Business Case
Abermain to Amberley Supply Reinforcement

Executive Summary

Amberley zone substation (SSABY) is supplied from Abermain bulk supply substation (SST136) via a 33kV ring network, which also supplies Karrabin zone substation (SSKBN), Marburg zone substation (SSMBG) and Rosewood zone substation (SSRWD). Energex has identified Willowbank, Ebenezer and Amberley areas for future growth and recent discussions with proponents such as Economic Development Queensland suggests that there will be additional load to the forecast coming online in the regulatory control period 2020-25.

Given the growth anticipated, there is expected to be N-1 limitations for the loss of various 33kV feeders in the ring network from 2023/24 onwards plus for a transformer outage at Amberley (ABY), in 2026/27. The interruption of supply in the contingency event of a loss of either a transformer or 33kV feeder would be longer than 30 minutes and as such would breach Energex's requirements under the Service Safety Net Targets. Therefore, capital investment is required.

The counterfactual, 'do nothing' option was considered but rejected as it fails to address the limitations outlined above as load growth in the study area continues. Another option to establish a new 25MVA 33/11kV single modular at Purga was considered but rejected, as there is no space availability at Karrabin zone substation to install another 33kV feeder circuit breaker inside the existing control buildings. Furthermore, there is no spare space to install another control building at SSKBN. Three options for addressing the forecast load growth in the study area were evaluated in this business case:

Option 1 – Establish a new 33kV feeder and install a second transformer at SSABY and 11kV bus

Option 2 – Establish Purga Zone Substation

Option 3 – Establish Plant Overload Protection Schemes (POPS) and defer installation of a new 33kV feeder and a second transformer at SSABY

All options also include the aged based replacement of 110/33kV transformers at Raceview beyond the current regulatory period.

Energex aims to minimise expenditure in order to keep pressure off customer prices, however understands that this must be balanced against critical network performance objectives. These include network risk mitigation (e.g. safety, bushfire), regulatory obligations (e.g. safety), customer reliability and security and preparing the network for the ongoing adoption of new technology by customers (e.g. solar PV). In this business case customer reliability and regulatory obligations are strong drivers, due to the forecast N-1 limitations and potential breaches of Safety Net criteria as load growth continues in the study area.

To this end, Option 1 is the preferred option, as it provides the most cost-effective means of addressing load growth and complying with Safety Net criteria. The option has a Net Present Value (NPV) of -$25.1M.

The direct cost of the program for each submission made to the AER is summarised in the table below. Note that all figures are expressed in 2018/19 dollars and apply only to costs incurred within the 2020-25 regulatory period for the preferred option.

Regulatory Proposal	Draft Determination Allowance	Revised Regulatory Proposal
$8.5M	$0	$8.5M

In response to the draft determination, shedding load manually is not a sufficient response due to the overhead 33kV feeders requiring reductions in load faster than can be achieved through remote control switching. Automatic load shedding through a POPS has been considered as a new option but proves to perform worse, economically, than the proposed option.

Contents

1 Introduction

Amberley zone substation (SSABY) is supplied from Abermain bulk supply substation (SST136) via a 33kV ring network, which also supplies Karrabin zone substation (SSKBN), Marburg zone substation (SSMBG) and Rosewood zone substation (SSRWD). Energex has identified Willowbank, Ebenezer and Amberley areas for future growth, resulting in a N-1 limitation for the loss of a 33kV feeder in the area.

1.1 Purpose of document

This document recommends the optimal capital investment necessary for maintaining Energex's Service Safety Net Targets in the Amberley district.

This is a preliminary business case document and has been developed for the purposes of seeking funding for the required investment in coordination with the Energex Revised Regulatory Proposal to the Australian Energy Regulator (AER) for the 2020-25 regulatory control period. Prior to investment, further detail will be assessed in accordance with the established Energy Queensland (EQL) investment governance processes. The costs presented are in $2018/19 direct dollars.

1.2 Scope of document

This document outlines the proposed works, other options considered, and the risk reductions achieved through the proposed works.

