Case For Investment (CFI): Capacity Constraint in Northern Gateway and Surrounding Precincts

August 2022

Endeavour Energy

Version Control and Approvals

Table 1 – Version Control

Version #	Date of Issue	Description
1	Aug 22	Initial issue

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Investment Title	**LOAD GROWTH IN THE NORTHERN GATEWAY AND SURROUNDING PRECINCTS**
<< project # / code >>	NPR-000067
Portfolio	AUGEX
CFI Date	July 2022
Pre RIT-D	☒
Final CFI	☐
Other	☐

As the highest cost credible solution for this need or opportunity exceeds $6M, it is recommended that Endeavour Energy commence the Regulatory Investment Test process, which will also assist in determining whether a market provided non-network alternative to this investment may be available. A screening report will be published before progressing to a Draft Project Assessment Report (DPAR) as per the RIT-D process. Further it is also recommended that Endeavour Energy commence other long timeframe activities such as community consultation and environmental approvals.

This CFI recommends investment in Northern gateway ZS with 132kV bus bar and 45MVA firm capacity, to meet the growing unserved energy (prior to 2025), and increase this to 90MVA firm capacity before 2033, on the basis that the preferred solution represents the highest value (economic benefit), and that a project value of $42.5M including contingency be approved for consideration in FY24 Portfolio Investment Plan.

1. Executive Summary

The summary below sets out the key aspects to consider in recommending this investment, including:

- drivers for undertaking the investment,
- investment timing, estimated costs and expected benefits, and
- options considered.

1.1 Recommendation

This CFI recommends:

- Endeavour Energy publish a screening report before progressing to a Draft Project Assessment Report (DPAR) as per the RIT-D process (Refer to Figure 1). This is because the identified need for this investment is a reliability correction action to meet Endeavour Energy's connection obligations in the NER. Additionally, non-network options were not found to be feasible.
- The project proceeds to preliminary release with preferred Option 3 which recommends capital expenditure to build Northern Gateway ZS with a firm capacity of 45 MVA by FY25 with two 132kV feeders from WSA TS connected to a 132kV busbar, and Firm capacity of 90MVA by 2033. Preliminary release enables development of project definitions, detailed design, environmental assessment and preliminary market engagement activities in accordance with Company Procedure GRM0051.

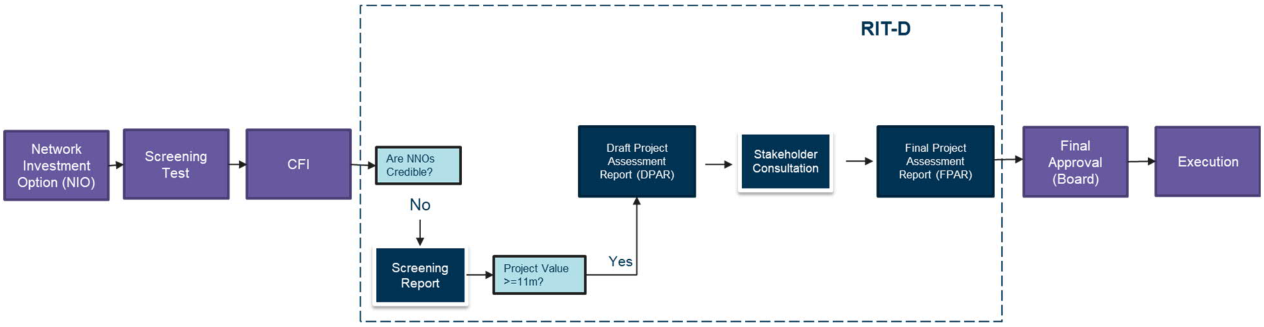


Figure 1: Endeavour Energy's RIT-D Process for this Project

1.1 Key Drivers

Recommendation to Investment in Northern Gateway ZS to address the load at risk due to significant load growth in the Kemps Creek and Luddenham Zone Substation catchment areas, before 2025 on the basis that the preferred solution represents the highest value (economic benefit). It recommends that a project value of $37.5M including contingency be approved for consideration in FY23 Portfolio Investment Plan

The preferred solution addresses the load at Risk, and unserved energy and has an overall Net benefit of $41,022M over a 30 year period. There are also substantial risks associated with negative media coverage and NSW government dissatisfaction if Endeavour Energy is unable to meet supply requirements for this area.

1.2 Options Considered

1.2.1 Long Term Network Options

To address the load at risk, the following options were examined, the ultimate arrangement will be the same however the order and staging is different for each proactive action:

- **BAU Activities** – No proactive intervention
- **Option 1** – Stage 1: Install ZS with a single tail ended Transformer, followed by Stage 2 which installs the second TX, followed by Stage 3 which completes the ZS to include 3 TX's and 132 Busbar
- **Option 2** – Stage 1: Install ZS with 2 tail ended TX, followed by Stage 2 which completes the ZS to include 3 TX's and 132 Busbar
- **Option 3** – Stage 1: Install ZS with 2 TX and 132kV Bus Bar, followed by Stage 2 which installs the Third TX
- **Option 4** – Non-Network Option

Table 2 outlines the long-term options to address the identified need. The table shows that Option 3 has the most significant economic benefit.

Option	Description	Solution Type	PV residual risk[1] $M	PV Cost[2] $M	PV Benefits[3]	NPV [4] $M	Rank	Assessment Description
N / A	No proactive intervention	Base case / counterfactual	41,052.0				5	Non-preferred as will lead to unacceptable risk or higher cost for customers if opportunity not captured
1	Establish ZS with single 45MVA tail ended transformer	Network solution	9.5	39.7	41,042.5	41,002.8	3	Technically feasible, lower net benefits
2	Establish tail ended transformer substation with 45MVA firm capacity	Network Solution	1.1	33.8	41,050.8	41,017.1	2	Technically feasible, lower net benefits
3	**Establish substation with 45MVA firm and 132kV busbar**	**Network solution**		**34.4**	**41,052.0**	**41,017.5**	**1**	**Preferred**
4	Demand management agreements with existing customers	Non-network solution					4	Technically feasible, lower net benefits

Table 2: Summary of Investment options Risk and benefits

2. Project Proposal

2.1 Identified Need or Opportunity

2.1.1 Overview and Precincts

The Western Sydney Aerotropolis area is a greenfield development of a new city covering 11,000 hectares of land, which will spearhead Western Sydney's future urbanisation. The proposed development features a precinct-based land use and zoning approach that will require significant development of electricity infrastructure to meet the needs of the area over the long term. The full development of the area is estimated to result in more than 100,000 new homes. The combined land use zoning of the area is detailed within the NSW Government's Western Sydney Aerotropolis Precinct Plan (dated March 2022). Figure 2 shows the precincts included in this plan. The area described as the Aerotropolis covers the mainly rural area that is bound by existing established locations of Erskine Park, St Marys, Luddenham, Bringelly, Leppington and Kemps Creek. The land area is approximately 11,000 hectares, however there will be significant green spaces to preserve the natural environment. The electricity supply plans will also incorporate the green space and the development requirements of the Aerotropolis precincts.

The catalyst for the development is the establishment of Sydney's second international airport at Badgerys Creek, however the strategic planning for the area also includes the establishment of Sydney's third city – the Western Parkland City.

In addition to the Western Sydney Airport (WSA), the Aerotropolis will also include a Metro rail line from St Marys to the Airport, major road developments including the M12 motorway and establishment of industries including agribusiness, transport and logistics, defence, aerospace, education and advanced manufacturing. The airport will also attract tourism and entertainment within the surrounding areas and greater Sydney.

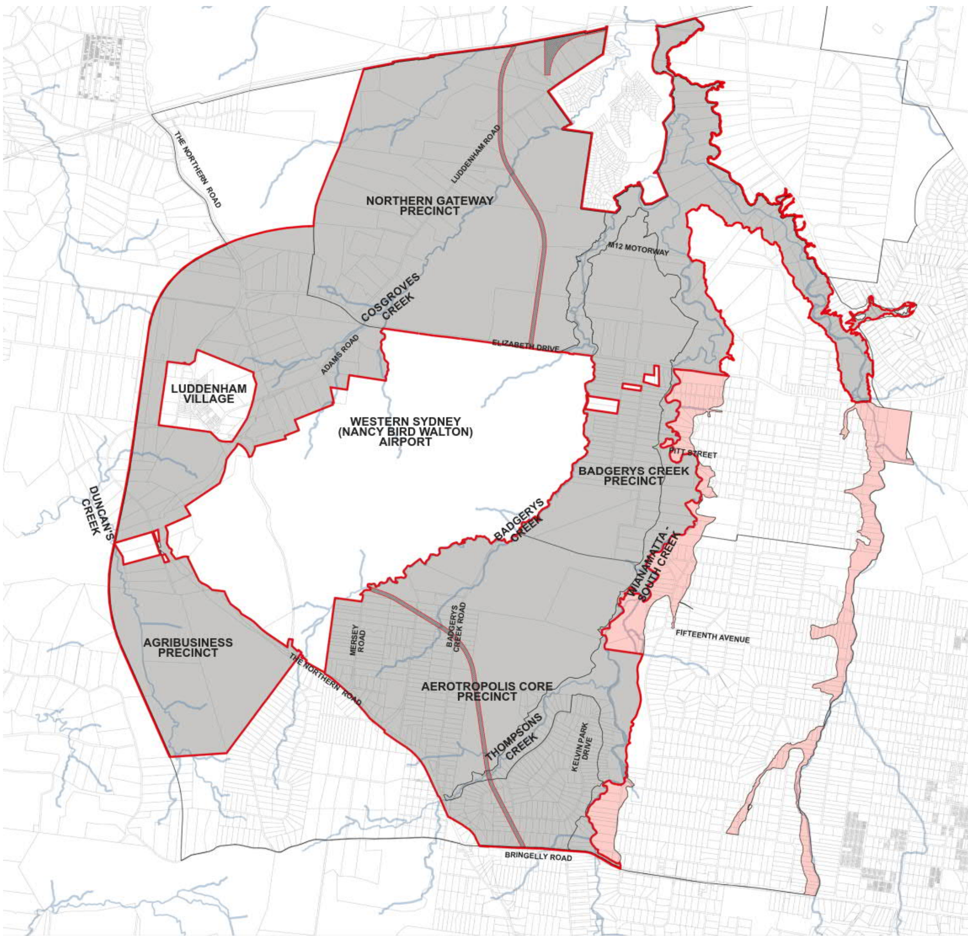


Figure 2 – Aerotropolis Precinct Plan (March 2022)

Northern Gateway Precinct

The Northern Gateway precinct is region that sits immediately north of the major entry to the airport itself. The Precinct will provide important links north into the greater Penrith area via the major transport infrastructure of the metro, motorway, freight, main road, strategic bus way and cycleway connections. The precinct will also become a hub for manufacturing, warehouse, and distribution functions.

