SSMST Makerston St 11kV Switchgear Replacement

Business Case

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energex
Part of Energy Queensland

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☒ Reliability ☐ CECV ☒ Safety ☒ Environment ☒ Financial
☐ Other

42 x 11kV oil circuit breakers at Makerston Street zone substation (SSMST) have been deemed to reach retirement age in 2031. The ongoing operation of these assets beyond their estimated retirement date presents a significant risk to safety and customer reliability.

The identified needs are to ensure:
• Risks to health and safety associated with electrical risks at the Makerston Street zone substation is managed in accordance with the WHS Regulation, which is a requirement under Electrical Safety Regulation.
• Electricity supply in the area around Brisbane CBD remains at a reliability level that is expected by the customers. Outages in the CBD could potentially cause major economic and financial disruption (especially during the 2032 Olympics games in Brisbane).</td></tr>
<tr><td>Summary of preferred option</td><td>Replace 11kV oil circuit breaker switchboard at SSMST with new indoor GIS, including protection relays and other associated equipment.</td></tr>
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<tr><td>$m, direct 2022-23</td><td>$0.464m</td><td>$0.517m</td><td>$3.731m</td><td>$2.293m</td><td>$1.374m</td><td>$8.378m</td></tr>
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<tr><td>Benefits</td><td>The financial benefits begin at $693k/annum in 2032 increasing to $1.03m/annum by 2040</td></tr>
<tr><td>Consumer engagement</td><td>This project was presented at a number of customer forums throughout our regulatory engagement process.</td></tr>
</table>

2 BACKGROUND

2.1 Network arrangement

Makerston Street Zone Substation (SSMST) is a 110 kV to 11 kV substation providing 11 kV supply to Brisbane CBD and South Brisbane area. The substation supplies predominantly commercial customers, the maximum recorded demand was 58.4 MVA in Summer 2022/23.

The substation is connected to the 110 kV network via four 110 kV feeders, there are three 110/11 kV transformers and a 11 kV switchboard with 42 circuit breakers to distribute power to the 11 kV network.

The geographical location of Energex's sub-transmission network and substations in the area is shown in Figure 1 and Figure 2.

