NPR-000021 Supply to Science Park and Surrounding Area

Case for Investment
March 2022

Endeavour Energy

Endorsements

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Contents

1. Executive summary

The purpose of this document is to outline recommendations for solutions to emerging network constraints assessed using increasing load at risk and associated risk factors. These risks are inputs to an options analysis that produces recommendations where assessed customer benefits outweigh risk-costs as required by the National Electricity Rules (NER). With greenfield developments where servicing capacity to connect new customers to the network is scarce, 'reliability corrective action' arising from an NER obligation to connect customers arises.

Sydney Science Park is now associated with the Western Sydney Airport growth precinct developments, and together with residual servicing needs of the Northern Gateway Precinct, will drive 40MVA new load by 2035. Existing infrastructure in the area is capable of supplying 6 MVA on the basis of feeders ecently established by the developer from a rural style zone substation in a neighbouring area.

This Case for Investment (CFI) recommends the establishment of a new 132/22kV 45MVA zone substation with a two 45MVA transformers in FY2024. This option utilises the existing 6MVA capacity of Luddenham ZS. This option produced the highest value or economic benefit considering load at risk presented by alternatives including;

- A 'no proactive action' option of utilising the existing 11kV network to service the total 43 MVA load by 2036;
- The staged installation of a single 132/22kV 45MVA transformer in FY2025 followed by a second 45MVA transformer in 2034.
- The installation of a two 132/22kV 45MVA transformer substation by FY2025 (preferred option)

Non-network solutions are considered as complementary to the preferred ZS option. Endeavour is currently working with SSP stakeholders to form the 'Microgrid Consulting Opportunity' - a strategy to incorporate Distributed Energy Resources (DER) including Battery Energy Storage Systems (BESSs). This will likely translate to demand reductions against typical commercial developments. Scenario analysis conducted indicates that the preferred option still delivers the most market benefits when technology solutions are adopted with the solution, and the real benefits from non-network solutions arise from consideration of a third transformer (when required).

Based on the analysis explained in this document Option 2 – establishment of a single zone substation site with a two transformer substation produces the option with the highest NPV value. This is assessed using key risk factors explained in section 4 and assesses a 'Do-nothing' approach as non-feasible given forecast load growth exceeding firm capacity in FY25. The following recommendations are made;

- It is recommended Option 2 – up front establishment of two 45MVA 132/22kV transformers proceed to preliminary release. This will enable development of project definitions, detailed design, environmental assessment and preliminary market engagement activities aligned to Company Procedure GRM0051.

- Following results of the 'Microgrid Consulting Opportunity' report, it is recommended BESSs be explored for the future distribution network if supported by sufficient reduction in network demand growth. Substation designs shall be compatible with inclusion of a BESS component in future.

- It is recommended the further non-network opportunities continue to be assessed with the developer in in conjunctions with development of this project, with a view to deferring future investments

- A Screening Report be published, consistent with a finding that due to the greenfield nature of the site and the lack of existing network or demand base for which a demand management could be subscribed, non-network options are not likely to be available to defer an initial network investment in the zone substation.

2. Purpose

The purpose of this document is to outline recommendations for potential solutions to emerging network constraints assessed as increasing load at risk and associated risk factors.

For investment decisions such as this one, Endeavour Energy views the lack of an ability to connect customers in accordance with the National Electricity Rules as “Reliability Corrective Action”. Risks are considered across two categories;

1. A market benefits test, which is required by the National Electricity Rules (NER) for projects which must be subject to the Regulatory Investment Test for Distribution (RIT-D). This is the primary focus of this document.

2. Impacts to the company and its shareholders. This second category of risks is only intended to inform the risk profile of the company.

Recommendations are made as a result of this assessment to deliver an optimal assessment of different network options.

3. Need/opportunity to be addressed

Sydney Science Park development site covers an area of approximately 288ha and is bound by the Warragamba to Prospect Water Supply Pipeline to the north, Luddenham Rd to the east and existing agricultural land to the south and west.

3.1 Load requirements and demand forecast

Sydney Science Park has been designed as a mixture of commercial, educational, residential and industrial facilities. It is driven by development of future Western Sydney airport and Metro Western line, from St Marys to the WSA, which will pass through this development. The Science Park development ultimate load is expected to be 45MVA by 2036.

