Establish Bohle Plains Zone Substation

Business Case

17 January 2024

ERGON ENERGY NETWORK
Part of Energy Queensland

CONTENTS

List of Tables

List of Figures

1 SUMMARY

<table>
<tr><th>Title</th><th>Establish Bohle Plains Zone Substation</th></tr>
<tr><td>DNSP</td><td>Ergon Energy</td></tr>
<tr><td>Expenditure category</td><td>☐ Replacement ☒ Augmentation ☐ Connections ☐ Non-Network</td></tr>
<tr><td>Identified need</td><td>☒ Legislation ☒ Regulatory compliance
☐ Reliability ☐ CECV ☐ Safety ☐ Environment ☐ Financial
☐ Other

The forecast loading for the substations and distribution feeders supplying the Bohle Plains area is expected to exceed the available N-1 substation and feeder capacity as early as 2027. In the event of a substation transformer fault or 11kV feeder cable fault, due to the repair timeframes, full restoration cannot be achieved in the 24hour timeframe required to comply with the minimum security of supply criteria “Safety Net” stipulated in the Distribution Authority for the Ergon DNSP.</td></tr>
<tr><td>Summary of preferred option</td><td>The proposed option to address the identified need is to establish a new 66/11kV Bohle Plains (BOPL) substation with a single transformer to address the reliability and safety net compliance risks in the Bohle Plains area.</td></tr>
<tr><td>Expenditure</td><td>
<table>
<tr><th>Year</th><th>Previous period</th><th>2025-26</th><th>2026-27</th><th>2027-28</th><th>2028-29</th><th>2029-30</th><th>2025-30</th></tr>
<tr><td>$m, direct 2022-23</td><td>$0.0m</td><td>$0.19m</td><td>$0.689m</td><td>$0.489m</td><td>$13.293m</td><td>$2.818m</td><td>$17.309m</td></tr>
</table>
</td></tr>
<tr><td>Benefits</td><td>The primary benefit is compliance with minimum network security criteria stipulated in the Distribution Authority for the DNSP.</td></tr>
</table>

2 BACKGROUND

2.1 Network Arrangement

The Bohle Plains area is currently supplied from the DG-07, DG-10, BO-05 and BO-10 11kV distribution feeders from Bohle (BOHL) 66/11kV Substation and Dan Gleeson (DAGL) 66/11kV Substation. DAGL is supplied from T092 Dan Gleeson 132/66kV Bulk Supply Substation which is located on the same site. The other two main substations in the Townsville West area BOHL and Black River (BLRI) 66/11kV substation are normally supplied from two 66kV feeders, the DAGL-BOHL 66kV feeder from T092 Dan Gleeson 132/66kV Bulk Supply Substation and the GARB-BOHL 66kV feeder from T046 Garbutt Bulk Supply Substation.

The connected zone substations customers and loads are summarised below:

- **Bohle zone substation (BOHL)** – is a 66/11kV zone substation which supplies approximately 5,112 predominantly residential customers. It supplies 100 GWh of energy annually, with 35% of this energy consumed by residential customers.
- **Dan Gleeson zone substation (DAGL)** – is a 66/11kV zone substation which supplies approximately 8,127 predominantly residential customers. It supplies 95 GWh of energy annually, with 66% of this energy consumed by residential customers.
- **Black River zone substation (BLRI)** – is a 66/11kV zone substation which supplies approximately 8,349 predominantly residential customers. It supplies 87 GWh of energy annually, with 78% of this energy consumed by residential customers.

Figure 1 shows the existing network arrangement and Figure 2 and Figure 3 show the geographic layout of the Bohle Plains area network.

