Hays Inlet–Narangba Establish new 33kV Feeder

Business Case

19 November 2024

energex
Part of Energy Queensland

CONTENTS

List of Tables

List of Figures

DOCUMENT VERSION

Version Number	Change Detail	Date	Updated by
1.0	Approved Version	15/11/2024	General Manager Grid Planning

1 SUMMARY

Title	Hays Inlet – Narangba - Establish a new 33kV feeder
DNSP	Energex
Expenditure category	☐ Replacement ☒ Augmentation ☐ Connections ☐ Tools and Equipment ☐ ICT ☐ Property ☐ Fleet
Identified need *(select all applicable)*	☐ Legislation ☒ Regulatory compliance ☐ Reliability ☐ CECV ☐ Safety ☐ Environment ☒ Financial ☐ Other This investment is driven by inadequate capacity on the Hays Inlet-Deception Bay-Burpengary-Narangba 33kV network to supply the forecast load under both system normal and N-1 conditions. The system normal capacity shortfall resulted in emergency load shedding during Summer 2023/24. As the load continues to increase in this area, the amount and duration of load shedding increases each year. Further to this, this investment has a positive cost/benefit analysis based on Value of Customer Reliability (VCR). Specifically, currently there is significant energy at risk due to the capacity shortfall. This proposed investment aims to ensure adequate supply capacity in the Deception Bay-Burpengary-Narangba area to meet the growing demand.
Summary of preferred option	The proposed option is to establish a new 33kV feeder from Hays Inlet bulk supply substation (SSHIL) to Narangba zone substation (SSNRA).
Expenditure	(see table below)
Benefits	The forecast load at risk under system normal condition and N-1 contingency will be addressed following the completion of this project.
Consumer engagement	

Year	2025-26	2026-27	2027-28	2028-29	2029-30	Total 2025-30
$m, direct 2022-23	$0m	$0m	$3.768m	$4.853m	$13.474m	**$22.095m**

2 BACKGROUND

Deception Bay, Narangba, Burpengary and surrounding suburbs are located approximately 30km North of Brisbane CBD. The area has been growing steadily and is continuing to grow with new emerging communities under development. There is insufficient capacity in the electricity network to supply the load in the area.

2.1 Network Arrangement

F305, F311 and F497 are 33kV feeders from SSHIL Hays Inlet Bulk Supply substation that provides electricity supply to approximately 25,200 customers in a mesh network via SSDBY Deception Bay zone substation, SSBGY Burpengary zone substation and SSNRA Narangba zone substation. The supply area covers two emerging community areas at Burpengary East and Narangba East.

The load on this 33kV feeder mesh network has already exceeded its ratings in Summer 2023/24. It is forecast that the load will continue to grow.

The connected zone substations customers and loads are summarised below:

- **Deception Bay zone substation (SSDBY)** – is a 33/11kV zone substation supplying approximately 10,200 predominantly residential customers. The maximum recorded demand was 31.14 MVA in Summer 2023/24.
- **Burpengary zone substation (SSBGY)** – is a 33/11kV zone substation supplying approximately 8,000 predominantly residential customers. The maximum recorded demand was 27.45 MVA in Summer 2023/24.
- **Narangba zone substation (SSNRA)** - is a 33/11kV zone substation supplying approximately 7,000 predominantly residential customers. The maximum recorded demand was 29.89 MVA in Summer 2023/24.

Figure 1 shows the network arrangement and Figure 2 shows the geographic layout of the supply area.