The Northern Gateway development at the eastern corner of Luddenham Rd and Elizabeth Dr will largely be supplied from a zone substation within that precinct. However, a proportion of the precinct’s load will be supplied from SSP ZS. The Northern Gateway residual load is expected to be approximately 20MVA by 2036. Actual total load of the Northern Gateway precinct is expected to be approximately 40MVA by 2036.

Figure 1: Location of Science Park development in Endeavour Energy supply area

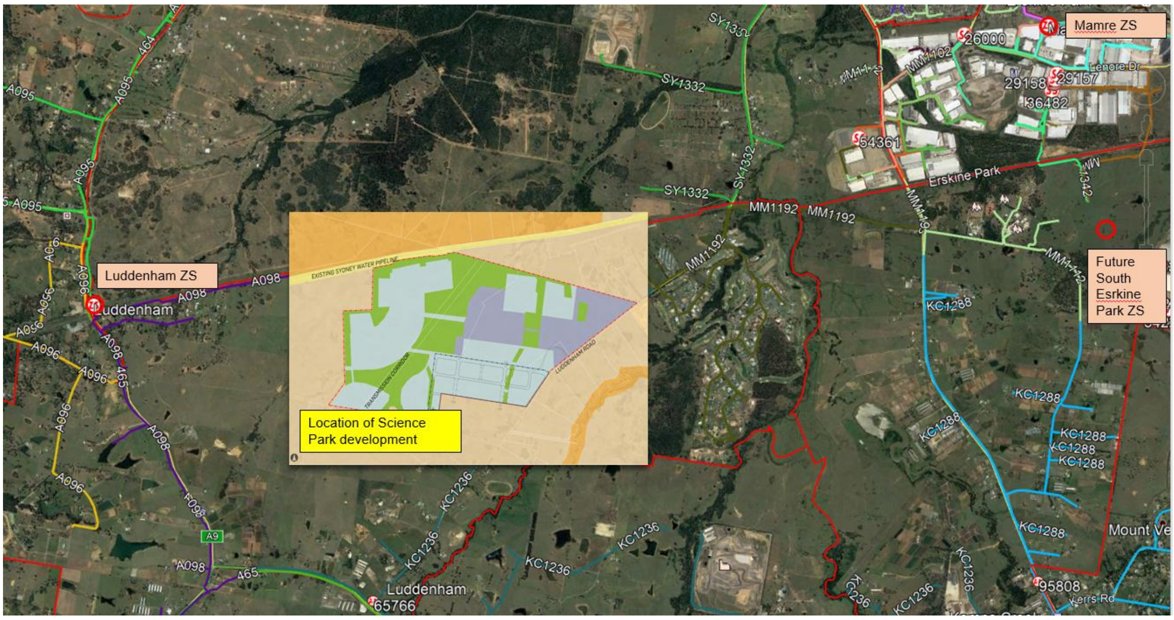
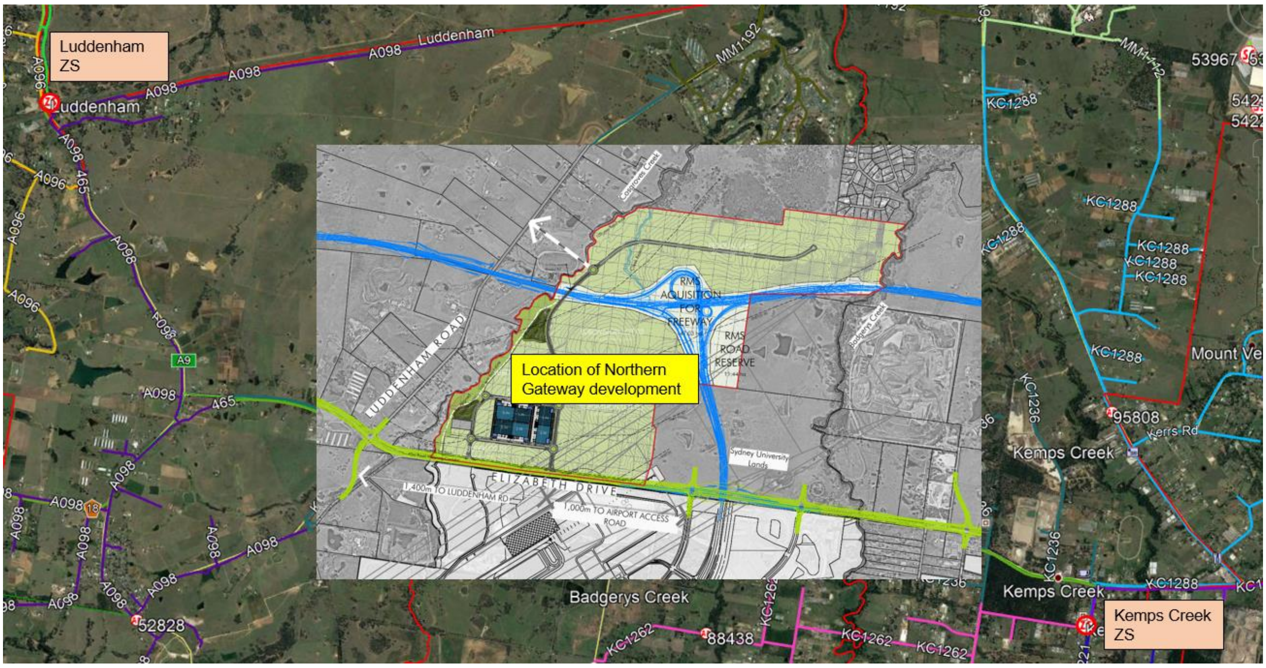


