Appendix 4.8: Canberra CBD PJR

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

November 2018

evoenergy

Project Justification Report

Project name	**Supply to Canberra CBD**
Expenditure type	Capital Expenditure
Business Group	Asset Strategy
Regulatory Period	1 July 2019 to 30 June 2024
Total Project Cost Estimate	$892,600 excluding corporate overheads, excluding contingency, and excluding GST
Five year total spend 2019-24	$892,600 excluding corporate overheads, excluding contingency, and excluding GST
CAPEX category	ENAA Distribution
Primary driver	Load growth in Canberra City CBD
Project Number	20004673

Contents

1. Executive Summary

This Project Justification Report addresses the growth of electricity demand in the Canberra Central Business District (CBD) area and evaluates options re how Evoenergy can meet these needs.

The maximum demand in the Canberra Central Business District (CBD) 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 City to the Lake long term 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.

Evoenergy has an existing project to install a new 11 kV feeder from Civic Zone Substation to Edinburgh Ave by June 2019.

In addition, this Project Justification Report proposes a new 11 kV feeder from Civic Zone Substation to London Circuit by June 2020.

The proposed new 11 kV feeder from Civic Zone Substation to London Circuit will inter-tie with 11 kV feeders from City East and Telopea Park Zone Substations to provide backup security of supply in the event of a contingency.

Other options considered include an additional feeder from City East Zone Substation to London Circuit, demand management, and a grid battery. The selected option has the highest (ie least negative) Net Present Cost, and the lowest Capital Cost of all options evaluated.

A preliminary cost estimate for the selected option of a new feeder from Civic Zone Substation to London Circuit is **$892,600 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 2020.

2. Strategic Context and Expenditure Need

There is significant development underway and proposed for the Canberra CBD and surrounding area, comprising a mixture of multi-storey commercial and residential buildings.

2.1. Existing infrastructure in the Canberra CBD area

There are several 11 kV feeders supplying the Canberra Central Business District and surrounding area. These feeders emanate from City East, Civic and Telopea Park 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 the Canberra CBD and surrounding area

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
Akuna	CE	4.5	5.9	5.0	6.6	49%	30%	48%	28%	45%	30%	42%
Allara	CE	4.5	5.9	5.0	6.6	53%	21%	50%	31%	93%	84%	71%
Binara	CE	4.9	6.5	5.4	7.2	68%	72%	68%	47%	69%	44%	63%
Bunda	CE	4.5	5.9	5.0	6.6	50%	26%	50%	29%	51%	30%	48%
Chisholm	CE	5.1	6.9	5.8	7.7	97%	52%	70%	53%	85%	55%	63%
Constitution	CE	3.1	6.3	3.5	7.0	73%	41%	76%	40%	66%	42%	73%
Cooyong	CE	4.8	6.3	5.3	7.0	69%	40%	75%	49%	83%	48%	75%
Elec House	CE	4.8	6.3	5.3	7.0	49%	26%	48%	27%	48%	23%	48%
Ferdinand	CE	5.5	7.3	6.2	8.2	57%	59%	58%	58%	54%	56%	53%
Lonsdale	CE	5.4	7.2	6.0	8.0	103%	59%	75%	60%	82%	58%	80%
Northbourne	CE	4.0	5.3	4.5	5.9	48%	47%	55%	46%	64%	53%	56%
Quick	CE	3.6	4.8	4.4	5.8	81%	74%	63%	73%	65%	63%	51%
Wolseley	CE	4.5	5.9	5.0	6.6	74%	80%	91%	83%	78%	81%	8%
CSIRO	Civic	4.4	5.8	4.9	6.5	94%	51%	83%	55%	83%	78%	63%
Hobart Long	Civic	4.4	5.8	4.9	6.5	74%	62%	89%	66%	91%	61%	100%
Hobart Short	Civic	4.8	6.4	5.3	7.1	38%	61%	87%	62%	96%	76%	89%
Bowen	TP	5.5	7.3	6.2	8.2	81%	44%	69%	41%	60%	92%	125%
Edmund Barton	TP	3.3	4.5	3.8	5.0	94%	37%	63%	42%	56%	39%	52%
Gallery	TP	3.3	4.5	3.8	5.0	96%	50%	82%	60%	102%	124%	124%
Mundaring	TP	5.0	6.7	5.7	7.6	7%	8%	8%	8%	17%	22%	19%
Riverside	TP	3.3	4.5	3.8	5.0	90%	57%	92%	54%	95%	52%	92%

In addition to the 11 kV feeders listed in Table 1, Evoenergy proposes to install an additional feeder from Civic Zone Substation to Edinburgh Ave (to be known as **Edinburgh** feeder) by 30 June 2019.