Agribusiness North Precinct

To the immediate West of the Airport is the Agribusiness Precinct. This Precinct will offer offers key access points to the Airport, allowing the development of agribusiness uses which could include integrated logistics, air freight, integrated intensive production, food innovation, fresh product and value-added food and pharmaceuticals.

2.1.2 Existing infrastructure not suitable to service growth

Table 4 shows the area under study in relation to the two nearest existing Zone Substations, namely Kemps Creek ZS and Luddenham ZS. The land comprising the Northern Gateway Precinct is currently serviced by a single 11kV rural standard feeder 7.4 km (feeder route) away from Kemps Creek ZS, which is not capable of supporting any large development in the region.

Both Luddenham ZS and Kemps Creek ZS are forecast to exceed their firm rating in near term forecast period and are also supplying various early load connections across the wider Aerotropolis.

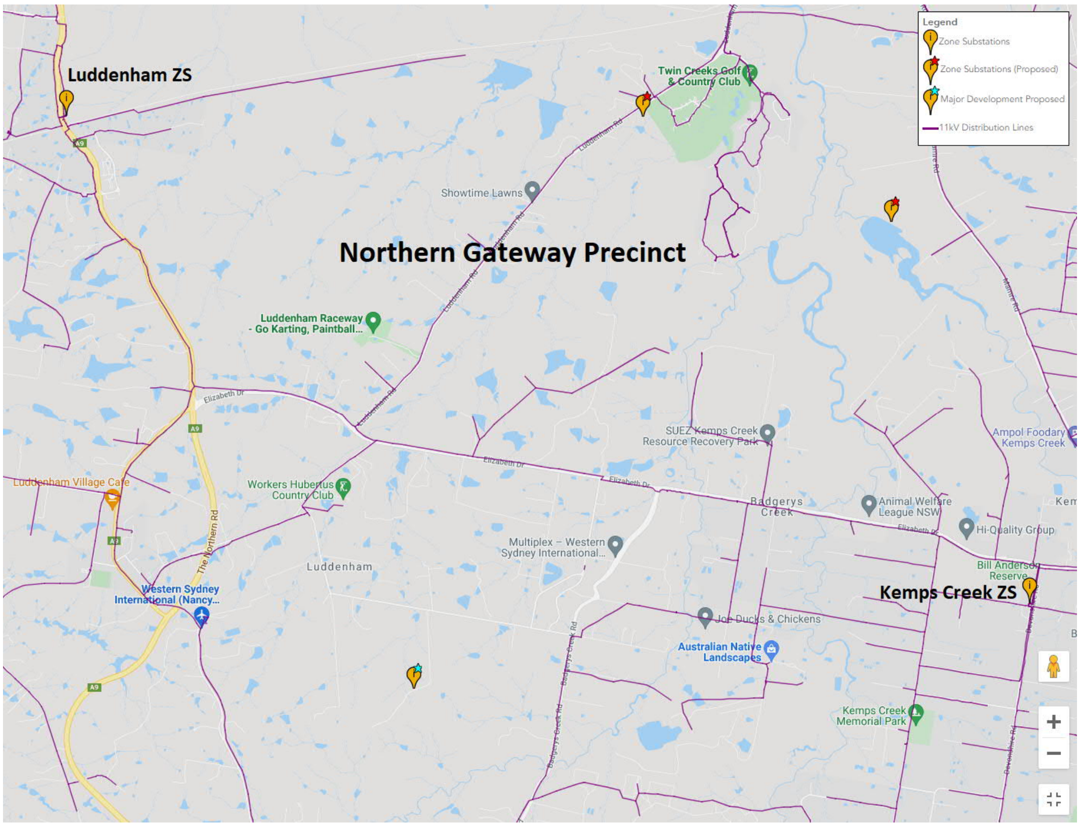


Figure 3 - Location of Kemps Creek ZS and Luddenham ZS with respect to Northern Gateway Precinct as shown on Endeavour Energy's DAPR Portal

2.1.3 Integration with Endeavour Energy Area Plans

Endeavour Energy's Western Sydney Aerotropolis Area Plan (June 2022) provides a macro, long term macro view of the region. The plan identifies the lack of existing infrastructure and proposes a number of new zone substations as possible investments – including a future 'Northern Gateway Zone Substation'. The plan also importantly identifies the percentage of Precinct servicing by the various Zone Substations, and in reference to Table 3 below, shows the intent of a centrally located substation within the Northern Gateway Precinct will serve connections to a small percentage of connection in adjacent Precincts such as Agribusiness.

Substation	Precinct	Percentage	MVA
Northern Gateway ZS	Northern Gateway East	100%	23
	Northern Gateway West	80%	20
	Agribusiness North	35%	49
	Luddenham Rd to Northern Rd	20%	17

Table 3 - Northern Gateway ZS catchment area Precincts

The Western Sydney Aerotropolis Area Plan also discusses the use of 22kV as the preferred distribution voltage. This is due to lower net costs, higher asset utilisation and greater support for high load densities as expected in the Aerotropolis region. As such it is anticipated that feeders reticulated out of the proposed Northern Gateway ZS will be at 22kV.

2.1.4 Applications and Enquiries received to date

Endeavour Energy is actively supporting multiple Developer groups that are working to release land holdings in the Northern Gateway and Agribusiness North districts. Some of the received applications include, and are also shown in Figure 4 and Figure 5.

- Enquiry ENL3708 for 250ha with 12 Super Lots for warehousing and advanced logistics with an assessed load of approximately 37 MVA (~6MVA in 2023, ~14MVA in 2024, ~20MVA in 2025)
- Application UIS0949 for an initial 1.5MVA reticulation in Northern Gateway Precinct
- Application UIL59031 for an initial 1.5MVA in Agribusiness Precinct North at Adams Road
- Enquiry ENL4318 for 55ha of development in Agribusiness North, ultimate load of 20MVA with initial load connections in 2024.

Combining ongoing receipt of enquiries and applications in the region requesting load from 2024, and with the Airport on track to begin operations in 2026, Endeavour Energy has high level of confidence in the uptake and ultimate load forecasts for the Precincts under study.

Figure 4 – Indicative Master Plan provided by developer for part Northern Gateway Precinct

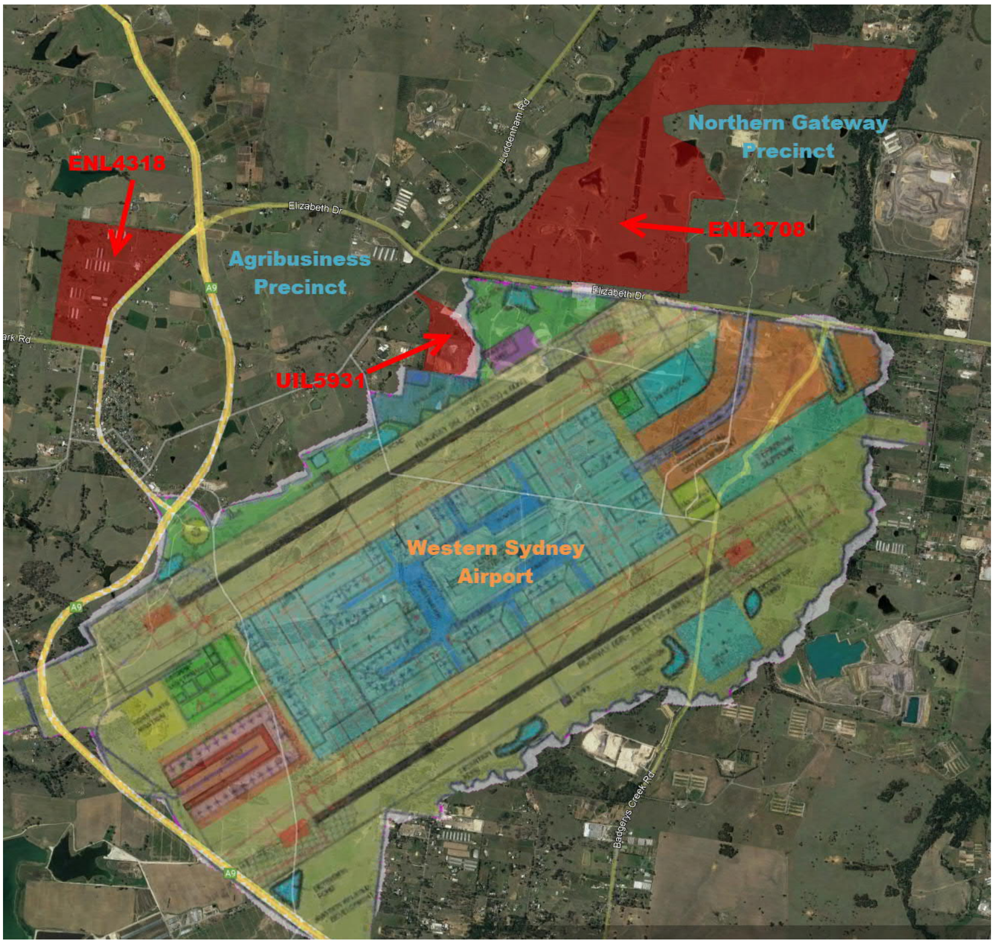


Figure 5 – Indicative enquiries and applications received in Northern Gateway and Agribusiness Precincts

2.1.5 Load forecast

The demand forecast for the area under study considering the major new connections and network constraints listed above is detailed in Figure 6 and Table 4 below and the forecast presents central, high and low cases.