Figure 2: Location of Northern Gateway (BHL) development in Endeavour Energy supply area



The Science Park and Northern Gateway developments are estimated to have a ratio of 64% commercial load, 33% of residential load and 3% of industrial load (Figure 4).

The initial load of the development can be serviced by the remaining 6MVA capacity at Luddenham ZS as per the 2019/20 summer demand.

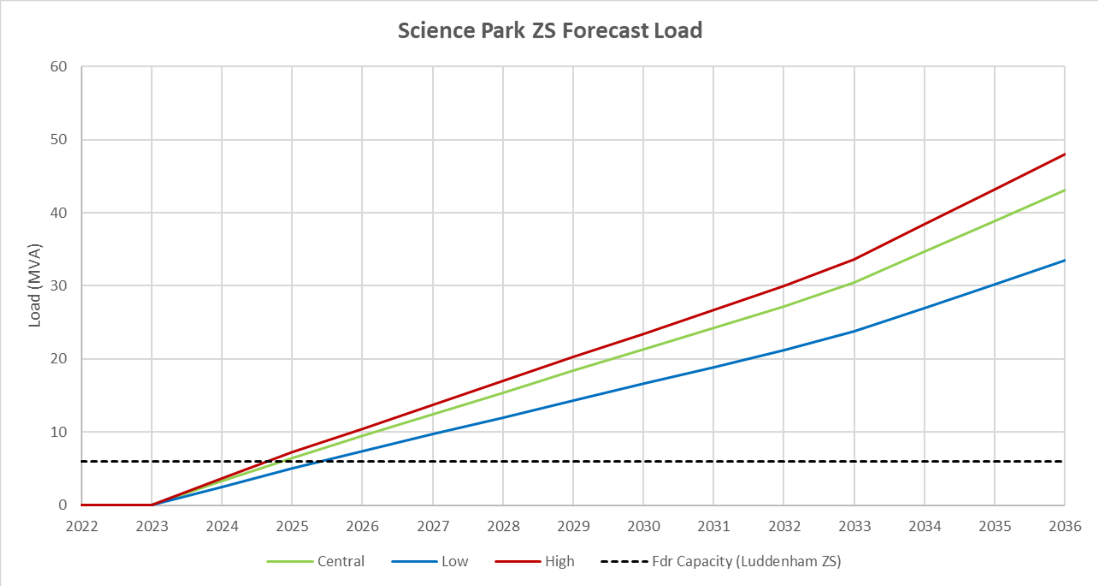


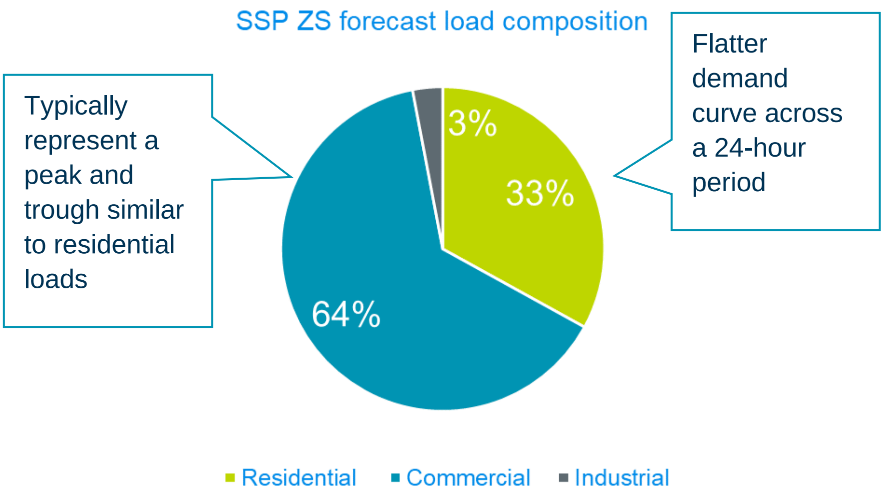
Figure 3: Demand forecast explained as load at risk for SSP ZS represented by two major growth projects - Sydney Science Park development and residual load from Northern Gateway. Load growth is shown accounting for existing[2] distribution capacity from adjacent substation (Luddenham ZS)

Table 1 - Forecast load and load at risk for the project

	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Science Park load		0.2	3	6	9	12	15	18	21	24	27	30	33	36	39
Northern Gateway Residual Load			1.1	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0	8.1	10.4	12.6	14.9
Total load on proposed ZS after Diversity			3.3	6.5	9.5	12.4	15.4	18.3	21.3	24.3	27.2	30.5	34.7	38.9	43.1
Available capacity at Luddenham ZS	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Total unserved load (MVA)	0	0	0	0.5	3.5	6.4	9.4	12.3	15.3	18.3	21.2	24.5	28.7	32.9	37.1

[2] An earlier project (PR756) has made this capacity available through the removal of the AFIC unit at Luddenham Zone Substation which allowed space for two additional feeders to be connected to Luddenham Zone Substation. These two feeders now form the basis for 'established' capacity available for and in the Science Park Precinct. To facilitate the removal of the AFIC unit, existing load control customers were converted to time cl