2.2. Driving need for infrastructure investment

Forecast additional maximum demand in the Canberra CBD 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 CBD and surrounding area

Canberra CBD Forecast Load Growth											
Proposed Development and Net Additional Diversified Load in MVA	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Total**
PN20002983 - B3,5 & 15 S3 - 31 London Circuit. Residential 201 units, Commecial 668 m², Car park 7000 m².	0.8										**0.8**
PN20003048 - B21 S 63 - Corner London Cicruit & Knowles Place. Residential 84,500 m², Commercial 11,800 m², Retail 8,100 m², Car park 71,000 m². The Barracks.		1.3	1.5	1.5	1.5	0.7					**6.5**
PN20003655 - B1-12 S48, 54 Northbourne Avenue, Commercial 1600 m².	0.5										**0.5**
PN20003928 - B27 S26 - Corner Northbourne Ave & Cooyong St. Commercial 14,590m², Retail 215m², Car park 7600m², Plant 791m².	1.3										**1.3**
PN20003371 - B3 S12 - 20 Allara St. Residential 346 units, Commercial 1400 m², Car park 13000 m².	0.5	1.0									**1.5**
PN20005626 - B19 S29, 16 Lonsdale St. Residential 50 units, Commercial 535 m², Car park 3500 m².		0.3									**0.3**
PN20006231 - B24 S19 - Hotel & Commercial Development : Corner London Circuit and Constitution Ave (Block H)		0.5	2.0	2.0							**4.5**
CSIRO Black mountain campus redevelopment		1.5									**1.5**
City to Lake development Stage 1 - Corner Commonwealth Ave & London Circuit. Residential 607 units, Commercial 107,068 m², Community 32883 m². (Blocks O, P, Q)			4.5	4.2	1.0						**9.7**
City to Lake development Stage 2 - Corner Commonwealth Ave and Parkes Way. Residential 2,130 units, Commercial 37,583 m². (Blocks F,U, V, W, X, Y, Z)								2.0	2.0	3.3	**7.3**
B23 S19, Corner Northbourne Ave & London Circuit. New Canberra Theatre. (Blocks B, D)			0.5	0.5							**1.0**
B8 S3, Between Constitution Ave & Parkes Way (CIT car park). Residential & Commercial 9450 m². (Block T1)		0.5	1.5								**2.0**
B6 S3, Corner Constitution Ave & Parkes Way. UNSW campus 35190 m². (Block T2)			0.5	1.5	1.5	1.5					**5.0**
Expansion and redevelopment of National War Memorial, Treloar Cres, Campbell.			1.0	1.0							**2.0**
B13 S63, Corner Northbourne Ave & London Circuit. Commercial 9372 m². (Block A)					0.5	0.5					**1.0**
B14 S63, Corner Vernon Circle & Northbourne Ave. Commercial 2362 m². (Block C)					0.3						**0.3**
B27 S19, Corner Vernon Circle & Constitution Ave. Commercial 5702 m². (Block G)					0.5						**0.5**
B20 S63, Corner Vernon Circle & Commonwealth Ave. Mixed use 168,000 m². (Blocks I, J)			2.0	3.1	1.0						**6.1**
Canberra Metro traction power station TPS8 - corner Constitution Ave & Coranderrk St.							1.9				**1.9**
Canberra Metro traction power station TPS9 - 51 Russell Dr.							1.9				**1.9**
Additional Load (MVA)	**3.1**	**5.1**	**13.5**	**13.8**	**6.3**	**2.7**	**3.8**	**2.0**	**2.0**	**3.3**	
Cumulative additional forecast load (MVA)	**3.1**	**8.1**	**21.6**	**35.4**	**41.7**	**44.4**	**48.2**	**50.2**	**52.2**	**55.5**	

Table 2 shows that cumulative forecast diversified additional load in the area by 2024 will be approximately 48.2 MVA. The existing feeders (as listed in Table 1) plus the proposed Edinburgh feeder 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 does not exceed $5 million so this project will not 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.