1.3 Identified Need

Energex aims to minimise expenditure in order to keep pressure off customer prices, however understands that this must be balanced against critical network performance objectives. These include network risk mitigation (e.g. safety, bushfire), regulatory obligations (e.g. safety), customer reliability and security and preparing the network for the ongoing adoption of new technology by customers (e.g. solar PV). In this business case customer reliability and regulatory obligations are strong drivers, due to the forecast N-1 limitations and potential breaches of Safety Net criteria as load growth continues in the study area.

Based on the 2018 load forecast, there are expected to be safety net breaches for N-1 outages on the 33kV feeder network, beginning in 2023-24. This would breach Energex's requirements under the Service Safety Net targets, due to the restoration time exceeding 30 minutes, and as such capital investment is required. In addition, an N-1 limitation is expected at SSABY for a loss of a 33/11kV transformer at SSABY, which would also result in the breach of the Service Safety Net Targets.

Economic Development Queensland (EDQ) has proposed an industrial subdivision in the Willowbank area west of Ipswich. Whilst the initial stage of the development only involves 18 lots, the lots range in size from 0.8 to 20 Ha and there is potential for large industrial customers to be located in the area. This is characterised as a 10% probability of a 12MVA block-load coming online in 2023. This would result in N-1 limitations, causing Service Safety Net Target breaches, in 2023.

This proposal aligns with the CAPEX objectives and criteria from the National Electricity Rules as detailed in Appendix C.

1.4 Energy Queensland Strategic Alignment

Table 1 details how the Abermain to Amberley Supply Reinforcement contributes to Energy Queensland's corporate and asset management objectives. The linkages between these Asset Management Objectives and EQL's Corporate Objectives are shown in Appendix D.

Table 1: Asset Function and Strategic Alignment

Objectives	Relationship of Initiative to Objectives
Ensure network safety for staff contractors and the community	Providing additional capacity in the Abermain area will reduce the risk of assets failing in service due to overloading, which can present a safety risk to staff and members of the public.
Meet customer and stakeholder expectations	Through reinforcing the Amberley supply, Energex will be able to meet Safety Net restoration times, increasing the reliability for customers and reducing the risk of extended outages.
Manage risk, performance standards and asset investments to deliver balanced commercial outcomes	The proposed works will ensure Energex meets the Safety Net requirements and, in the process, reduce the risk of extended outages under a credible contingency.
Develop Asset Management capability & align practices to the global standard (ISO55000)	The proposed works have been developed in accordance with established planning standards and systems to align with the asset management standards.
Modernise the network and facilitate access to innovative energy technologies	This project will be subject to consideration through the Regulatory Investment Test for Distribution (RIT-D) process to ensure that suitable non-network innovative solutions are considered.

1.5 Applicable service levels

Corporate performance outcomes for this asset are rolled up into Asset Safety & Performance group objectives, principally the following Key Result Areas (KRA):

- Customer Index, relating to Customer satisfaction with respect to delivery of expected services
- Optimise investments to deliver affordable & sustainable asset solutions for our customers and communities

Under the Distribution Authorities, EQL is expected to operate with an 'economic' customer value-based approach to reliability, with "Safety Net measures" for extreme circumstances. Safety Net measures are intended to mitigate against the risk of low probability vs high consequence network outages. Safety Net targets are described in terms of the number of times a benchmark volume of energy is undelivered for more than a specific time period. A table of safety net obligations can be found in Appendix F. EQL is expected to employ all reasonable measures to ensure it does not exceed minimum service standards (MSS) for reliability, assessed by feeder types as

- System Average Interruption Duration Index (SAIDI), and;
- System Average Interruption Frequency Index (SAIFI).

Both Safety Net and MSS performance information are publicly reported annually in the Distribution Annual Planning Reports (DAPR). MSS performance is monitored and reported within EQL daily.

As per the Safety net standard, for sub-transmission lines supplying non-urban zone substations, during a single contingency event (Customer Outcome Standard Category: Rural), interruption of supply up to 40MVA is permissible for the first 30 minutes, followed by a maximum interruption of up to 15MVA, provided all load except for up to 10MVA can be restored within 4 hours, and the remaining load fully restored after 12 hours. Refer Appendix F.

1.6 Compliance obligations

Table 2 shows the relevant compliance obligations for this proposal.