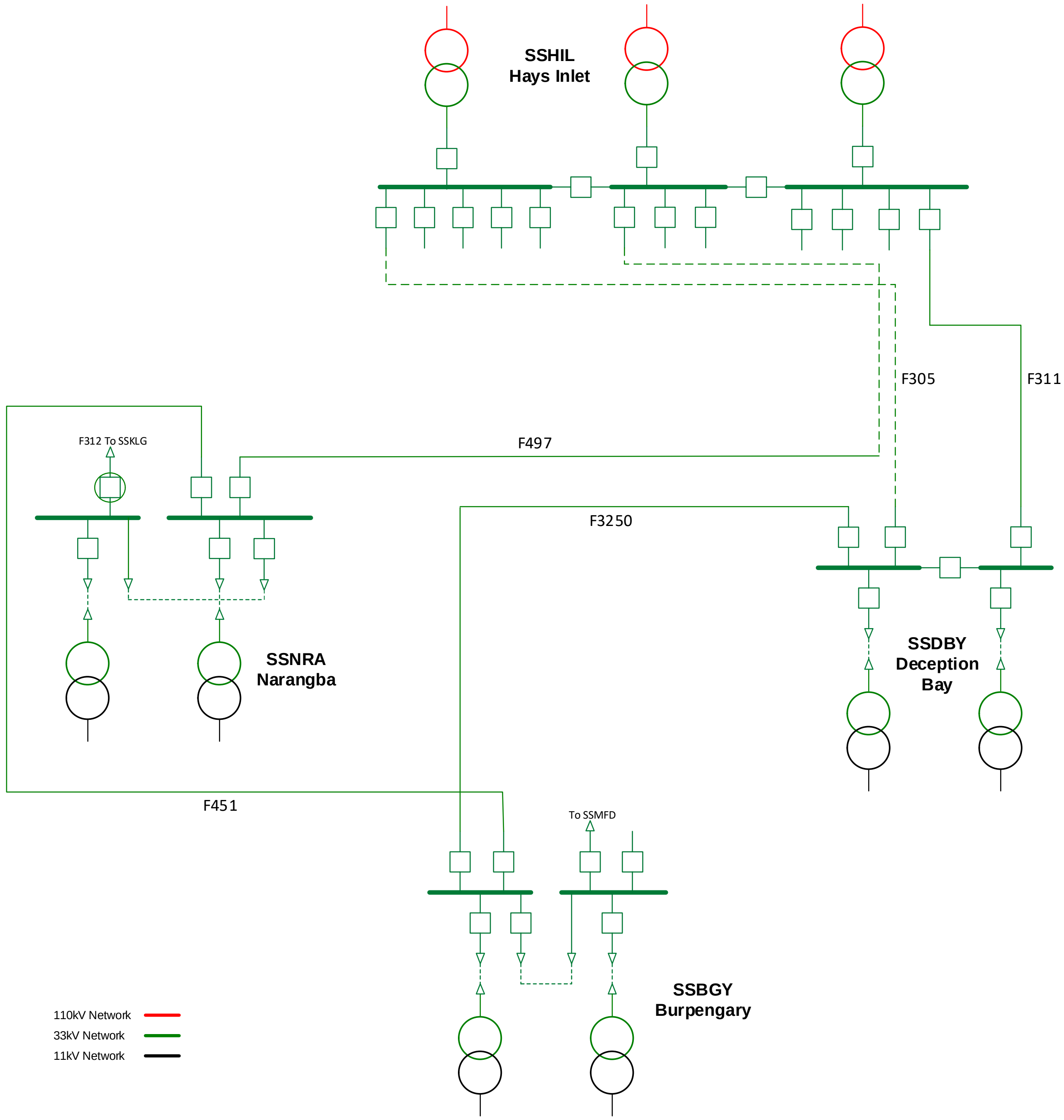


Figure 1 – Existing 33kV network diagram

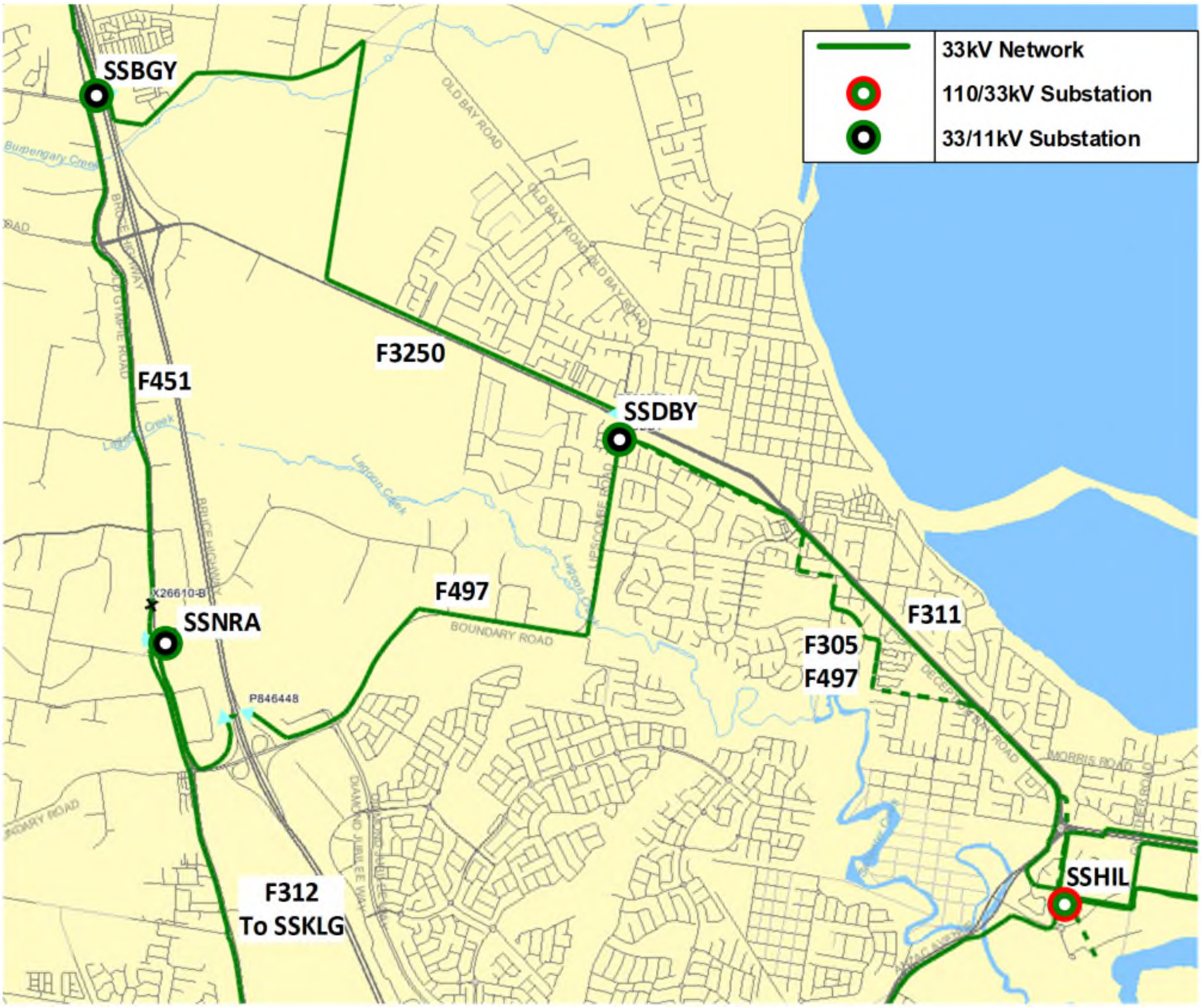


Figure 2 – Geographic view of the network

3 IDENTIFIED NEED

This investment is driven by inadequate capacity on the Hays Inlet-Deception Bay-Burpengary-Narangba 33kV network to supply the forecast load under both system normal and N-1 conditions. The system normal capacity shortfall resulted in emergency load shedding during Summer 2023/24. As the load continues to increase in this area, the amount and duration of load shedding increases each year.

Further to this, this investment has a positive cost/benefit analysis based on Value of Customer Reliability (VCR). Specifically, currently there is significant energy at risk due to the capacity shortfall.

This proposed investment aims to ensure adequate supply capacity in the Deception Bay-Burpengary-Narangba area to meet the growing demand.

3.1 Compliance

3.1.1 Sub-transmission Network

Under its Distribution Authority Energex must plan and develop its supply network in accordance with good electricity industry practice, having regard to the value that end users of electricity place on the quality and reliability. In line with standard industry practice, Energex undertakes analysis of system capacity under normal conditions such that no sub-transmission network asset is planned to be operated above its normal cyclic capacity for a 10% probability of exceedance (PoE) load forecast.

Furthermore, the Distribution Authority stipulates that Energex 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 (PoE) load forecast.

SSDBY, SSBGY and SSNRA zone substations are classified as Urban, and as such, the following Safety Net criteria apply:

<u>Urban – following an N-1 event:</u>

- No greater than 40MVA (16,000 customers) is without supply for more than 30 minutes;
- No greater than 12MVA (5,000 customers) is without supply for more than 3 hours; and
- No greater than 4MVA (1,600 customers) is without supply for more than 8 hours.

3.2 Sub-transmission Network Limitations

The network limitation that the proposed investment aims to address is the inadequate capacity under system normal condition to supply all load in the Deception Bay, Burpengary and Narangba areas and associated non-compliances with the Safety Net.