This proposed new feeder to the Canberra CBD has 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 five options (plus the Do Nothing option) to provide additional capacity to Canberra CBD as listed in Table 4.

Table 4: Options considered for provision of additional capacity to Canberra CBD

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 Civic Zone Substation to London Circuit**	**Selected as higher NPC**
2	Network	Construct new 11 kV cable feeder from City East Zone Substation to London Circuit	Not selected due to lower NPC
3	Non-network	Demand side management	Not selected as does not meet minimum requirements and lower NPC
4	Mixed	Delay preferred network option using grid battery	Not selected as cost of delay exceeds benefits
5	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 CBD 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).

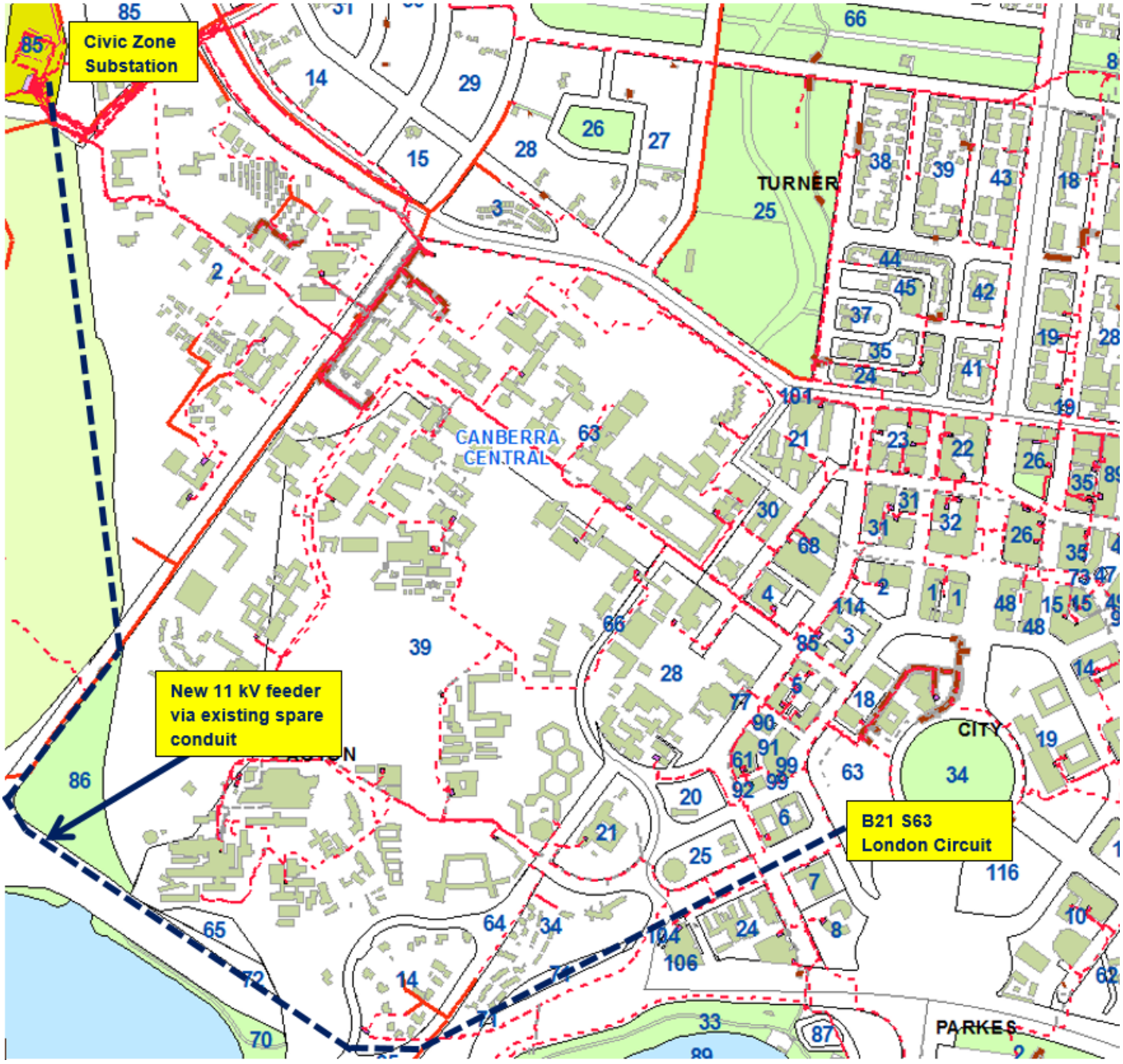
4.1.2. Option 1: Construct new 11 kV feeder from Civic Zone Substation to London Circuit