Figure 1 – Existing network diagram of the Bohle Plains area network

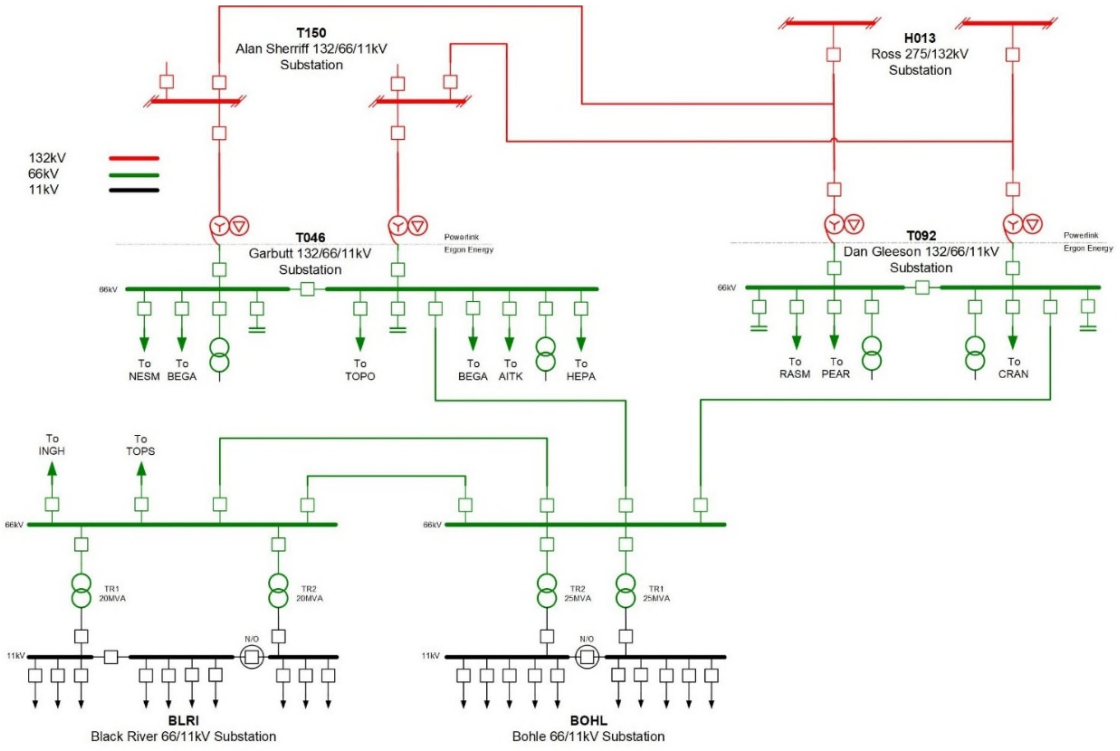


Figure 2 – Geographic of the Bohle Plains sub-transmission network

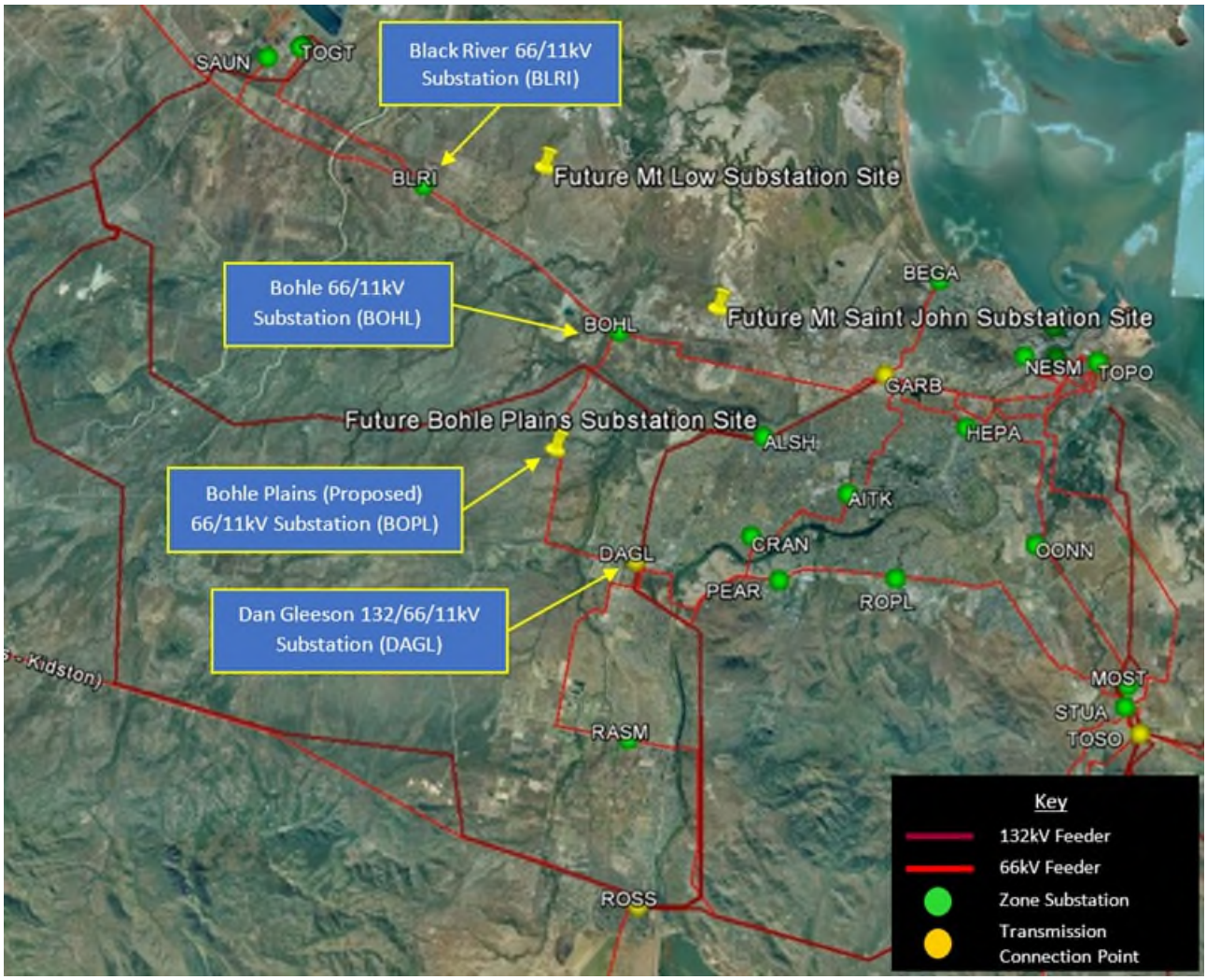
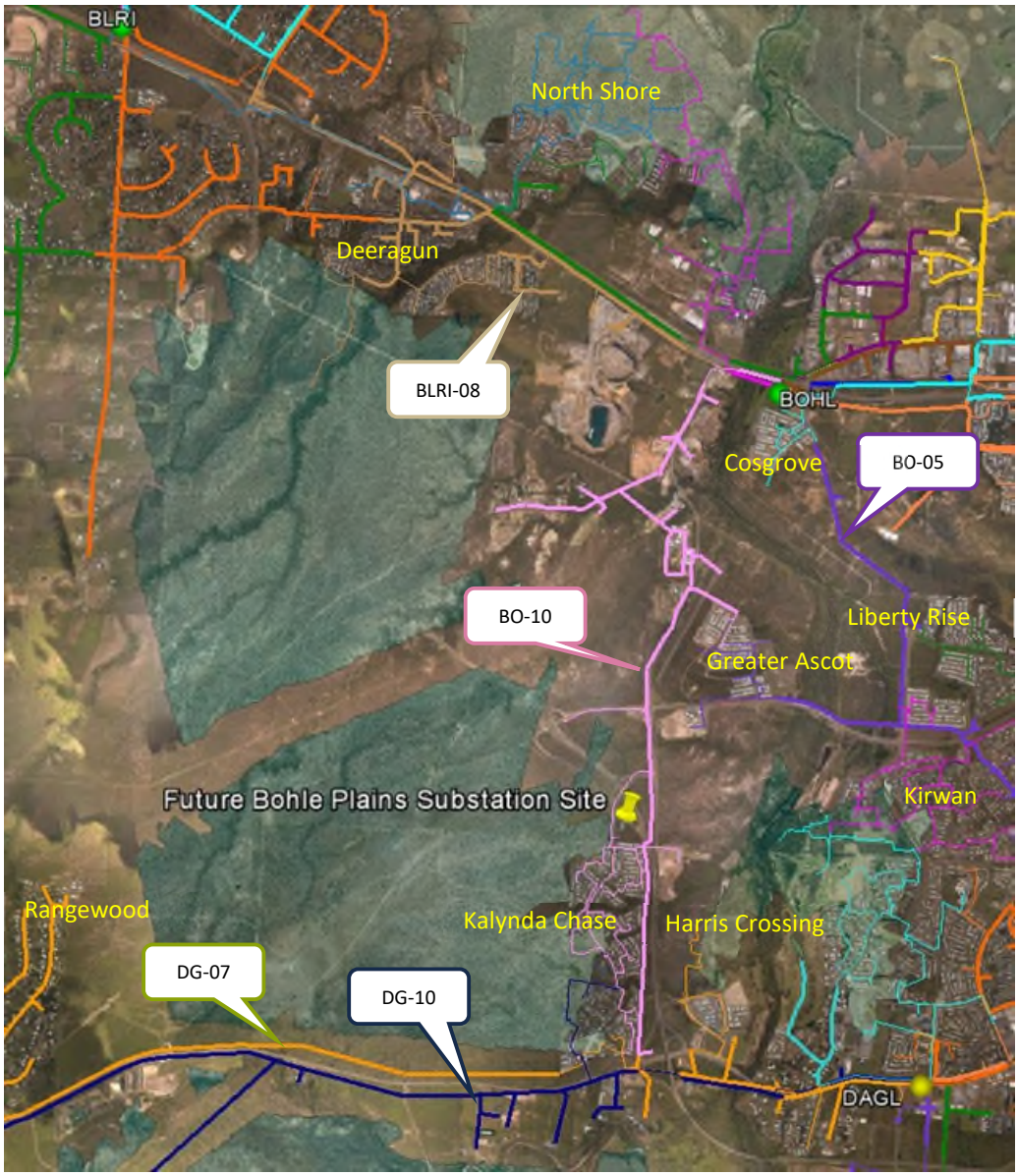


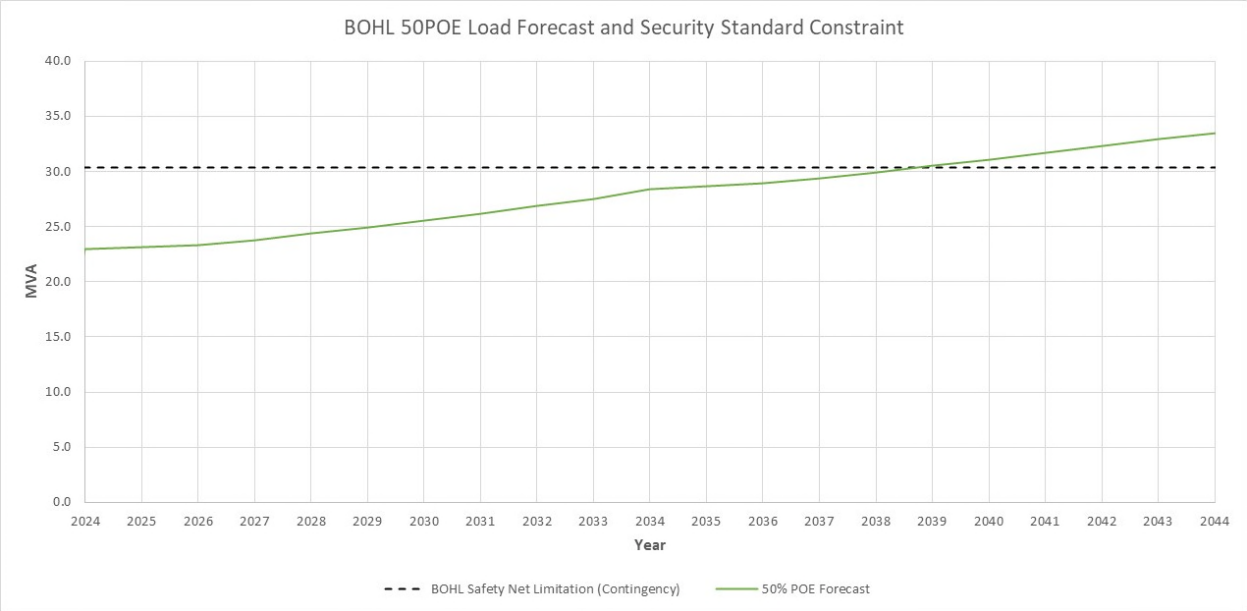
Figure 3 - Geographic of the Bohle Plains distribution network



2.1.1 Bohle (BOHL) Substation Capacity

BOHL substation capacity is limited by the 66/11kV transformers, providing a Normal Cyclic Capacity (NCC) of 52.7 MVA and an Emergency Cyclic Capacity (ECC) of 26.4 MVA. The 50PoE load forecast and safety net limit for a contingency is shown in Figure 4. This assessment assumes 4 MVA of load can be transferred to adjacent substations via the 11kV feeder ties during a contingency, if required.

