New Morayfield East Zone Substation

Business Case
January 2024

energex
Part of Energy Queensland

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DOCUMENT VERSION

Version Number	Change Detail	Date	Updated by
1.0	Reviewed	08/12/2023	Principal Planning Engineer
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1 SUMMARY

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<tr><td>DNSP</td><td>Energex</td></tr>
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<tr><td>Identified need</td><td>☐ Legislation ☒ Regulatory compliance
☐ Reliability ☐ CECV ☐ Safety ☐ Environment ☐ Financial
☐ Other

Under its Distribution Authority, Energex must adhere to the Safety Net which identifies the principles that apply to the operation of network assets under network contingency conditions. It has been identified that under a N-1 contingency of feeder 448-1, feeders 305-1, 3250-1 and 3251-1 will overload during peak period. In addition, SSMFD will not meet the Safety Net regulatory obligation for an outage of one of the transformers.</td></tr>
<tr><td>Summary of preferred option</td><td>The proposed option is to establish a new 33/11kV Morayfield East (SSMFE) single modular 25MVA substation. In addition, based on the study of the current area geographically and taking into consideration the future network routes and easements, a mix of 4km of new overhead feeder and 5km of 33kV underground feeder between SST11 and SSMFE is proposed to be installed to address the regulatory compliance risk.</td></tr>
<tr><td>Expenditure</td><td>
<table>
<tr><th>Year</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>-</td><td>$0.136m</td><td>$0.319</td><td>$4.803m</td><td>$10.771m</td><td>$16.029m</td></tr>
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</td></tr>
<tr><td>Benefits</td><td>This project is compliance driven expenditure under our Safety Net obligations. As such, it is a lowest cost option assessment.</td></tr>
</table>

2 BACKGROUND

2.1 Network Arrangement

Caboolture bulk supply substation (SST11) has 6 x 33kV feeders, supplying 8 x zone substations including Caboolture West substation (SSCBW); Morayfield substation (SSMFD), Morayfield North substation (SSMFN), Wamuran substation (SSWMR), Caboolture substation (SSCBT), Ningi substation (SSNGI), Toorbul Point substation (SSTPT) and Bribie Island substation (SSBIS). SST11 provides electricity supply to predominantly domestic customers in the Caboolture, Campbells Pocket, Upper Caboolture, Elimbah, Meldale and Bribie Island areas.

The connected zone substations customers and loads are summarised below:

- **Caboolture West zone substation (SSCBW)** – is a 33/11kV zone substation supplying approximately 9,159 predominantly residential customers. The maximum recorded demand was 28.7MVA in Summer 2022/23.
- **Morayfield zone substation (SSMFD)** – is a 33/11kV zone substation supplying approximately 9,352 predominantly residential customers. The maximum recorded demand was 31.3MVA in Summer 2022/23.
- **Morayfield North zone substation (SSMFN)** – is a 33/11kV zone substation supplying approximately 7,011 mixed residential and commercial customers. The maximum recorded demand was 30.1MVA in Summer 2022/23.
- **Wamuran zone substation (SSWMR)** – is a 33/11kV zone substation supplying approximately 1,504 predominantly residential customers. The maximum recorded demand was 4.3MVA in Summer 2022/23.
- **Caboolture zone substation (SSCBT)** – is a 33/11kV zone substation supplying approximately 8,420 predominantly residential customers. The maximum recorded demand was 25.4MVA in Summer 2022/23.
- **Ningi zone substation (SSNGI)** – is a 33/11kV zone substation supplying approximately 3,500 predominantly residential customers. The maximum recorded demand was 10MVA in Summer 2022/23.
- **Toorbul Point zone substation (SSTPT)** – is a 33/11kV zone substation supplying approximately 3,300 predominantly residential customers. The maximum recorded demand was 6.8MVA in Summer 2022/23.
- **Bribie Island zone substation (SSBIS)** – is a 33/11kV zone substation supplying approximately 10,945 predominantly residential customers. The maximum recorded demand was 26.7MVA in Summer 2022/23.

SSMFN zone substation is supplied by SST11 bulk supply substation via two 33kV feeders, F461 and F499. SSMFD, SSCBW and SSMFN zone substations form a mesh network where SSMFD is supplied by both SSCBW and SSMFN via 33kV feeder F448.

There is a normally opened 33kV feeder, F3251, between SSMFD and Burpengary (SSBGY) zone substation, which could enable Hays Inlet (SSHIL) bulk supply substation to provide remote transfer supply to approximately half of SSMFD.