Option 1 considers the installation of a new 11 kV cable feeder from Civic Zone Substation to London Circuit to meet the growing demand in the Canberra CBD area.

Civic Zone Substation is nearest to the proposed major development on the corner of London Circuit and Edinburgh Ave. The route length of the 11 kV feeder from Civic Zone Substation to this development is approximately 3.6 km. There will be a spare conduit available for 3.2 km from Civic Zone Substation to Edinburgh Ave (to be installed under a separate project). It is proposed two conduits (one spare) are installed from Edinburgh Ave to the development at London Circuit B21 S63. This proposed new feeder will be known as **London feeder**.

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

Figure 1: Proposed 11 kV cable feeder route from Civic Zone Substation to London Circuit



A preliminary estimated cost for Option 1, for the installation of a new feeder from Civic Zone Substation to London Circuit is **$892,600 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

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

Proposed project completion is by June 2020.

4.1.3. Option 2: Construct new 11 kV feeder from City East Zone Substation to London Circuit

Option 2 considers the installation of a new 11 kV cable feeder from City East Zone Substation to London Circuit B21 S63 to meet the growing load demand.

City East Zone Substation is not the closest to the proposed development on the corner of London Circuit and Edinburgh Ave. The route length of an 11 kV feeder from City East Zone Substation to this development is approx. 4.0 km. There are no spare conduits available along this route.

A preliminary cost estimate for Option 2, the installation of a new feeder from City East Zone Substation, is **$2,567,000 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPV comparison in Appendices A and B.

Option 2 is not selected due to its lower 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 discussed further within the Demand Management Paper.

To defer the London feeder to the next regulatory control period (beyond 2024), it is estimated that non-network solutions would need to provide a maximum demand of approximately 3.9 MVA pa.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 0.57 MVA. This does not meet the minimum capacity required of 3.9 MVA by 2020 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	Binara Feeder	Total
Customer – owned embedded generation	0.20 MVA	0.30 MVA	**0.50 MVA**
Customer – owned energy storage	0.02 MVA	0.03 MVA	**0.05 MVA**
Load curtailment	0.01 MVA	0.01 MVA	**0.02 MVA**
Total	**0.23 MVA**	**0.34 MVA**	**0.57 MVA**

In summary, a maximum demand reduction of 0.57 MVA could be achieved if all the above non-network options were implemented. This is not sufficient to defer the new feeder.

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 CBD 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 1

This option utilises a grid battery to enable Option 1 to b 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 **$1,485,677 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 Canberra CBD however, the grid battery was not economic due to the relative certainty of demand and a preliminary cost estimate of **$15,816,300 excluding corporate overheads, contingency and GST**. Refer to cost estimates, cash flows and NPC comparison in Appendices A and B.

4.1.7. 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 Edinburgh feeder (to be installed by 30 June 2019) plus the proposed new London 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 Edinburgh feeder and London feeder from Civic Zone Substation are required.

