	69%	40%
Ijong	CE	4.1	5.4	5.1	6.7	75%	72%	72%	70%	68%	67%	67%
Masson	CE	4.8	6.4	5.3	7.1	51%	54%	58%	56%	55%	51%	58%
Wakefield	CE	4.5	5.9	5.0	6.7	86%	86%	88%	78%	87%	84%	79%
Wattle	Civic	5.2	6.9	5.9	7.8	72%	58%	64%	53%	109%	46%	50%

2.2. Driving need for infrastructure investment

Forecast additional maximum demand in the Canberra City North, Lyneham and Dickson 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.

Customer applications or enquiries for the projects listed in Table 2 are included as attachments in Appendix C.

Table 2: Proposed Developments in Canberra City North, Lyneham and Dickson area

Canberra City North, Lyneham and Dickson Forecast Load Growth											
Proposed Development and Net Additional Diversified Load in MVA	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Total**
PN20005471 - B6 S30 - 11 Donaldson St Braddon. Commercial development 3800 m².		0.4									0.4
PN20005138 - B5 S30 - 7 Donaldson St Braddon. Mixed development: 140 units Residential; 2080 m² Commercial; 6500 m² Car park.		1.5									1.5
PN20004917 - B7-9 S18 - 92 Northbourne Ave Braddon. Mixed develoment: 250 units Residential; 189 rooms hotel; Commercial and Car park.		1.6									1.6
PN20004045 - 12 Wattle St, Lyneham. Canberra Metro traction power station TPS 4 (2.6 normal/ 5.2 Emergency).	5.2										5.2
PN20003452 - S96 - Corner Cooyong St and Donaldson St. Commercial development: Canberra Centre Extension.		1.0	1.0	2.0	2.5	1.8					8.3
PN20005209 - B19 S33 - Challis St, Dickson. Mixed development: 144 units Residential; 14900 m² Commercial; 1470 m² Community child-care facility.		2.0									2.0
20005206 - B20 S33 Dickson - Residential 102 apartments, commercial 3770 m² & car park 16124 m²			1.0								1.0
Lyneham on Northbourne - 253 Northbourne Ave. Mixed development: 1044 units Residential; 2000m² Commercial.					2.4						2.4
Dickson on Northbourne - 25 Karuah St. Mixed development: 945 units Residential; 7538 m² Commercial; Hotel 96 rooms. (SOHO)			1.4		1.8	2.1	2.0				7.3
B1 S6 Dickson - 242 Northbourne Ave. Mixed development: 406 units Residential; 949 m² Commercial; Car park.			1.2								1.2
PN20002255 - B3 S28 32 Mort St. Mixed development: 60 units Residential; 1195 m² Commercial; 4200 m² Car park.	0.3										0.3
PN20003882 - B17 S61 corner Bradfield St and Melba St. 282 units Residential.		1.0									1.0
Mixed development - B21 S30 Dickson : 140 apartments, supermarket , retail and car park					1.5						1.5
Yowani Development - corner Barton Highway and Northbourne Ave. Residential Development.							2.0	3.0	2.0		7.0
Forcast Additional Load pa (MVA)	**5.5**	**7.4**	**4.6**	**2.0**	**8.2**	**3.9**	**4.0**	**3.0**	**2.0**	**0.0**	
Cumulative Forecast Additional Load (MVA)	**5.5**	**12.9**	**17.5**	**19.5**	**27.7**	**31.6**	**35.6**	**38.6**	**40.6**	**40.6**	

Table 2 shows that cumulative forecast diversified additional load in the area by 2024 will be approximately 35.6 MVA. The existing feeders (as listed in Table 1) will be configured and spare capacity utilised to supply these additional loads as much as possible. However due to the geographical locations of some loads and high forecast loading of feeders in specific areas, additional feeders will be required.

The proposed residential developments in Canberra City are primarily multi-storey apartment buildings. To date these have tended to be all-electric and built without solar PV or battery energy storage facilities. Although the buildings themselves and installed appliances (reverse cycle heat pumps, LED lighting etc) are energy efficient, an after diversity maximum demand (ADMD) figure of 2.5 kVA per unit has been assumed. This allows for current energy efficiency measures and will allow for the expected uptake of electric vehicle charging facilities and instantaneous hot-water heating systems in the future. A concerted effort is proposed by Evoenergy as part of its Demand Side Management initiative, to work with developers and their designers at an early stage, to consider alternative energy sources such as gas and solar PV, and to increase energy efficiency by installing building management systems, centralised gas hot-water heating systems, and gas-powered evaporative cooling systems etc.

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.

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

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

3.2. Regulatory Compliance

3.2.1. National Electricity Law and National Electricity Rules

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

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

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

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

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

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

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

3.2.2. Capital Expenditure Objectives and Criteria

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

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

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

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

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

3.2.3. Regulatory Investment Test

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

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

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 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, plus known customer-initiated point load requests and applications (copies of these point load connection applications are attached in Appendix C).