Figure 4: Forecast demand composition for SSP ZS



3.2 Alternative sources of spare capacity

In addition, servicing the surrounding load growth, SSP ZS offers a strategic position for future developments including significant growth near Luddenham Rd. SSP ZS is positioned to service these forecast growth areas while minimising network constraints. Existing substations are approximately 8kms away from the forecast load centre, increasing the risk of diminishing line capacity through load conductor losses and voltage constraints. Figure 1 indicates the approximate positioning of SSP ZS in relation to adjacent zone substations and the proposed load centres.

In assessing HV and capacity requirements the following were assessed.

Table 2: Alternative sources of capacity, forecast to firm and distance from the SSP load centre. Luddenham and Mamre will be used as initial load sources.

Alternative source	Distance from load centre (km)	Spare capacity (MVA)	Forecast to exceed firm
Luddenham	7	6	2023
Mamre	9	2.3	2022

4. Consequence of ‘no proactive intervention’

This case for investment examines the risks and benefits of undertaking a non-proactive approach. This assesses the option of increasing load at risk and associated risk-costs based on the best available knowledge including the Summer Demand Forecast 2021-2030. It also assesses risk for scenarios where new customers will continue to be connected to the existing network and once installed capacity is exhausted, connection of new customers will either cease, or all customers will only have partial access to supply. This forms the basis of ‘reliability corrective action’ being required.