The table also shows the forecast on the 33/11kV transformers at Luddenham Zone Substation. The load at risk used for the calculation of unserved energy is also presented from 2022 to 2031. The figure shows that without additional electrical capacity in the area, the forecast demand for all three scenarios by 2024 will result in unserved load.

An important observation of the below graph is the downturn in the forecast scenarios in 2026-2027 years. This forecast is the full Luddenham ZS forecast that also includes adjacent development at Sydney Science Park. An approved project to establish a Zone Substation to serve Sydney Science Park precincts is acknowledged by the load transfer off Luddenham ZS onto the zone substation.

Figure 7 is included to show the forecast of the Northern Gateway and Agribusiness Precincts under study specifically within this CFI.

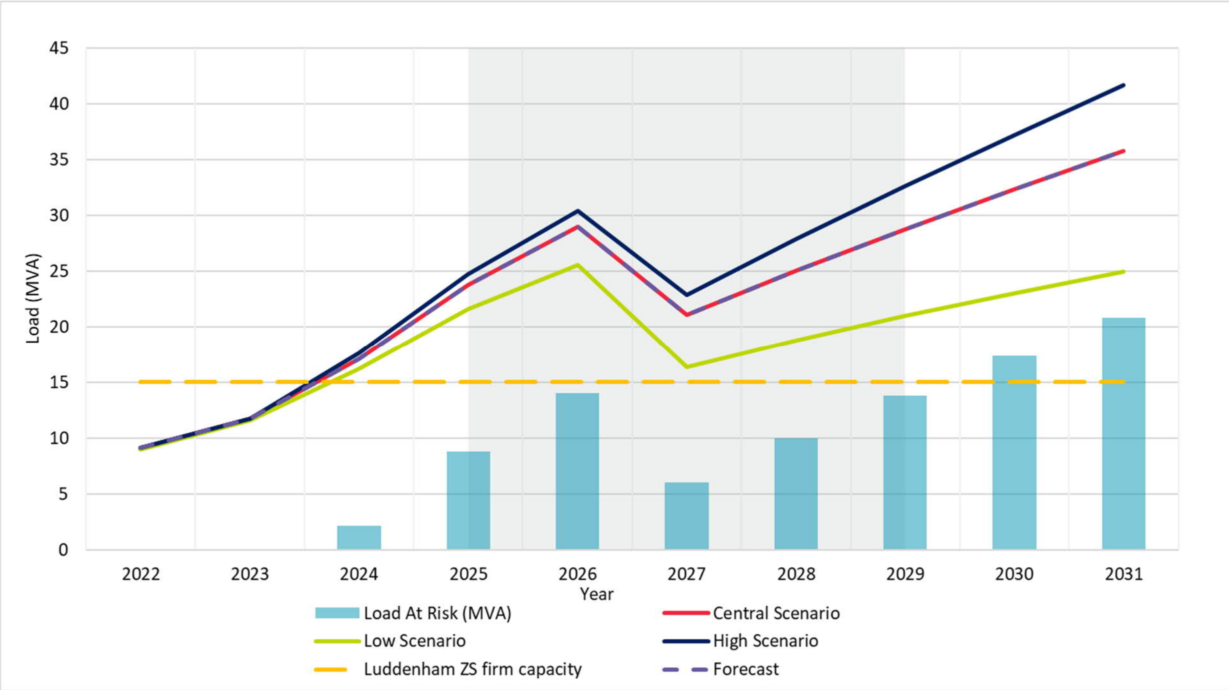


Figure 6 – Demand Forecast and existing system capacity

Demand Forecast (MVA)	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2036	2041	2046	2051
Luddenham ZS forecast (diversified)	8.4	11.0	15.3	18.5	20.3	8.9	9.4	9.7	9.8	9.8	10.1	10.3	10.6	10.9
Northern Gateway East	0.0	0.0	1.3	2.7	4.0	5.3	6.6	8.0	9.3	10.6	17.2	23.9	26.5	26.5
Northern Gateway West	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.7	4.0	5.3	12.0	18.7	25.4	26.7
Luddenham Village	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Agribusiness North	0.0	0.0	0.0	3.0	6.0	8.9	10.6	12.3	14.0	15.6	29.6	41.6	54.6	66.9
Total Undiversified	11.4	14.7	21.4	29.7	36.3	26.3	31.3	36.0	40.4	44.8	72.3	98.0	120.7	134.6
Total Diversified at 80% diversity	9.1	11.8	17.1	23.8	29.0	21.0	25.0	28.8	32.4	35.8	57.9	78.4	96.5	107.7
Central - Demand Forecast	9.1	11.8	17.1	23.8	29.0	21.0	25.0	28.8	32.4	35.8	57.9	78.4	96.5	107.7
Low - Demand Forecast	9.0	11.6	16.2	21.6	25.6	16.4	18.8	21.0	23.0	25.0	38.4	50.6	63.5	75.9
High - Demand Forecast	9.1	11.8	17.7	24.7	30.4	22.9	27.9	32.6	37.2	41.7	68.6	94.1	115.5	126.8
Luddenham ZS firm capacity	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0				
Forecast	9.1	11.8	17.1	23.8	29.0	21.0	25.0	28.8	32.4	35.8				
Load At Risk (MVA)	0.0	0.0	2.1	8.8	14.0	6.0	10.0	13.8	17.4	20.8				

Table 4 – Demand Forecast and existing system capacity

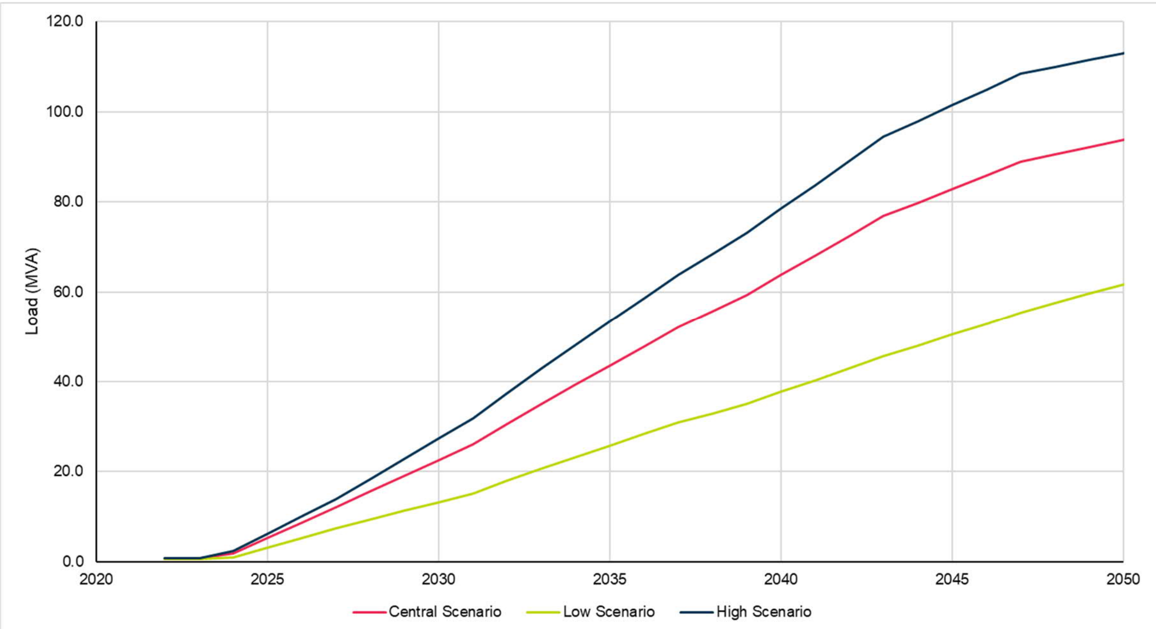


Figure 7 – Northern Gateway and Agribusiness load forecast (without existing network)

2.1.6 Investment timing

Table 5 below shows the status of the three important criteria to determine the timing. Based on the zoning, development and status of supporting infrastructure it is evident that investment is required.

Criteria	Low or later growth time frame	Moderate growth in medium term expected	High growth likely in shorter term
Zoning status	Not part of any official release area and not rezoned	Part of official release area but not rezoned yet	Yes rezoned
Development status	No current activity	First stages already planned /committed to	construction commenced for initial stages
Supporting infrastructure (water/sewer, roads, transport)	Lack of other infrastructure commitment	Planned/committed initial stages of other infrastructure	Significant progress on roads and transport and water/sewer infrastructure already

Table 5 – Investment Timing Criteria

2.2 Related Projects

Proposed future zone substation will be located at a site that will be acquired under project NLP-000044.

2.3 Assumptions

Key assumptions relating to the economic evaluation of the viable options are listed below:

- The 7 January 2022 version of the HK model was used.
- Dollars are given in FY22.
- A study period of 30 years was used – due to the significant rate of load growth.
- The discount rate was set to 3.26% based on the pre-tax real WACC.
- A VCR of $44,580 was used based on 55% commercial, 21% industrial and 24% residential load.
- Asset maintenance cost based on 0.4% of the project cost.
- Benefits and comparison of options beyond the reliability corrective action period are based on avoided unserved energy.
- An estimate of $5 Million was included to establish distribution feeders, 22kV conversions and auto transformers. Due to the uncertainty of the final masterplan for the Northern Gateway area, scoping of these works has not been carried out however it is estimated this project will establish between four to six feeders.