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

Figure 1 – Existing network diagram of the Caboolture area

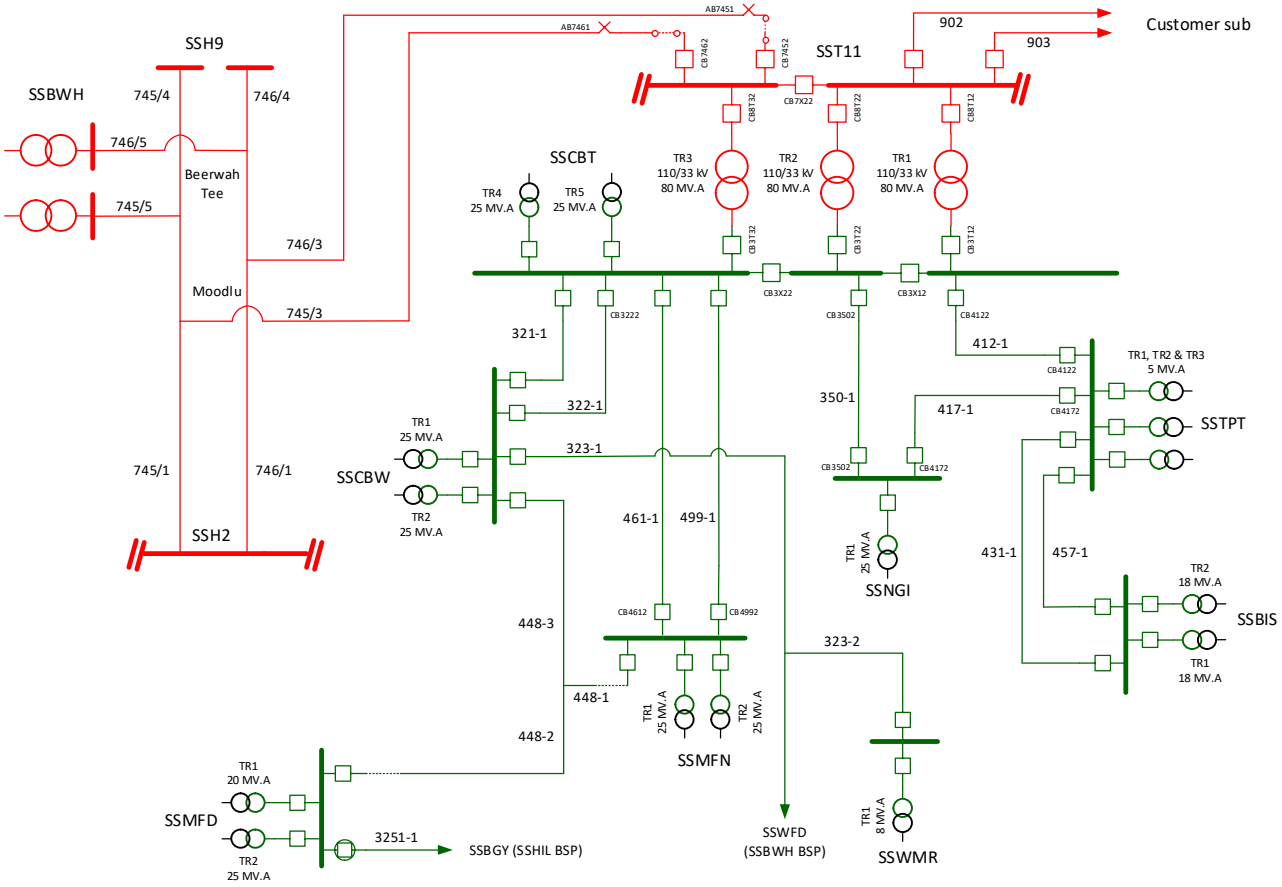


Figure 2 – Geographic of the Caboolture network

3 IDENTIFIED NEED

The identified need is to ensure supply in the area around Morayfield remains compliant with Safety Net requirements, which is a regulatory obligation as outlined in the Distribution Authority.

This investment is driven by insufficient capacity to restore supply within the required timeframes as stipulated in the Safety Net under the following scenarios:

- 33kV feeders F305, F3250 and F3251 will overload during peak period following a N-1 contingency of F448.
- there is load at risk following a N-1 contingency at SSMFD.

3.1 Compliance

3.1.1 Sub-transmission Network

Under its Distribution Authority, 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 (50PoE) load forecast.

SSMFD zone substation as well as 33kV feeders F305, F3250 and F3251 are all classified as Urban, and as such, the following Safety Net criteria apply:

Urban – following an N-1 event:

- 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
- no greater than 4MVA (1,600 customers) is without supply for more than 8 hours.

Further to an assessment against its Safety Net obligations, in accordance with industry practice Energex also undertake an analysis of system capacity under normal conditions such that no sub-transmission network asset should be operated above its normal cyclic capacity for a 10% probability of exceedance (PoE) load forecast.

3.1.2 Distribution network

To meet our Safety Net obligations Energex needs to maintain adequate automated, remote and manual transfer capability via its 11kV feeders without exceeding their Normal Cyclic Capacities.