Figure 4 – BOHL Load Forecast and Security Standard Constraint

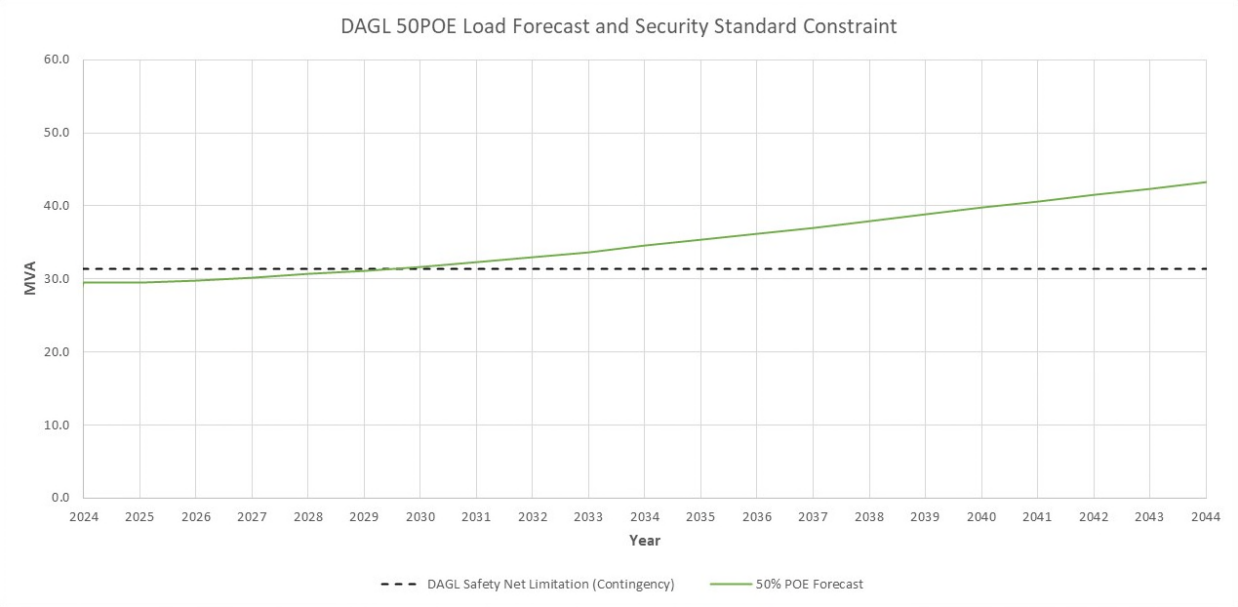


As shown above, there are safety net limitations forecast at BOHL in 2038.

2.1.2 Dan Gleeson (DAGL) Substation Capacity

DAGL substation capacity is limited by the 11kV transformer cables, providing a Normal Cyclic Capacity (NCC) of 42.4 MVA and an Emergency Cyclic Capacity (ECC) of 27.4 MVA. The 50PoE load forecast and safety net limit for a contingency is shown in Figure 5. This assessment assumes 4 MVA of load can be transferred to adjacent substations via the 11kV feeder ties during a contingency, if required.

Figure 5 – DAGL Load Forecast

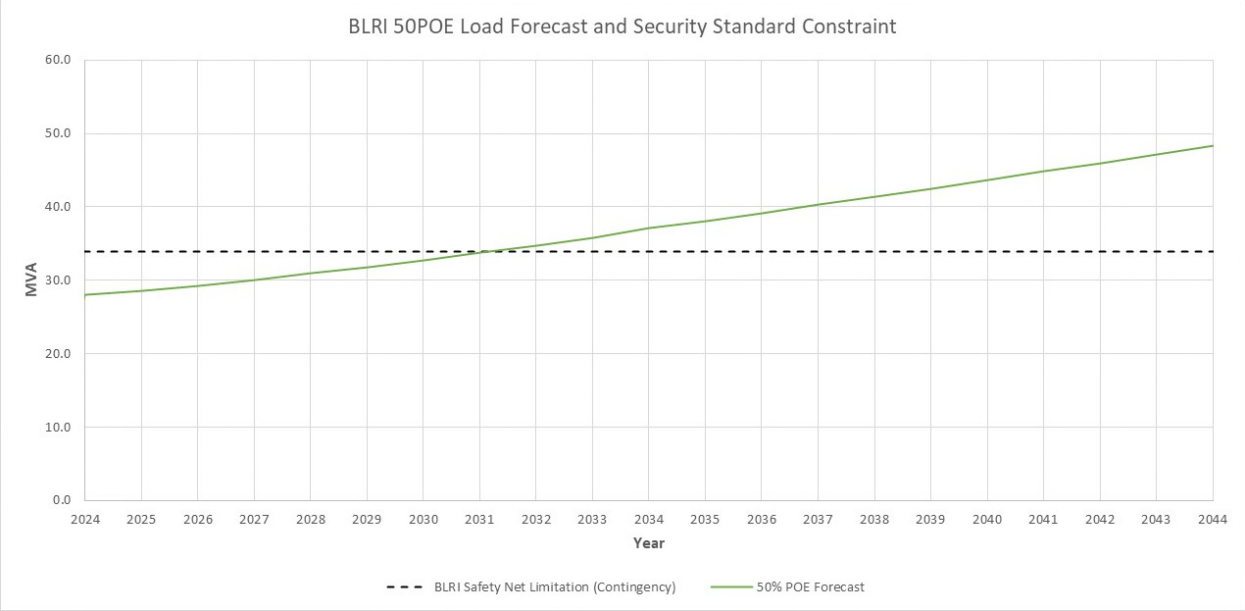


As shown above, there are safety net limitations forecast at DAGL in 2029.

2.1.3 Black River (BLRI) Substation Capacity

BLRI substation capacity is limited by the 66/11kV transformers, providing a Normal Cyclic Capacity (NCC) of 56 MVA and an Emergency Cyclic Capacity (ECC) of 29.9 MVA. The 50PoE load forecast and safety net limit for a contingency is shown in Figure 6. This assessment assumes 4 MVA of load can be transferred to adjacent substations via the 11kV feeder ties during a contingency, if required.

Figure 6 – BLRI Load Forecast

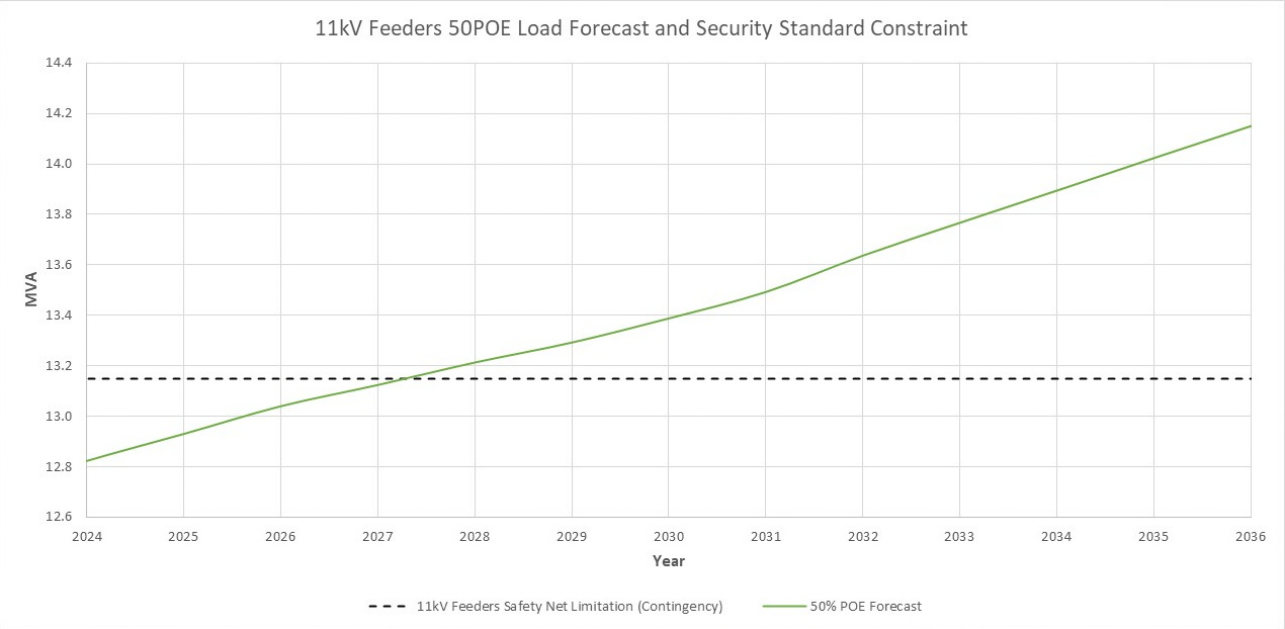


As shown above, there are safety net limitations forecast at BLRI in 2031.