3. Options Considered

3.1 Summary of Options

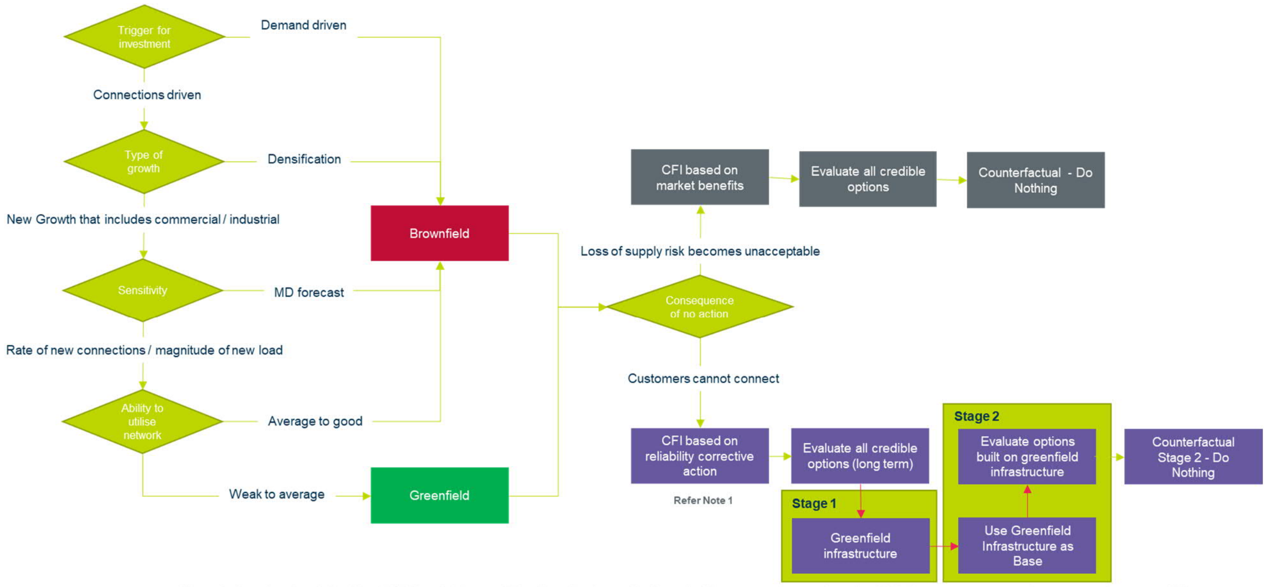
The options comparison table below sets out the ***credible options*** that were considered, together with a counterfactual option: "*no proactive intervention*" to assist the overall comparison. These include all substantially differing commercially and technically credible options, including non-network solutions. Credible options (or a group of options) are those that meet the following criteria:

- addresses the identified need
- is (or are) commercially and technically feasible
- can be implemented in sufficient time to meet the identified need

For all options a review period of 30 years has been used with a discount rate of 3.26%.

Refer to Appendix **Error! Reference source not found.** for details on RIT-D process (if relevant).

To provide a fit-for-purpose response to the growth challenge as well as be consistent with the NER and AER guidelines, Endeavour Energy has segmented the growth investments into two types, greenfield and brownfield. Figure 8 below shows the decision framework used to determine the investment requirements.



Note 1: Per Section 3.3 of the RIT-D guidelines, if the identified need is for reliability corrective action, the RIT-D proponent may choose to select a credible option as its base case (a 'base credible option').

Figure 8 – Investment decision matrix

Based on the decision rule outlined in Figure 8, the following are the characteristics of the area:

- Investment is classified as **greenfield.**
- Identified need based on consequence of no action for the greenfield development is **reliability corrective action**[1].

Figure 9 below (subset of the decision rule included in Executive Summary) have been utilised to outline the options.

[1] Refer Growth Servicing Strategy for definitions of greenfield and brownfield sites

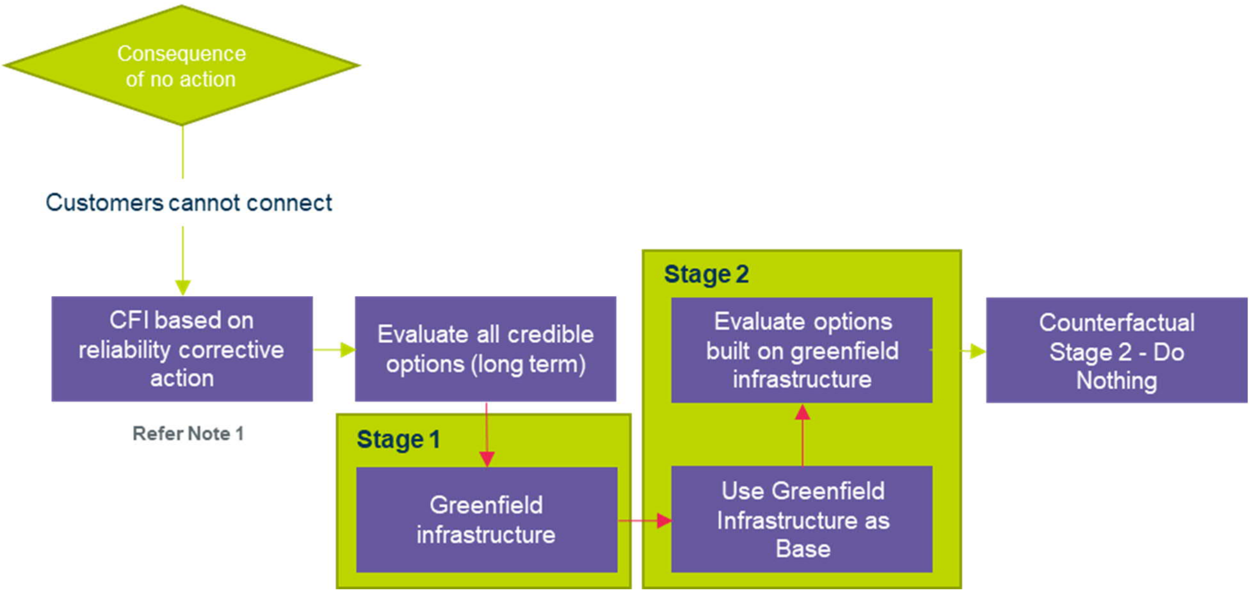


Figure 9 – Investment decision matrix

Option	Description	Solution Type	PV residual risk[1] $M	PV Cost[2] $M	PV Benefits[3]	NPV [4] $M	Rank	Assessment Description
N / A	No proactive intervention	Base case / counterfactual	41,052.0				5	Non-preferred as will lead to unacceptable risk or higher cost for customers if opportunity not captured
1	Establish ZS with single 45MVA tail ended transformer	Network solution	9.5	39.7	41,042.5	41,002.8	3	Technically feasible, lower net benefits
2	Establish tail ended transformer substation with 45MVA firm capacity	Network Solution	1.1	33.8	41,050.8	41,017.1	2	Technically feasible, lower net benefits
3	**Establish substation with 45MVA firm and 132kV busbar**	**Network solution**		**34.4**	**41,052.0**	**41,017.5**	**1**	**Preferred**
4	Demand management agreements with existing customers	Non-network solution					4	Technically feasible, lower net benefits

Table 6 – Summary of Investment options Risk and benefits

Notes:
1: PV residual risk cost (or savings for opportunities) post the investment. Further details on the risks considered can be found in Appendix A.
2: PV of total costs, both Capex and Opex. See Appendix C for further details.
3: PV of total quantified benefits, both risk mitigated and any forecast decrease in Capex or Opex arising as a result of undertaking the investment (opportunities).
4: PV Benefits less PV Investment Costs

Consequence of ‘no proactive intervention’

The consequence of not proceeding with the investment in a network option for the study area is significant unserved energy due to the existing supply network being constrained and incapable of supplying the forecast demand for the area.

Figure 10 and Table 7 shows the expected unserved energy and the value of the expected unserved energy. The load duration curve used for the calculations is Moorebank ZS which has a similar load profile of industrial loads to that expected for the Western Sydney Employment Lands.

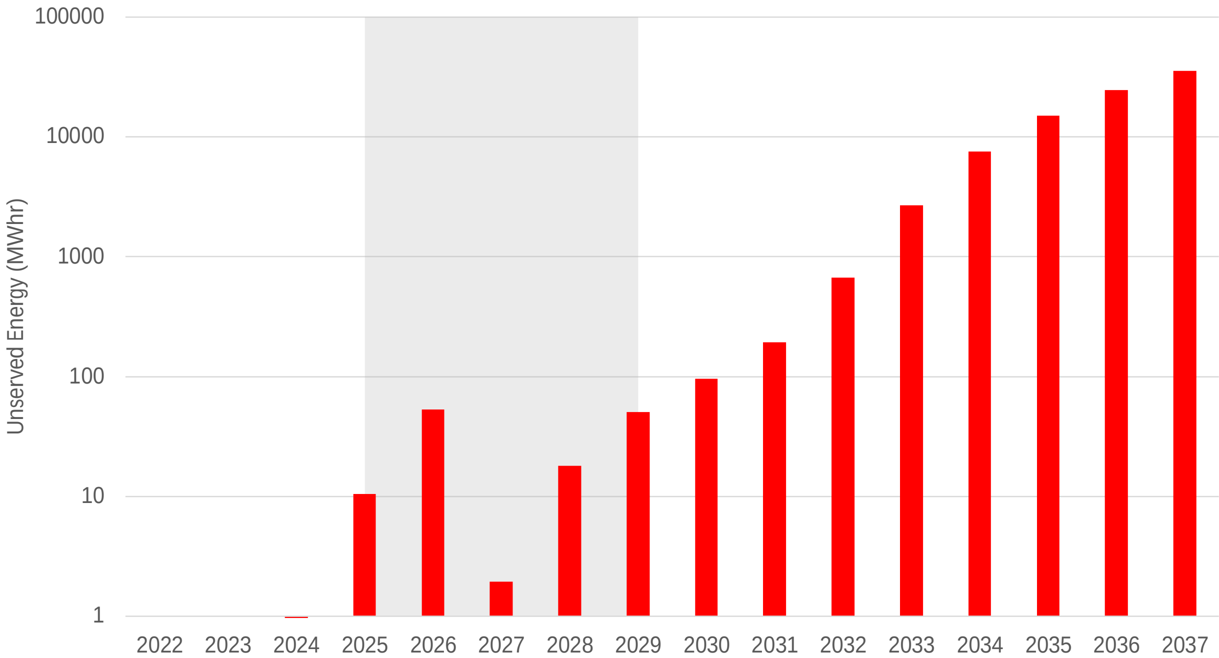


Figure 10 – Load at risk

Year	2023	2024	2025	2026	2027	2028	2029	2030
Expected Unserved Energy (MWhrs)	0	0	11	53	2	18	51	94
Value of Unserved Energy ($M)	0	0	0.47	2.36	0.09	0.80	2.26	4.30

Note between 2024-2025, the expected unserved energy decreases due to the completion of construction activities at Science Park Zone Substation and the transfer of loads off luddenham and onto the new site at Science Park.