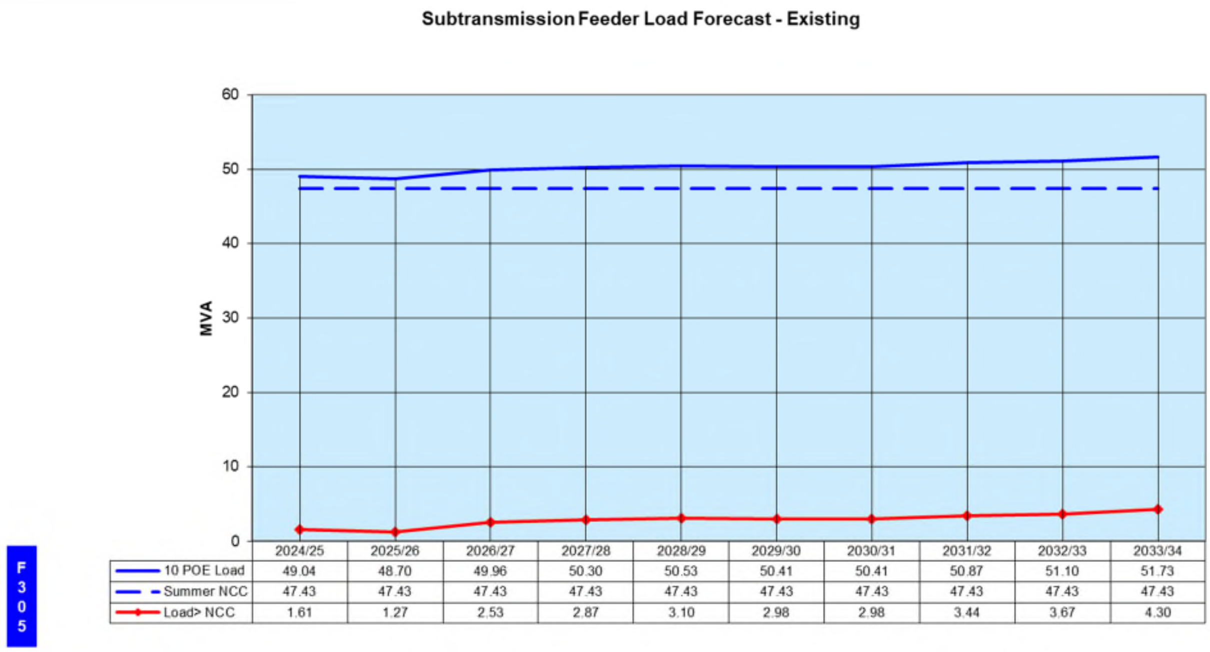
3.2.1 33kV Feeder F305 Limitations

33kV feeder F305 is an underground feeder connecting SSDBY to SSHIL, the route length is approximately 5.3km. The feeder NCC, ECC and 2HEC are shown below:

- Normal Cyclic Capacity (NCC) – 830A (47.44MVA)
- Emergency Cyclic Capacity (ECC) – 830A (47.44MVA)
- 2 Hour Emergency Capacity (2HEC) – 1200A (68.58MVA), limited by circuit breaker and overcurrent protection.

System Normal Limitation

The 10 year 10 PoE load forecasts, the existing Normal Cyclic Capacity (NCC) and Load at Risk (Load > NCC), are shown in Figure 3.



	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
10 POE Load	49.04	48.70	49.96	50.30	50.53	50.41	50.41	50.87	51.10	51.73
Summer NCC	47.43	47.43	47.43	47.43	47.43	47.43	47.43	47.43	47.43	47.43
Load> NCC	1.61	1.27	2.53	2.87	3.10	2.98	2.98	3.44	3.67	4.30

Figure 3 – F305 Load Forecast

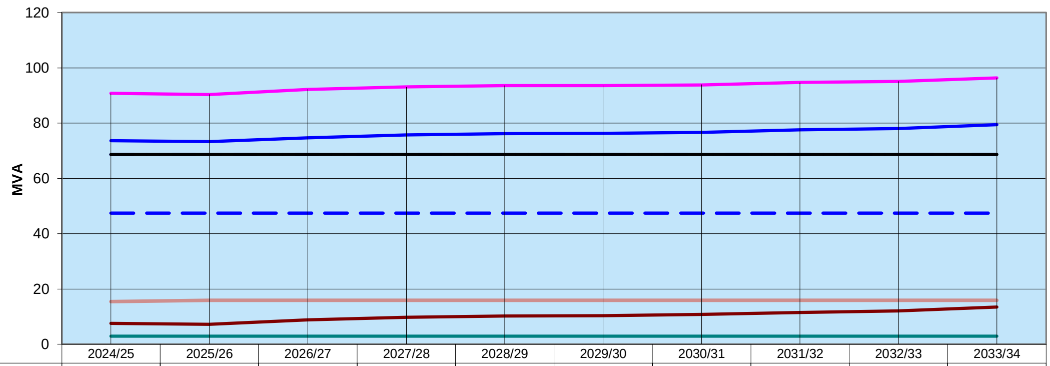
As shown in the above figure, the 10%POE load forecast exceeds the normal cyclic capacity by 1.61MVA in 2024/25, increasing to 4.3MVA in 2033/34. Emergency load shedding was employed in Summer 2023/24 to manage the overload, which resulted in loss of supply to 1683 customers for 3 hours.

The load at risk for the upcoming years will be managed by operational strategies such as deployment of mobile generators and temporarily load transfers during peak periods.

Safety Net Limitations

In addition to the system normal limitation, feeder F305 does not meet the Safety Net requirements.

The 10 year 50 PoE load forecasts, the existing Emergency Cyclic Capacity (ECC), 2 Hour Emergency Capacity (2HEC), Overcurrent Protection setting, Initial Load at Risk (LAR), Available Transfers, Mobile Plant capacities and Residual LAR are shown in Figure 4.



F305 (F497 OOS)	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
50 POE Load	73.56	73.22	74.71	75.73	76.19	76.31	76.71	77.51	78.02	79.39
Summer ECC	47.43	47.43	47.43	47.43	47.43	47.43	47.43	47.43	47.43	47.43
Summer 2HEC	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58
Overcurrent Protection	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58
Initial LAR	90.73	90.34	92.21	93.05	93.53	93.55	93.84	94.65	95.12	96.36
Available Transfers	15.50	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Mobile Plant	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Residual LAR	7.63	7.29	8.78	9.81	10.26	10.38	10.78	11.58	12.09	13.46

Figure 4 – F305 Load Forecast

As shown in the above figure, based on the 50%POE load forecast, there is a breach of Safety Net for feeder F305 following an outage of feeder F497.