2.1.4 Distribution Feeder Capacity

The Bohle Plains area is currently supplied from the DG-07, DG-10, BO-05 and BO-10 11kV distribution feeders from Bohle (BOHL) 66/11kV Substation and Dan Gleeson (DAGL) 66/11kV Substation. The 50PoE load forecast and safety net limit for a contingency is shown in Figure 7. A contingency on one of these feeders would require load to be transferred to the adjacent feeders. This assessment assumes that a cable fault on one of these feeders would take > 24hours to repair, 1 MVA of load can be transferred from the intact feeders to adjacent feeders via 11kV feeder ties during a contingency and 1 MVA of mobile generation can be deployed, if required.

Figure 7 - Forecast Distribution feeder loading



As shown above, there are safety net limitations forecast on the distribution feeders in 2027.

Note: A subsequent study will be undertaken to review the 66kV sub-transmission network and, based on the findings, any further network investments required to maintain the adequacy of the 66kV network will be proposed as required.

3 REQUIREMENT FOR BOHLE PLAINS SUBSTATION PROJECT

Section 3.1 outlines the identified need for a project at Bohle Plains based on compliance with minimum security of supply criteria "Safety Net" stipulated in the Distribution Authority for the Ergon DNSP. The counter factual analysis is provided in Section 4 and provides a monetisation of the risks associated with continued operation of the network with existing assets. Credible options to address the identified need are then provided in Section 0 with comparison to the counter factual.

3.1 Identified Need

The Bohle Plains area is currently supplied from the DG-07, DG-10, BO-05 and BO-10 11kV distribution feeders from Bohle (BOHL) 66/11kV Substation and Dan Gleeson (DAGL) 66/11kV Substation. The Bohle Plains area is one of the main residential development areas in the Townsville region with a number of new subdivisions under development.

The forecast loading for the substations and distribution feeders supplying the Bohle Plains area is expected to exceed the available N-1 substation and feeder capacity as early as 2027. In the event of a substation transformer fault or 11kV feeder cable fault, due to the repair timeframes, full restoration would not be able to be achieved in the 24hour timeframe required to comply with the minimum security of supply criteria.

3.1.1 Compliance Criteria

Under its Distribution Authority, Ergon Energy must adhere to the Safety Net which identifies the principles that apply to the operation of network assets under network contingency conditions. System contingency related capability is assessed against available load transfers, emergency cyclic capacity (ECC) ratings, non-network response, mobile plant, mobile generators, and short-term ratings of plant and equipment, where available, using a 50% probability of exceedance (50PoE) forecast load. BOHL, BLRI and DAGL are classified as Regional Centre substations, with the following Safety Net criteria applying:

- Regional Centre – Following a credible contingency event, load not supplied must be:
    - Less than 20MVA (5000 customers) after 1 hour
    - Less than 15MVA (3600 customers) after 6 hours
    - Less than 5MVA (1200 customers) after 12 hours
    - Fully restored within 24 hours.

3.1.2 Supply to the Bohle Plains area after a transformer or feeder outage

The available N-1 transformer capacity at DAGL, transferrable load and curtailable load is forecast to be inadequate to maintain supply to the Bohle Plains area under peak 50POE load conditions beyond 2029 as shown in Figure 5.

The available N-1 11kV distribution feeder capacity, deployable mobile generation and curtailable load is forecast to be inadequate to maintain supply to the Bohle Plains area under peak 50POE load conditions beyond 2027 as shown in Figure 7.

In the event of a fault on a substation transformer or an underground substation exit cable for one of the feeders supplying the Bohle Plains area there is a risk that a portion of the forecast load would be unsupplied for more than 24 hours, thereby breaching Safety Net requirements. The typical repair times for a substation transformer fault or an underground cable fault would exceed the 24hour period required to restore supply to all customers.

3.1.3 Timing

The forecast load for the Bohle Plains area indicates a security standard load at risk in 2027 due to inadequate N-1 11kV distribution feeder capacity as shown in Figure 7.

4 COUNTERFACTUAL ANALYSIS

The monetised risk of the counterfactual is outlined below. The counter factual considers the risks associated with the identified need by proceeding with continued operation of the existing assets with current maintenance regimes and replacing assets on failure. For risk quantification Ergon Energy considers five value streams. The ones pertinent to this project include Reliability, Financial and Export and is shown in Figure 8. While risk quantification has been provided for completeness, the primary driver for the project is to meet a safety net limitation.

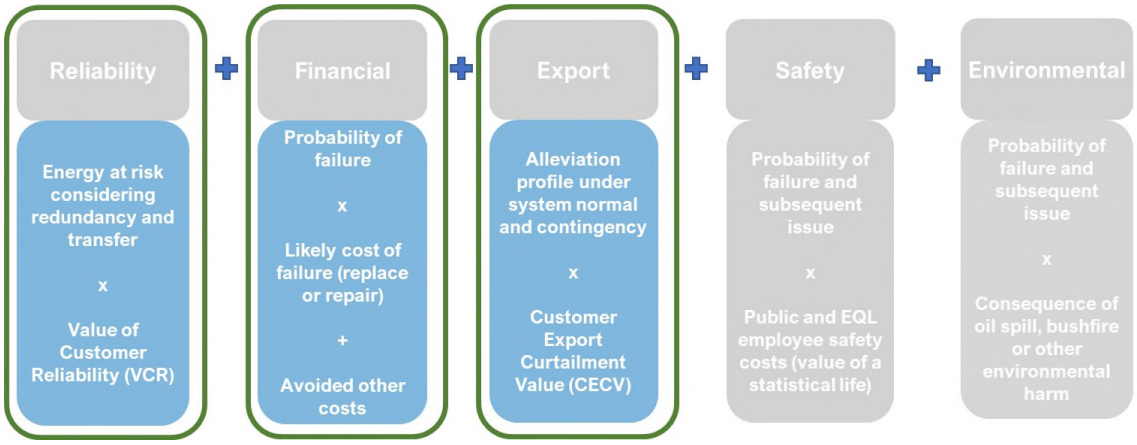
4.1 Risk Quantification Value Streams

The risk quantification of the counterfactual at Bohle Plains has considered three primary value streams, *reliability, financial* and *export,* as shown in Figure 8 and described in further detail below.

- **Reliability:** There is potential unserved energy within the Bohle Plains area following an outage on a substation transformer or 11kV distribution feeder due to limited backup transfer capacity.
- **Financial:** Replacing single assets on failure as individual failed in-service projects has been assumed to incur a 30% increase in cost in comparison to a planned project.
- **Export:** There is potential customer export curtailment within the Bohle Plains area under system normal conditions and following an outage on a substation transformer or 11kV distribution feeder due to limited backup transfer capacity.

Ergon Energy broadly considers five value streams for investment. These are shown in Figure 8.