Table 7 – Value of Expected Unserved Energy as a result of “no proactive intervention”

3.2 Option 1: 3 Stage project commencing with Establishing Zone Substation with a Single Tail ended transformer substation

Scope

A high level Scope for Option 1 is as below:

Stage 1: **FY2023 – FY2025**

- Install 1 x 132/22kV power transformer
- Install 1 x 132kV feeder from Western Sydney Airport TS
- Install 1 x 22kV bus section with 5 x 22kV circuit breakers
- Install 1 x auxiliary transformer
- Install protection and control equipment
- Associated 132kV feeder protection works at Western Sydney Airport
- Associated 22kV cabling
- Establish 4-6x distribution feeders

Stage 2: FY2027 – FY2029

- Install 1 x 132/22kV power transformer
- Install 1 x 132KV feeder from Western Sydney Airport TS
- Install 2 x 22kV bus sections each with 5 x 22kV circuit breakers
- Install 1 x auxiliary transformer
- Associated 132kV Feeder protection works at Western Sydney Airport
- Associated 22kV cabling

Stage 3: FY2030 – FY2032

- Install 3 x 132kV bus sections with 4 x feeder and 3 x transformer circuit breakers
- Install 1 x 132/22kV Power Transformer
- Associated 132kV and 22kV cabling

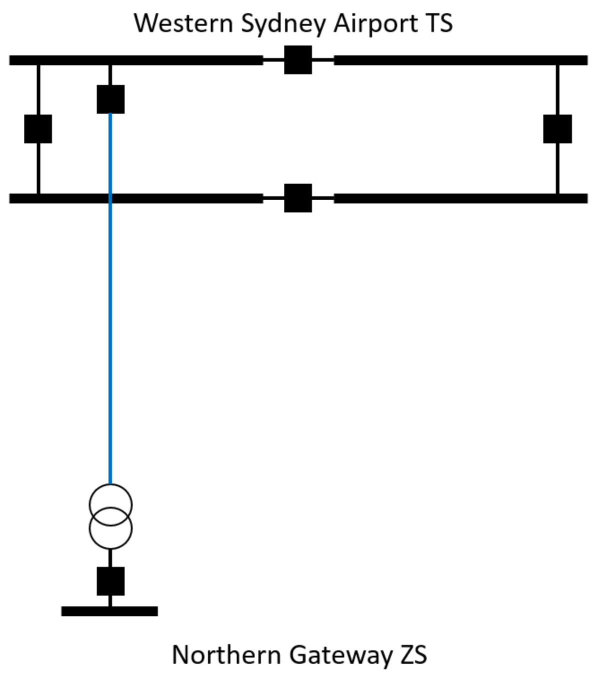


Figure 11 – Option 1 Stage 1 Single Line Diagram

Assumptions

Total costing has been obtained, however for the breakdown of stages were estimated.

In order to compare the option of tail ended transformers to installing a 132kV busbar in Option 3, a risk cost was added for potential unserved energy to Badgerys Creek ZS. Due to spacing constraints on Elizabeth Dr, there is a probability that Endeavour Energy may not be able to obtain additional ducts to run feeders from Western Sydney Airport TS to the proposed Badgerys Creek ZS. In this event, a feeder to supply Badgerys Creek ZS will need to come from Northern Gateway ZS which would require the installation of a busbar. To model this, the expected unserved energy for Badgerys Creek ZS has been added for this option with a 20% probability for two years. The assumed construction time for the busbar installation is two years.

Cost

The total cost of the project is below:

Stage	Cost $M
Stage 1: FY2023 – FY2025	16.2
Stage 2: FY2027 – FY2029	11.2
Stage 3: FY2030 – FY2032	14.1
Total Cost	**41.6**
PV cost	**39.7**

Table 8 - Option 1 Cost breakdown by Stage

Benefits

This option has a large PV benefit of $41,042M in addressing the forecasted load at Northern Gateway. This option does however also carry with it some risk dependant on load growth and optimal time for subsequent stages, and also with regard to causing potential delays to downstream projects should a new switching point be required from a Busbar at Northern Gateway, or if future large customers in the area wish to connect.

NPV

This overall NPV of this option is $41,003M and is significantly NPV positive

Summary

This option has significant overall benefit however is not the overall preferred option as is the lowest NPV option.

3.3 Option 2: 2 stage project commencing with Establishing Zone substation with 2 tail ended Transformers

Scope

A high level Scope for Option 2 is as below:

Stage 1: **FY2023 – FY2025**

- Install 2 x 132/22kV power transformers
- Install 2 x 132KV feeders from Western Sydney Airport TS.
- Install 3 x 22kV bus sections each with 5 x 22kV circuit breakers
- Install 2 x auxiliary transformers
- Install protection and control equipment
- Associated 132kV feeder protection works at Western Sydney Airport
- Associated 22kV cabling
- Establish 4-6x distribution feeders

Stage 2: FY2030 – FY2032

- Install 3 x 132kV bus sections with 4 x feeder and 3 x transformer circuit breakers
- Install 1 x 132/22kV Power Transformer
- Associated 132kV and 22kV cabling

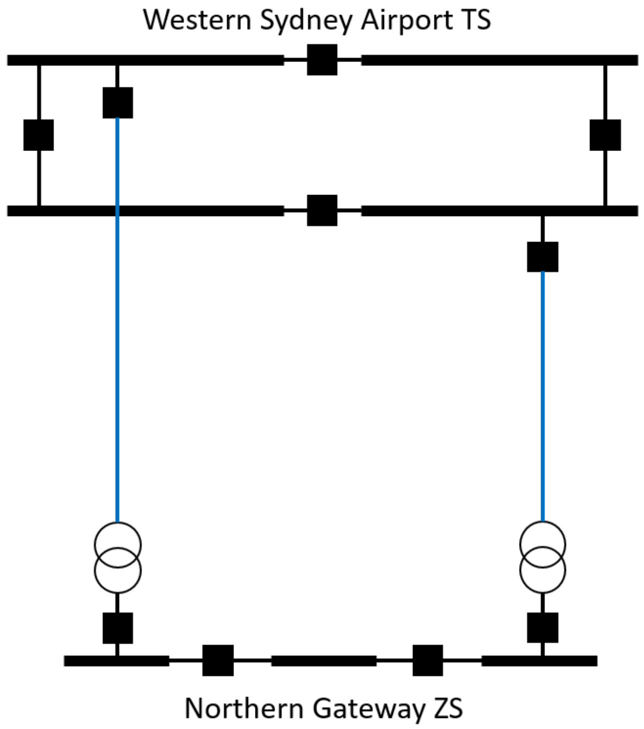


Figure 12 – Option 2 Stage 1 Single Line Diagram

Assumptions

Total costing has been obtained, however for the breakdown of stages were estimated.

In order to compare the option of tail ended transformers to installing a 132kV busbar in Option 3, a risk cost was added for potential unserved energy to Badgerys Creek ZS. Due to spacing constraints on Elizabeth Dr, there is a probability that Endeavour Energy may not be able to obtain additional ducts to run feeders from Western Sydney Airport TS to the proposed Badgerys Creek ZS. In this event, a feeder to supply Badgerys Creek ZS will need to come from Northern Gateway ZS which would require the installation of a busbar. To model this, the expected unserved energy for Badgerys Creek ZS has been added for this option with a 20% probability for two years. The assumed construction time for the busbar installation is two years.

Cost

The total cost of the project is below:

Stage	Cost $M
Stage 1: FY2023 – FY2025	25.7
Stage 2: FY2030 – FY2032	14.1
Total Cost	**39.8**
PV cost	**33.8**

Table 9 - Option 2 Cost breakdown by stage

Benefits

This option has a large PV benefit of $41,051M in addressing the forecasted load at Northern Gateway. Whilst this option allows for some deferral, it also carries with it some risk with regard to causing potential delays to downstream projects should a new switching point be required from a Busbar at Northern Gateway, or if future large customers in the area wish to connect.

NPV

This overall NPV of this option is $41,017M and is significantly NPV positive

Summary

This option has significant overall benefit and is ranked second highest based on NPV analysis, and is very close to the preferred option in terms of overall benefit.

3.4 Option 3: 2 stage project commencing with Establishing Zone substation with 2 Transformers and 132kV Busbar

Scope

A high level Scope for Option 1 is as below:

Stage 1: **FY2023 – FY2025**

- Install 2 x 132/22kV power transformers
- Install 2 x 132kV bus sections with 2 x feeder circuit breakers and 2 x transformer circuit breakers
- Install 2 x 132kV feeders from Western Sydney Airport TS
- Install 3 x 22kV bus sections each with 5 x 22kV circuit breakers
- Install 2 x auxiliary transformers
- Install protection and control equipment
- Associated 132kV feeder protection works at Western Sydney Airport TS
- Associated 22kV cabling
- Establish 4-6x distribution feeders

Stage 2: FY2030 – FY2033

- Install 1 x 132kV bus section with 1 x transformer circuit breaker
- Install 1 x 132-22kV Power Transformer
- Associated 132kV 22kV Cables

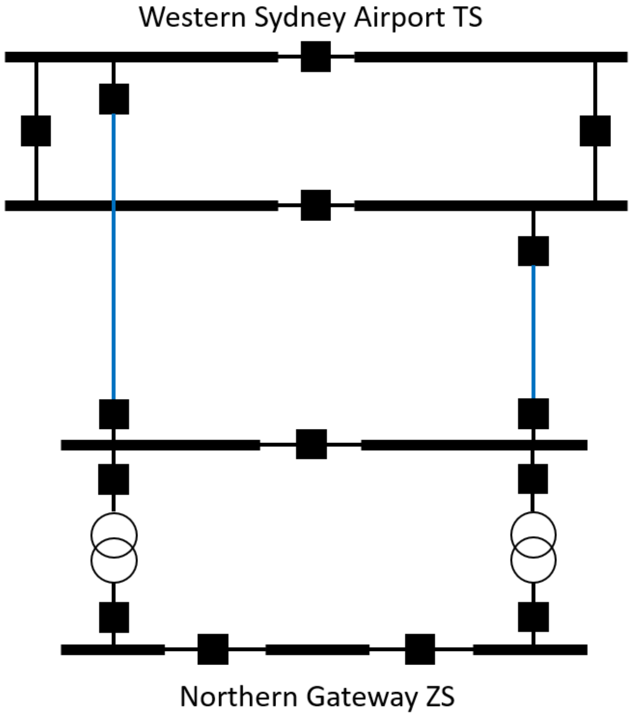


Figure 13 – Option 3 Stage 1 Single Line Diagram

Assumptions

Total Costing has been obtained, however for the breakdown of stages were estimated,

Cost

The total Cost of the project is below:

Stage	Cost $M
Stage 1: FY2023 – FY2025	31.1
Stage 2: FY2030 – FY2033	7.3
Total Cost	**38.4**
PV cost	**34.5**

Table 10 - Cost breakdown of Option 3 by stages

Benefits

This option has a large PV benefit of $41,052M in addressing the forecasted load at Northern Gateway. By installing the Busbar early, this option allows for flexibility and addressing potential delays to downstream projects should a new switching point be required from a Busbar at Northern Gateway, or if future large customers in the area wish to connect.