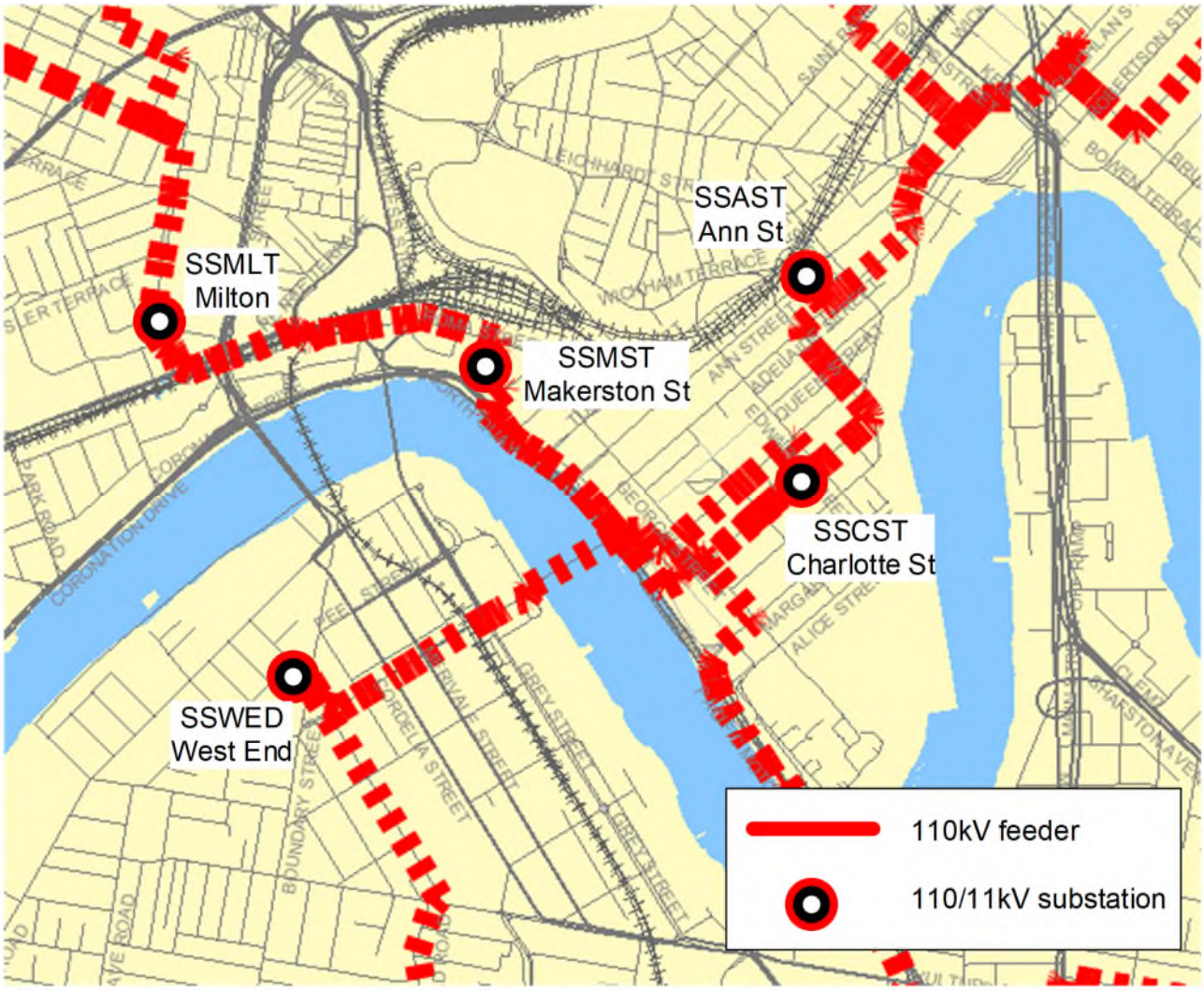

Figure 1: Existing network arrangement (geographic view)