As a **first step,** Evoenergy applies deterministic planning criteria to identify where existing or emerging constraints exist on the network. The deterministic approach can lead to uneconomic outcomes. For that reason further analysis is performed to confirm whether the investment proposal is justified economically.

Therefore, as a **second step,** Evoenergy applies probabilistic assessment of risk to determine whether network investment is justified. The value of avoided risk is estimated using probabilistic methodology.

Thus, benefit is expressed as avoided risk. The risk may include other components, but typically unserved energy is the dominant risk component for augmentation projects. If avoided risk exceeds the cost of the proposed augmentation, the investment is considered economic. The assessment of risk is based on the probability of a credible contingency event occurring sufficiently frequently, and with such consequences as to justify Evoenergy to take prudent action to mitigate against it. The probability of a credible contingency event occurring at a time when load exceeds firm capacity, is used to calculate unserved energy.

The value of unserved energy compared with the cost of the investment, determines the prudency of the augmentation.

The value of Unserved Energy identified in this PJR (refer Appendix B2) is high due to the fact that forecast demand exceeds the thermal capacity of the existing network.

To meet the forecast demand under the Do Nothing option (ie connecting all new loads to existing feeders only),

would require operating some feeders above their thermal ratings. 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).

In addition, non-network solutions and demand side management solutions are considered when evaluating project options. To inform Evoenergy's position, as part of this assessment, Evoenergy models various load forecast outcomes using Monte Carlo methodology to select the preferred option. This modelling allows Evoenergy to consider whether a demand side solution is a viable option and should be explored further.

These proposed new feeders to the Canberra City North, Lyneham and Dickson area have been selected as the preferred option taking into account the available capacity (Table 1), forecast load (Table 2) and the corresponding reduction of risk. It is considered to be a prudent investment, because the avoided risk is higher than the cost of investment. Furthermore, at the time of investment the risk value exceeds the annualized cost of investment.

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

Evoenergy has considered four options (plus the Do Nothing option) to provide additional capacity and security of supply to Canberra City North, Lyneham and Dickson areas as listed in Table 4.

Table 4: Options considered for provision of additional capacity and security of supply to Canberra City North, Lyneham and Dickson

Option	Option type	Description	Evaluation
0	Network	Do nothing	Not selected as does not meet minimum requirements
1	**Network**	**Construct new 11 kV cable feeder from City East Zone Substation to Donaldson St (2019-20); construct new 11 kV cable feeder from Civic Zone Substation to Dooring St (2020-21); and extend Haig feeder to Dickson area (2021-22).**	**Selected as higher NPC**
2	Non-network	Demand side management and embedded generation	Not selected as does not meet minimum requirements and lower NPC
3	Mixed	Delay preferred network option using a grid battery	Not selected as cost of delay exceeded benefits
4	Non-network	Grid battery only	Not selected due to lower NPC

4.1. Options Description

4.1.1. Do Nothing Option

The 'Do Nothing' option requires connecting all new loads to existing feeders in the Canberra North, Lyneham and Dickson area. This would require operating most feeders above their firm rating and operating some feeders up to their thermal limits.

The 'Do Nothing' option would result in insufficient network capacity in the area as some feeders would be forced to operate beyond their thermal rating (and would consequently be tripped by over-current protection), 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 as all new loads could not be supplied and would place considerable load at risk in the event of a feeder contingency.

The value of energy at risk under the Do Nothing option is high based on the probability of a contingency event occurring at the same time as demand exceeds firm capacity (refer Appendix B2).