NPV

This overall NPV of this option is $41,018M and is significantly NPV positive

Summary

This option has significant overall benefit and is ranked second highest based on NPV analysis, and is very close to the preferred option in terms of overall benefit.

3.5 Sensitivity and Scenario Analysis

A sensitivity study was also undertaken in this economic evaluation. Sensitivity and threshold testing were conducted for the three variables used in the HK model for this economic evaluation: discount rate, capital cost and VCR. Option 3 had generally had the largest NPV for the tested standard ranges of sensitivities and there was no tipping point found between the options. Details of the sensitivity analysis can be found in the figure below.

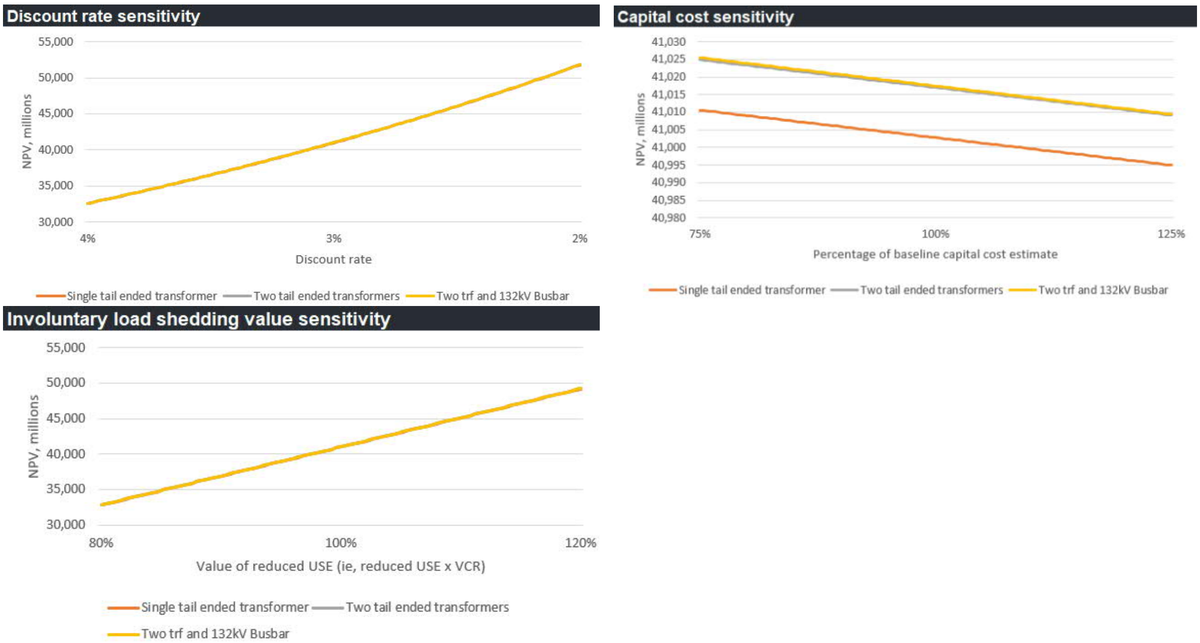


Figure 14 – Sensitivity analysis

3.6 Weighted NPV scenarios

Scenario analysis has been carried out by the model. The parameters of the scenario analysis are presented below.

User Interface

Scenarios	
Scenario selection	
Scenario	Scenario 1

Scenario weighting	Scenario 1	Scenario 2	Scenario 3
Weighting	0.50	0.25	0.25

General inputs

General	Unit	Value	Selection	Scenario 1	Scenario 2	Scenario 3	User defined
Commercial discount rate	Percent	3.26%	Central	Central	High	Low	Central

Cost inputs

Cost	Unit	Value	Selection	Scenario 1	Scenario 2	Scenario 3	User defined
Capital cost	Percent	100%	Central	Central	High	Low	Central
Planned routine maintenance and refurbishment	Percent	100%	Central	Central	High	Low	Central
Unplanned corrective maintenance	Percent	100%	Central	Central	High	Low	Central
Decommissioning costs	Percent	100%	Central	Central	Central	Central	Central
Non-network option provider costs	Percent	100%	Central	Central	High	Low	Central
Cost X	Percent	100%	Central	Central	High	Low	Central
Cost Y	Percent	100%	Central	Central	Central	Central	Central
Cost Z	Percent	100%	Central	Central	Central	Central	Central

Benefit inputs

Avoided 'risk cost' benefits	Unit	Value	Selection	Scenario 1	Scenario 2	Scenario 3	User defined
Reliability and security risk costs	Scenario	NA	Central	Central	Low	High	Central
Safety and health risk costs	Scenario	NA	Central	Central	Low	High	Central
Environmental risk costs	Scenario	NA	Central	Central	Low	High	Central
Legal/regulatory compliance risk costs	Scenario	NA	Central	Central	Low	High	Central
Financial risk costs	Scenario	NA	Central	Central	Low	High	Central

Market benefits	Unit	Value	Selection	Scenario 1	Scenario 2	Scenario 3	User defined
Involuntary load shedding - VCR	$/MWh	44,580	Central	Central	Low	High	Central
Involuntary load shedding - MWh	Scenario	NA	Central	Central	Low	High	Central
Difference in timing of unrelated expenditure	Scenario	NA	Central	Central	Low	High	Central
Difference in timing of unrelated expenditure	Percent	100%	Central	Central	Low	High	Central
Voluntary load curtailment - VCR	$/MWh	44,580	Central	Central	Low	High	Central
Voluntary load curtailment - MWh	Scenario	NA	Central	Central	Low	High	Central
Costs for non RIT-D proponent parties	Percent	100%	Central	Central	Central	Central	Central
Electricity energy losses	$/MWh	100	Central	Central	Central	Central	Central
Change in load transfer capacity and the capacity for embedded generators to take	Percent	100%	Central	Central	Central	Central	Central
Other classes of market benefits	Percent	100%	Central	Central	Central	Central	Central

Figure 15 – Houston Kemp Parameters

Variable	Scenario 1 - baseline	Scenario 2 – low benefits	Scenario 3 – high benefits
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)	$44,580 /MWh (from AER VCR report)	$35,664/MWh 30% lower than baseline	$53,496/MWh 30% higher than baseline
Discount rate	3.26% (WACC)	2.22%	4.3
Scenario weighting	50%	25%	25%

Table 11 – Summary of scenarios investigated

The scenarios have been weighted as 50% for Scenario 1 being the most likely with Scenarios 1 and 2 being given a weighting of 25%. The weighted NPV for each option is shown below. The table below shows that Option 3 is still the preferred option.

Table 12 - Weighted net present value of options

Option	Scenario 1 NPV ($M)	Scenario 2 NPV ($M)	Scenario 3 NPV ($M)	Weighted NPV ($M)	Option ranking
Option 1	41,003	9,363	62,899	38,567	3
Option 2	41,017	9,381	62,912	38,582	2
Option 3	41,018	9,380	62,913	38,582	1

3.7 Proposed Investment Timing

The proposed investment timing for this project to commence is FY2023. However, the optimal timing is FY2026 based on where the value of unserved energy from the no proactive intervention scenario, exceeds the investment costs.

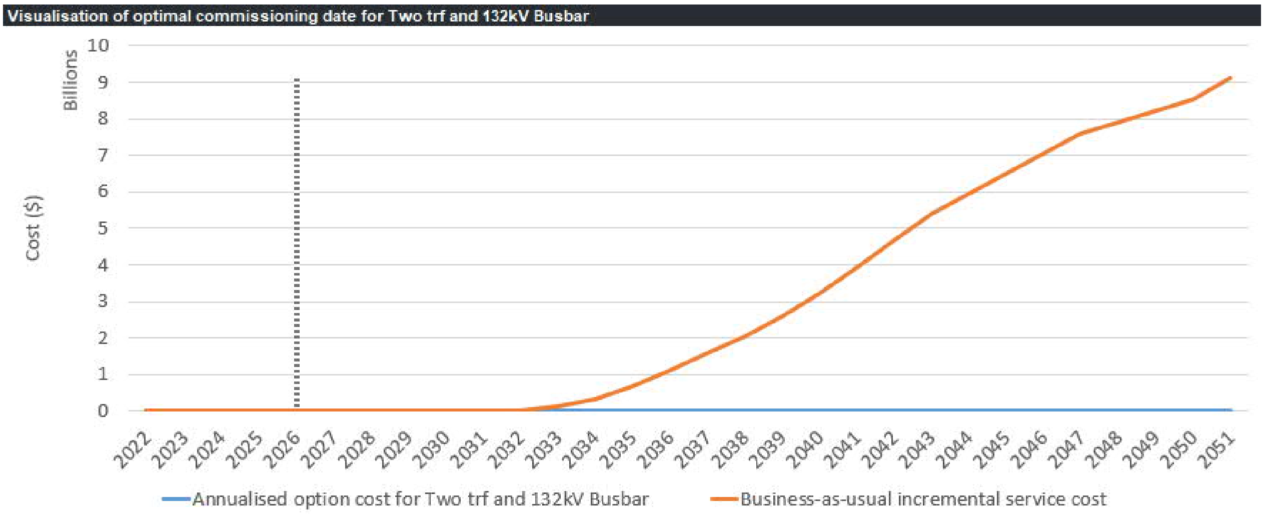


Figure 16 – Optimal timing Output from Houston Kemp model for Project commissioning.