It should be noted that the ‘no proactive intervention’ case includes extension of two 11kV feeders into the 22kV subject area from Luddenham 33/11kV zone substation. With the use of 3 MVA 11/22kV autotransformers, this forms the basis of existing capacity available in the area, noting that the 15MVA firm Luddenham Zone substation has some available capacity. As this work is already nearing completion and allows for capacity from the closes adjacent zone substation to be made available in the subject area, the cost of this work has not been included in the NPV analysis as it has already been incurred, in this case by the developer. Further 11kV extensions are not easily possible due to the physical limitations of the existing assets, and the high potential for stranded assets once the SSP ZS is built.

This section documents the most relevant risk factors applied, including;

- Involuntary load shedding
- Financial risk-cost of not meeting NEM obligations
- Safety and environmental risk costs.

4.1 Involuntary Load Shedding Risk costs

Section 3 explains that this development will exhaust existing capacity and attract load at risk from FY25 onwards. Risk costs have been capped at the corresponding expected unserved energy values five years after installed capacity is first exhausted.

Table 3 – Involuntary Load Shedding Risk costs – no proactive action Base Case scenario.

	Involuntary Load Shedding Risk costs ($m)									
Year	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**	**FY31**
Risk Costs ($m)	0	0	0	0.8	52.7	245.9	517.9	857.8	1243.2	1679.9

Value of Customer Reliability (VCR) cost for this development is estimated to be $39,997, based on the load percentage ratio of 64% for commercial,33% for residential and 3% for industrial.

4.2 Financial risk cost of failure to supply

Financial risk of delaying construction of the zone substation is a risk to the company as a result of statutory obligations to provide supply. Clauses 5.2.3(d)(1) and (6) of the National Electricity Rules provide an obligation for Network Service Providers to connect customers. Furthermore, Clause 5.2.3(b) of the National Electricity Rules (NER) relates to effective operation and proper performance of the system and service such that supply security and reliability is maintained to customers. Failure to meet this obligation constitutes Tier 1 breach of the NER and can attract a penalty of 10% of annual turnover, and an infringement notice penalty of $67,800. This risk has been estimated at $800,000 pa once capacity is exhausted in the no proactive action base case.

Table 4 - Financial Risk costs for Base Case scenario, addressed by the preferred option

	Financial Risk costs ($m)									
Year	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**	**FY31**
Risk Costs ($m)*	0	0	0	0.8	0.8	0.8	0.8	0.8	0.8	0.8

4.3 Safety risk costs

The constraints analysed in the Science Park and surrounding area are capacity related and there are no known safety issues with the existing network assets.

Section 4.1 and 4.2 outline costs associated with potential outages to customers and includes safety costs in the cost of unserved energy. Further assessments of safety risk must be carried out during design and construction in accordance with Endeavour Energy standards.

4.4 Resulting Base case annual risk costs

Table 5 - No Intervention Annual Risk Costs

	No Intervention Annual Risk Costs									
Year	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**	**FY31**
Risk Costs ($m)	0	0	0	1.6	53.5	246.7	518.7	858.6	1244.0	1244.0

5. Description of proposed method to address need or opportunity and options considered

Option 1 –Staged installation of 132/22kV Zone Substation with two 45MVA transformers

This option proposes to establish a new zone substation with one 45MVA transformer installed in FY25 with a second deferred to FY34 based on current forecasts. It is proposed this substation cut in and out of the proposed 132kV Aerotropolis feeder [2]. The feeder is due for completion in FY2024 and is capable of connecting to and supplying a future ZS.

Load forecast for the precinct indicates that the single 45MVA transformer would have significant load at risk by 2034. Non-typical network solutions are being examined that increases the uncertainty of the timing of future additional capacity beyond an initial 45MVA installation (See Section 6).

Option 2 – 132/22kV Zone Substation with two 45MVA transformers

This option proposes to establish two 45MVA transformers in a single stage by 2025.

It is proposed this substation cut in and out of the proposed 132kV Aerotropolis feeder [2]. The feeder is due for completion in FY2024 and is capable of connecting to and supplying a future ZS.

Load forecast for the precinct indicates that the two 45MVA transformer solution would eliminate all load at risk well into the foreseeable future. As the second transformer eliminates significant volumes of load at risk valued at VCR, the cost difference between the staged versus upfront installation of the transformers becomes insignificant in the NPV calculation. This therefore is the preferred option.