Figure 8 – Value Streams for Investment



4.1.1 Risks

The counterfactual risk for the study area is a zone substation transformer outage at either BOHL or DAGL or 11kV distribution feeder cable fault during the peak load period. In quantifying the VCR and CECV benefits of the existing network, the following assumptions have been used:

- **Forced Outage rate** – The transformer outage rates are predicted using a Weibull distribution with a Shape Parameter (β) of 3.6 and a Characteristic Life (η) of 79 for 66/11kV transformers. The 11kV feeder cable outage rates are predicted using an average outage rate of 0.75 outages per 100km / year. A flat outage rate of 0.027 has been applied for the first 4 years to capture the increased risk of failure in the first years of a transformers life.
- **Restoration** – it has been estimated that the average rectification time would be 48 hours for a 66/11kV transformer outage. This considers repair / replacement time in the event of a permanent fault on the transformer. It has been estimated that the average rectification time would be 24 hours for a 11kV cable fault. This considers time to locate, excavate and repair / replace the cable.
- **Generation Support** – for this assessment it has been assumed that 1MVA of generation could be deployed to supply load in the Bohle Plains area within 8hours.
- **Transfers** – for this assessment it has been assumed that 4MVA of manual load transfer capacity is available to BOHL and DAGL via 11kV feeder ties from neighbouring substations. For 11kV distribution feeder outages on BO5, BO10, DG7 and DG10, the assessment assumes 4 into 3 capacity is available on these four feeders and that 1MVA of load can also be shifted to other neighbouring feeders.
- **VCR Rate** – a VCR rate of $45.39 has been used for BOHL and a VCR of $34.83 has been used for DAGL. The weighting applied to each customer type is shown in Table 1 and Table 2.
- **CECV** – determined using the values published in the customer export curtailment value (CECV) methodology on the AER website.
- **Emergency replacement Cost:** On failure of assets the plant will be replaced like-for-like with an additional 30% cost in comparison to the planned project.
- **Risk timeframe** – the risks have been quantified over a 60-year period.

Figure 9 – Counterfactual VCR Risk

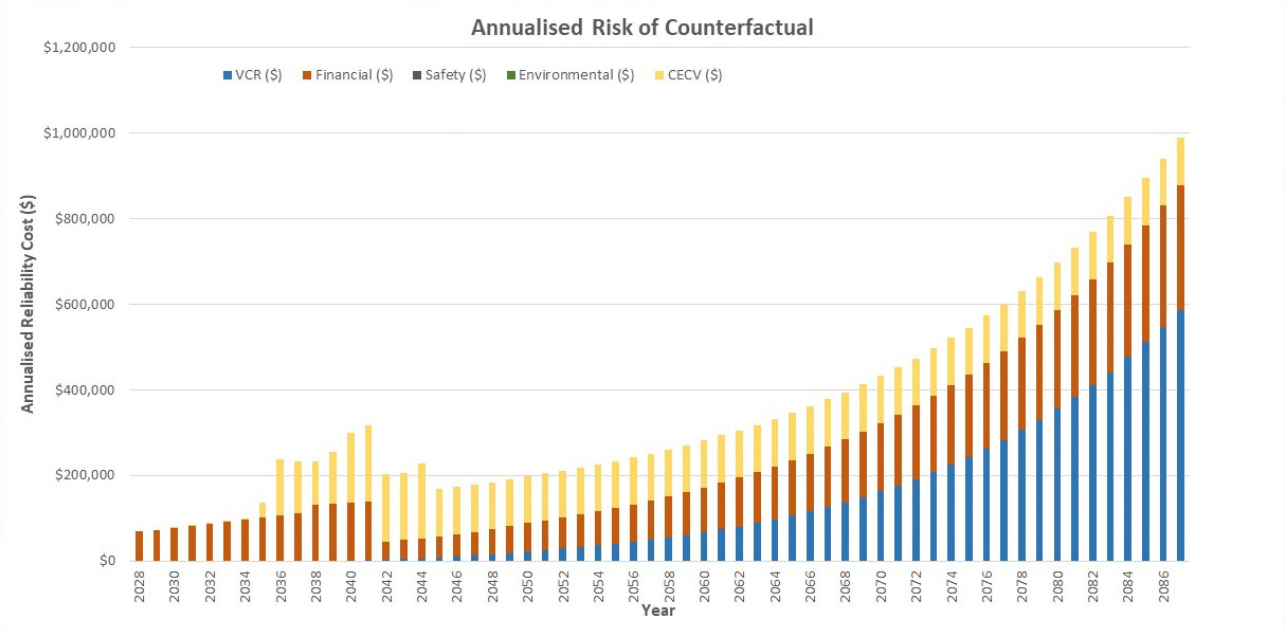


Table 1 - VCR weighting applied to each customer type for BOHL

	Postcode	Annual Consumption (kWH)	VCR
Domestic	4818	35,372,598	$26.64
Commercial		46,366,473	$49.54
Industrial		18,398,417	$70.97
Agricultural			$42.14
Average VCR			$45.39

Table 2 - VCR weighting applied to each customer type for DAGL

	Postcode	Annual Consumption (kWH)	VCR
Domestic	4818	63,019,251	$26.64
Commercial		30,937,471	$49.54
Industrial		1,685,432	$70.97
Agricultural		8,676	$42.14
Average VCR			$34.83

5 OPTIONS ANALYSIS

In the process of determining the most cost-effective solution to address the identified network limitations, Ergon Energy has sought to identify a practicable range of technically feasible, alternative options that could satisfy the network requirements in a timely and efficient manner.

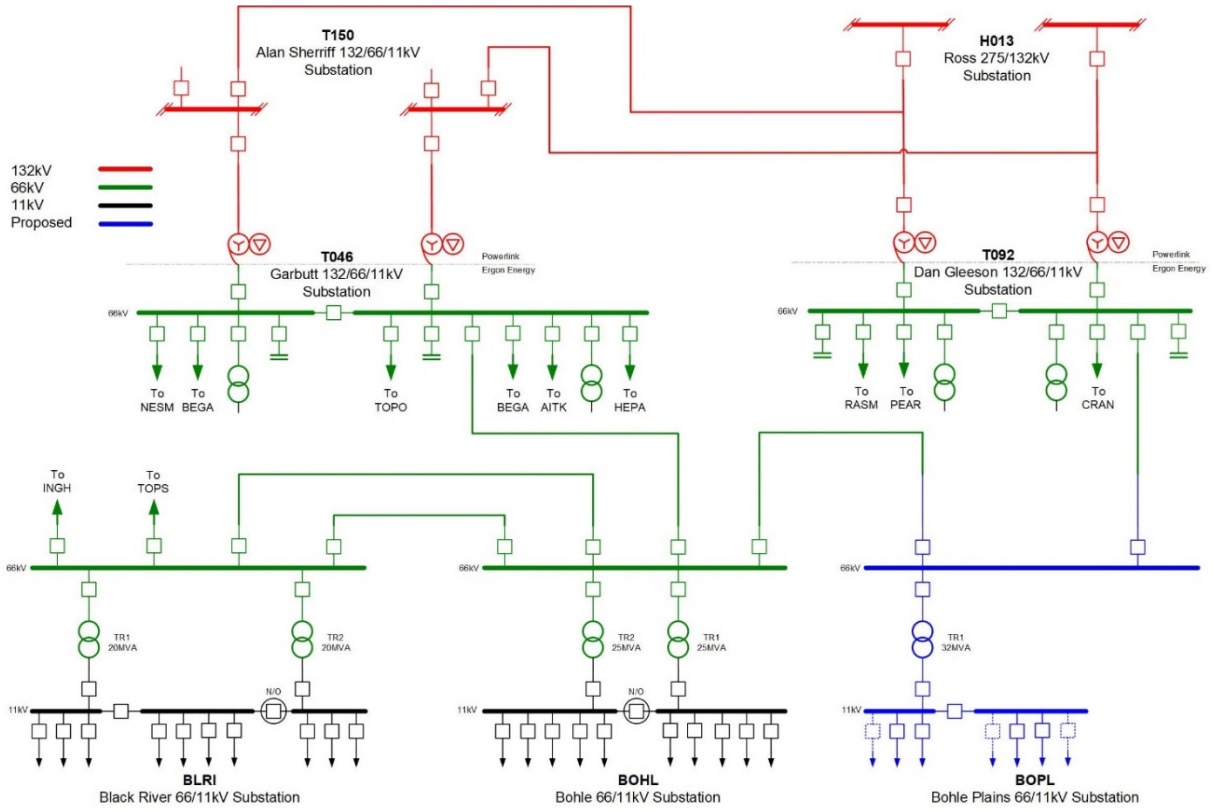
As the project progresses the requirements under the NER for RIT-D will be followed and where a feasible non-network solution is identified to address the limitation or defer the network option, it will be outworked to ensure efficient investment.