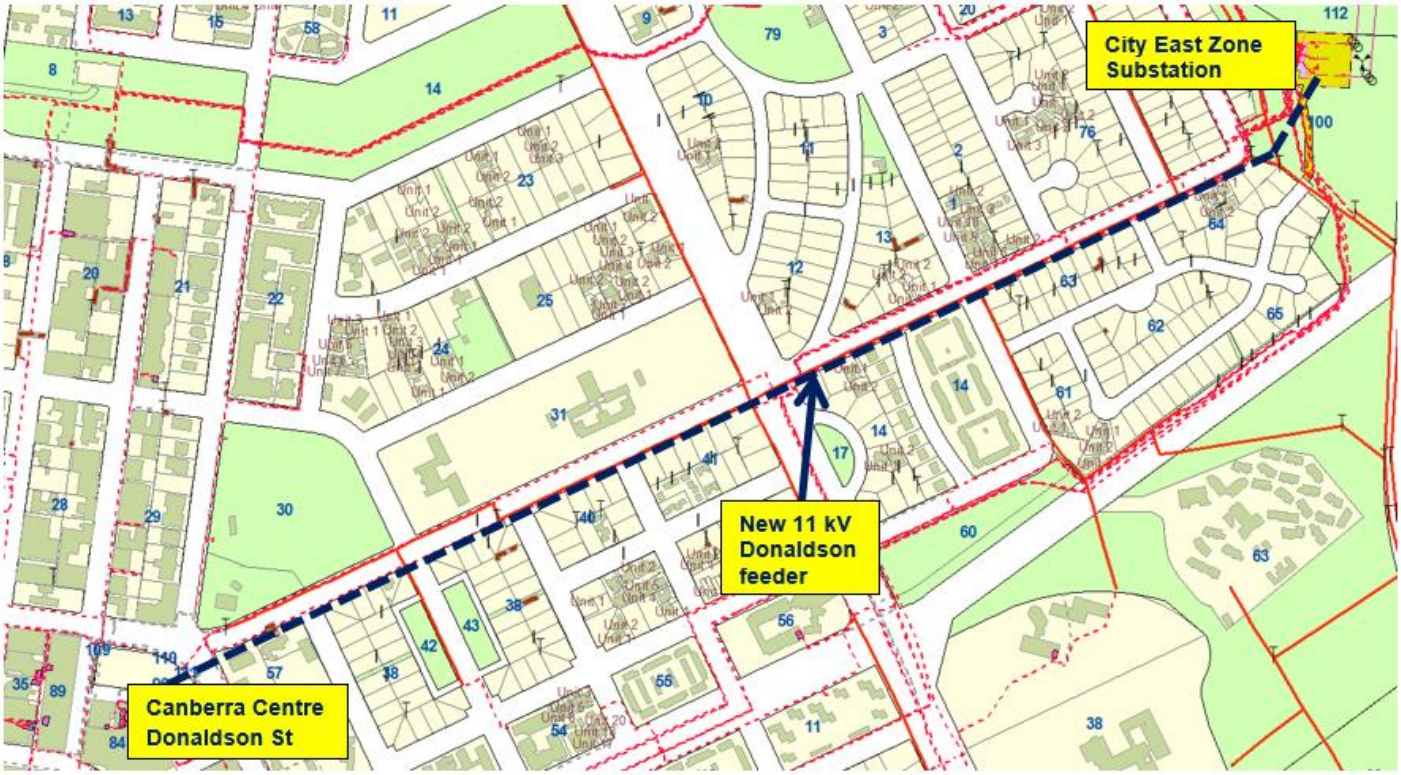
4.1.2. Option 1: Construct new 11 kV cable feeder from City East Zone Substation to Donaldson St; construct new 11 kV cable feeder from Civic Zone Substation to Dooring St; and extend 11 kV Haig feeder

Option 1 considers the installation of a new 11 kV cable feeder from City East Zone Substation to Donaldson St (to meet the growing demand in the City North area); plus a new 11 kV cable feeder from Civic Zone Substation to Dooring St (to meet the growing demand in the Lyneham area); and extension of the Haig feeder to Morphett St (to meet the growing demand in the Dickson area).

City East Zone Substation is nearest to the proposed major extension of the Canberra Centre at the corner of Cooyong St and Donaldson St, Canberra City North. The route length of the 11 kV feeder from City East Zone Substation to this development is approximately 2.4 km. There are no spare conduits available along this route. It is proposed to install three conduits (including two spare for future needs) from City East Zone Substation along Chisholm and Donaldson Streets to this site. This proposed new feeder will be known as **Donaldson feeder**.

Figure 1 illustrates the proposed cable route of the new Donaldson feeder from City East Zone Substation. Proposed cable to be 3c/400mm^2 AL XLPE.

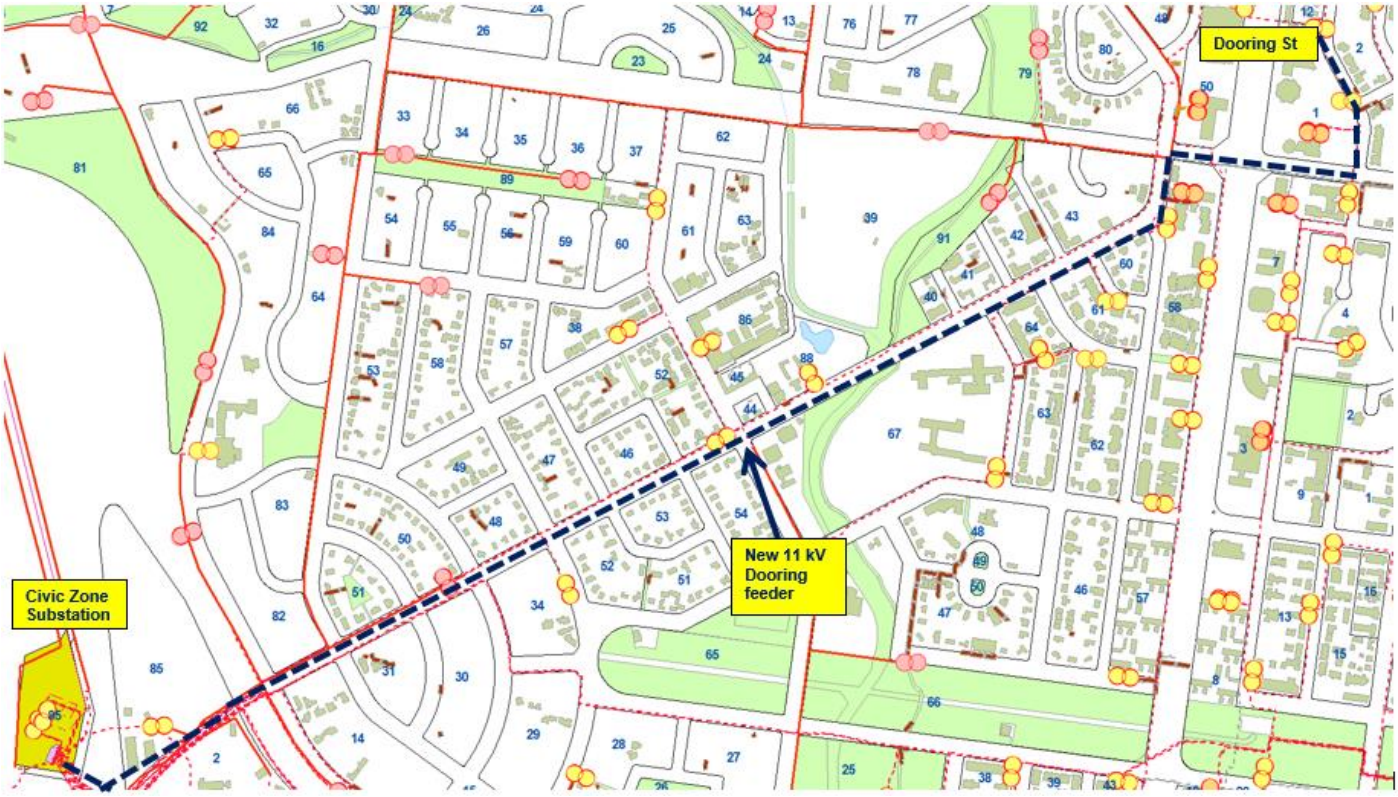
Figure 1: Proposed 11 kV cable feeder route from City East Zone Substation to Donaldson St