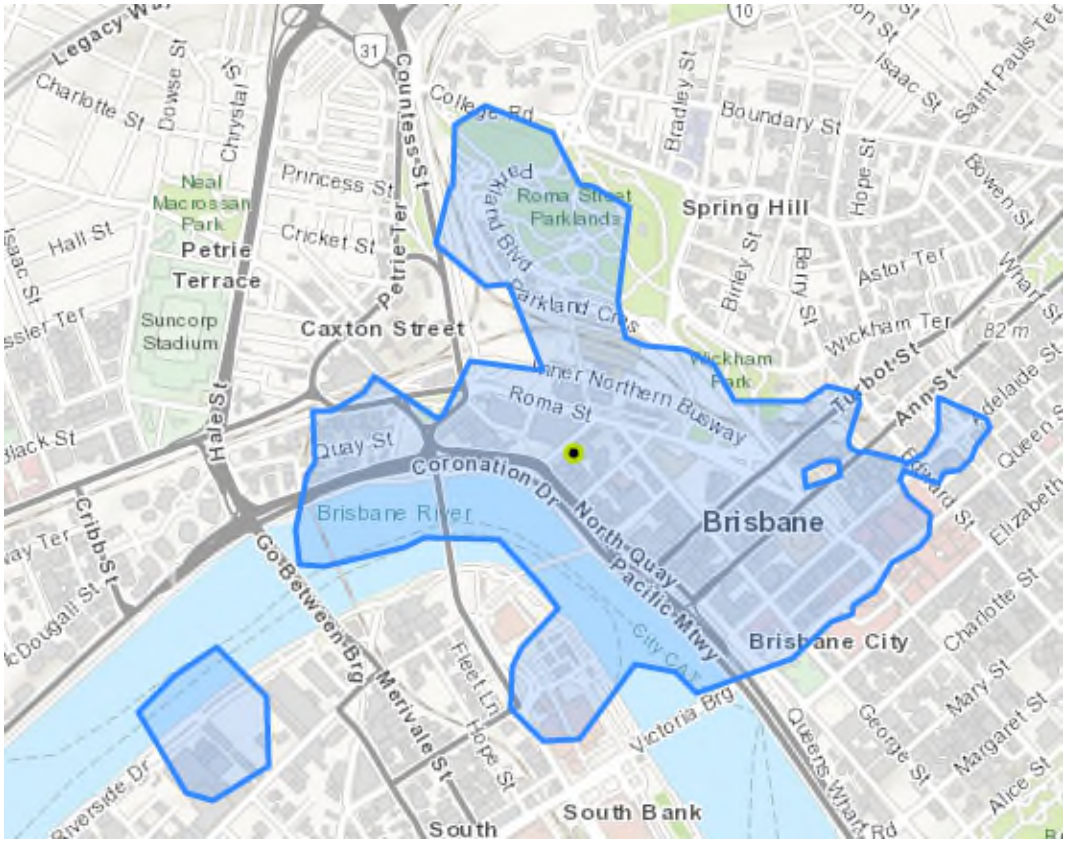

Figure 2 SSMST 11kV Supply Area

A schematic view of the existing substation arrangement is shown in Figure 3 below.

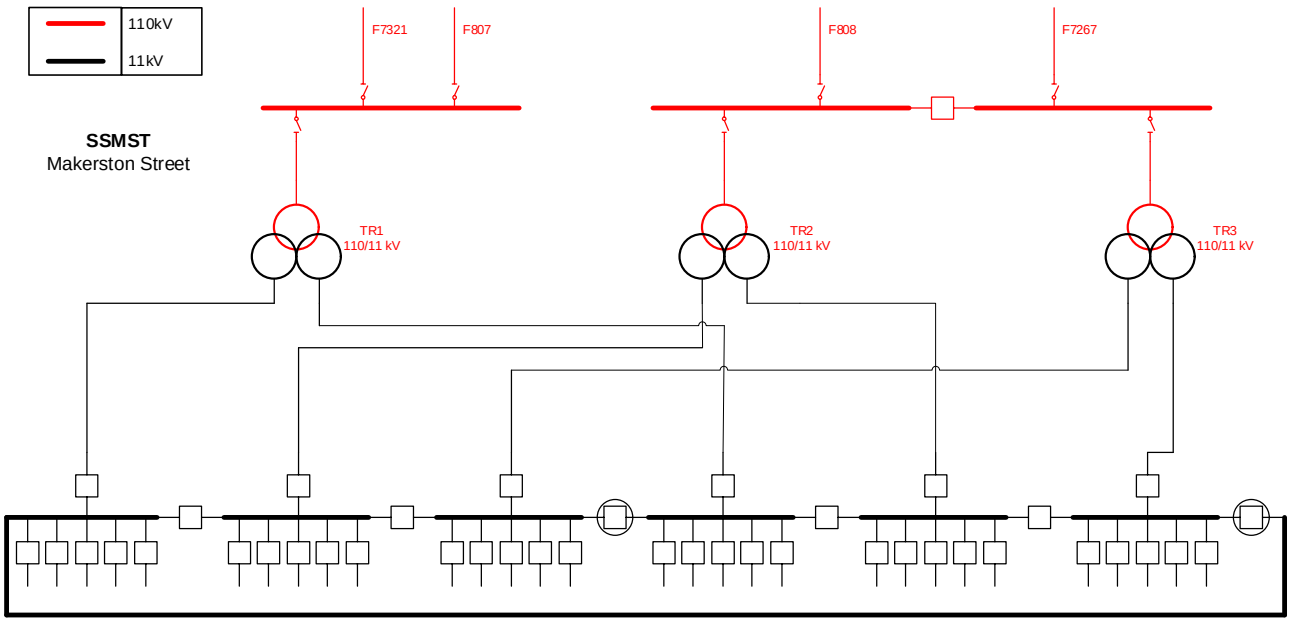

Figure 3: Existing network arrangement (schematic view)

2.2 Asset condition

Energex has identified the following equipment at SSMST are to be retired due to deteriorated conditions.