Under this scenario, the load on F305 is expected to exceed the overcurrent protection setting, therefore protection will trip off F305. All the load on SSDBY, SSBGY and SSNRA will then fall on F311, which will also overload and trip on overcurrent protection. This results in total loss of supply to SSDBY, SSBGY and SSNRA, giving an initial Load at Risk of 90.73MVA in 2024/25.

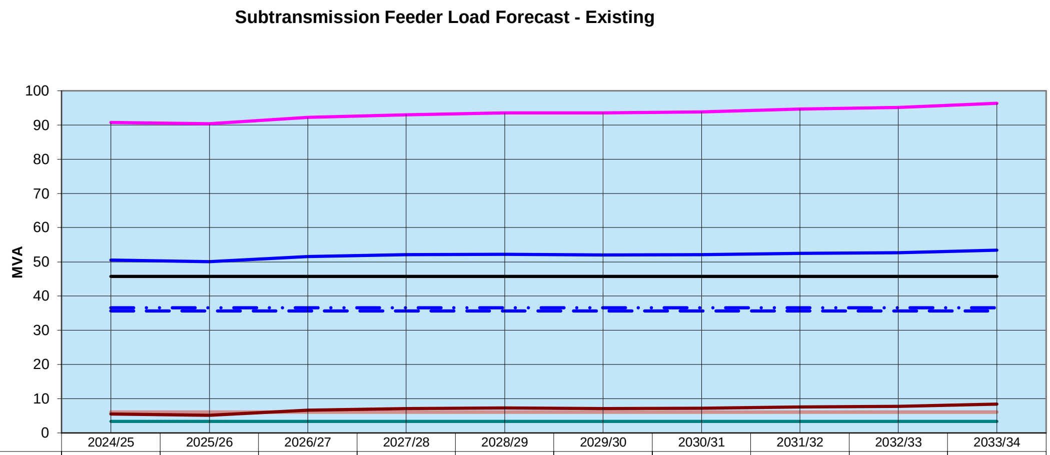
Some of SSNRA load can be transferred to Griffin bulk supply network, remaining load can be partially restored after investigation and the healthy feeders returned to service. The residual Load at Risk (LAR) after considering transfers and deployment of mobile generation is 7.63MVA in 2024/25, increasing to 13.46MVA in 2033/34.

3.2.2 33kV Feeder F311 Limitations

F311 is an overhead feeder connecting SSDBY to SSHIL, the route length is approximately 5km. The feeder NCC, ECC and 2HEC are:

- Normal Cyclic Capacity (NCC) – 623A (35.61MVA)
- Emergency Cyclic Capacity (ECC) – 623A (35.61MVA)
- 2 Hour Emergency Capacity (2HEC) – 640A (36.58MVA)

The 10 year 50 PoE load forecasts, the existing Emergency Cyclic Capacity (ECC), 2 Hour Emergency Capacity (2HEC), Overcurrent Protection setting, Initial Load at Risk (LAR), Available Transfers, Mobile Plant capacities and Residual LAR are shown in Figure 5.



F311 (F305 OOS)	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
50 POE Load	50.47	50.07	51.56	52.07	52.18	52.01	52.13	52.47	52.70	53.39
Summer ECC	35.61	35.61	35.61	35.61	35.61	35.61	35.61	35.61	35.61	35.61
Summer 2HEC	36.58	36.58	36.58	36.58	36.58	36.58	36.58	36.58	36.58	36.58
Overcurrent Protection	45.73	45.73	45.73	45.73	45.73	45.73	45.73	45.73	45.73	45.73
Initial LAR	90.73	90.34	92.21	93.05	93.53	93.55	93.84	94.65	95.12	96.36
Available Transfers	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05
Mobile Plant	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Residual LAR	5.51	5.11	6.60	7.11	7.22	7.05	7.17	7.51	7.74	8.43

Figure 5 – F311 Load Forecast

As shown in the above figure, based on the 50%POE load forecast, there is a breach of Safety Net for feeder F311 following an outage of feeder F305.

Under this scenario, the load on F311 is expected to exceed the overcurrent protection setting, therefore protection will trip off F311. All the load on SSDBY, SSBGY and SSNRA will then fall on F497, which will also overload and trip on overcurrent protection. This results in total loss of supply to SSDBY, SSBGY and SSNRA, giving an initial Load at Risk of 90.73MVA in 2024/25.

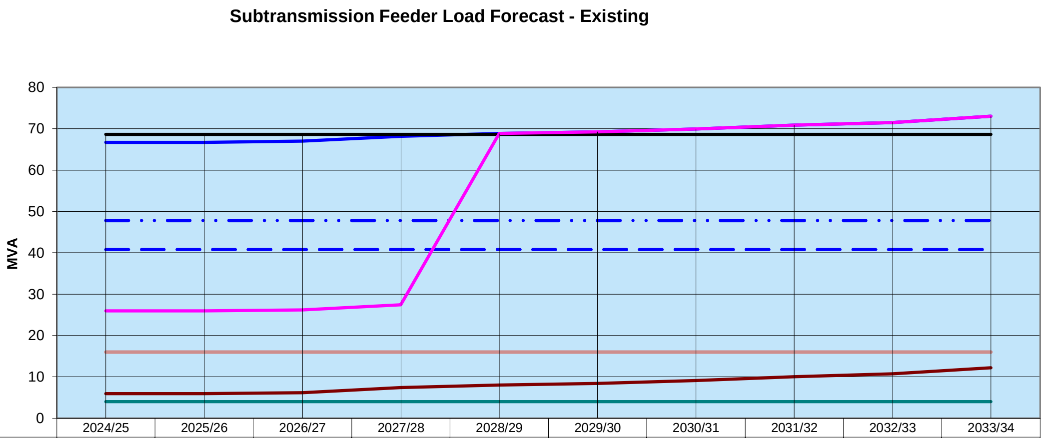
Some of SSNRA load can be transferred to Griffin bulk supply network, remaining load can be partially restored after investigation and the healthy feeders returned to service. The residual Load at Risk (LAR) after considering transfers and deployment of mobile generation is 5.51MVA in 2024/25, increasing to 8.43MVA in 2033/34.