5.1 Option 1 – Establish Bohle Plains Zone Substation with 1 x 32MVA Transformer

This option involves:

- Establishing a new zone substation at Bohle Plains with 2 x 66kV feeder bays, 1 x 66kV transformer bay, 1 x 32MVA 66/11kV transformer, 11kV switchboard, establishment of 4 x 11kV feeders and reconfiguration of the BOHL and DAGL 11kV network.
- The second transformer would be installed as part of a future project which is estimated to be required in 2038.

Figure 10 – Option 1 network diagram



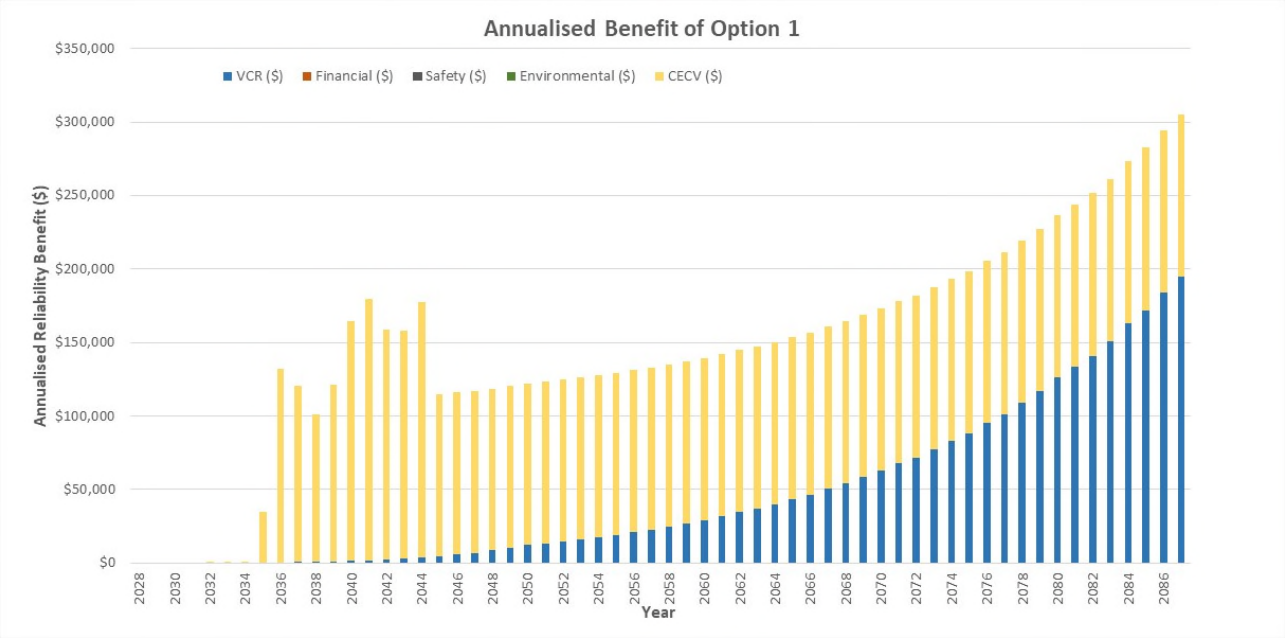
5.1.1 Option 1 Costs

Option 1 has been estimated to have $17.3m of direct costs, which has been factored into the NPV to be incurred in 2028. The installation of a second transformer at this substation has been estimated at $2.6m direct cost, which has been factored into the NPV as a cost in 2038.

5.1.2 Option 1 Benefits

Following the completion of the new substation, load will be transferred from BOHL and DAGL reducing the load at risk for a transformer or feeder outage at either BOHL or DAGL. As such, the calculated VCR and CECV benefits compared to the counterfactual have been included in the NPV as a benefit. The quantified benefits for Option 1 are shown in Figure 11.

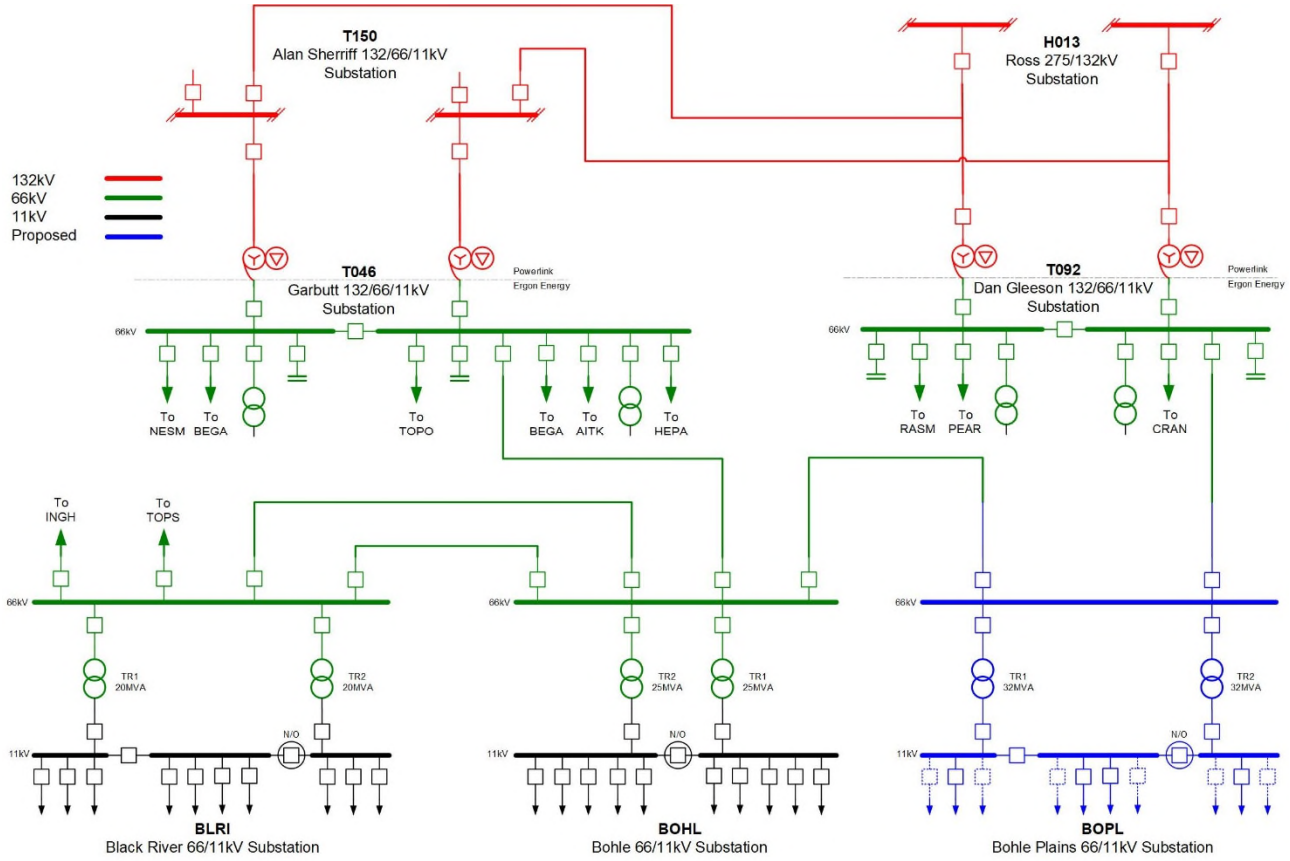
Figure 11 – Option 1 VCR Benefits



5.2 Option 2 – Establish Bohle Plains Zone Substation with 2 x 32MVA Transformers

This option involves establishing a new zone substation at Bohle Plains with 2 x 66kV feeder bays, 2 x 66kV transformer bays, 2 x 32MVA 66/11kV transformers, 11kV switchboard, establishment of 4 x 11kV feeders and reconfiguration of the BOHL and DAGL 11kV network.