- 42 x 11kV circuit breakers to be retired by 2031
- 92 x protection relays on the 11kV assets to be retired between 2025 and 2035
- 12 x protection relays on the 110kV assets to be retired by 2032

2.3 Zone substation capacity

Makerston Street Zone Substation (SSMST) is equipped with 3 x 50MVA 110/11kV transformers. The substation capacity is limited by the 11kV transformers, providing NCC, ECC and 2HEC as below:

- Normal Cyclic Capacity (NCC) – 157.3 MVA
- Emergency Cyclic Capacity (ECC) – 114.7 MVA
- 2 Hour Emergency Capacity (2HEC) – 124.2 MVA
- Security Standard Safety Net Constraint – 124.2 MVA

Figure 4 shows the 50% POE load forecast and security standard constraint for SSWED.

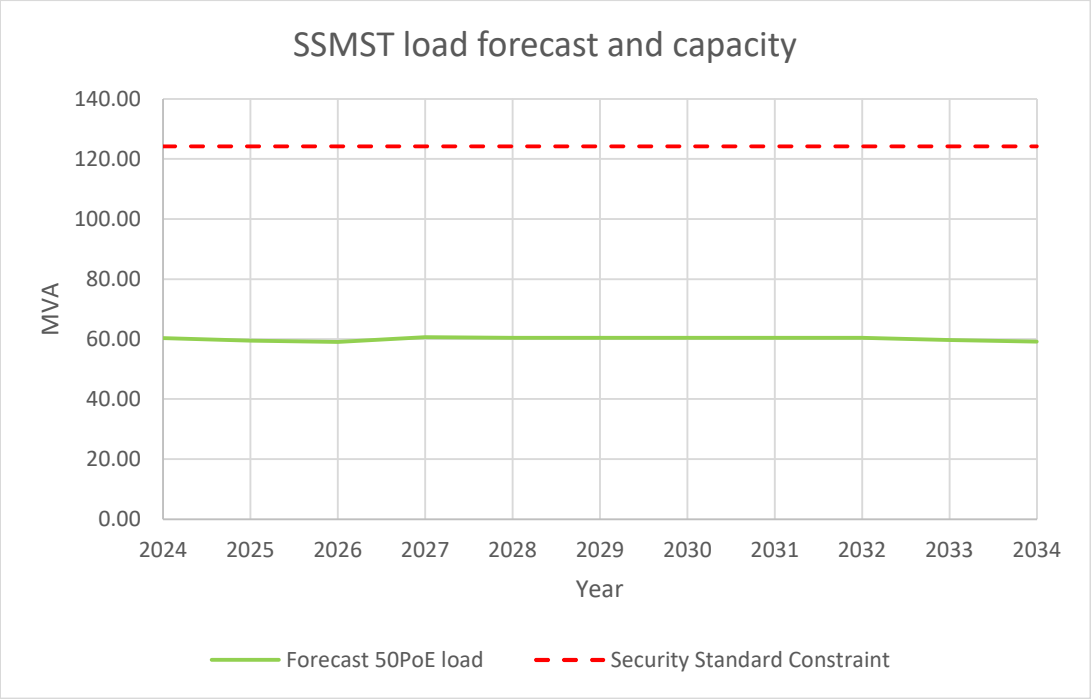

Figure 4: SSMST load forecast and capacity

3 IDENTIFIED NEED

The identified needs are to ensure:

- Risks to health and safety associated with electrical risks at the Makerston Street zone substation is managed in accordance with the WHS Regulation, which is a requirement under Electrical Safety Regulation.
- Electricity supply in the area around Brisbane CBD remains at a reliability level that is expected by the customers. Outages in the CBD could potentially cause major economic and financial disruption.