3.8 Non-Network Options

The National Electricity Rules (NER) require Distribution Network Service Providers (DNSP) to investigate non-network options as part of planning for major network augmentations. This includes determining whether non-network options will be technically and economically feasible in deferring or avoiding network augmentations and also to utilise market and public consultation in sourcing possible non-network options.

This project has an estimated cost of greater than $6M and requires a screening of non-network options and consultation at Draft Project Assessment and Final Project Assessment stages.

'Identified need' for this Regulatory Investment Test for Distribution (RIT-D)

We have initiated a Regulatory Investment Test for Distribution (RIT-D) to investigate, and consult on, how to most efficiently facilitate the connection of the new major loads in the Northern Gateway and surrounding precincts.

Endeavour Energy is required to connect customers under section 5.2.3(d) of the National Electricity Rules (NER), which state that "A Network Service Provider must:

> (1) Review and process applications to connect or modify a connection which are submitted to it and must enter into a connection agreement…
>
> (6) Permit and participate in commissioning of facilities and equipment which are to be connected to its network in accordance with rule 5.8;"

We therefore consider the identified need for this investment to be a 'reliability corrective action' under the RIT-D since investment is required to comply with the above NER obligations.

The timing of the identified need for this RIT-D, and so the required timing for credible options to address the need, is determined by when the expected load requiring connection will exceed the existing network capacity. This is currently anticipated to be 2025/26, based on the customer connection interim supply arrangements in place.

Importantly, no construction on new distribution investments will commence until there is a high degree of certainty that the anticipated loads will be seeking connection to our network at the timing indicated. Further, we note that new customers will contribute to the costs of the investment (as well as the cost of the wider network), via their 'Distribution Use of System' tariffs.

The distribution network augmentation to support the development of the Northern Gateway area was included as part of our regulatory proposal to the Australian Energy Regulator (AER) for the current regulatory control period and also identified in our most recent Distribution Annual Planning Report (DAPR).

A non-network screening notice will be published in accordance with NER clause 5.17.4(c), and will state that there is unlikely to be a non-network option that could form a potential credible option on a standalone basis, or that could form a significant part of a potential credible option.

The screening notice will explain the greenfields nature of the development and the existing lack of supply capacity to meet the demand of the development area and that non-network options would not be feasible from both the technical and commercial considerations.

To illustrate the situation further, if there were a commercially feasible non-network option located in the Northern Gateway area it would require this proposed network augmentation to provide its connection to the national electricity market and would therefore not be able to defer or avoid the augmentation. Following the completion of the augmentation with the commissioning of the proposed Northern Gateway ZS it would be technically feasible to connect a non-network option to defer or avoid futher augmentation in the local network.

The determination of the 'reliability correction action' basis for the project provides the foundation for the non-network screening notice that we intend to publish.

In addition to this determination we have conducted feasibility testing of non-network options using the New Technology Master Plan (NTMP) tool. These results also demonstrate the non-network options are not currently feasible for this network need. The results are shown in Appendix **Error! Reference source not found.**.

4. Detailed description and costs of preferred option

Detailed Cost breakdown can be seen in the appendices:

Below is the summary of the estimate. Please note that the use of the term 'Option 2' below is in relation to the naming convention of the options at the time of detailed cost estimation. This is the same as the named Option 3 within this CFI.

Option 2 Stage 1

- Two (2) sections of 132kV switchgear comprising of two (2) feeder CB's + two (2) transformer CB's + two (2) bus section CB's inside two (2) portable type buildings.
- Two (2) 132/22kV transformers
- Three (3) sections of 22kV switchgear comprising of 15 x 22kV CBs inside three (3) portable type buildings.
- One (1) control and protection portable building.
- Two (2) auxiliary transformers.
- Two (2) 132kV feeders from Western Sydney Airport TS.
- Associated 22kV transformer and bus tie cables.
- Associated 132kV feeder protection works at Western Sydney Airport TS.

Option 2 Stage 2

- One (1) section of 132kV switchgear comprising of two (2) feeder CB's + one (1) transformer CB inside one (1) portable type building.
- One (1) 132/22kV transformer
- Associated 132kV and 22kV cables

COST ESTIMATE			
Substation	**Estimate**	**Contingency**	**Total**
Option No.2 Stage 1	**$26,100,000**	**$3,220,000**	**$29,320,000**
Option No.2 Stage 2	**$7,300,000**	**$860,000**	**$8,160,000**

In addition, an estimate of $5 Million is required to establish distribution feeders, 22kV conversions and auto transformers. Due to the uncertainty of the final masterplan for the Northern Gateway area, scoping of these works has not been carried out however it is estimated this project will establish between four to six feeders.

5. Recommendations and Next Steps

It is recommended that:

- Endeavour Energy publish a screening report before progressing to a Draft Project Assessment Report (DPAR) as per the RIT-D process (Refer to Figure 17). This is because the identified need for this investment is a reliability correction action to meet Endeavour Energy's connection obligations in the NER. Additionally, non-network options were not found to be feasible.

- The project proceeds to preliminary release with preferred Option 3 which recommends capital expenditure to build Northern Gateway ZS with a firm capacity of 45 MVA, including 132kV switchgear, busbar and bus section breakers by end of FY25 with 2 x 132kV feeders from WSA TS/ZS. Preliminary release enables development of project definitions, detailed design, environmental assessment and preliminary market engagement activities in accordance with Company Procedure GRM0051.

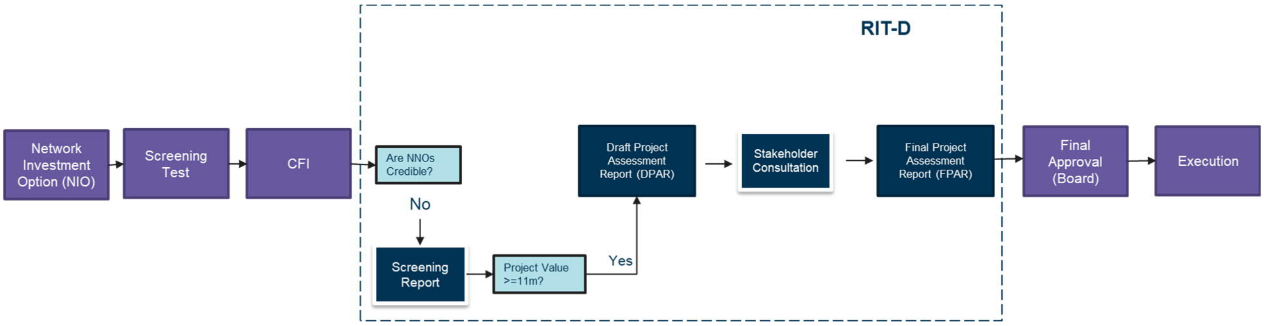


Figure 17 – Endeavour Energy's RIT-D Process for this Project

Appendices

A. Listing of benefits, risks, and residual risks considered

The NER states that quantifiable economic market benefits (needs) include changes in involuntary load shedding. The costs and benefits analysis described in the previous section included this benefit in determining the best option. Endeavour Energy's Unserved Energy Template was used to estimate the involuntary load shedding that can be prevented because of proactive action. The involuntary load shedding was utilised by the HK model along with a Value of Customer Reliability to calculate a market benefit.

There were no other identified risks that were included in the costs and benefits analysis.

The proposed options for this project have various benefits and risks. These are summarised in the tables below.

Benefit	Description	Model	Option 1 PV $M	Option 2 PV $M	Option 3 PV $M
Value of avoided unserved energy	The NER states that quantifiable economic market benefits (needs) include changes in involuntary load shedding.	Endeavour Energy's Unserved Energy Template was used to estimate the involuntary load shedding that can be prevented as a result of proactive action. The involuntary load shedding was utilised by the HK model along with a Value of Customer Reliability to calculate a market benefit.	41,042	41,051	41,052

Table 12 – Benefits

Safety Considerations

The constraints analysed in the Northern Gateway area are capacity related. In analysing expected unserved energy for the constraint we have considered the impact of potential widespread outages. The proposed investment solutions will be designed to current network standards to ensure safe operation of the network for our staff and public. The proposed solution reduces the expected unserved energy and is considered SFAIRP.

Non Network Options and the New Technology Master Plan tool

The New Technology Master Plan (NTMP) tool was used to evaluate credible non-network options with the network constraints for the Northern Gateway area.

Under the ‘Reliability Corrective Action’ determination of the identified need for the Northern Gateway area, Endeavour Energy has determined that non-network options are not feasible and the NTMP tool and assessment has been used for the purpose of the CFI, however will not be included in the RIT-D documents.

Figure 18 shows the comparison of non-network solutions and network solutions against the base case (“no proactive intervention”) and Figure 19 compares non-network options in comparison to the network solution.