Civic Zone Substation is nearest to the proposed major Soho residential development at Dooring St, Lyneham. The route length of the 11 kV feeder from Civic Zone Substation to this development is approximately 3.0 km. There are no spare conduits available along this route. It is proposed to install three conduits (including two spare for future needs) from Civic Zone Substation along David St, Wakefield Ave and Dooring St to this site. This proposed new feeder will be known as **Dooring feeder**.

Figure 2 illustrates the proposed cable route of the new Dooring feeder from Civic Zone Substation. Proposed cable to be 3c/400mm^2 AL XLPE.

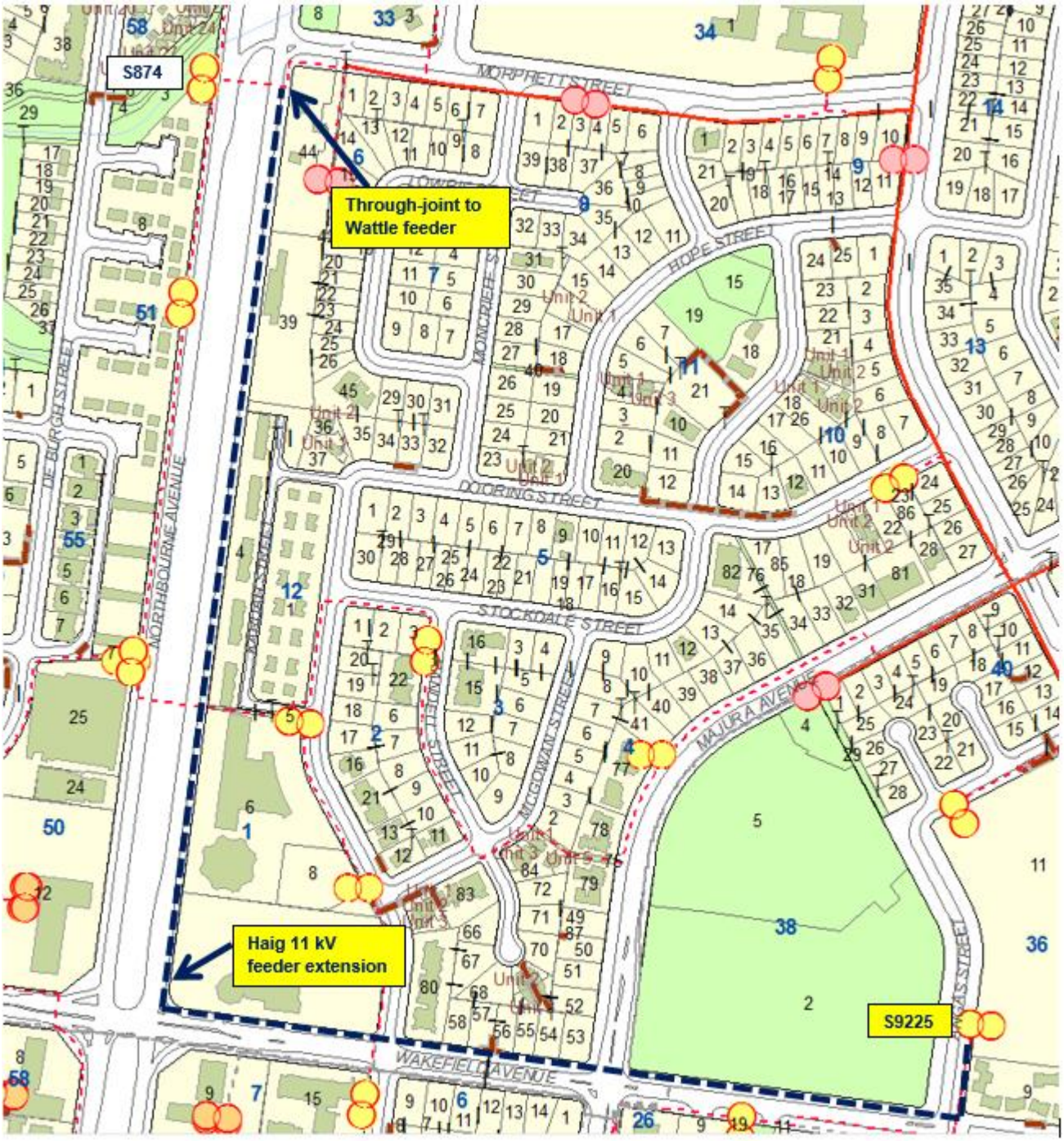
Figure 2: Proposed 11 kV feeder cable route from Civic Zone Substation to Dooring St