The ongoing operation of these assets beyond their estimated retirement date presents a significant risk to safety and customer reliability.

3.1 Problem Statement

As SSMST supplies load to the Brisbane CBD, it has a comprehensive 11kV network and associated 11kV switchgear arrangement. The 11kV switchboard at SSMST is 1970 vintage and consists of forty-two oil circuit breakers. An engineering evaluation has determined that this switchgear is due to be retired by 2031.

Continued operation of the switchboard beyond 2031 could result in inability to clear faults, tank rupture or bushing failure, increasing the likelihood of hot oil escaping to the environment or severe injury or fatality if substation crews are in the yard during the failure. Also, failure of the 11kV switchgear has the potential to result in extensive damages to multiple plants in the substation, causing prolonged widespread outages to customers. Accessing the substation under emergency replacement would be very difficult and it is not possible to maintain full supply to customers during the emergency replacement.

Furthermore, in 2032 Brisbane will host the Summer Olympic and Para-Olympic games. SSMST is a key substation supplying major competition venues in the Brisbane CBD. There will be an increased population during the games, as well as worldwide attention. Prolonged outages are unacceptable.

3.2 Counterfactual analysis (Base case)

3.2.1 Summary

Energex broadly considers five value streams for investment. These are shown in Figure 3.

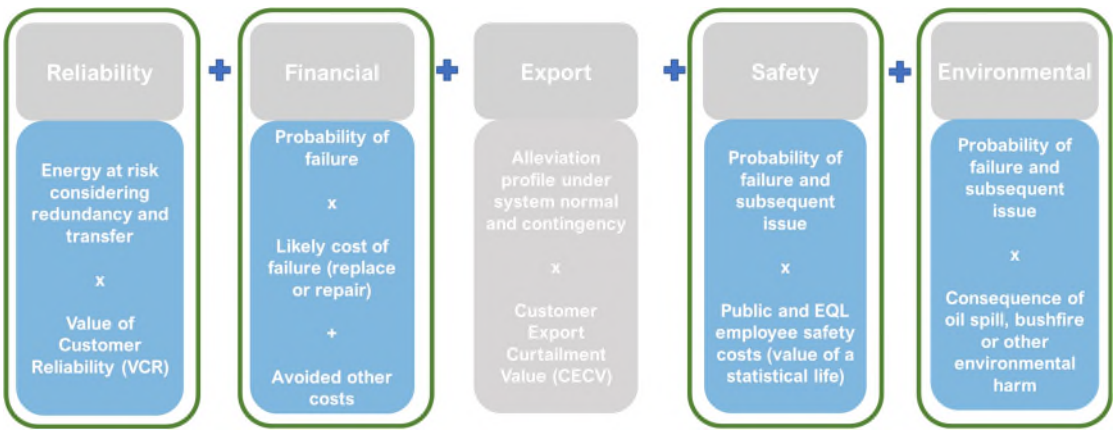

Figure 5 Value Streams for Investment

The four value streams that are relevant to this business case are reliability, financial, safety and environmental.

The counterfactual considers the continued operation of the network with existing assets and has four primary elements for consideration:

- Maintaining substation equipment beyond the recommended retirement year increases the safety risks to substation staff and to the public. e.g. there is an increased chance of catastrophic failure of oil insulated switchgear which could cause severe injuries or a fatality to workers within the substation. Mal-operation of protection relays can lead to unsafe conditions on the network which presents a risk to staff and the public.
- There is potential unserved energy within the supply area following the failure of a circuit breaker. There are radial feeders that are supplied from SSMST, transfers and generators are required to restore supply to these feeders.
- There is potential environment harm if the insulating oil escapes the circuit breaker.
- The emergency replacement cost is much higher than a planned replacement project. Specifically, works at CBD substations needs to be carefully planned and communicated to the community due to restricted space and close proximity to neighbours.

3.2.2 Costs

No costs have been included in the NPV analysis for the counterfactual scenario.

3.2.3 Risk quantifications

For the risk quantification of the counterfactual the following data has been used for a forced outage to the 11kV CBs.