Parallel Technology Solutions

The question of developer-initiated solutions (microgrid, distributed and centralised battery solutions has been proposed and currently being investigated. The question arises of how the adoption of demand shaping future technology solutions will affect the choice of the preferred option. Using the current RIT-D evaluation framework and the HK model, further analysis was carried out on the basis of these demand shaping influencers. The following scenarios based around the two options presented above were evaluated.

- Option 1 (Staged -1 x 45 MVA transformer) with 25% network peak demand shaving from technology solutions
- Option 1 (Staged – 1 x 45 MVA transformer) with 50% peak demand shaving from technology solution
- Option 2 (2 x 45 MVA transformer solution) with 25% network peak demand shaving technology solutions.

NPV analysis carried out on these scenarios with the HK model indicate that Option 2 – 2 x 45 MVA transformers remains the preferred option. This is because during the modelling years under consideration, there is no residual unserved energy left after the solution (having all being credited to the solution), whereas with the other option and all the scenarios around it, there is always some residual unserved energy left that is not credited to the project and presents itself as a risk that Endeavour Energy has to bear after the solution is implemented. See section 6 for further details about specific technology solutions being considered.

Summary of options analysis

Detailed explanation of options analysis undertaken included in Section 7. To make options comparison clearer, NPV specified is relative to the non-preferred option. Actual NPV of the preferred option is $14.3b.

Table 6: Summary of option table following NPV analysis of risk-costs and opportunities

Option description	Risk Cost Post Investment ($m)	Proposed Investment Cost, capex/opex ($m)	NPV ($m)	Rank	Assessment outcome
'Do nothing' and use of existing 11kV Distribution Network	$4b			3	Capacity constraint Dist Fdrs in Science Park; Luddenham ZS
Staged 132/22kV substation with deferred 45MVA transformer		20	0	2	Technically feasible; lower nett benefits
132/22kV substation with two 45MVA transformers		24	19.9	1	Preferred Option

6. Non-network consideration

Electricity Distributors in NSW operate under the licence requirement (under the NSW Electricity Supply Act 1995) to investigate non-network alternatives to network augmentation for specific capital expenditure projects. The National Electricity Rules (NER) requires Distribution Network Service Providers (DNSP) to investigate non-network options by utilising a consultation process as part of planning for major network upgrades.

The NER calls for a regulatory investment test for distribution (RIT-D) process to be used in determining the solution that delivers the highest net market benefit in addressing the network limitation. A "screening test" is performed for all network limitations where the most expensive credible option is greater than $6 million.

Due to the greenfield nature of the site and the lack of existing network or demand base for which a demand management could be subscribed, we consider there to be no non-network options available to defer an initial network investment in the zone substation. We do however note considerable some noteworthy opportunity for non-network solutions to play a role in deferring future investments as follows:

Alternative distribution network models

Stakeholders representing the Sydney Science Park development are considering how Distributed Energy Resources (DER) and new technology approaches could be utilised to reach progressive targets for onsite and offsite renewable energy generation. This will likely translate to reduced overall energy consumption (and potentially lower demand in peak periods). Endeavour Energy is currently assessing alternative distribution network strategies through the Microgrid Consulting Opportunity report. The results of this report will inform whether an alternative network design is required to address this uncertainty and maximise customer benefits (See Section 10 Recommendations).

We do however note that any plans to connect distributed small or large greenfield renewable energy plants in the region will still require the network hosting capacity and configuration afforded by the substation and improved network hosting capacity.

Zone source and distributed battery solutions

Large scale battery energy storage systems are deployed to 11/22kV bus voltages, typically at zone substation sites, as potential alternative network solutions. Grid batteries can alleviate network constraints by enabling greater capacity headroom through 'peak shaving' – exporting charged capacity in response to peak demand periods. Equivalent functions can be provided through reduced capacity units distributed throughout the network as 'shared batteries' or community batteries. Modelling increasing peak demand above firm addressed by a battery storage solution explains network value in terms of capital deferral – the present value of delaying alternative assets to address an emerging network need.

Similarly for these assets to connect and operate without constraint, they will depend first on a backbone of network infrastructure, such as that proposed in this CFI. The initial solution as proposed includes a specification for space and switchgear requirements to facilitate a grid connected battery. This approach offers option value for future load growth in the area once basic infrastructure is established.