3.2 Sub-transmission Network Limitations

There are four important characteristics of the network to understand when considering the proposed investment:

- Transformer loading at SSMFD
- 33kV feeder 305
- 33kV feeder 3250
- 33kV feeder 3251

3.2.1 Morayfield (SSMFD) Substation Limitations

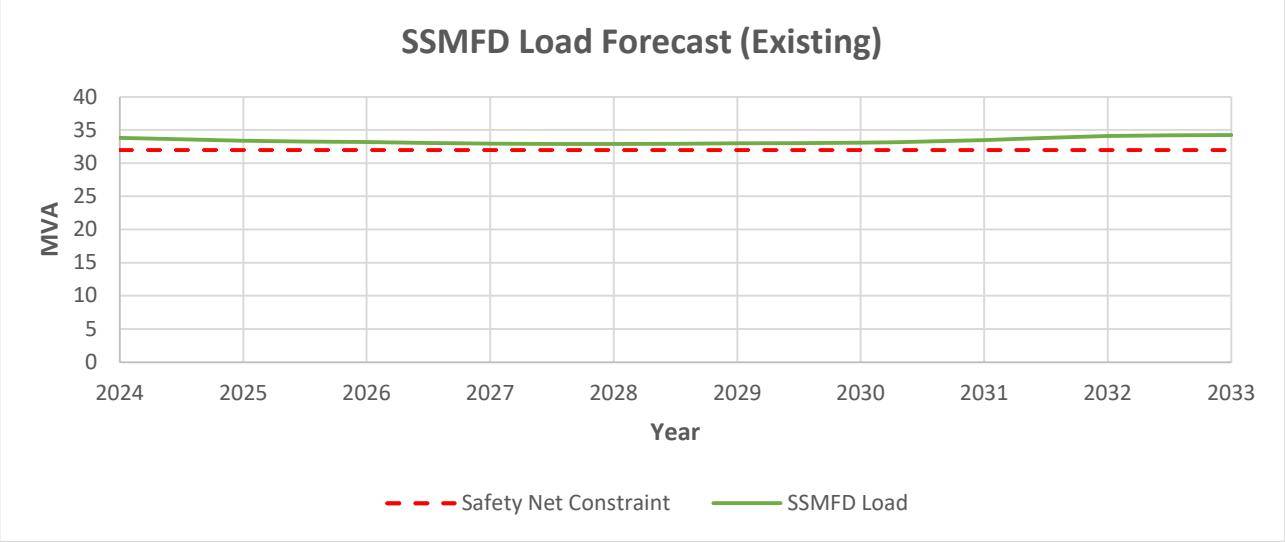
SSMFD is equipped with 1 x 20MVA and 1 x 25MVA 33/11kV transformers. The substation capacity is limited by the 33/11kV transformers and provides an NCC, ECC and 2HEC as below:

- Normal Cyclic Capacity (NCC) – 47.8MVA
- Emergency Cyclic Capacity (ECC) – 25.0MVA
- 2 Hour Emergency Capacity (2HEC) – 27.0MVA
- Safety Net Constraint – 32.0MVA

  The Safety Net Constraint includes all capabilities that can be made available within the required restoration timeframe for Urban category, following the loss of a transformer at SSMFD. Specifically, this comprises 25.0MVA of ECC, 3MVA of manual transfer and 4MVA of mobile generation.

Figure 3 shows the 50% POE load forecast and safety net constraint for SSMFD.

Figure 3 – SSMFD Load Forecast



As shown in the above figure, based on the 50%POE load forecast, there is a breach of Safety Net at SSMFD. This results in substation Load at Risk (LAR) of approximately 1.1MVA in 2029/30 under N-1 conditions, after including 3MVA of 11kV manual transfer available for SSMFD to transfer load to neighbouring substations as well as the deployment of 4MW of mobile generation at SSMFD.

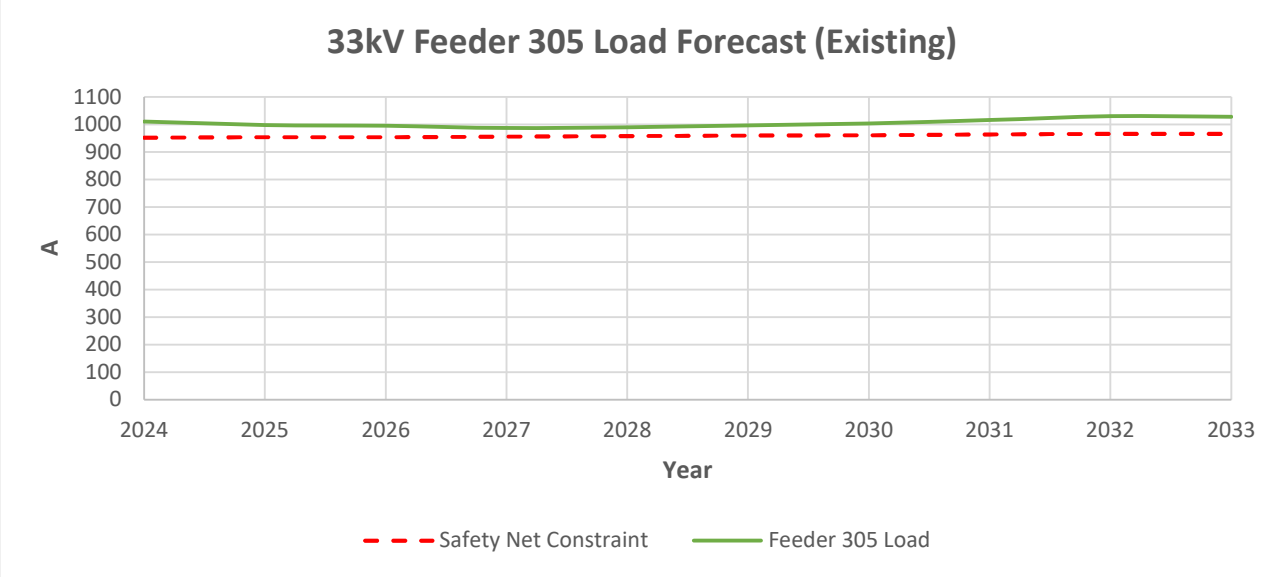
3.2.2 33kV Feeder 305 Limitations

33kV feeder 305 (SSHIL – SSDBY) is an approximately 5.3km underground cable and the feeder provides an NCC, ECC and 2HEC as below:

- Normal Cyclic Capacity (NCC) – 759A
- Emergency Cyclic Capacity (ECC) – 759A
- 2 Hour Emergency Capacity (2HEC) – 1291A.

Figure 4 shows the 50% POE load forecast and safety net constraint for feeder 305.

Figure 4 – Feeder 305 Load Forecast



As shown in the above figure, based on the 50%POE load forecast, there is a breach of Safety Net for feeder 305. This results in Load at Risk (LAR) of approximately 2.5MVA in 2029/30 following an outage of 33kV feeder F448, after including 11kV manual transfers at SSMFD and Deception Bay zone substation (SSDBY), remote transfer of half of Narangba zone substation (SSNRA) to Griffin bulk supply network, as well as 4MW of mobile generation at SSMFD.

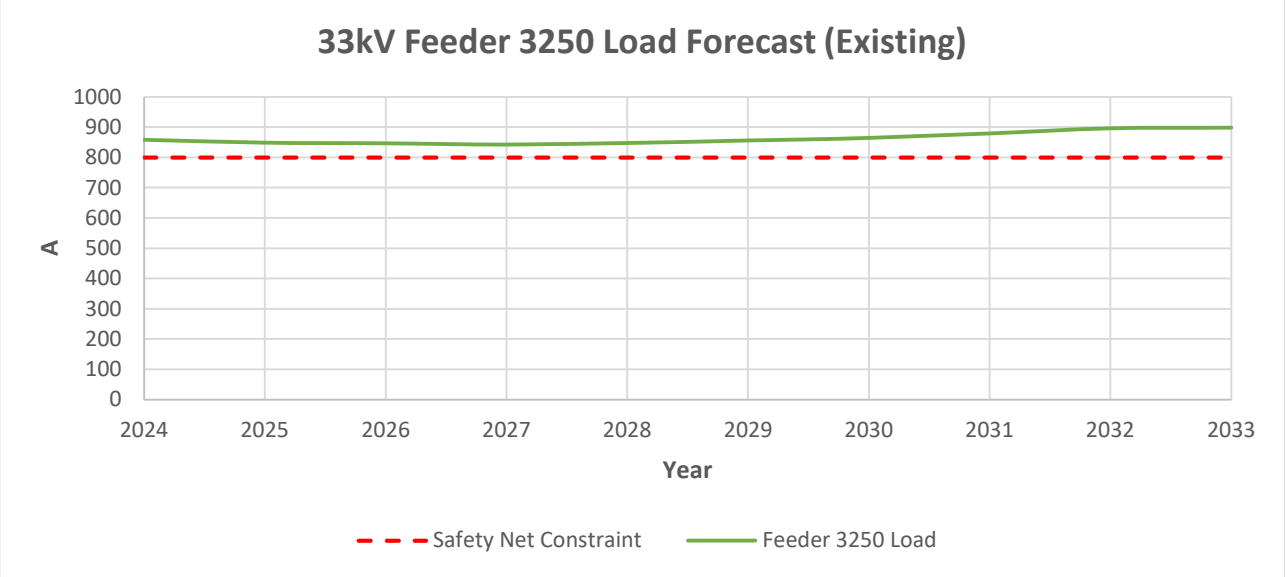
3.2.3 33kV Feeder 3250 Limitations

33kV feeder 3250 (SSDBY - SSBGY) is comprised of approximately 5.9km of overhead and 326m of underground cable and the feeder provides an NCC, ECC and 2HEC (limited by circuit breaker) as below:

- Normal Cyclic Capacity (NCC) – 713A
- Emergency Cyclic Capacity (ECC) – 713A
- 2 Hour Emergency Capacity (2HEC) – 800A

Figure 5 shows the 50% POE load forecast and safety net constraint for feeder 3250.

Figure 5 – Feeder 3250 Load Forecast



As shown in the above figure, based on the 50%POE load forecast, there is a breach of Safety Net for feeder 3250. This results in substation Load at Risk (LAR) of approximately 3.7MVA in 2029/30 following an outage of 33kV feeder F448, after remotely transfer half of Narangba (SSNRA) zone substation to Griffin bulk supply substation.