- **11kV CB failure rate** – probability of failure 0.02 / CB in 2030, increasing as equipment ages.
- **Emergency replacement** – the cost is estimated to be $5M per 11kV bus.
- **Transfers** – limited transfers are available on a distribution feeder level, generators will be required to fully restore supply.
- **Restoration** – following an outage, it has been estimated that the restoration of supply would take up to 48 hours.
- **VCR Rate** – a VCR rate of $49.31 / kWh has been used, with the mix of customers weighted towards commercial customers.
- **Risk timeframe** – risks were calculated over a 60-year period, starting from 2030 to align with the investment year of Option 1.

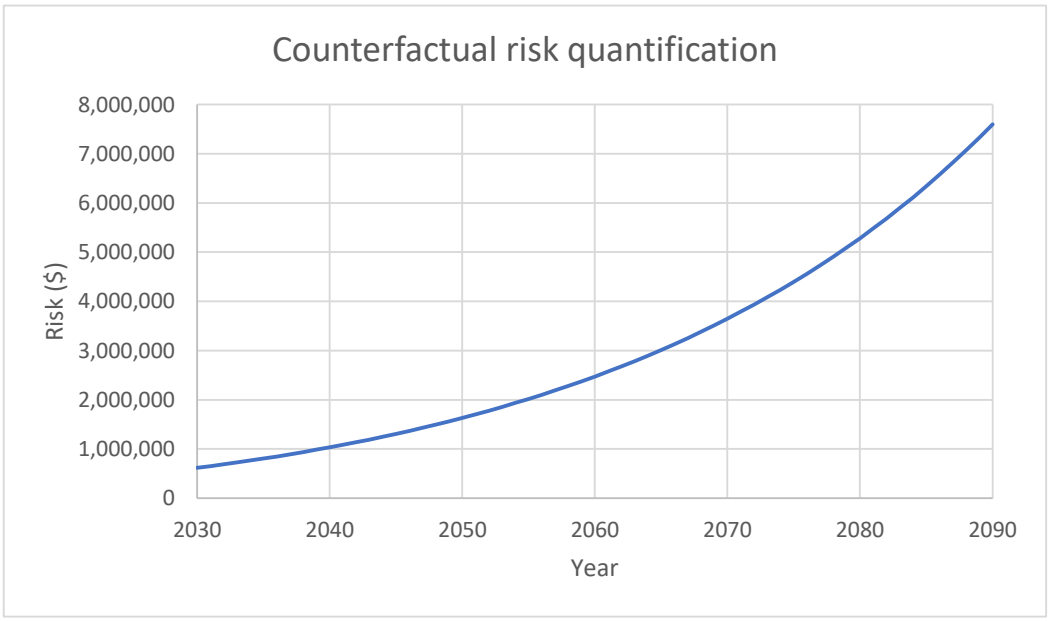

Figure 6 Counterfactual risk

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 considered; the options are:

Option 1: Replace 11kV switchboard and associated equipment at SSMST.

Option 2: Decommission SSMST and transfer all load to adjacent substations. This option has been rejected due to adjacent substations being physically constrained to install additional 11kV circuit breakers and re-routing the underground cables for 42 feeders in the CBD would require substantial road closures and potential business interruptions that are not feasible.

As a result of this process, Energex has identified only a single option that represents a practical alternative to the counter factual to address the network limitations in the required timeframe.

4.1 Option 1

This option involves replacing existing indoor 11kV switchboard with new indoor GIS and associated equipment, as well as upgrading protection scheme to meet current Energex standards. The investment enhances safety for personnel, maintains customer reliability, reduces probability of environmental damage and reduces the inefficient expenditure associated with reactive replacement due to emergency replacement from catastrophic failure of aging plant.