Table 6: Forecast Loads and Proposed Feeder Supplies

Canberra CBD Forecast Load Growth											
Proposed Development and Net Additional Diversified Load in MVA	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Total**
PN20002983 - B3,5 & 15 S3 - 31 London Circuit. Residential 201 units, Commecial 668 m², Car park 7000 m².	0.8										**0.8**
Proposed feeder to supply above load	CSIRO										
PN20003048 - B21 S 63 - Corner London Cicruit & Knowles Place. Residential 84,500 m², Commercial 11,800 m², Retail 8,100 m², Car park 71,000 m². The Barracks.		1.3	1.5	1.5	1.5	0.7					**6.5**
Proposed feeder to supply above load	New London feeder										
PN20003655 - B1-12 S48, 54 Northbourne Avenue, Commercial 1600 m².	0.1										**0.1**
Proposed feeder to supply above load	Northbourne										
PN20003928 - B27 S26 - Corner Northbourne Ave & Cooyong St. Commercial 14,590m², Retail 215m², Car park 7600m², Plant 791m².	1.3										**1.3**
Proposed feeder to supply above load	Cooyong										
PN20003371 - B3 S12 - 20 Allara St. Residential 346 units, Commercial 1400 m², Car park 13000 m².	0.5	1.0									**1.5**
Proposed feeder to supply above load	Akuna										
PN20005626 - B19 S29, 16 Lonsdale St. Residential 50 units, Commercial 535 m², Car park 3500 m².		0.3									**0.3**
Proposed feeder to supply above load	Lonsdale										
PN20006231 - B24 S19 - Hotel & Commercial Development : Corner London Circuit and Constitution Ave		0.5	2.0	2.0							**4.5**
Proposed feeder to supply above load	Electricty House										
CSIRO Black mountain campus redevelopment		1.5									**1.5**
Proposed feeder to supply above load	CSIRO										
City to Lake development Stage 1 - Corner Commonwealth Ave & London Circuit. Residential 607 units, Commercial 107,068 m², Community 32883 m².			4.5	4.1	1.0						**9.6**
Proposed feeder to supply above load	Riverside, ANU Backup and Edinburgh										
City to Lake development Stage 2 - Corner Commonwealth Ave and Parkes Way. Residential 2,130 units, Commercial 37,583 m².								2.0	2.0	3.3	**7.3**
Proposed feeder to supply above load	Gallery, Bowen, Riverside and Edinburgh										
B23 S19, Corner Northbourne Ave & London Circuit. New Canberra Theatre.			0.5	0.5							**1.0**
Proposed feeder to supply above load	Northbourne										
B8 S3, Between Constitution Ave & Parkes Way (CIT car park). Residential & Commercial 9450 m².		0.5	1.5								**2.0**
Proposed feeder to supply above load	Wolseley										
B6 S3, Corner Constitution Ave & Parkes Way. UNSW campus 35190 m².			0.5	1.5	1.5	2.0					**5.5**
Proposed feeder to supply above load	Constitution and Wolseley										
Expansion and redevelopment of National War Memorial, Treloar Cres, Campbell.			1.0	1.0							**2.0**
Proposed feeder to supply above load	Ferdinand										
B13 S63, Corner Northbourne Ave & London Circuit. Commercial 9372 m².					0.5	0.5					**1.0**
Proposed feeder to supply above load	Northbourne										
B14 S63, Corner Vernon Circle & Northbourne Ave. Commercial 2362 m².					0.3						**0.3**
Proposed feeder to supply above load	Northbourne										
B27 S19, Corner Vernon Circle & Constitution Ave. Commercial 5702 m².					0.5						**0.5**
Proposed feeder to supply above load	Hobart Short										
B20 S63, Corner Vernon Circle & Commonwealth Ave. Mixed use 168,000 m².			2.0	3.1	1.0						**6.1**
Proposed feeder to supply above load	Binara and Edmund Barton										
Canberra Metro traction power station TPS8 - corner Constitution Ave & Coranderrk St.							1.9				**1.9**
Proposed feeder to supply above load	Wolseley										
Canberra Metro traction power station TPS9 - 51 Russell Dr.							1.9				**1.9**
Proposed feeder to supply above load	Mundaring										
Additional Load (MVA)	**2.7**	**5.1**	**13.5**	**13.7**	**6.3**	**3.2**	**3.8**	**2.0**	**2.0**	**3.3**	
Cumulative additional forecast load (MVA)	**2.7**	**7.7**	**21.2**	**34.9**	**41.2**	**44.4**	**48.2**	**50.2**	**52.2**	**55.5**	

Table 7 lists the existing and proposed feeders to the Canberra CBD and surrounding area with their existing maximum demand, forecast maximum demand at 2024 and forecast maximum demand at 2028.