The Haig feeder emanates from City East Zone Substation. It is lightly loaded and it is proposed to extend it to the proposed developments in the Dickson area. The route length for the extension of the Haig feeder from distribution substation S 9225 to the corner of Northbourne Ave / Morphett St is approx 1.5 km. There are no spare conduits available along this route. The Wattle feeder cable will be disconnected from S874 and through-jointed to the extended Haig feeder.

Figure 3 illustrates the proposed Haig feeder extension. Proposed cable to be 3c/400mm^2 AL XLPE.

Figure 3: Proposed 11 kV Haig feeder cable extension to Dickson



A preliminary cost estimate for Option 1 is **$5,521,500 excluding overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

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

Proposed project completion is by June 2022.

4.1.3. Option 2: Demand management

Option 2 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 Donaldson and Dooring feeders and Haig feeder extension to the next regulatory control period (beyond 2024), it is estimated that non-network solutions would need to provide a maximum demand of approximately 12 MVA pa.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 1.04 MVA. This does not meet the minimum capacity to enable the new feeder to be deferred.

These non-network options are summarised in Table 5.

Table 5: Summary of latent demand management

Non-network Option	Electricity House feeder	Bunda feeder	Binara feeder	Cowper feeder	Total
Customer – owned embedded generation	0.20 MVA	0.20 MVA	0.30 MVA	0.20 MVA	**0.90 MVA**
Customer – owned energy storage	0.02 MVA	0.02 MVA	0.03 MVA	0.03 MVA	**0.10 MVA**
Load curtailment	0.01 MVA	0.01 MVA	0.01 MVA	0.01 MVA	**0.04 MVA**
Total	**0.23 MVA**	**0.23 MVA**	**0.34 MVA**	**0.24 MVA**	**1.04 MVA**

In summary, a maximum demand reduction of 1.04 MVA could be achieved if all the above non-network options were implemented. This is not sufficient to defer the new feeders.

Third party non-network proposals will be requested in Evoenergy's 2018 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 Canberra City North, Lyneham and Dickson it was determined that more than 55% 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.

4.1.4. Option 4: Grid battery to defer Option 1

This option utilises a grid battery to enable Option 1 to be deferred. This option has the advantage of deferring the investment until greater certainty in future demand is known. However, given the relatively high certainty of future demand for this project and the relatively high cost of the grid battery, this option was assessed as higher cost than the network Option 1 with a preliminary cost estimate of **$7,234,249 excluding corporate overheads, contingency and GST.** Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

4.1.5. 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 Canberra City North, Lyneham and Dickson however, the grid battery was not economic due to the relative certainty of demand and a preliminary cost estimate of **$84,837,579 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

4.1.6. Options Analysis

Table 6 lists the forecast new loads (as per Table 2) and states which feeder Evoenergy proposes to connect and supply each load from. This includes the proposed new Donaldson and Dooring feeders and proposed extended Haig feeder.

It should be noted that it is not feasible to utilise all available spare capacity of existing feeders due to their geographic location, inter-connectivity and proximity to new loads. These forecast loads make allowance for predicted penetration of rooftop solar PV and battery storage systems.

Table 6 shows that to meet the forecast load demands through to June 2024, all existing feeders plus the proposed new Donaldson and Dooring feeders plus the extended Haig feeder are required.