3.2.3 33kV Feeder F497 Limitations

F497 is a mixed underground and overhead feeder connecting SSNRA to SSHIL, the route length is approximately 11km. The feeder NCC, ECC and 2HEC are shown below:

- Normal Cyclic Capacity (NCC) – 713A (40.75MVA)
- Emergency Cyclic Capacity (ECC) – 713A (40.75MVA)
- 2 Hour Emergency Capacity (2HEC) – 800A (45.73MVA), limited by circuit breaker and overcurrent protection.

The 10 year 50 PoE load forecasts, the existing Emergency Cyclic Capacity (ECC), 2 Hour Emergency Capacity (2HEC), Overcurrent Protection setting, Initial Load at Risk (LAR), Available Transfers, Mobile Plant capacities and Residual LAR are shown in Figure 6 below.



F497 (F3250 OOS)	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
50 POE Load	66.70	66.70	66.93	68.19	68.82	69.22	69.90	70.82	71.50	72.99
Summer ECC	40.75	40.75	40.75	40.75	40.75	40.75	40.75	40.75	40.75	40.75
Summer 2HEC	47.78	47.78	47.78	47.78	47.78	47.78	47.78	47.78	47.78	47.78
Overcurrent Protection	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58	68.58
Initial LAR	25.95	25.95	26.18	27.44	68.82	69.22	69.90	70.82	71.50	72.99
Available Transfers	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Mobile Plant	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Residual LAR	5.95	5.95	6.18	7.44	8.07	8.47	9.15	10.07	10.75	12.24

Figure 6 – F497 Load Forecast

As shown in the above figure, based on the 50%POE load forecast, there is a breach of Safety Net for feeder F497 following an outage of feeder F3250.

Under this scenario, the load on F497 is expected to exceed 2HEC from 2024/25, which will trigger Plant Overload Protection Scheme to automatically shed load. The initial Load at Risk is forecast to be 25.95 in 2024/25. From 2028/29, the load on F497 is expected to exceed the overcurrent protection setting, therefore protection will trip off F497. This will result in total loss of supply to SSBGY and SSNRA, giving an initial Load at Risk of 68.8MVA in 2028/29.

Some of SSNRA load can be transferred to Griffin bulk supply network, remaining load can be partially restored after investigation and the healthy feeder returned to service. The residual Load at Risk (LAR) after considering transfers and deployment of mobile generation is 5.95MVA in 2024/25, increasing to 12.24MVA in 2033/34.

Load Duration

The 2023/24 combined load duration curve for the 33kV feeders F305, F311 and F497 is shown in Figure 7.

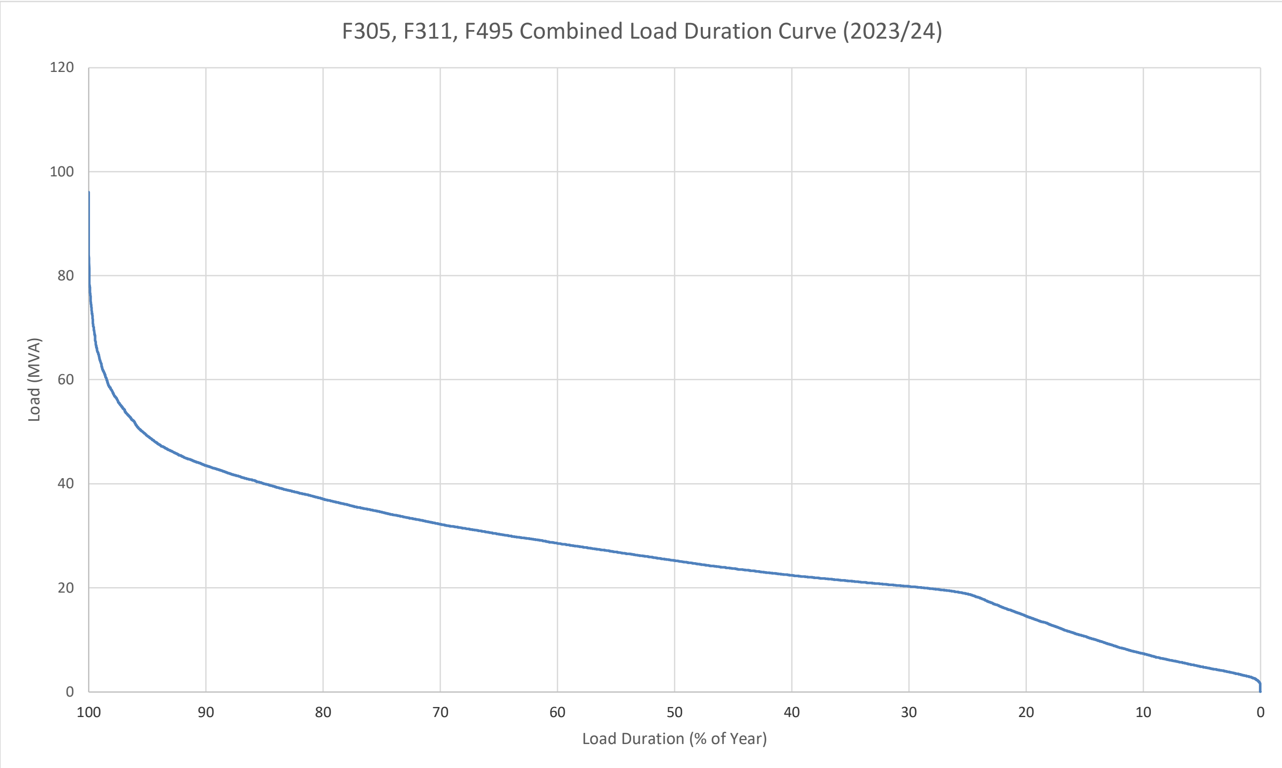


Figure 7 – 33kV feeders F305, F311, F497 combined load duration curve

3.3 Counterfactual analysis

The counterfactual scenario is to continue maintain and operate the network as it is currently designed without further augmentation.

3.3.1 Value Streams

Energex broadly considers five value streams for investment. These are shown in Figure 8. The two value streams that are relevant to this business case are *reliability*.