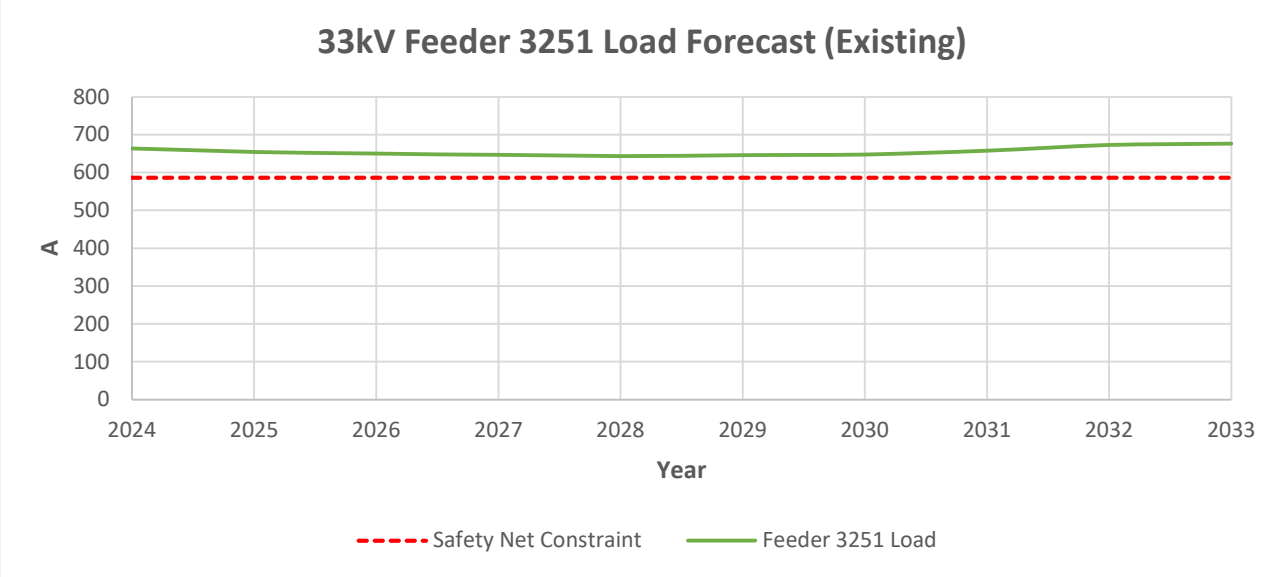
3.2.4 33kV Feeder 3251 Limitations

33kV feeder 3251 (SSBGY - SSMFD) is comprised of approximately 5km of overhead and 432m of underground cable and the feeder provides an NCC, ECC and 2HEC as below:

- Normal Cyclic Capacity (NCC) – 464A
- Emergency Cyclic Capacity (ECC) – 464A
- 2 Hour Emergency Capacity (2HEC) – 664A

Figure 6 shows the 50% POE load forecast and safety net constraint for SSMFD.

Figure 6 – Feeder 3251 Load Forecast



As shown in the above figure, based on the 50%POE load forecast, there is a breach of Safety Net for feeder 3251. This results in Load at Risk (LAR) of approximately 3.51MVA in 2029/30 following an outage of 33kV feeder F448, after including 3MVA of 11kV manual transfer available SSMFD to transfer load to neighbouring substations as well as 4MW of mobile generation deployed at SSMFD.

4 OPTIONS ANALYSIS

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

4.1 Option 1 – Establish Single Modular Substation

This option will permanently transfer load from SSMFD to a new 33/11kV zone substation (SSMFE) at an Energex owned site in Morayfield East to address the identified limitations.

This proposed works involve:

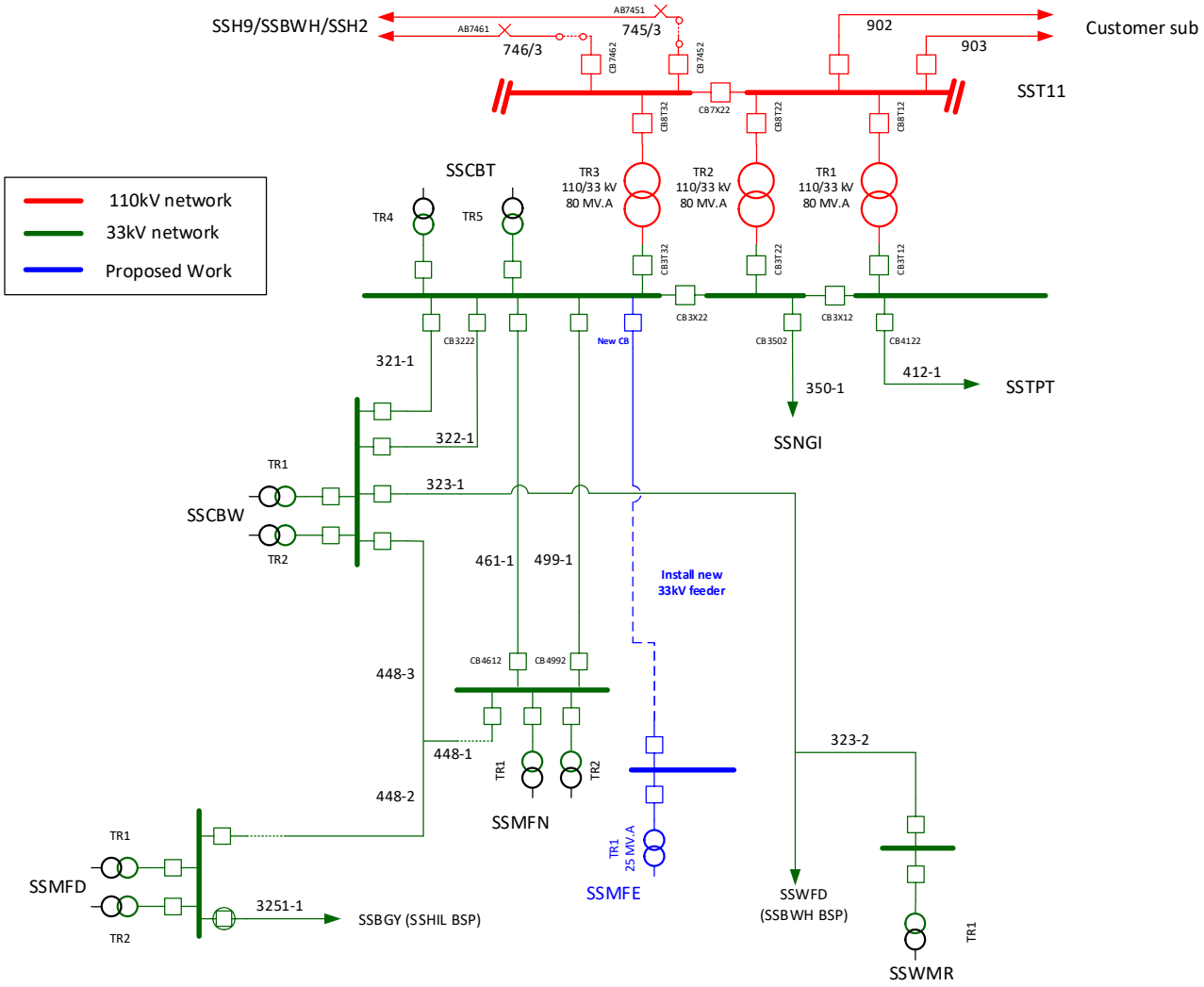
- Establish a single modular substation, which includes a 33/11kV 25MVA transformer at an Energex owned land.
- Construct a standard prefabricated (modular) building that consists of 4 x 33kV indoor circuit breakers, 7 x 11kV indoor circuit breakers, protection panels, COMMS and SCADA panels.
- Construct approximately 4km of new overhead feeder and 5km of 33kV underground feeder between SST11 and SSMFE.
- Install new 11kV feeder tails from SSMFE to cut into existing MFD12A and MFN12A.

4.1.1 Future Stages:

The future work for this option is required to meet the network security standard at the new substation SSMFE which involves:

- Install 2nd 25MVA transformer at SSMFE and install new 11kV feeders to de-load MFD2A and CBW6.
- Construct 3.5km of 33kV feeder from SSMFN to SSMFE.

Figure 7 – Option 1 network diagram



4.1.2 Costs

Option 1 has an estimated initial direct cost of $24.6m for this regulatory period, which has been factored into the NPV as a cost in 2030.

4.2 Option 2 – Reinforce SSMFN

This option will permanently transfer load from SSMFD to SSMFN by establishing a new 11kV feeder from SSMFN to and reconfigure the distribution network to deload SSMFD. The 33kV network supplying SSMFN will need to be upgraded to cater for the increased load at SSMFN.

The works under this option involve:

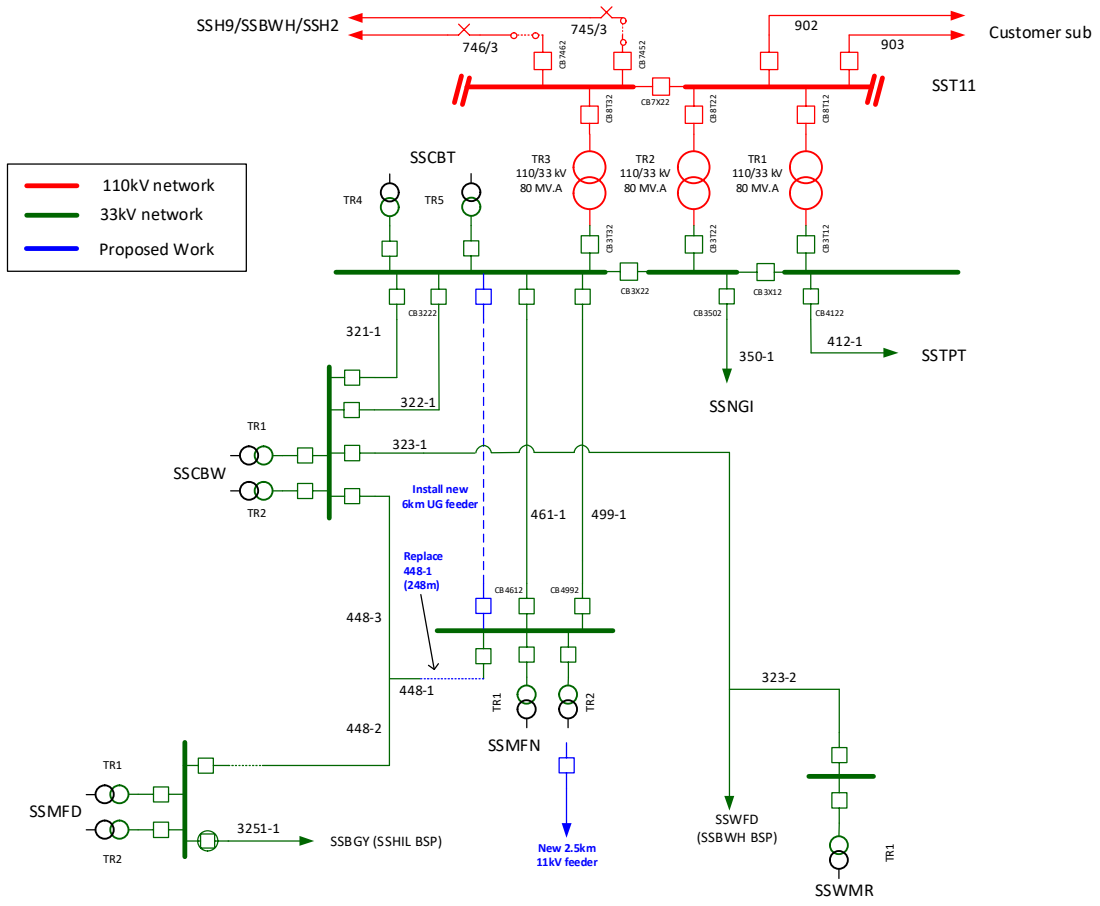
- Install 2.5km of 11kV underground feeder from SSMFN to de-load MFD8A.
- Construct 6km of 33kV underground feeder between SST11 and SSMFN.
- Replace around 248m of limiting section on feeder 448-1.