PR756 – conversation of AFIC load control systems to smart meter driven application

Endeavour in in the process of implementing a non-network solution under our project PR756 to support the interim supply of the development area by converting the AFIC controlled load system to an alternative distributed controlled load system and facilitating the removal of AFIC motor generator units from Luddenham ZS to allow for connection of additional feeders to the SSP development area. The initial capacity provided to the Science Park from Luddenham Zone Substation has been facilitated through this project and is already taken into account in Figure 3 as 'existing distribution capacity from Luddenham ZS)

We recognise the considerable value these opportunities may play for this site once greenfield connection is established, but we note that none are expected to be sufficient in standalone to subvert the need for the initial greenfield network investment described in this CFI. We therefore recommend this investment proceeds to screening report, where each of these options can be explored in greater detail in a Screening Report.

7. Detailed costs and benefits analysis

The Houston Kemp (HK) model is a statistics tool used to assess different options as a function of cost-benefit. The tool takes in risk-cost and opportunity inputs, in particular the value of unserved energy, produces a valuation as NPV and applies basic sensitivity models. Resulting outputs are used as data points to inform a recommendation.

Inputs and results

Inputs to the HK model presented as different scenarios of sensitivity for Sydney Science Park are outlined in table 6 below. The study is conducted over a ten-year period. A weighted summary of equal 1/3rds from each scenario explains that **Option 2 – Upfront installation of 2 x 45MVA transformers** produces the highest NPV result of two viable options explained in Section 5. This option is assessed to include risks associated with an N-1 configuration.

Table 6: HK model inputs summarised considering high and low scenarios of key inputs.

Variable	Scenario 1 - baseline	Scenario 2 – higher VCR	Scenario 3 – lowerVCR
Capital cost	Estimated network capital costs	25% increase in the estimated network capital costs	25% decrease in the estimated network capital costs
Value of customer reliability (VCR)	$39,997/MWh (from AER VCR report)	$49,996/MWh	$29,998/MWh
Discount rate	3.26% (WACC)	2.76% (WACC + 2%)	3.76% (WACC - 2%)
Maintenance costs	Estimated network maintenance costs	25% decrease in the estimated network maintenance costs	25% increase in the estimated network maintenance costs

Table 7: Summary of NPV results for the two viable options explained in Section 5.

Option	Scenario 1 NPV ($M)	Scenario 2 NPV ($M)	Scenario 3 NPV ($M)	Weighted NPV ($M)	Option ranking
Single 45MVA transformer	0	0	0	0	2
2x 45MVA transformers	19.9	9.1	35.8	21.4	1

NPV values are referenced to the non-preferred option for clarity. Actual NPVs are around $14b

8. Detailed description and costs of preferred option: Option 2 – Upfront installation of 2 x 132/22kV 45MVA transformers

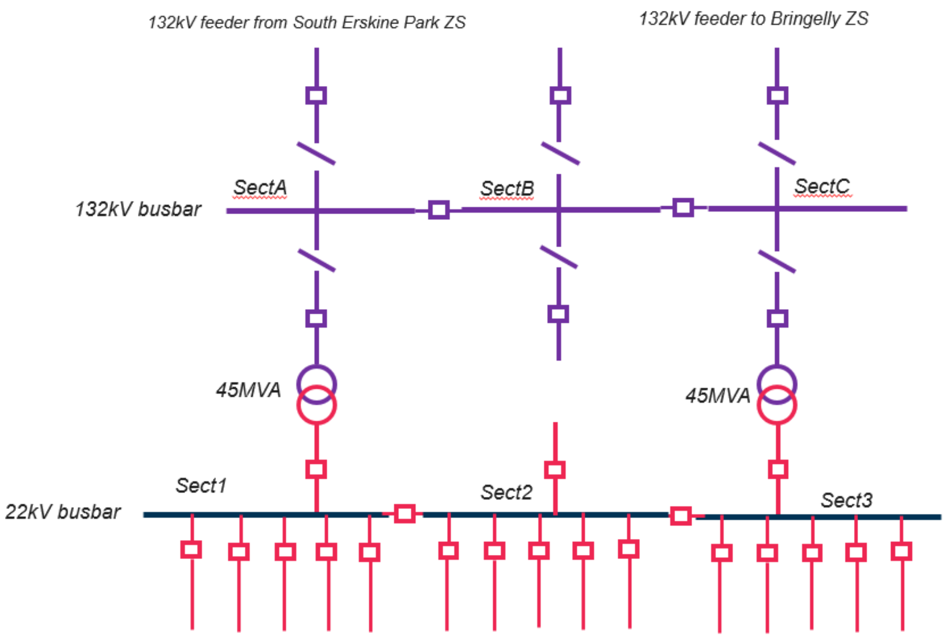
Based on the analysis undertaken in Section 7, the option to establish a new 132/22kV 2x45MVA zone substation at Science Park is explored in detail. The proposed new zone substation is named “Science Park Zone Substation”. Endeavour Energy has negotiated with the Science Park developer for a dedicated zone substation site for a transfer cost to be negotiated. The settlement for the purchase of this property is anticipated in FY2022.