Table 2: Compliance obligations related to this proposal

Legislation, Regulation, Code or Licence Condition	Obligations	Relevance to this investment
QLD Electrical Safety Act 2002 **QLD Electrical Safety Regulation 2013**	We have a duty of care, ensuring so far as is reasonably practicable, the health and safety of our staff and other parties as follows: • Pursuant to the Electrical Safety Act 2002, as a person in control of a business or undertaking (PCBU), EQL has an obligation to ensure that its works are electrically safe and are operated in a way that is electrically safe.[1] This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work.[2]	This proposal ensures the provision of an acceptable quality and reliability of supply of existing and new customers in the next regulatory period, by providing additional capacity in the Abermain area to meet load growth.
Distribution Authority for Energex issued under section 195 of *Electricity Act 1994* (Queensland)	Under its Distribution Authority: • The distribution entity 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 of electricity services. • The distribution entity will ensure, to the extent reasonably practicable, that it achieves its safety net targets as specified. • The distribution entity must use all reasonable endeavours to ensure that it does not exceed in a financial year the Minimum Service Standards (MSS)	This proposal outlines the limitations of the current system in a credible contingency event under the forecast load growth and addresses the need to meet the Safety Net requirements through sufficient N-1 supply reinforcement.
National Electricity Rules, Chapter 5	Schedule S5.1 of the National Electricity Rules, Chapter 5 provides a range of obligations on Network Services Providers relating to Network Performance Requirements. These include: • Section S5.1.9 Protection systems and fault clearance times • Section S5.1a.8 Fault Clearance Times • Section S5.1.2 Credible Contingency Events	This proposal ensures the reliability of service in the Abermain area under the credible contingency event of the loss of a transformer at a zone substation.

[1] Section 29, *Electrical Safety Act 2002*
[2] Section 30 *Electrical Safety Act 2002*

1.7 Limitation of existing assets

Amberley zone substation (SSABY) is supplied from Abermain bulk supply substation (SST136) via a 33kV ring network, which also supplies Karrabin zone substation (SSKBN), Marburg zone substation (SSMBG) and Rosewood zone substation (SSRWD). This existing arrangement is shown in Figure 1. A schematic diagram is shown in Figure 2 on page 6.