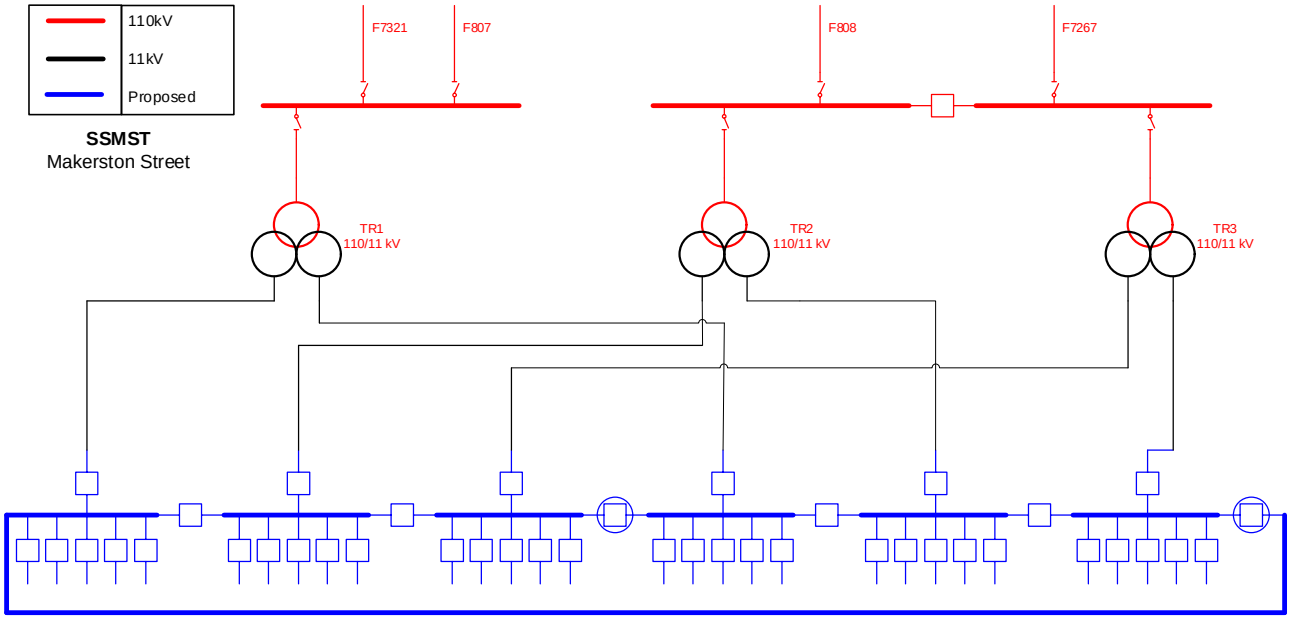

Figure 7 Proposed network arrangement

4.1.1 Costs

The replacement of the 11kV circuit breakers at MST is estimated at $10.552m, which has been factored into the NPV as a cost in 2030.

4.1.2 Benefits

Following the completion of the circuit breakers in 2030, the risk associated with the failure of the circuit breakers decreases in comparison to the counterfactual. The benefits associated with the reduced probability of failure is shown in Figure 4. These benefits have been included in the NPV analysis.