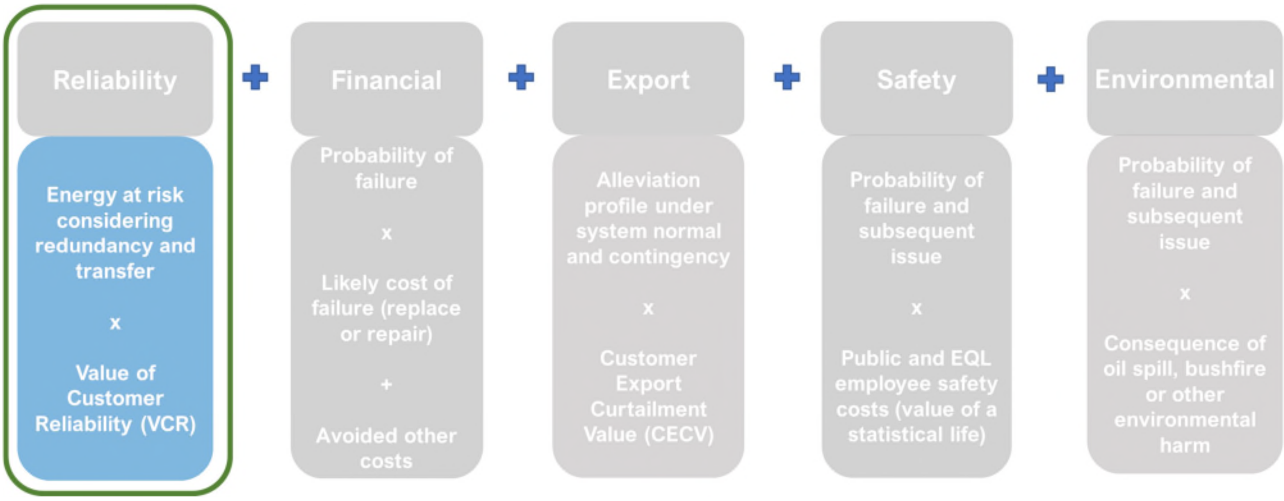


Figure 8 – Value Streams for Investment

- **Reliability:** There is potential unserved energy following an outage of F305, F311, F3250 or F497, the remaining feeders are unable to supply the full load.

3.3.2 Risk Quantifications

The counterfactual risk is an outage of the feeder F305, F3250 or F497, resulting in loss of supply to customers. In calculating the VCR implications of the existing network, the following assumptions have been used:

- **F305 Outage rate** – 0.008 outages / year. This is an extremely low rate as it is an underground feeder.
- **F311 Outage rate** – 0.277 outages / year.
- **F3250 Outage rate** – 0.334 outages / year.
- **F497 Outage rate** – 0.314 outages / year.
- **Restoration** – following an outage, it has been estimated that the rectification of the outage would be 6 hours for overhead feeder and 24 hours for underground feeder.
- **Transfers** – all available transfers via remote (30 minutes) or manual (3 hours) switching have been considered.

- **VCR Rate** – a VCR rate of $39.11/kWh has been used, calculated according to the weighting of energy supplied to the domestic, commercial and industrial customers in the area.

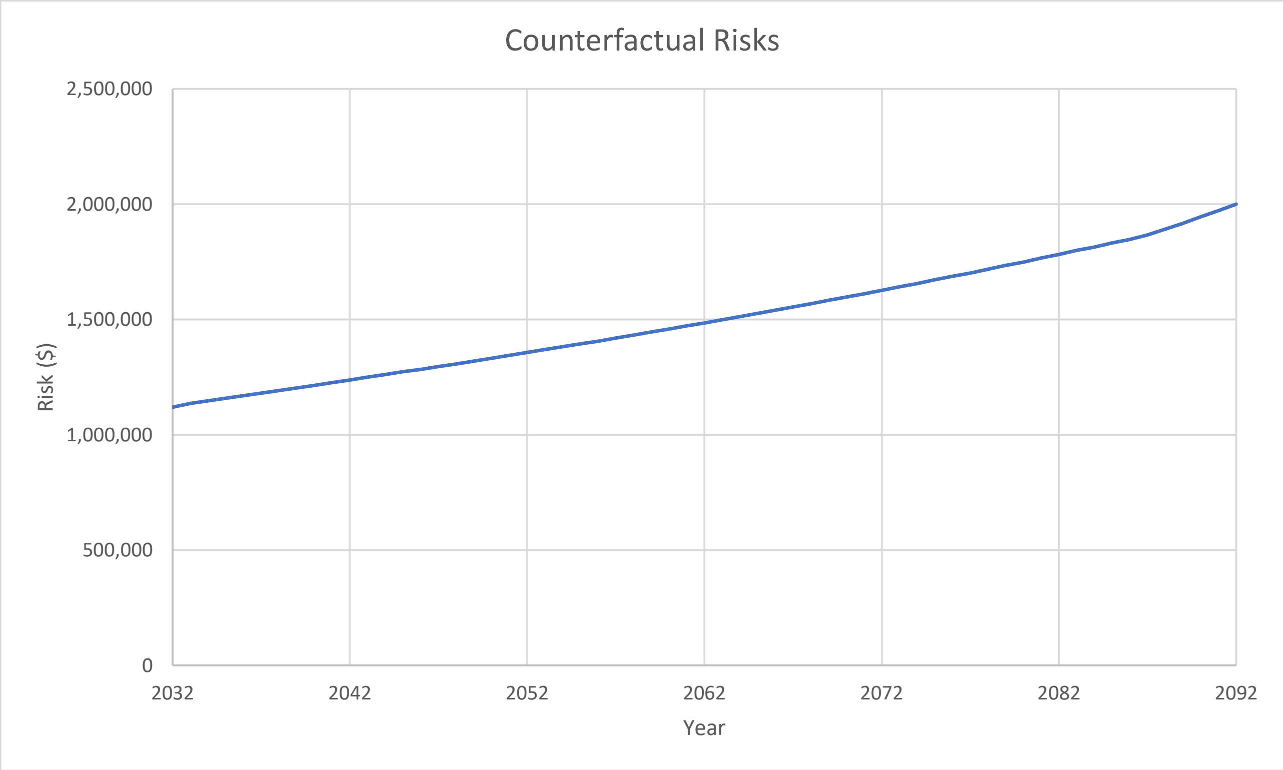


Figure 9 – Counterfactual Risk Quantification

4 OPTIONS ANALYSIS

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

Two options have been identified to address the capacity issue in SSHIL network. Identified options are:

Option 1 – Establish a new 33kV UG feeder from SSHIL to SSNRA (Hays Inlet Bulk Supply to Narangba Zone substation)

Option 2 – Establish a new 33kV UG feeder from SSHIL to SSBGY (Hays Inlet Bulk Supply to Burpengary Zone substation)

Note: The option of constructing feeders fully or partially as overhead (OH) was considered but rejected as it is deemed to be not feasible given the practicality issues (OH circuits are already occupying the road easements for these feeders), community and Council expectations.