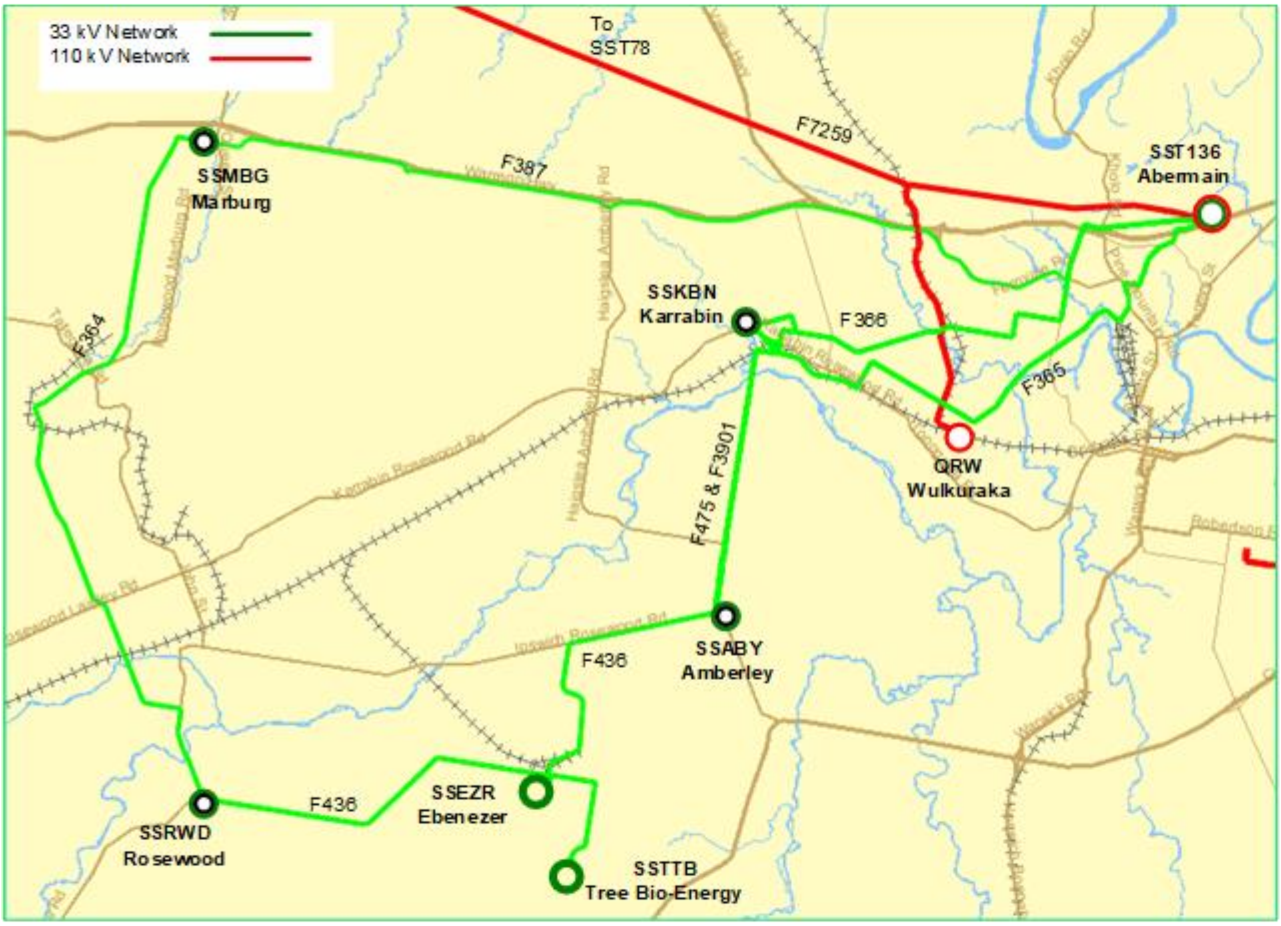

Figure 1: Existing Network Arrangement (Geographic View)

A number of substation and sub-transmission limitations have been identified for the 2020-2025 regulatory control period and are outlined below.

Sub-transmission Network Limitations

The following limitations have been identified for the 33kV feeder network in the study area, refer Table 16, Appendix H:

- The 50% POE load on F365 (Abermain Bulk Supply to Karrabin) is forecast to exceed 2HEC in summer 2023/2024 for F366 out of service.
- The 50% POE load on F366 (Abermain Bulk Supply to Karrabin) is forecast to exceed 2HEC in summer 2023/2024 for F365 out of service.
- The 50% POE load on F364 (Marburg to Rosewood) is forecast to exceed 2HEC in summer 2025/2026 for F365/ F366 out of service.
- The 50% POE load on F387 (Abermain Bulk Supply to Marburg) is forecast to exceed 2HEC in summer 2026/2027 for F365/ F366 out of service.

While the load can be fully restored following manual transfers and through the provision of emergency generation, these transfers cannot be carried out fast enough to avoid loss of the feeders.

A breach of the 2HEC rating would require the reduction of the load to below the 2HEC rating within 1-2 minutes to avoid overheating of the conductor.

Energex considers that a network operator would not be able to manually shed customer load in the time required, particularly where any outage is caused during a storm event. As a result, it would be necessary for the operator to trip the entire 33kV network to meet this timeframe. An alternative to manually shedding the 33kV network is for an automatic shedding scheme to be established and this is considered as one of the feasible options below.

By virtue of the need to trip the feeders immediately on loss of one feeder, a safety net breach arises – for example, by 2023/24 for an outage of F365, F366 is over its 2-hour rating and the load tripped will be 827A or 47MVA (above the 40MVA safety net limit).

Substation Limitations

SSABY is equipped with 1 x 25MVA 33/11kV transformer. The substation capacity is limited by the transformer and the following parameters:

- Normal Cyclic Capacity (NCC) – 26.3 MVA
- Emergency Cyclic Capacity (ECC) – 0 MVA
- Two (2) Hour Emergency Capacity (2HEC) – 0 MVA

Based on the current load forecast (excluding Economic Development Queensland load), Table 3, Energex has an N-1 limitation for Service Safety Net Target breaches in the case of the loss of a transformer at ABY in Oct 2026. This arises because it is a single transformer site, and the maximum manual 11kV transfers plus mobile generation capacity is exceeded by 2026/27, leaving unsupplied load for a long period – until a spare transformer could be installed. The generation estimate of 10MVA in this case is optimistic – it is unlikely that this capacity could be readily sourced and installed in a reasonable timeframe, so a further safety breach is likely at an earlier date.