Figure 12 – Option 2 network diagram



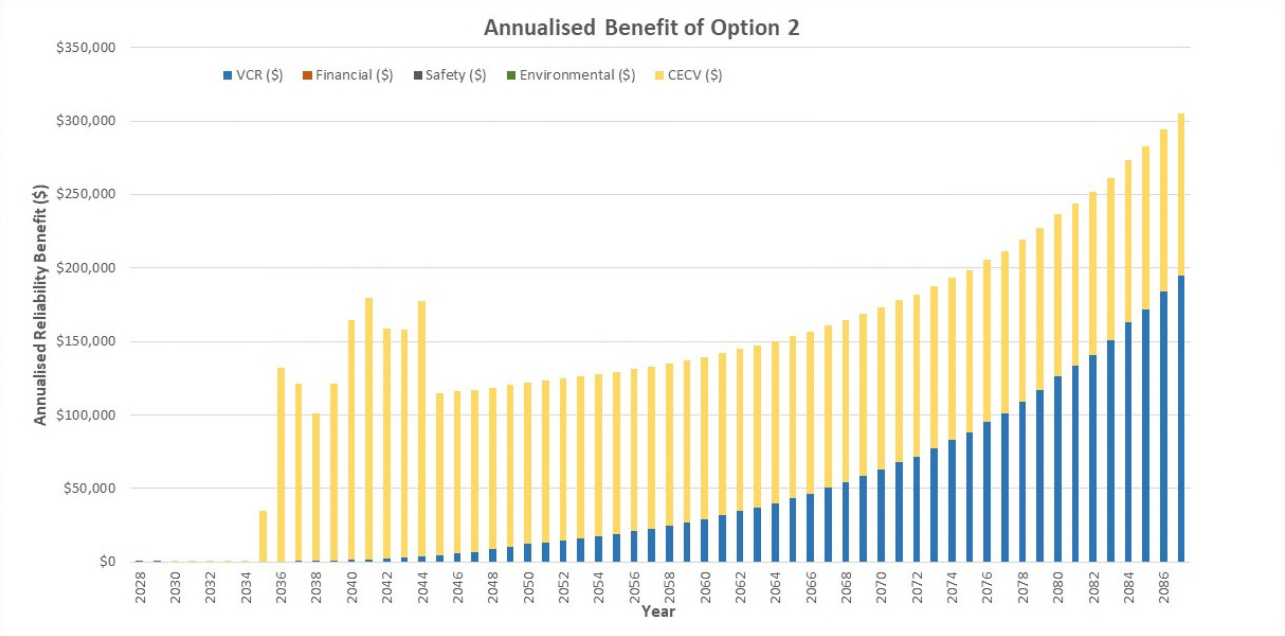
5.2.1 Option 2 Costs

Option 2 has been estimated to have $20.2m of direct cost, which has been factored into the NPV to be incurred in 2028.

5.2.2 Option 2 Benefits

Following the completion of the new substation, load will be transferred from BOHL and DAGL reducing the load at risk for a transformer or feeder outage at either BOHL or DAGL. As such, the calculated VCR and CECV benefits compared to the counterfactual have been included in the NPV as a benefit. The quantified benefits for Option 2 are shown in Figure 13.

Figure 13 – Option 2 VCR Benefits



5.3 Option 3 – Upgrade Dan Gleeson, Bohle and Black River Substations and install additional 11kV feeders into the area to defer the establishment of BOPL

This option involves:

- Upgrading BLRI with 2 x 32MVA 66/11kV transformers, upgrading BOHL with 2 x 32MVA transformers, upgrading BOHL 11kV transformer cables, upgrading DAGL transformer cables, installing new 11kV feeder bays at BOHL & DAGL, establishing a new 11kV feeder from DAGL and a new 11kV feeder from BOHL to supply the Bohle Plains area.
- This option defers the need for the new substation until 2038.