Table 6: Forecast Loads and Proposed Feeder Supplies

Canberra City North Forecast Load Growth											
Proposed Development and Net Additional Diversified Load in MVA	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Total**
PN20005471 – B6 S30 – 11 Donaldson St Braddon. Commercial development 3800 m².		0.4									0.4
Proposed feeder to supply above load	Chisholm										
PN20005138 – B5 S30 – 7 Donaldson St Braddon. Mixed Development: 140 units Residential; 2080 m² Commercial; 6500 m² Car park.		1.5									1.5
Proposed feeder to supply above load	Chisholm										
PN20004917 – B7–9 S18 – 92 Northbourne Ave Braddon. Mixed Develoment: 250 units Residential; 189 rooms hotel; Commercial and Car park.		1.6									1.6
Proposed feeder to supply above load	Braddon										
PN20004045 – 12 Wattle St, Lyneham. Canberra Metro traction power station TPS 4 (2.6 normal/ 5.2 Emergency).	5.2										5.2
Proposed feeder to supply above load	Wattle										
PN20003452 – S26 – Corner Cooyong St and Donaldson St. Commercial development. Canberra Centre extension.		1.0	1.0	2.0	2.5	1.8					8.3
Proposed feeder to supply above load	New Donaldson feeder from City East										
PN20005209 – B19 S33 – Challis St, Dickson. Mixed Development: 144 units Residential; 14900 m² Commercial; 1470 m² Community child-care facility.		2.0									2.0
Proposed feeder to supply above load	Cowper and extended Haig										
PN20005206 – B20 S33 Dickson – 102 apartments, commercial 3770 m2 & car park 16124 m²			1.0								1.0
Proposed feeder to supply above load	Miller										
Lyneham on Northbourne – 253 Northbourne Ave. Mixed Development: 1044 units Residential; 2000m² Commercial.					2.4						2.4
Proposed feeder to supply above load	Extended Haig										
Dickson on Northbourne – 25 Karuah St. Mixed Development: 345 units Residential; 7538 m² Commercial; Hotel 96 rooms.			1.4		1.8	2.1	2.0				7.3
Proposed feeder to supply above load	New Dooring feeder from Civic										
B1 S6 Dickson – 242 Northbourne Ave. Mixed development: 406 units Residential; 949 m² Commercial; Car park.			1.2								1.2
Proposed feeder to supply above load	Ijong										
PN20002255 – B3 S28 32 Mort St. Mixed devlopment: 60 units Residential; 1195 m² Commercial; 4200 m² Car park.	0.3										0.3
Proposed feeder to supply above load	Braddon										
PN20003882 – B17 S61 corner Bradfield St and Melba St. 282 units Residential.		1.0									1.0
Proposed feeder to supply above load	Ebden										
Mixed development – B21 S30 Dickson : 140 apartments, supermarket , retail and car park					1.5						1.5
Proposed feeder to supply above load	Cowper										
Yowani Development – corner Barton Highway and Northbourne Ave. Residential Development.							2.0	3.0	2.0		7.0
Proposed feeder to supply above load	Ebden and future new feeder from Gold Creek Zone Substation in 2025										
Forcast Additional Load pa (MVA)	**5.5**	**7.4**	**4.6**	**2.0**	**8.2**	**3.9**	**4.0**	**3.0**	**2.0**	**0.0**	
Cumulative Forecast Additional Load (MVA)	**5.5**	**12.9**	**17.5**	**19.5**	**27.7**	**31.6**	**35.6**	**38.6**	**40.6**	**40.6**	

Table 7 lists the existing and proposed feeders to the Canberra City North, Lyneham and Dickson areas with their existing maximum demand, forecast maximum demand at 2024 and forecast maximum demand at 2028.

Table 7: Canberra City North, Lyneham and Dickson areas feeders load forecasts (including proposed new feeders)

Feeder	Zone Substation	Firm rating MVA (summer)	Thermal rating MVA (summer)	Existing max demand MVA (summer)	Forecast max demand MVA (summer 2024)	Forecast max demand MVA (summer 2028)
Braddon	**City East**	5.4	7.2	3.2	4.7	4.7
Cowper	**City East**	4.8	6.5	4.9	5.5	6.5
Ebden	**City East**	5.8	7.7	3.9	7.6	4.2
Ijong	**City East**	5.0	6.7	3.2	5.3	4.5
Masson	**City East**	5.0	6.7	4.2	5.7	4.5
Wakefield	**City East**	5.3	7.1	3.6	5.9	5.9
Miller	**Civic**	5.9	7.8	5.4	6.6	6.6
Wattle	**Civic**	5.9	7.8	3.4	6.1	5.3
Donaldson (2020)	**City East**	5.5	7.3	–	6.3	6.3
Dooring (2021)	**Civic**	5.5	7.3	–	6.3	6.3
Haig (2022)	**City East**	5.2	7.0	1.6	6.5	6.5

Yellow denotes feeder loaded above its firm rating. Orange denotes proposed new feeder or extended feeder.

Loading of feeders to their thermal rating would risk large amounts of unserved energy in the event of a contingency.

4.1.7. Summary of Options Analysis

A summary of the options considered is presented in Table 8.