There is potential for large industrial customers to be located in the area, due to the proposed Economic Development Queensland industrial subdivision. This is characterised as a 10% probability of a 12MVA block-load coming online in 2023. This would result in N-1 limitations, causing Service Safety Net Target breaches, in 2023.

The remaining substations in the network area, Karrabin, Rosewood and Marburg zone substations do not have any limitations within the study period.

Table 3: SSABY Load At Risk – Current Load Forecast

Plant OOS	Year	50% POE Load (MVA)	Summer ECC (MVA)	Summer 2HEC (MVA)	Auto transfers available (MVA)	Remote transfers available (MVA)	Manual transfers available (MVA)	Mobile generation required (MVA)	Load At Risk excl EDQ (MVA)
TR1 or TR2	2020	3.9	0.0	0.0	0.0	0.0	2.7	10.0	
	2021	5.0	0.0	0.0	0.0	0.0	2.7	10.0	
	2022	7.3	0.0	0.0	0.0	0.0	2.7	10.0	
	2023	9.1	0.0	0.0	0.0	0.0	2.7	10.0	
	2024	10.2	0.0	0.0	0.0	0.0	2.7	10.0	
	2025	11.1	0.0	0.0	0.0	0.0	2.7	10.0	
	2026	12.0	0.0	0.0	0.0	0.0	2.7	10.0	
	2027	12.9	0.0	0.0	0.0	0.0	2.7	10.0	0.2
	2028	13.9	0.0	0.0	0.0	0.0	2.7	10.0	1.2