4.1 Option 1 – Establish a new 33kV feeder from SSHIL to SSNRA

This option solves the system normal limitation and N-1 limitation on the 33kV feeder network by providing an additional infeed from Hays Inlet Bulk Supply substation to Narangba zone substation.

This option involves:

- Extend 33kV bus and install a new circuit breaker at SSHIL.
- Construct approx. 8km of 33kV UG feeder from SSHIL to SSNRA
- At SSBGY, transfer F3250 from 33kV bus BB31 to the spare CB on BB32.

A schematic view of the proposed development is shown in the diagram below.

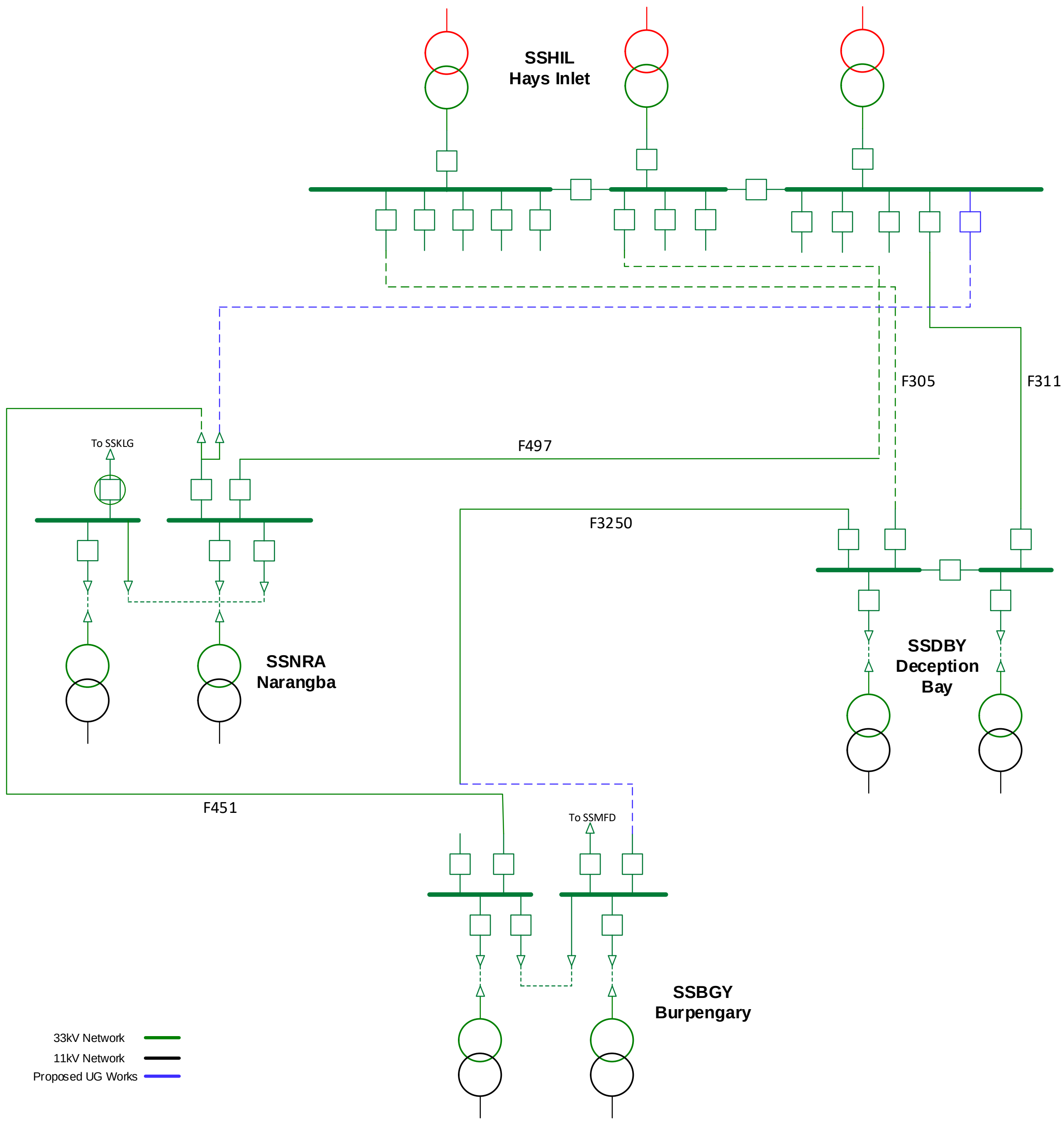


Figure 10 – Option 1 network diagram

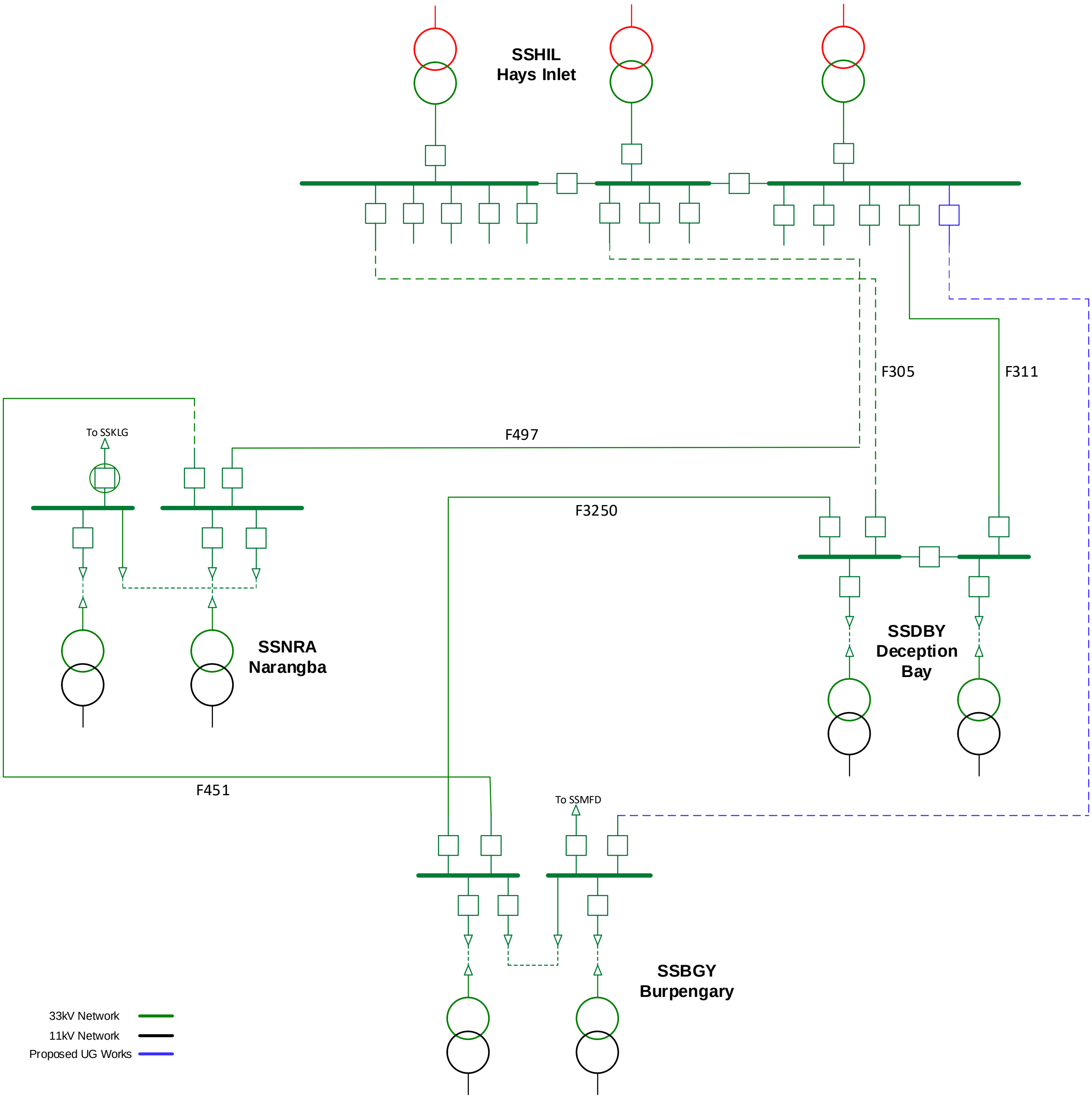
4.1.1 Costs

Option 1 has an estimated initial direct cost of $31.25m, which has been factored into the NPV as a cost in 2032.

4.2 Option 2 – Establish a new 33kV feeder from SSHIL to SSBGY

This option addresses the system normal limitation and N-1 limitation on the 33kV feeder network by providing an additional infeed from Hays Inlet Bulk Supply substation to Burpengary zone substation. This option involves:

- Extend 33kV bus and install a new circuit breaker at SSHIL.
- Construct approx. 11km of 33kV UG feeder from SSHIL to SSBGY.



4.2.1 Costs

Option 2 has an estimated initial direct cost of $40.99m, which has been factored into the NPV as a cost in 2032.

4.3 Economic Analysis

4.3.1 Cost summary 2025-30

Option 1 to establish a new 33kV feeder from SSHIL to SSNRA is the preferred option and has been estimated as $31.25m. The forecast expenditure by year is shown in Table 1.

Table 1 – Cost summary 2025-30

Option	2025-26	2026-27	2027-28	2028-29	2029-30	Total 2025-30
Establish a new 33kV feeder from SSHIL to SSNRA	$0m	$0m	$3.768m	$4.853m	$13.474m	**$22.095m**

4.3.2 NPV analysis

From the table below, Option 1 provides the highest net present value.

The net NPV of Option 1 under the base case is $1.675m, with the Capex and Opex NPV shown in Table 2. Table 3 shows the results having changed various inputs into the financial model.

Table 2 – Base Case NPV analysis

Option	Rank	Net NPV	Capex NPV	Opex NPV	Benefits NPV
Establish a new 33kV feeder from SSHIL to SSNRA	1	$1.675m	-$23.206m	-$0.432m	$25.313m