Table 7: Canberra CBD and surrounding area 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)
Akuna	**City East**	4.5	5.9	1.9	4.7	4.7
Allara	**City East**	4.5	5.9	3.2	5.7	5.7
Binara	**City East**	4.9	6.5	3.0	5.3	5.3
Bunda	**City East**	4.5	5.9	2.2	5.0	5.0
Chisholm	**City East**	5.1	6.9	3.2	5.6	5.6
Constitution	**City East**	3.1	6.3	2.3	6.3	6.3
Cooyong	**City East**	4.8	6.3	3.6	4.9	4.9
Elec House	**City East**	4.8	6.3	0.4	4.9	4.9
Ferdinand	**City East**	5.5	7.3	2.9	4.9	4.9
Lonsdale	**City East**	5.4	7.2	4.4	4.7	4.7
Northbourne	**City East**	4.0	5.3	2.3	4.7	4.7
Quick	**City East**	3.6	4.8	1.8	4.2	4.2
Wolseley	**City East**	4.5	5.9	0.4	5.8	5.8
CSIRO	**Civic**	4.4	5.8	2.8	5.0	5.0
Hobart Long	**Civic**	4.4	5.8	4.4	4.4	4.4
Hobart Short	**Civic**	4.8	6.4	4.2	4.7	4.7
Bowen	**Telopea Park**	5.5	7.3	6.8	3.8	5.8
Edmund Barton	**Telopea Park**	3.3	4.5	1.7	3.8	3.8
Gallery	**Telopea Park**	3.3	4.5	4.1	2.1	4.0
Mundaring	**Telopea Park**	5.0	6.7	0.96	3.6	3.6
Riverside	**Telopea Park**	3.3	4.5	3.0	3.5	3.5
Edinburgh (2019)	**Civic**	5.5	7.3	–	6.5	6.5
London (2020)	**Civic**	5.5	7.3	–	6.3	6.3

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

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

4.1.8. Summary of Options Analysis

Table 8: 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 new 11 kV feeder from Civic Zone Substation to London Circuit**	**$892,600**	**$892,600**	**-$882,010**	**Selected due to higher NPC**
2	Construct new 11 kV feeder from City East Zone Substation to London Circuit	$2,567,000	$2,567,000	-$2,536,545	Not selected due to lower NPC
3	Demand management	N/A	N/A	N/A	Not selected as does not meet need
4	Grid battery to defer Option 1	$1,485,677	$1,485,677	-$1,438,050	Not selected as deferral not economic
5	Grid battery only	$15,816,300	$3,462,235	-$8,039,260	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 Civic Zone Substation to London Circuit (London feeder).

Financial analysis shows Option 1 to be the best option due to its higher (i.e. 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 feeder will provide capacity and security of supply to the proposed new developments at London Circuit, Canberra CBD.

Timing is scheduled for completion by June 2020.

The preliminary cost estimate of the selected option is **$892,600 excluding overheads, contingency and GST**.

The proposed 11 kV feeder will provide ties to existing feeders from City East and Telopea Park 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