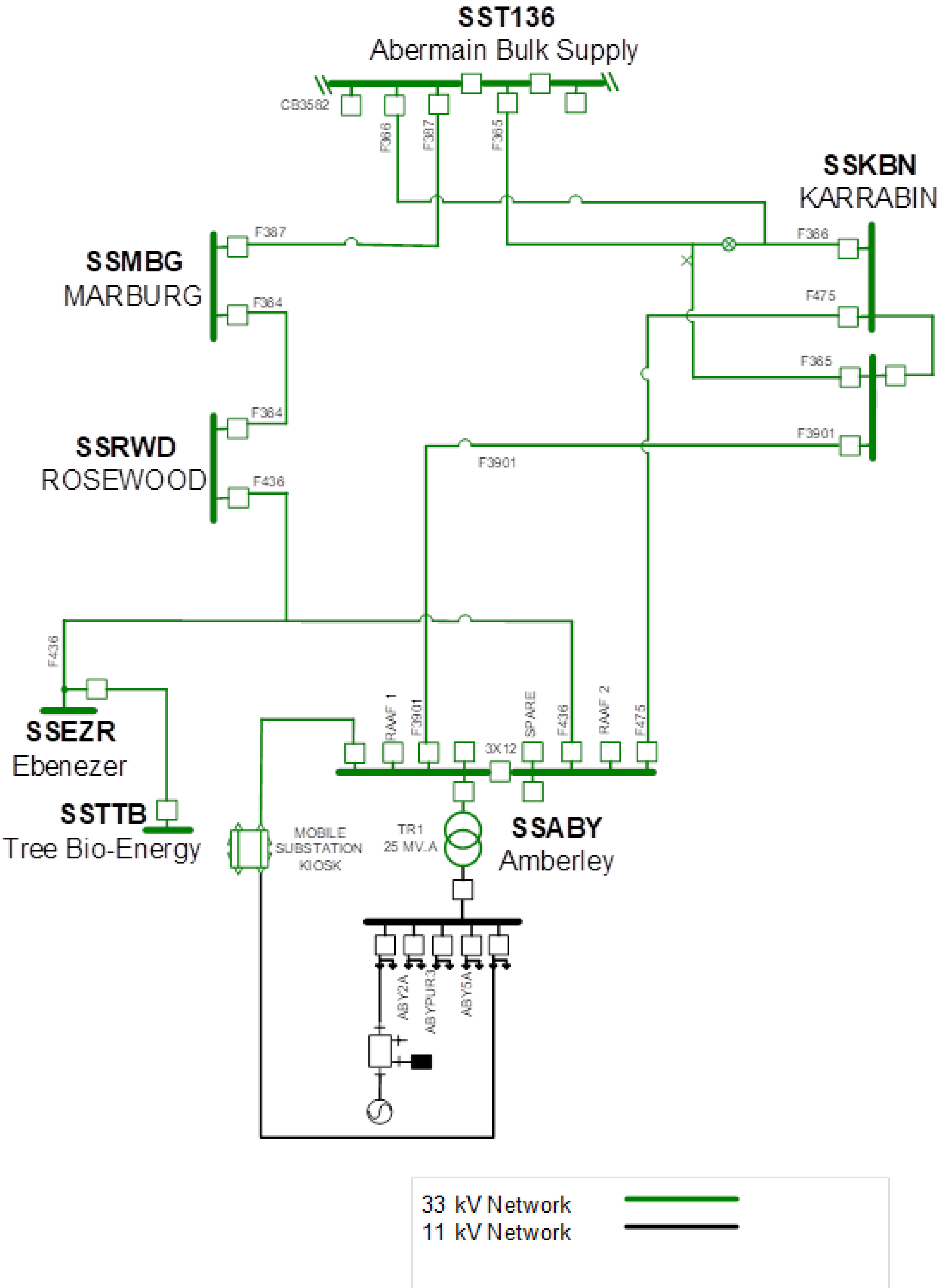

Figure 2: Existing Network Arrangement Schematic

2 Counterfactual Analysis

2.1 Purpose of asset

The Abermain and Amberley substations supply over 24,000 customers in total, a mix of domestic and C&I. In additional the Royal Australian Air Force (RAAF) Base at Amberley is supplied from SSABY.

2.2 Business-as-usual service costs

The business as usual (BAU) service costs for these assets are the operational costs associated with ongoing operations. In addition to these costs, significant emergency response and replacement costs would be incurred for the counterfactual BAU case in the event that failure of the transformer at ABY occurs or that assets become overloaded due to demand growth. These are not explicitly costed in this case; however, it is noted that there are significant safety, reliability and compliance risks associated with asset failures.

2.3 Key assumptions

The expected risks and outcomes of the counterfactual case are based on the existing load forecast. If the development at Willowbank does indeed increase the projected demand, it is expected that the risk likelihood will increase at a faster rate as limitations will occur sooner.

In the counterfactual, the identified limitations are not addressed, and the risks outlined in Section 2.4 will not be resolved. Specifically:

- During a single contingency event, interruption of supply for an outage of F364, F365, F366, F387 or F3901/F475 will exceed 30 mins, breaching the Safety Net outlined in Energex's Distribution Authority.
- A moderate Customer Impact Risk for adverse regional media attention or the loss of a single large customer.
- During a single contingency event, interruption of supply for an outage of TR1 at SSABY more than 10MVA of load will be without supply after three hours, breaching the Safety Net outlined in Energex's Distribution Authority.

As such, Energex considers that the counterfactual is an unacceptable solution for the identified limitations.

2.4 Risk assessment

This risk assessment is in accordance with the EQL Network Risk Framework and the Risk Tolerability table from the framework is shown in Appendix E.

Table 4: Counterfactual risk assessment

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Outage of 33kV feeder between SST136 and SSKBN F365/366, resultant load on F366/365 exceeds feeder thermal capacity, **shed up to 5,000 customers**.	Customer	3 *(interruption to 5,000 customers)*	3 *(Unlikely)*	**9** ***(Low)***	2023

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Without augmenting the network, the Safety Net legislated requirement as part of the Distribution Authority is not met, resulting in the regulator to be notified and **improvement notice issued by regulator**.	Legislated	4 *(improvement notice issued by regulator)*	3 *(Unlikely)*	**12** ***(Moderate)***	2023
Fault on TR1 at SSABY results in **total loss of supply of substation load for more than 12 hours** affecting more than 100 customers until mobile transformers and Mobile Plant are able to restore all supply.	Customer	2 *(interruption >3 hours)*	3 *(Unlikely)*	**6** ***(Low)***	2026

Further details of the risk ratings and descriptions can be found in Energy Queensland's Network Risk Framework.