Table 8: Summary of Options

Option	Description	Total Capital Cost 2019-39	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 new 11 kV cable feeder from City East Zone Substation to Donaldson St, new 11 kV feeder from Civic Zone Substation to Dooring St, and extend Haig feeder to Dickson**	**$5,521,500**	**$5,521,500**	**-$4,805,841**	**Selected due to higher NPC**
2	Demand side management	N/A	N/A	N/A	Not selected as does not meet need
3	Grid battery to defer Option 1	$7,998,639	$7,998,639	-$6,456,529	Not selected as deferral not economic
4	Grid battery only	$84,837,579	$16,203,879	-$42,061,231	Not selected due to lower NPC

4.2. Recommendation

The selected option is Option 1, the installation of a new 11 kV cable feeder from City East Zone Substation to Donaldson St, Canberra City North (Donaldson feeder), plus the installation of a new 11 kV cable feeder from Civic Zone Substation to Dooring St, Lyneham (Dooring feeder), plus extension of the Haig feeder to Morphett St, Dickson.

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

The new and extended feeders will provide capacity and security of supply to the proposed developments in Canberra City North, Lyneham and Dickson areas.

The project will be carried out in three stages with completion by June 2022.

The preliminary cost estimate for the selected option is **$5,521,500 excluding overheads, contingency and GST**.

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

Appendix A – Preliminary Cost Estimates

Cost Estimate – Option 1: 11 kV cable feeder from City East Zone Substation to Donaldson St, 11 kV cable feeder from Civic Zone Substation to Dooring St, and extend Haig feeder to Dickson

Installation of 11 kV feeder from City East Zone Substation to Donaldson St 2.4 km (Stage 1); installation of 11 kV feeder from Civic Zone Substation to Dooring St (Stage 2); and extension of Haig feeder to Dickson 1.5 km (Stage 3). Assume 3 conduits per open trench and directional drill.									3.0 km
Preliminary Estimate ± 30% Accuracy									
Description	**Notes**	**Unit**	**$/Unit**	**Stage 1 Quantity**	**Stage 1 Cost**	**Stage 2 Quantity**	**Stage 2 Cost**	**Stage 3 Quantity**	**Stage 3 Cost**
Trenching and drilling					$1,226,000		$2,007,000		$1,000,100
Clearing of route where required	Allowance	m2	$10	2000	$20,000	3000	$30,000	1160	$11,600
Directional drilling	Assume drilling with no rock. Assume three conduits per drill.	m	$600	1200	$720,000	3000	$1,800,000	1500	$900,000
Open trenching and backfilling	Assume excavation with no rock. Backfill with bedding sand and native soil. Assume three conduits per trench.	m	$300	1200	$360,000	30	$9,000	30	$9,000
Cable jointing and haulage pits	Assume every 500m	ea	$3,000	6	$18,000	11	$33,000	4	$12,000
Traffic management	Allowance	m	$5	2400	$12,000	3000	$15,000	1500	$7,500
Reinstatement incl revegetation as required	Allowance	m3	$40	2400	$96,000	3000	$120,000	1500	$60,000
Cabling works					$228,400		$297,500		$144,500
11 kV 3c/400mm2 Al XLPE cable		m	$56	2400	$134,400	3000	$168,000	1500	$84,000
Throughjoints	Assume every 500m	ea	$1,000	5	$5,000	9	$9,000	3	$3,000
Terminations	Terminations at City East, Civic and distribution substations	ea	$1,500	2	$3,000	9	$13,500	2	$3,000
Conduit and marker tape	3x150mm plus 1x63mm	m	$15	2400	$36,000	3000	$45,000	1500	$22,500
HV Cables Test & Commissioning	Allowance	ea	$2,000	1	$2,000	1	$2,000	1	$2,000
Cable installation labour and plant		m	$20	2400	$48,000	3000	$60,000	1500	$30,000
Electrical (Secondary System)					$12,000		$12,000		$12,000
Protection & Control					$5,000		$5,000		$5,000
P&C Secondary Cabling	per feeder panel	ea	$2,500	1	$2,500	1	$2,500	1	$2,500
P&C Test & Commission	Allowance	ea	$2,500	1	$2,500	1	$2,500	1	$2,500
Protection upgrade if required	Allowance	ea	$40,000	1	$40,000	1	$40,000	1	$40,000
DC Supply System					$7,000		$7,000		$7,000
DC Cabling	per switchgear panel/bay	ea	$5,000	1	$5,000	1	$5,000	1	$5,000
DC Test & Commission	Allowance	ea	$2,000	1	$2,000	1	$2,000	1	$2,000
Other Required Works					$40,000		$40,000		$40,000
Site supervision	Allowance	ea	$20,000	1	$20,000	1	$20,000	1	$20,000
Detailed design	Allowance	ea	$20,000	1	$20,000	1	$20,000	1	$20,000
SCADA					$4,000		$4,000		$4,000
SCADA connections for new feeder panels		ea	$2,000	1	$2,000	1	$2,000	1	$2,000
Test & Commissioning	Allowance	ea	$2,000	1	$2,000	1	$2,000	1	$2,000
Indirect Costs					$150,000		$150,000		$150,000
Development Application	Allowance	ea	$50,000	1	$50,000	1	$50,000	1	$50,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea	$25,000	1	$25,000	1	$25,000	1	$25,000
Project management and administration	Allowance	ea	$75,000	1	$75,000	1	$75,000	1	$75,000
Stage Sub Total without overheads					**$1,660,400**		**$2,510,500**		**$1,350,600**
Project Sub Total without overheads									**$5,521,500**
Overheads									
Overall average overhead rate	Allowance	27%		1	$448,308	1	$677,835	1	$364,662
Stage Sub Total with overheads					**$2,108,708**		**$3,188,335**		**$1,715,262**
Project Sub Total with overheads									**$7,012,305**
Contingency									
All project works	Preliminary allowance	10%		1	$210,870.80	1	$318,833.50	1	$171,526.20
Stage total with all overheads and contingency					**$2,319,579**		**$3,507,169**		**$1,886,788**
Project total with all overheads and contingency									**$7,713,536**