Installation of 11 kV feeder from Civic Zone Substation to London Circuit. One Spare conduit will be installed from Civic zone substation to Nishi Building on Edinburgh Ave under project 1752000 & 17519152. Total route length for new feeder is approx 3.6 km. Spare Conduit available for 3.2 km. For remaining 400m from Nishi building to London Circuit, assume one trench with 2 conduits (1 spare) and one directional drill with 2 conduits.					
Preliminary Estimate ± 30% Accuracy					
Description	**Notes**	**Unit**	**$/Unit**	**Quantity**	**Cost**
Trenching and drilling					$386,000
Clearing of route where required	Allowance	m2	$10	2000	$20,000
Directional drilling	Assume drilling with no rock. Assume two conduits per drill. Assume 50% of 400 m to be drilled, ie 200m.	m	$600	200	$120,000
Open trenching and backfilling	Assume drilling with no rock. Assume two conduits per trench. Assume 50% of 400 m to be trenched, ie 200m.	m	$300	200	$60,000
Cable jointing and haulage pits	Assume every 500m	ea	$3,000	8	$24,000
Traffic management		m	$5	3600	$18,000
Reinstatement incl revegetation as required	Allowance	m3	$40	3600	$144,000
Cabling works					$340,600
11 kV 3c/400mm2 Al XLPE cable		m	$56	3600	$201,600
Throughjoints	Assume every 500m	ea	$1,000	8	$8,000
Terminations	Terminations at City East CB and distribution substation switchgear	ea	$1,500	2	$3,000
Conduit and marker tape	(3x150mm plus 2x63mm) + (1x150mm plus 1x63mm)	m	$15	3600	$54,000
HV Cables Test & Commissioning	Allowance	ea	$2,000	1	$2,000
Cable installation labour and plant		m	$20	3600	$72,000
Electrical (Secondary System)					$12,000
Protection & Control					$5,000
P&C Secondary Cabling	per feeder panel	ea	$2,500	1	$2,500
P&C Test & Commission	Allowance	ea	$2,500	1	$2,500
Protection upgrade if required	Allowance	ea	$40,000	1	$40,000
DC Supply System					$7,000
DC Cabling	per switchgear panel/bay	ea	$5,000	1	$5,000
DC Test & Commission	Allowance	ea	$2,000	1	$2,000
Other Required Works					$0
	Allowance	ea		1	$0
	Allowance	ea		1	$0
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					$150,000
Development Application	Allowance	ea	$100,000	1	$100,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea		1	$0
Project management and administration	Allowance	ea	$50,000	1	$50,000
Project Sub Total without overheads					**$892,600**
Overheads					
Overall average overhead rate	Allowance	27%		1	$241,002
Project Sub Total with overheads					**$1,133,602**
Contingency					
All project works	Preliminary allowance	10%		1	$113,360
Project total with all overheads and contingency					**$1,246,962**

A.2 Cost Estimate – Option 2

Installation of 11 kV feeder from City East Zone Substation to London Circuit. Total route length for new feeder is approx 4 km. Assume one trench with 2 conduits (1 spare) and one directional drill with 2 conduits.					
Preliminary Estimate ± 30% Accuracy					
Description	**Notes**	**Unit**	**$/Unit**	**Quantity**	**Cost**
Trenching and drilling					$2,024,000
Clearing of route where required	Allowance	m2	$10	2000	$20,000
Directional drilling	Assume drilling with no rock. Assume two conduits per drill. Assume 50% of 4 km to be drilled, ie 2 km.	m	$600	2000	$1,200,000
Open trenching and backfilling	Assume drilling with no rock. Assume two conduits per trench. Assume 50% of 4 km to be trenched, ie 2 km.	m	$300	2000	$600,000
Cable jointing and haulage pits	Assume every 500m	ea	$3,000	8	$24,000
Traffic management		m	$5	4000	$20,000
Reinstatement incl revegetation as required	Allowance	m3	$40	4000	$160,000
Cabling works					$377,000
11 kV 3c/400mm2 Al XLPE cable		m	$56	4000	$224,000
Throughjoints	Assume every 500m	ea	$1,000	8	$8,000
Terminations	Terminations at City East CB and D Sub switchgear	ea	$1,500	2	$3,000
Conduit and marker tape	(3x150mm plus 2x63mm) + (1x150mm plus 1x63mm)	m	$15	4000	$60,000
HV Cables Test & Commissioning	Allowance	ea	$2,000	1	$2,000
Cable installation labour and plant		m	$20	4000	$80,000
Electrical (Secondary System)					$12,000
Protection & Control					$5,000
P&C Secondary Cabling	per feeder panel	ea	$2,500	1	$2,500
P&C Test & Commission	Allowance	ea	$2,500	1	$2,500
Protection upgrade if required	Allowance	ea	$40,000	1	$40,000
DC Supply System					$7,000
DC Cabling	per switchgear panel/bay	ea	$5,000	1	$5,000
DC Test & Commission	Allowance	ea	$2,000	1	$2,000
Other Required Works					$0
	Allowance	ea		1	$0
	Allowance	ea		1	$0
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					$150,000
Development Application	Allowance	ea	$100,000	1	$100,000
Contractor's Preliminaries, site establishment and disestablishment	Allowance	ea		1	$0
Project management and administration	Allowance	ea	$50,000	1	$50,000
Project Sub Total without overheads					**$2,567,000**
Overheads					
Overall average overhead rate	Allowance	27%		1	$693,090
Project Sub Total with overheads					**$3,260,090**
Contingency					
All project works	Preliminary allowance	10%		1	$326,009
Project total with all overheads and contingency					**$3,586,099**