While the risks represented are considered to be Moderate under the Energy Queensland Network Risk Framework; Energex does not consider this risk to be reduced to a level "as low as reasonably practicable". Critically, there will be clear compliance breaches in relation to the Service Safety Net Targets as prescribed under Energex's Distribution Authority.

2.5 Retirement or de-rating decision

Retirement or de-rating of the assets would result in immediate N-1 limitations and a breach of the Safety Net requirements and as such is not a viable option. Retiring a 33kV feeder would leave the connected substations without supply and in the case of SSABY, the retirement of the single transformer would render the substation obsolete.

3 Options Analysis

3.1 Options considered but rejected

The option to establish a new 25MVA 33/11kV single modular at Purga was considered. This option included:

- Cut in 33kV feeder 3972 (Yamanto YMT – Flinders FDS) into Purga (Single Circuit (SCCT) overhead 1.5 km)
- Establish a single modular substation at Purga supplied from Abermain Bulk Supply.
- Build 7kms of SCCT overhead 33kV feeder from SSKBN to Purga.
- Plant Overload Protection Schemes (POPS) and auto changeover at Purga for 33 kV auto contingency to Raceview for loss of either feeder F3901 or F475, F365 or F366.
- Re-conductor 33kV feeder F387 and F364 to Pluto.

This option was not considered feasible as there is no space availability at Karrabin zone substation to install another 33kV feeder circuit breaker inside the existing control buildings. Furthermore, there is no spare space to install another control building at SSKBN.

3.2 Identified options

3.2.1 Network options

Option 1: Establish a new 33kV feeder and install the 2nd transformer at SSABY and 11kV bus.

The proposed schematic is shown in Figure 3.

This option involves establishing a new 33kV feeder from T136 to SSABY in October 2023:

- Establishing approximately 16km of new 33kV overhead SCCT construction
- Termination to spare circuit breaker (CBSPARE22) at SSABY
- Termination to spare 33kV CB3582 at T136.

This option also involves installing the 2nd transformer and 11kV bus at SSABY in Oct 2025 which comprises of:

- a new 25 MVA 33/11 kV transformer (TR12) and neutral earthing reactor (NEX).
- a new 11kV switchgear building with 1 x 11kV transformer Circuit-Breaker (CB), 5 x 11kV feeder CBs and 1 x 11kV bus tie CB.
- a new 315kVA station service transformer.
- a new 6.6 MVAR, 12kV standard capacitor bank.

The new 33 kV feeder will mitigate the load at risk for the loss of F365, F366, F364, F387, F475 or F3901. The 2nd transformer and 11kV switchgear at SSABY will mitigate the Residual Load At Risk (RLAR) for the loss of a transformer at SSABY. The work undertaken in each of these scope items is made up of different work groups and types, meaning that there would be limited efficiencies from doing the work as a single project. Furthermore, separating this work into two projects allows Energex the opportunity to assess the load growth in the area before investing in the network. Further economic analysis can be found in Section 7.2.

The direct capital cost for the new 33kV feeder plus the second transformer at SSABY have estimated direct costs of $5,543,397 and $3,025,000. It should be noted that these costs have been built from Energex's standard estimates which have been used for options analysis purposes and are accurate to +-50%.