Appendix B – Financial Analysis

B.1 Capital Expenditure Cash Flow for Each Option

Financial Year	Option 1	Option 2	Option 3	Option 4
2019/20	$1,660,400	N/A	$2,477,139	
2020/21	$2,510,500			$2,477,139
2021/22	$1,350,600			$4,575,580
2022/23			$5,521,500	$4,575,580
2023/24				$4,575,580
2024/25				$4,575,580
2025/26				$4,575,580
2026/27				$4,575,580
2027/28				$4,575,580
2028/29				$4,575,580
2029/30				$4,575,580
2030/31				$4,575,580
2031/32				$4,575,580
2032/33				$4,575,580
2033/34				$4,575,580
2034/35				$4,575,580
2035/36				$4,575,580
2036/37				$4,575,580
2037/38				$4,575,580
2038/39				$4,575,580
Total Cost (20 years)	**$5,521,500**	**N/A**	**$7,998,639**	**$16,203,879**
2019-24 Regulatory Control Period Cost	**$5,521,500**	**N/A**	**$7,998,639**	**$84,837,579**

B.2 NPC Analysis

The Net Present Cost (NPC) was calculated using a Monte-Carlo simulation model. The simulation randomly selects a peak demand growth rate for each year that is within ± 10% of the forecasted spot loads expected in 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 Canberra City North, Lyneham and Dickson

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

Options:

One – new 11 kV feeder from City East Zone Substation, plus new feeder from Civic Zone Substation, plus extension of Haig feeder.
Three – best non-network option (grid battery).
Four – best mixed network and non-network combination (Option one plus grid battery).

RESULTS (Average over 50 simulations):

Option:	One	Three	Four
NPC (2019-2024)	-$4,370,120	-$6,456,529	-$11,888,028
NPC (2019-2039)	-$4,805,841	-$6,456,529	-$41,264,554
Network Option total Capital Cost	$5,521,500	$5,521,500	-
Option Capital Cost (2019-2024)	$5,521,500	$7,998,639	$15,863,320
Option Capital Cost (2019-2039)	$5,521,500	$7,998,639	$83,261,118

Unserved Energy:

The following table estimates the volume of unserved energy (USE) in kWh under the Do Nothing scenario.

Feeder	USE Exceeding	FY 18/19	FY 19/20	FY 20/21	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27
Ebden	Firm	2	2	2	2	2	2	39	39	79
	Thermal	0	0	0	0	0	0	45,616	45,616	199,306
Ijong	Firm	0	0	85	85	85	243	601	601	601
	Thermal	0	0	10,421	10,421	10,421	540,645	4,880,553	4,880,553	4,880,553
Miller	Firm	0	4	4	4	4	4	4	4	4
	Thermal	0	9,131	9,131	9,131	9,131	9,131	9,131	9,131	9,131
Masson	Firm	0	0	0	0	0	0	0	0	0
	Thermal	0	0	0	0	0	0	0	0	0
Wakefield	Firm	0	0	0	2	2	34	34	34	34
	Thermal	0	0	0	1,000	1,000	2,276	2,276	2,276	2,276
Braddon	Firm	0	0	0	0	0	0	0	0	0
	Thermal	0	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Cowper	Firm	1	1	1	1	1	1	172	297	297
	Thermal	0	0	0	0	0	0	935,830	2,392,962	2,392,962
Wattle	Firm	0	0	1	8	26	26	26	26	26
	Thermal	0	0	0	16,267	64,976	64,976	64,976	64,976	64,976
	Total USE	**1**	**1**	**2**	**16,275**	**65,003**	**65,003**	**1,001,006**	**2,458,261**	**2,458,261**
	Value of USE	**$27**	**$27**	**$54**	**$438,286**	**$1,750,531**	**$1,750,531**	**$26,957,092**	**$66,200,969**	**$66,200,969**

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. New loads have been allocated to existing feeders where possible in the most optimal manner to utilise available spare capacity and minimise unserved energy. It is not always possible to utilise available spare capacity because the geographical location of some new loads do not match the geographical location of existing feeders and it is not cost effective to extend such feeders.

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. This is a very conservative figure to use as approximately 60% of load in the Canberra City North, Lyneham and Dickson area is supplied to Business Customers – AEMO's published VCR for this category of customer is $44.72/kWh.
- 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 feeders to the Canberra City North, Lyneham and Dickson areas 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.