4.2.1 Future Stages:

The future work for this option is required to meet the network security standard at SSMFN as it continues to supply future load at SSMFD:

- Install 2km of 11kV feeder from SSMFN to de-load MFD2A and CBW6.
- Install 3rd 25MVA transformer at SSMFN and a new modular switchgear building.

Figure 8 – Option 2 network diagram



4.2.2 Costs

Option 2 has an estimated initial direct cost of $16.6m, which has been factored into the NPV as a cost in 2030.

4.3 Option 3 – New 110/11kV Substation

This option will permanently transfer load from SSMFD to a new 110/11kV zone substation at Upper Caboolture to address the identified limitations.

The works under this option involve:

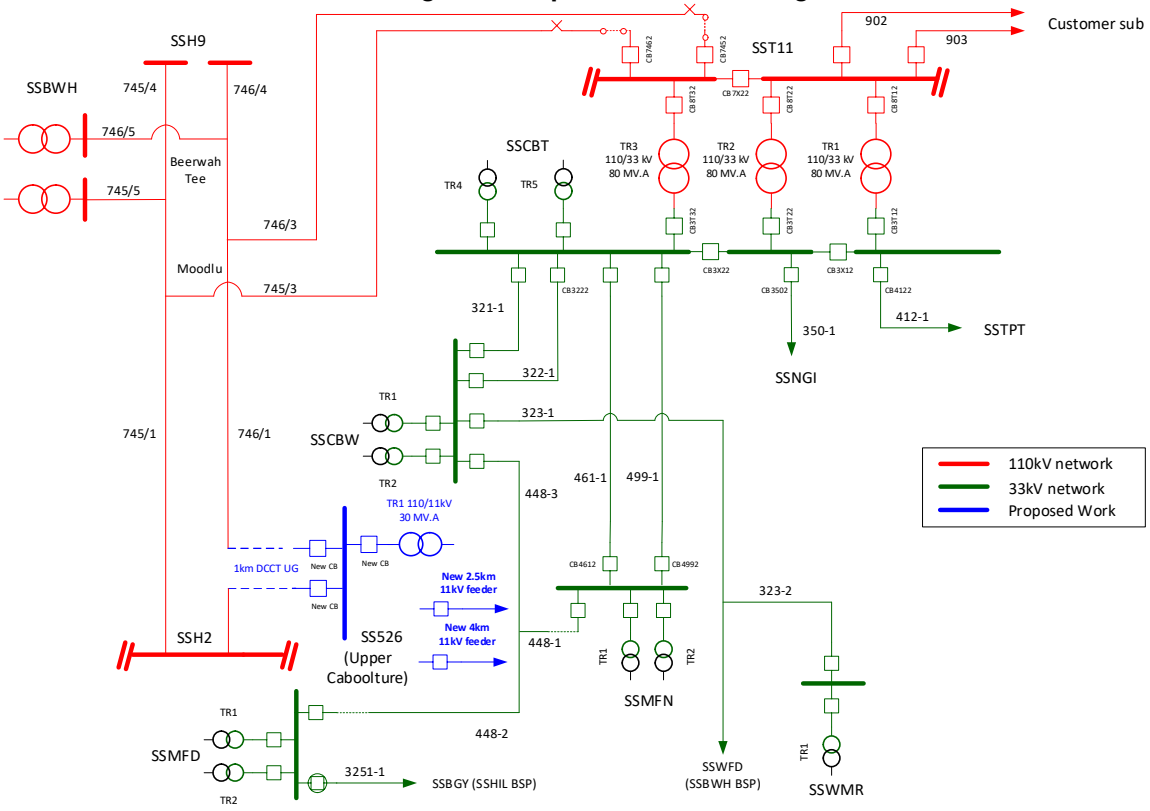
- Establishing a new 110/11kV Upper Caboolture (526) substation with a single 30MVA transformer.
- Construct new 1km of underground 110kV double circuit in and out of feeder 746.
- Install 2.5km of 11kV feeder from SSMFN to de-load MFD8A.
- Install 4km of 11kV feeder from Upper Caboolture substation to de-load MFN13A and MFN5A.