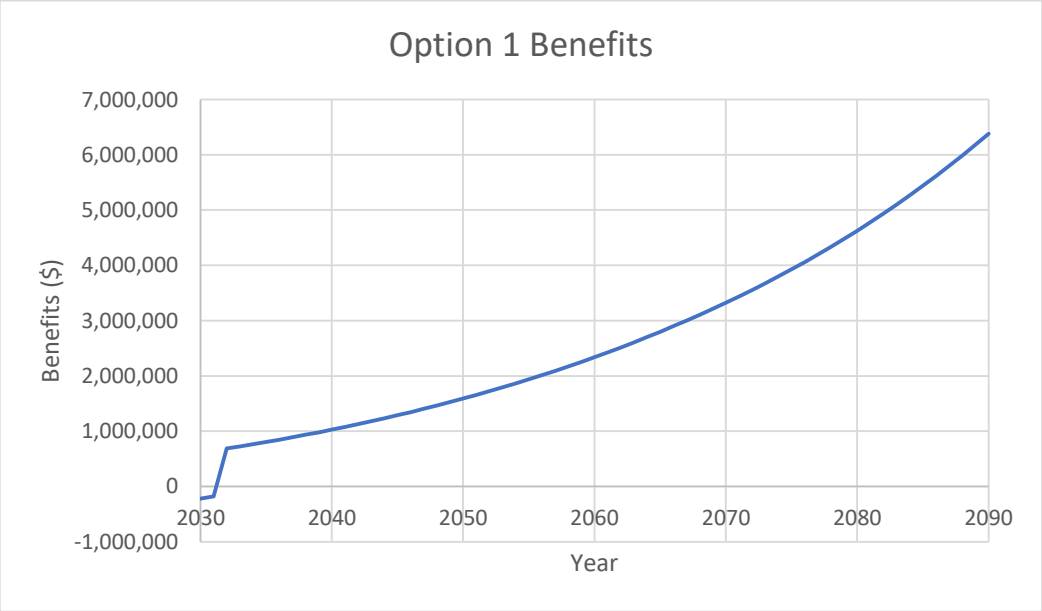

Figure 8 Annual Benefits of Option 1

4.2 Economic Analysis

4.2.1 Cost summary 2025-30

Option 1 is the preferred option and has been estimated at $10.552m based on 2022/23 costings. The forecast expenditure would span over 6 years, the expenditure across the 2025-30 regulatory period is shown in **Table 1**.

Option	2025-26	2026-27	2027-28	2028-29	2029-30	Total 2025-30
Option 1 - Replace 11kV switchboard and associated equipment at SSMST	$0.464m	$0.517m	$3.731m	$2.293m	$1.374m	$8.378m

Table 1 Cost summary 2025-30

4.2.2 NPV analysis

The NPV under the base case is $23.7m, with the Capex and Opex NPV shown in Table 2. The results are based on a discount rate of 3.5%.

Option	Rank	Net NPV	Capex NPV	Opex NPV	Benefits NPV
Option 1 - Replace 11kV switchboard and associated equipment at SSMST	1	$23.747m	-$8.294m	-$0.196m	$32.237m

Table 2 Base Case NPV Analysis

A sensitivity analysis was conducted by changing various inputs in the financial model, the results are shown in Table 3.

Option	Discount rate		Failure rate		Benefits	
	2.5%	4.5%	125%	75%	125%	75%
Option 1 - Replace 11kV switchboard and associated equipment at SSMST	$36.981m	$15.225m	$31.538m	$15.956m	$31.807m	$15.688m

Table 3 NPV Sensitivity Analysis

4.3 Optimal Timing

Due to the Olympics infrastructure construction restrictions, Energex will be unable to undertake any major infrastructure projects between 2030 and 2033, meaning that the optimum timing for this project is by 2030 at the latest to reduce the risk of failure during the Olympic games.

5 RECOMMENDATION

Table 4 Options Analysis Scorecard

Criteria	Option 1 – Replace 11kV Switchgear at MST
Net Present Value	$23.747m
Investment cost	$10.552m
Investment Risk	Medium
Benefits	$32.237m
Delivery time	6 years
Detailed analysis – Benefits	Financial benefits begin at $693k/annum in 2032 increasing to $1.03m/annum by 2040
Detailed analysis – Risks	Delaying this project increases the risk of equipment failure due to keeping ageing assets in service beyond the expected useful service life.
Detailed analysis - Advantages	This option removes aging plant from service, which are prone to failure. This will maintain custom reliability, comply with workplace health and safety requirements, plus also reduces potential environmental contamination risks due to oil leakages.

APPENDICES

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 4.4.1 and Section 4.4.2
6.5.7 (c) (1) (ii) the costs that a prudent operator would require to achieve the capital expenditure objectives	Section 4.4.1 and Section 4.4.2
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 4.4.1 and Section 4.4.2

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	$0.464m	$0.517m	$3.731m	$2.293m	$1.374m	$8.378m