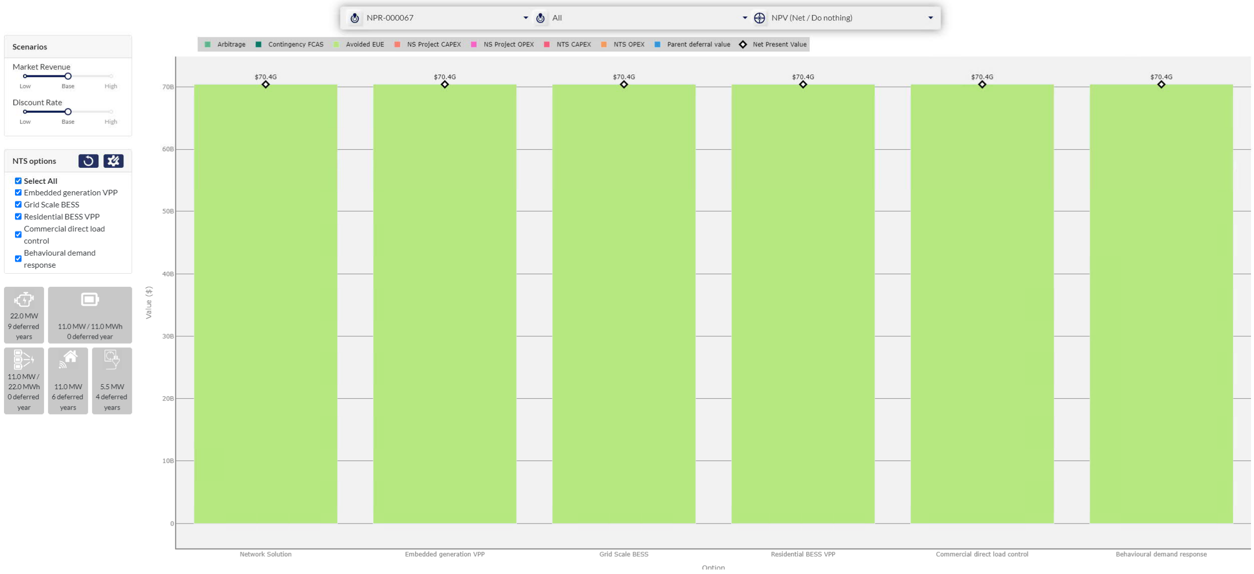


Figure 18: NTMP Output for Non-Network Options when compared to the Base Case.

Figure 19 :NTMP Output for Non-Network Options when compared to the Network Solution

Table 13 below shows an overview of the outputs from the NTMP tool and includes comments on the qualitative assessment of the non-network options considered.

Non-Network Options	Outcomes	Qualitative Assessment	Comments
Grid-Scale Storage (11.0 MW /11.0 MWh)	Does not defer network investment	✕	Not feasible as it does not defer network investment
VPP (22 MW)	Potentially defer the network investment by 9 years	✕	Not a feasible option as this is a new development.
Residential BESS VPP (11.0 MW /22 MWh)	Does not defer network investment	✕	Not feasible as it does not defer network investment
Commercial Direct Load Control (11.0 MW)	Potentially defer the network investment by 6 years	✕	Not feasible due to lack of greenfield infrastructure.
Behavioural Demand Response (5.5 MW)	Potentially defer the network investment by 4 years	✕	Not feasible due to lack of greenfield infrastructure.

Table 13: Non-Network - New Technology Options.

B. Assumptions and Data for HK modelling

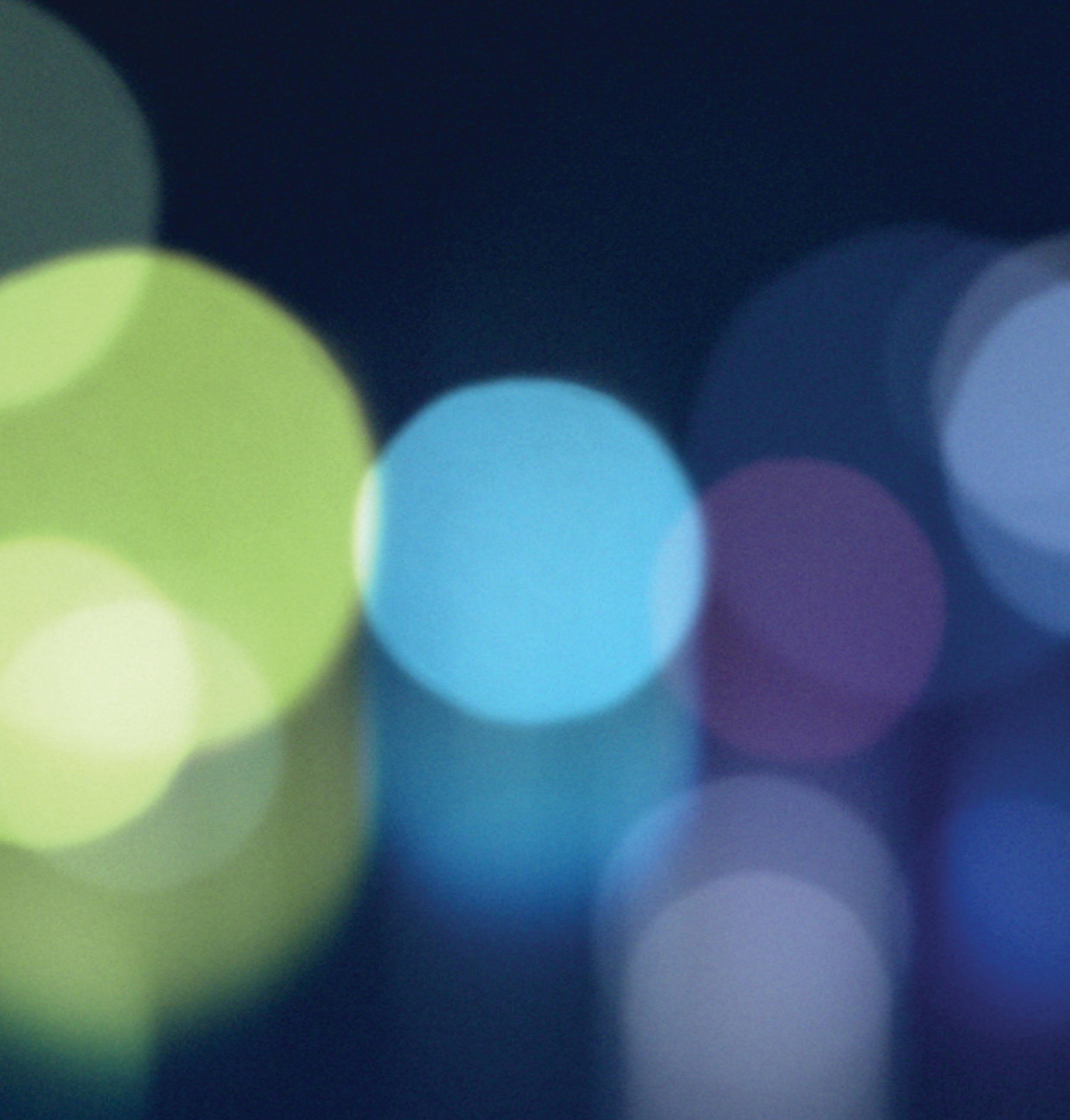
The Houston Kemp RIT-D model (HK model) was utilised in the economic evaluation of the viable options. The main assumptions are:

- The 7 Jan 2022 version of the HK model was used.
- Dollars are given in FY22.
- A study period of 30 years was used.
- The commercial discount rate was set to 3.26% based on the pre-tax real WACC.
- A VCR of $44,580 for the Northern Gateway area
- Capital costs as follows:

Table 6: Capital cost inputs to HK model

Capital cost						[Do not insert or delete rows from this table]	
Number	Option name	Capex component	Amount	Start year	End year	Commission year	Asset life
1	Single tail ended transformer	Stage 1, Year 1 costs	2,435,850	2023	2023	2025	30
1	Single tail ended transformer	Stage 1, Year 2 costs	7,307,550	2024	2024	2025	30
1	Single tail ended transformer	Stage 1, Year 3 costs	6,495,600	2025	2025	2025	30
1	Single tail ended transformer	Stage 2, Year 1 costs (2nd	1,685,850	2027	2027	2029	30
1	Single tail ended transformer	Stage 2, Year 2 costs	5,057,550	2028	2028	2029	30
1	Single tail ended transformer	Stage 2, Year 3 costs	4,495,600	2029	2029	2029	30
1	Single tail ended transformer	Stage 3, Year 1 costs (3rd	2,115,000	2030	2030	2032	30
1	Single tail ended transformer	Stage 3, Year 2 costs	6,345,000	2031	2031	2032	30
1	Single tail ended transformer	Stage 3, Year 3 costs	5,640,000	2032	2032	2032	30
2	Two tail ended transformers	Stage 1, Year 1 costs	3,855,000	2023	2023	2025	30
2	Two tail ended transformers	Stage 1, Year 2 costs	11,565,000	2024	2024	2025	30
2	Two tail ended transformers	Stage 1, Year 3 costs	10,280,000	2025	2025	2025	30
2	Two tail ended transformers	Stage 2, Year 3 costs (3rd	2,115,000	2030	2030	2032	30
2	Two tail ended transformers	Stage 2, Year 3 costs	6,345,000	2031	2031	2032	30
2	Two tail ended transformers	Stage 2, Year 3 costs	5,640,000	2032	2032	2032	30
3	Two trf and 132kV Busbar	Stage 1, Year 1 costs	4,665,000	2023	2023	2025	30
3	Two trf and 132kV Busbar	Stage 1, Year 2 costs	13,995,000	2024	2024	2025	30
3	Two trf and 132kV Busbar	Stage 1, Year 3 costs	12,440,000	2025	2025	2025	30
3	Two trf and 132kV Busbar	Stage 2, Year 3 costs (3rd	1,095,000	2030	2030	2032	30
3	Two trf and 132kV Busbar	Stage 2, Year 3 costs	3,285,000	2031	2031	2032	30
3	Two trf and 132kV Busbar	Stage 2, Year 3 costs	2,920,000	2032	2032	2032	30

- The expected unserved energy (EUSE) was calculated using the “RIT-D Unserved Energy Template” with the following details:
  - The EUE (template v0.8) was used. with power transformers having a 1% failure rate
  - Transmission feeders N-1 outages were also modelled, for 7 faults per 100km of Transmission Line.
  - 30MVA of distribution feeder’ capacity was used, and for an N-1 scenario 15MVA
  - The standard industrial LDC was used which is based off Moorebank ZS.
  - The forecast load for is based on data from the department of planning and existing Customer applications we have for the catchment area.
  - Estimates were obtained from Substation group, however for variations to Options staging, the estimates were combined with Samp Unit rates to determine a new estimate



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