Project scope of works

The scope of works for the Option 2 network option includes:

- **Zone Substation:**
  - Establish a new indoor control building to accommodate 22kV switchboards and other equipment
  - Two 132/22kV 45MVA transformers
  - 132kV indoor busbar with two of 132kV CBs, bus section CB and two 132kV TX CBs
  - 22kV switchboard with two bus sections containing five of 22kV CBs each, one 22kV bus section CB and two 22kV TX CBs.
  - 132kV and 22kV protection equipment and communication works
  - Associated 22kV distribution works
  - Consideration of rooftop solar panels to offset the carbon emissions associated with AC loads involved in operating/controlling the substation.
  - Consideration of space for future incorporation of a grid battery.

Figure 5: Single line diagram for proposed zone substation



- **Transmission Lines:**
  - Cut in and out of 132kV Aerotropolis Feeder from Sydney West BSP to Bringelly ZS with cables matching the size and type of the 132kV Aerotropolis Feeder.

- **Distribution Works:**
  - Establish ten 22kV distribution feeders
  - Establish three 22/11kV auto transformers

8.1 Project Costs and Timing

The project cost is estimated to be $24,700,000 ($FY23 real) to construct Science Park ZS. A contingency amount of $2,610,000 (10.6% of the project costs) has been added to the cost estimates covering unforeseen site conditions which may arise and cause delays. The forecast zone substation construction expenditure will occur from 2022 to 2025 as shown in the Table 8 below.

Table 8: Project expenditure spread

Estimated Cost	2022/23	2023/24	2024/25	Total
Project cost (real) ($m)	3.71	11.11	9.88	24.7
Continency ($m)	0.38	1.18	1.04	2.6
Total ($m) Real	**4.09**	**12.29**	**10.92**	**27.3**
CPI ($m)	-	0.030276	0.053824	0.084100
Total ($m) Nominal	**4.09**	**12.32**	**10.97**	**27.4**

9. Recommendation and next steps

Analysis outlined in this document explains that Option 2 – up-front establishment of a 2x 45MVA 132/22kV zone substation site produces the option with the highest NPV value. This is assessed using key risk factors explained in section 4 and assesses the baseline approach of utilising existing infrastructure as non-feasible beyond FY25. It is recommended that;

- Option 2 – up front establishment of two 45MVA 132/22kV transformers proceed to preliminary release. This will enable development of project definitions, detailed design, environmental assessment, and preliminary market engagement activities aligned to Company Procedure GRM0051.
- space be allowed for and substation design be compatible with the installation of a future grid battery at the site.
- the impact of the non-network assessment continue to be assessed in the context of optimising any future investment requirements once this initial substation is established.
- It is recommended that a Screening Notice be published to outline findings of no viable current opportunities for demand management, while noting that once initial infrastructure is established through this project, it will create future opportunities for demand management.

10. Referenced documents and appendices

[1] CY21 EE specific VCRs
[2] PR741 CFI Aerotropolis Foundation Supply
[3] **PR723 Supply to Science Park and Northern Gateway NIO presentation**
[4] **Case for investment PR723 Science Park ZS – Developer Dedicated Site for the ZS**
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