Appendix B – Financial Analysis

Capital Expenditure Cash Flow for Each Option

Financial Year	Option 1	Option 2	Option 3	Option 4	Option 5
2019-20	$892,600	$2,567,000	N/A	$593,077	$593,077
2020-21				$892,600	$538,304
2021-22					$807,455
2022-23					$807,455
2023-24					$807,455
2024-25					$807,455
2025-26					$807,455
2026-27					$807,455
2027-28					$807,455
2028-29					$807,455
2029-30					$807,455
2030-31					$807,455
2031-32					$807,455
2032-33					$807,455
2033-34					$807,455
2034-35					$807,455
2035-36					$807,455
2036-37					$807,455
2037-38					$807,455
2038-39					$807,455
Total Cost (20 years)	**$892,600**	**$2,567,000**	**N/A**	**$1,485,677**	**$3,553,746**
2019-24 Regulatory Control Period Cost	**$892,600**	**$2,567,000**	**N/A**	**$1,485,677**	**$15,665,571**

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 the Canberra CBD. 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 CBD

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

Options:

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

RESULTS (Average over 50 simulations):

Option:	One	Two	Four	Five
NPC (2019-2024)	-$805,020	-$2,315,131	-$1,361,060	-$2,754,515
NPC (2019-2039)	-$882,010	-$2,536,545	-$1,438,050	-$8,315,225
Network Option total Capital Cost	$892,600	$2,567,000	$892,600	-
Option Capital Cost (2019-2024)	$892,600	$2,567,000	$1,485,677	$3,553,746
Option Capital Cost (2019-2039)	$892,600	$2,567,000	$1,485,677	$15,665,571

Option 1, construction of the new London feeder from Civic Zone Substation to London Circuit, is the preferred option as it has the highest (ie less negative) net present cost of all options. It also has the lowest capital cost of all options.

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
Allara	Firm	0	1	47	47	47	47
	Thermal	0	7,466	64,182	64,182	64,182	64,182
Constitution	Firm	0	0	0	10	84	84
	Thermal	0	0	0	0	413	413
ANU Backup	Firm	0	0	2	27	27	27
	Thermal	0	0	272	45,034	45,034	45,034
Gallery	Firm	0	0	0	0	0	0
	Thermal	0	0	0	0	0	0
Binara	Firm	0	0	0	88	242	283
	Thermal	0	0	0	202,585	1,976,790	3,295,470
Akuna	Firm	0	0	0	0	0	0
	Thermal	0	0	0	0	0	0
Bunda	Firm	0	0	0	0	0	17
	Thermal	0	0	0	0	0	895
Chisholm	Firm	0	0	0	0	7	7
	Thermal	0	0	0	0	3,316	3,316
Cooyong	Firm	0	0	0	0	0	0
	Thermal	0	0	0	0	0	0
Hobart Long	Firm	0	1	23	93	93	93
	Thermal	0	0	9,553	298,175	298,175	298,175
CSIRO	Firm	0	0	0	0	0	0
	Thermal	0	0	0	0	0	0
Elec House	Firm	0	0	16	16	16	16
	Thermal	0	0	24,428	24,428	24,428	24,428
ED Barton	Firm	0	0	1	5	36	36
	Thermal	0	0	0	18,569	58,905	58,905
Riverside	Firm	0	0	0	0	0	0
	Thermal	0	0	0	0	0	0
Hobart short	Firm	0	0	2	2	4	10
	Thermal	0	0	0	0	467	5,585
Ferdinand	Firm	0	0	0	0	0	0
	Thermal	0	0	0	0	0	0
Northbourne	Firm	0	0	0	0	3	9
	Thermal	0	0	0	0	1,663	5,521
Lonsdale	Firm	0	0	11	11	11	11
	Thermal	0	0	3,002	3,002	3,002	3,002
	Total USE	**0**	**1**	**34,021**	**341,287**	**384,975**	**384,975**
	Value of USE	**$0**	**$27**	**$916,186**	**$9,190,859**	**$10,367,377**	**$10,367,377**

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 customers in the Canberra CBD area are classed as 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 feeder to the Canberra CBD is 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.

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