Establish a new 33kV feeder from SSHIL to SSBGY	2	-$5.724m	-$30.441m	-$0.594m	$25.312m

Table 3 – NPV Sensitivity Analysis

Option	Discount rate		Failure rate		Benefits	
	2.5%	4.5%	75%	125%	75%	125%
Establish a new 33kV feeder from SSHIL to SSNRA	$8.383m	-$2.543m	-$4.653m	$8.001m	-$4.654m	$8.003m
Establish a new 33kV feeder from SSHIL to SSBGY	$0.467m	-$9.430m	-$12.051m	$0.602m	$-12.052m	$0.604m

4.4 Delivery Timeframe

Considering the complexity of the project and resource capabilities, this project is scheduled to be delivered in 2032.

5 RECOMMENDATION

It is recommended to establish a new feeder from SSHIL to SSNRA to address the system normal limitation and N-1 limitations identified on the 33kV network. Table 4 summarises the option under consideration.

Table 4 Options Analysis Scorecard

Criteria	Option 1 – Establish a new 33kV feeder from SSHIL to SSNRA	Option 2 - Establish a new 33kV feeder from SSHIL to SSBGY
Net Present Value	$1.675m	-$5.724m
Investment cost	$31.255m	$40.999m
Investment Risk	Medium	Medium
Benefits	0	0
Delivery time	5 Years	5 Years
Detailed analysis – Risks	Complex underground work in populated area, underboring across highway is required.	Complex underground work in populated area, underboring across highway is required.
Detailed analysis - Advantages	Shorter route length, lower cost.	No obvious advantages.

APPENDICES

Appendix 1: 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 4.1
6.5.7 (a) (2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;	Section 3, Section 4.1
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 3, Section 4.1
6.5.7 (a) (4) maintain the safety of the distribution system through the supply of standard control services.	Section 3, Section 4.1
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 4.3
6.5.7 (c) (1) (ii) the costs that a prudent operator would require to achieve the capital expenditure objectives	Section 4.3
6.5.7 (c) (1) (iii) a realistic expectation of the demand forecast and cost inputs required to achieve the capital expenditure objectives	Section 3.2, Section 4.3

Appendix 2: Reconciliation Table

Table 5 Reconciliation

Expenditure	2025-26	2026-27	2027-28	2028-29	2029-30	2025-30
Expenditure in business case $m, direct 2022-23	$0m	$0m	$3.768m	$4.853m	$13.474m	**$22.095m**