4.3.1 Future Stages

The future work for this option is required to meet the network security standard at the new 110/11kV Upper Caboolture substation which involves:

- Install 2nd 30MVA transformer at Upper Caboolture substation.

Figure 9 – Option 3 network diagram



4.3.2 Costs

Option 3 has an estimated initial direct cost of $26.4m, which has been factored into the NPV as a cost in 2030.

4.4 Option Considered but Rejected – Reinforce 33kV Sub-transmission Network and upgrade SSMFD substation

This option involves:

- Reconductoring approximately 5km of the existing 33kV overhead feeder F3251
- Reconductoring approximately 6km of the existing 33kV overhead feeder F3250
- Construct a new 5km of 33kV underground cable from SSHIL to SSDBY
- Install a third 25MVA modular substation at SSMFD.

This option is not feasible due to no space available at SSMFD to accommodate a third modular substation.

4.5 Economic Analysis

4.5.1 Cost summary 2025-30

Option 1 to establish a new SSMFE 33/11kV zone substation is the preferred option and has been estimated as $24.6m. The forecast expenditure would span over 5 years, the expenditure across the 2025-30 regulatory period is shown in Table 1.

Table 1 – Cost summary 2025-30 2022/23 $

Option	2025-26	2026-27	2027-28	2028-29	2029-30	Total 2025-30
Establish a new SSMFE 33/11kV zone substation	-	$0.136m	$0.319m	$4.803m	$10.771m	$16.029m

4.5.2 NPV analysis

From the table below, Option 1 is the lowest cost option. The NPV under the base case is - $23.703m, with the Capex, Opex and Benefits NPV shown in Table 2. Table 3 shows the results having changed various inputs in the financial model.

Table 2 – Base Case NPV analysis

Option	Rank	Net NPV	Capex NPV	Opex NPV
Establish a new SSMFE 33/11kV zone substation	1	-$23.703m	-$22.340m	-$1.362m
Construct a new 33kV feeder between SST11 and SSMFN	3	-$28.315m	-$26.911m	-$1.405m
Establish a new 110/11kV zone substation	2	-$26.570m	-$25.008m	-$1.562m

Table 3 – NPV Sensitivity Analysis

Option	Discount rate	
	2.5%	**4.5%**
Establish a new SSMFE 33/11kV zone substation	-$26.022m	-$21.554m
Construct a new 33kV feeder between SST11 and SSMFN	-$32.507m	-$24.683m
Establish a new 110/11kV zone substation	-$29.124m	-$24.177m

4.6 Optimal Timing

This is a Safety Net requirement. Due to the load forecast being under the actuals, this has led to us identifying the network limitation later than we would typically require, and it is anticipated that the earliest completion of this project is in 2030.

5 RECOMMENDATION

It is recommended to establish a new Morayfield East 33/11kV zone substation (SSMFE) to meet the projected load growth and enabling Energex to continue to meet the Safety Net regulatory obligation. Table 4 summarises the options under consideration.

Table 4 Options Analysis Scorecard

Criteria	Option 1 – Establish a new SSMFE 33/11kV zone substation	Option 2 – Construct a new 33kV feeder between SST11 and SSMFN	Option 3 - Establish a new 110/11kV zone substation
Net Present Value	-$23.703m	-$28.315m	-$26.570m
Investment cost	$24.6m	$16.6m	$26.4m
Delivery time	5 years	5 years	5 years
Detailed analysis – Risks	This option involves significant underground feeder work, which could encounter unforeseen issues that increase the cost of the project.	This Option may present risk during construction staging at SSMFN to manage outages whilst installing a 3rd transformer and feeder on site. This option also has a significant portion of underground, which could encounter unforeseen issues that increase the cost of the project.	This option requires reconfiguration of the TNSP's network, agreement with TNSP has not been reached. It could be difficult to acquire a substation site in the area.
Detailed analysis - Advantages	Close to the highly loaded SSMFD to provide reliable supply. It is an Energex owned site.	Close to the highly loaded SSMFD to provide reliable supply.	No obvious advantages.

Appendix 1: Alignment with the National Electricity Rules

Table 5 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 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 4.5
6.5.7 (c) (1) (ii) the costs that a prudent operator would require to achieve the capital expenditure objectives	Section 4.5
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

Appendix 2: Reconciliation Table

Table 6 Reconciliation

Expenditure	2025-26	2026-27	2027-28	2028-29	2029-30	2025-30
Expenditure in business case $m, direct 2022-23	-	$0.136m	$0.319m	$4.803m	$10.771m	$16.029m