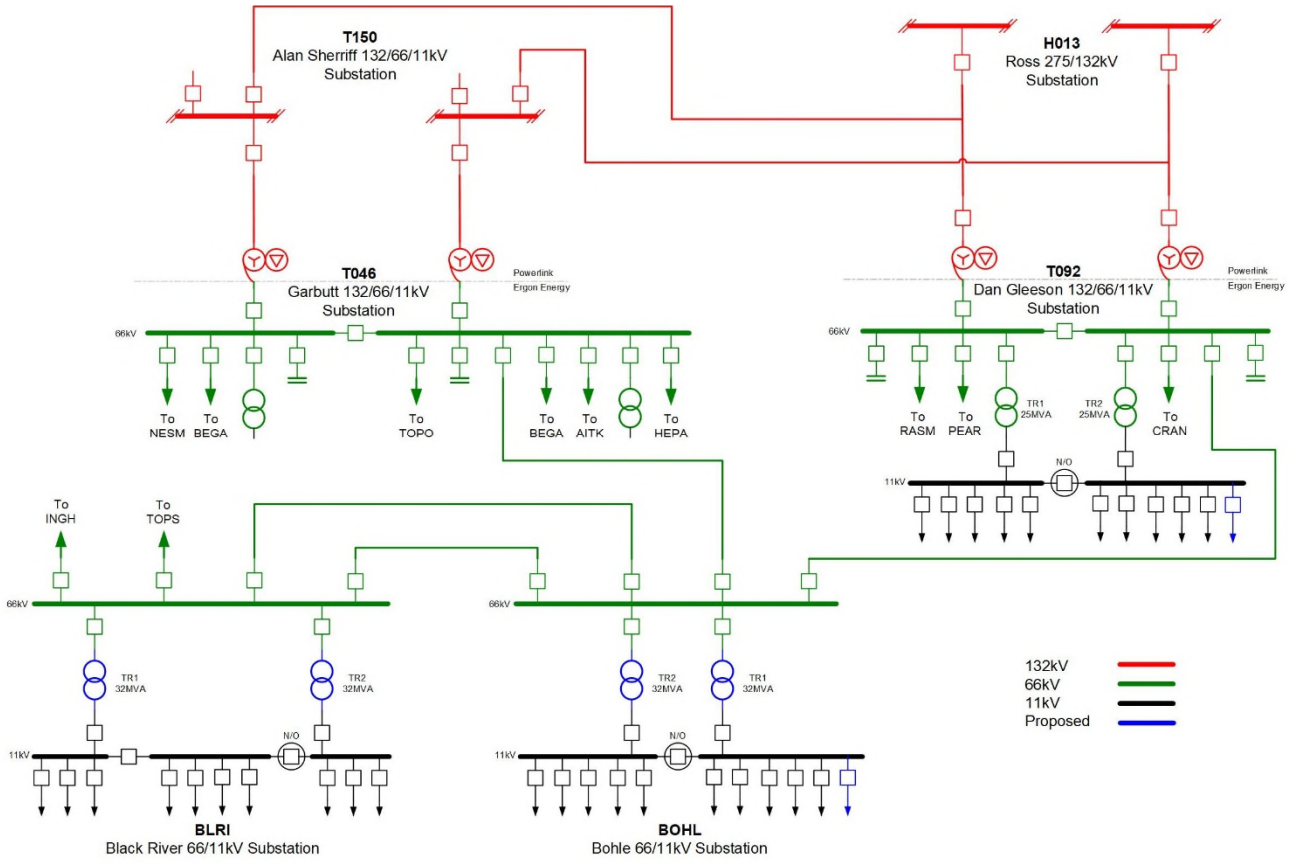


Figure 14 – Option 3 network diagram

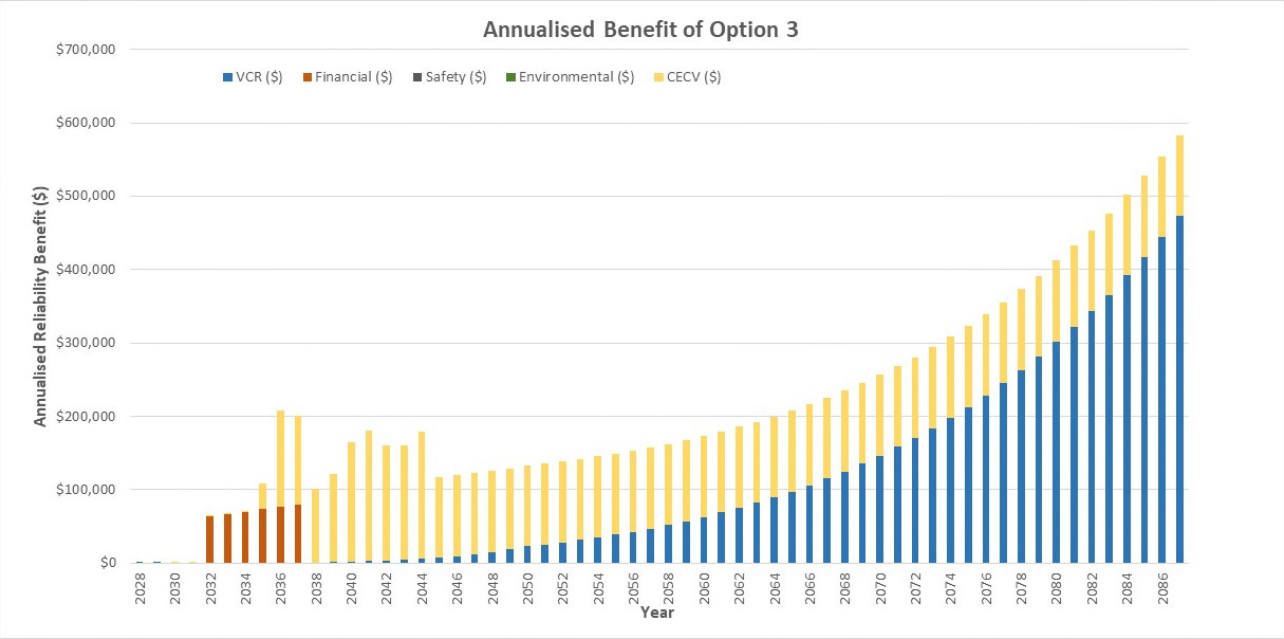
5.3.1 Option 3 Costs

Option 3 has been estimated to have $10.86m of direct costs in the 2025-30 AER period, which has been factored into the NPV to be incurred in 2028. The establishment of the new 66/11kV Bohle Plains (BOPL) substation with two transformers has been estimated at $20.2m direct cost, which has been factored into the NPV as a cost in 2038.

5.3.2 Option 3 Benefits

Following the completion of the transformer capacity upgrades at BOHL and DAGL and establishment of new 11kV feeders, the load at risk for a transformer or feeder outage at either BOHL or DAGL will be reduced. As such, the calculated VCR and CECV benefits compared to the counterfactual have been included in the NPV as a benefit. The quantified benefits for Option 2 are shown in Figure 15.

Figure 15 – Option 3 Benefits



6 ECONOMIC ANALYSIS

6.1 Cost summary 2025-30

The preferred option, Option 1 has an estimated direct cost of $17.3m. The forecast expenditure by year is shown in Table 3.

Table 3 – Cost summary 2025-30

Option	2025-26	2026-27	2027-28	2028-29	2029-30	Total Direct 2025-30
Establish Bohle Plains Zone Substation with 1 x 32MVA Transformer	$0.19m	$0.689m	$0.489m	$13.293m	$2.818m	$17.309m

6.2 NPV analysis

Table 4 shows the NPV of Capex, Opex and Benefits for the options using a discount rate of 3.5%.

Table 4 – Base Case NPV analysis

Option	Rank	Net NPV	Capex NPV	Opex NPV	Benefits NPV
Establish Bohle Plains Zone Substation with 1 x 32MVA Transformer	1	-$26.559m	-$20.852m	-$8.043m	$2.336m
Establish Bohle Plains Zone Substation with 2 x 32MVA Transformers	2	-$28.244m	-$21.990m	-$8.500m	$2.246m
Upgrade Dan Gleeson, Bohle and Black River Substations and install additional 11kV feeders into the area to defer the establishment of BOPL	3	-$30.648m	-$24.773m	-$9.466m	$3.591m

Table 5 shows the results having changed various inputs in the financial model. Option 1 remains the preferred option through all scenarios of the sensitivity analysis.

Table 5 – NPV Sensitivity Analysis

Option	Discount rate		Failure rate		Benefits	
	2.5%	4.5%	75%	125%	75%	125%
Establish Bohle Plains Zone Substation with 1 x 32MVA Transformer	-$27.943m	-$25.455m	-$26.551m	-$26.567m	-$27.143m	-$25.975m
Establish Bohle Plains Zone Substation with 2 x 32MVA Transformers	-$29.545m	-$27.241m	-$28.214m	-$28.274m	-$28.806m	-$27.682m
Upgrade Dan Gleeson, Bohle and Black River Substations and install additional 11kV feeders into the area to defer the establishment of BOPL	-$33.117m	-$28.508m	-$30.954m	-$30.342m	-$31.546m	-$29.750m

7 RECOMMENDATION

It is recommended to establish a new Bohle Plains 66/11kV substation by 2028 to address the reliability and safety net compliance risks in the Bohle Plains area, as per Option 1 (the preferred option) of this report. Table 6 summarises the options under consideration.

Table 6 Options Analysis Scorecard

Criteria	Option 1 – Establish Bohle Plains Zone Substation with 1 x 32MVA Transformer	Option 2 – Establish Bohle Plains Zone Substation with 2 x 32MVA Transformers	Option 3 - Upgrade Dan Gleeson, Bohle and Black River Substations and install additional 11kV feeders into the area to defer the establishment of BOPL
Net Present Value	-$26.559m	-$28.244m	-$30.648m
Investment cost (TCO)	$m	$m	$m
Investment Risk	Medium	Medium	Medium
Benefits	Meet requirements under DA with minimal staging.	Meet requirements under DA with least resource deployment	Meet requirements under DA with multiple stages and high risks for distribution works
Delivery time	Oct-2028	Oct-2028	Oct-2028
Detailed analysis – Benefits	The VCR benefits are initially negative from 2028, increasing to around $12k / annum by 2050.	The VCR benefits are initially $0.036k / annum from 2028, increasing to around $12k / annum by 2050.	The VCR benefits are initially $0.036k / annum from 2028, increasing to around $23k / annum by 2050.
Detailed analysis – Risks	Safety Net Compliance risk addressed by improving backup supply arrangement to Bohle Plains area.	Safety Net Compliance risk addressed by improving backup supply arrangement to Bohle Plains area.	Safety Net Compliance risk addressed by improving backup supply arrangement to Bohle Plains area.
Detailed analysis - Advantages	This option results in a secure and reliable supply for the Bohle Plains area network.	This option results in a secure and reliable supply for the Bohle Plains area network.	This option results in a secure and reliable supply for the Bohle Plains area network.

Appendix 1: Alignment with the National Electricity Rules

Table 7 Recommended Option's Alignment with the National Electricity Rules

NER capital expenditure objectives	Rationale
A building block proposal must include the total forecast capital expenditure which the DNSP considers is required in order to achieve each of the following (the capital expenditure objectives):	
6.5.7 (a) (1) meet or manage the expected demand for standard control services over that period	Section 3; Section 5
6.5.7 (a) (2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;	Section 3; Section 4; Section 5; Section 6
6.5.7 (a) (3) to the extent that there is no applicable regulatory obligation or requirement in relation to: (i) the quality, reliability or security of supply of standard control services; or (ii) the reliability or security of the distribution system through the supply of standard control services, to the relevant extent: (iii) maintain the quality, reliability and security of supply of standard control services; and (iv) maintain the reliability and security of the distribution system through the supply of standard control services	Section 4; Section 6
6.5.7 (a) (4) maintain the safety of the distribution system through the supply of standard control services.	Section 5; Section 6
NER capital expenditure criteria	**Rationale**
The AER must be satisfied that the forecast capital expenditure reflects each of the following:	
6.5.7 (c) (1) (i) the efficient costs of achieving the capital expenditure objectives	Section 4; Section 6
6.5.7 (c) (1) (ii) the costs that a prudent operator would require to achieve the capital expenditure objectives	Section 4; Section 6
6.5.7 (c) (1) (iii) a realistic expectation of the demand forecast and cost inputs required to achieve the capital expenditure objectives	Section 1; Section 6; Appendix 2

Appendix 2: Reconciliation Table

Table 8 Reconciliation

Expenditure	DNSP	2025-26	2026-27	2027-28	2028-29	2029-30	2025-30
Expenditure in business case $m, direct 2022-23	Ergon	$0.19m	$0.689m	$0.489m	$13.293m	$2.818m	**$17.309m**