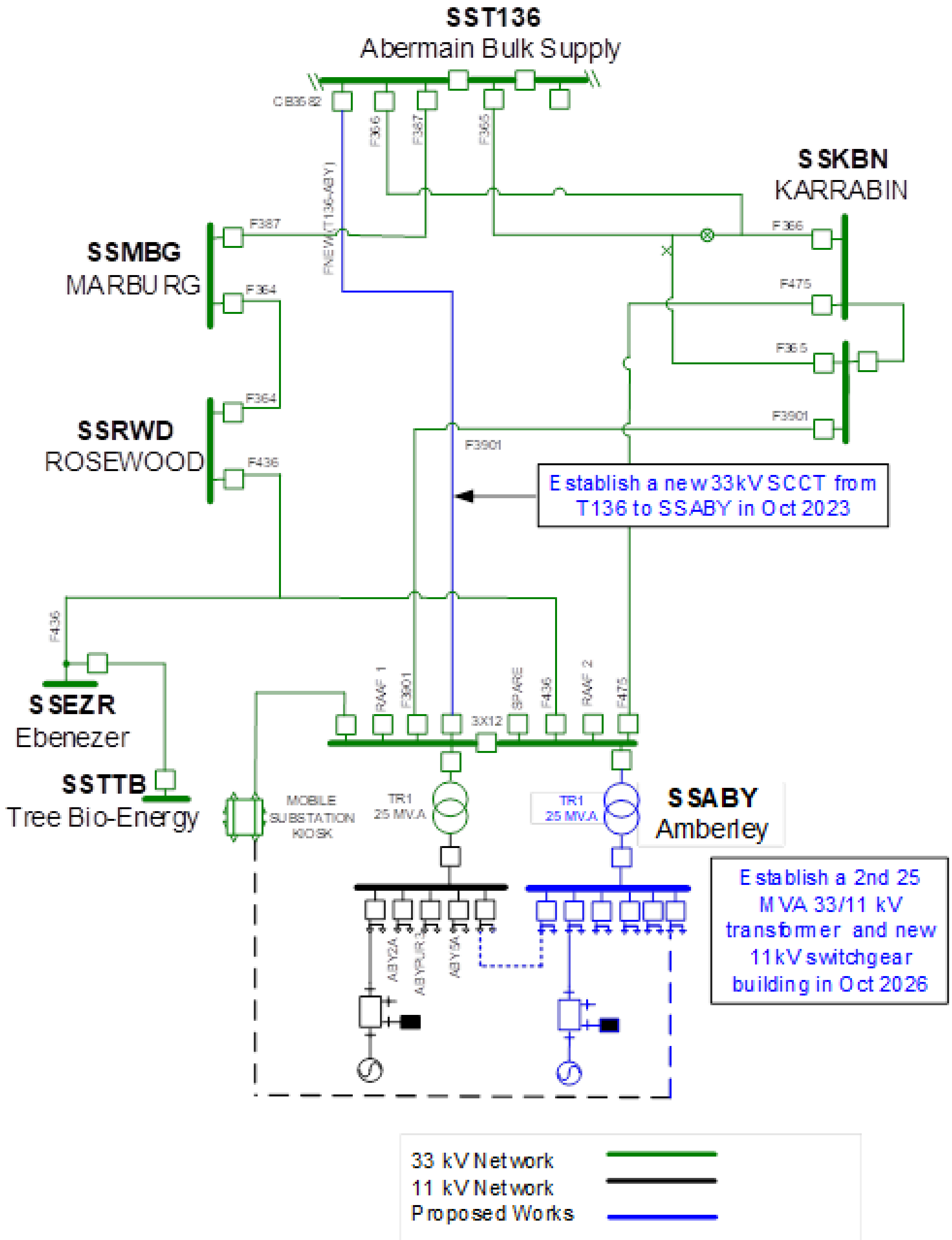

Figure 3: Option 1 Proposed Network Arrangement Schematic

Related Future Projects

October 2028 (End of life of transformers at Raceview Bulk Supply) – Replace 2 x 60 MVA 110/33kV transformers TR14236 & 14237 at Raceview Bulk Supply with 2 x 80 MVA 110/33kV transformers as they are reaching their end of life in 2028.

Option 2: Establish Purga Zone Substation

This option establishes a new zone substation at Purga in October 2023 to transfer load from Amberley zone substation to reduce the capacity constraints on the 33kV feeder network supplying Amberley and it also addresses the N-1 limitation at Amberley zone substation. The proposed schematic is shown in Figure 4. The works required under this option include:

- Establish a 1 x 25MVA 33/11kV single modular substation at Purga supplied from Raceview Bulk Supply.
- Build approximately 1km 33kV overhead SCCT feeder from Purga to cut into 33kV feeder 3972 (Yamanto zone substation – Flinders zone substation).
- Build 3.5kms of 33kV underground SCCT feeder from Yamanto zone substation – Ipswich South zone substation.
- Reconfigure the existing 33 kV network to create a three-ended feeder F3972.

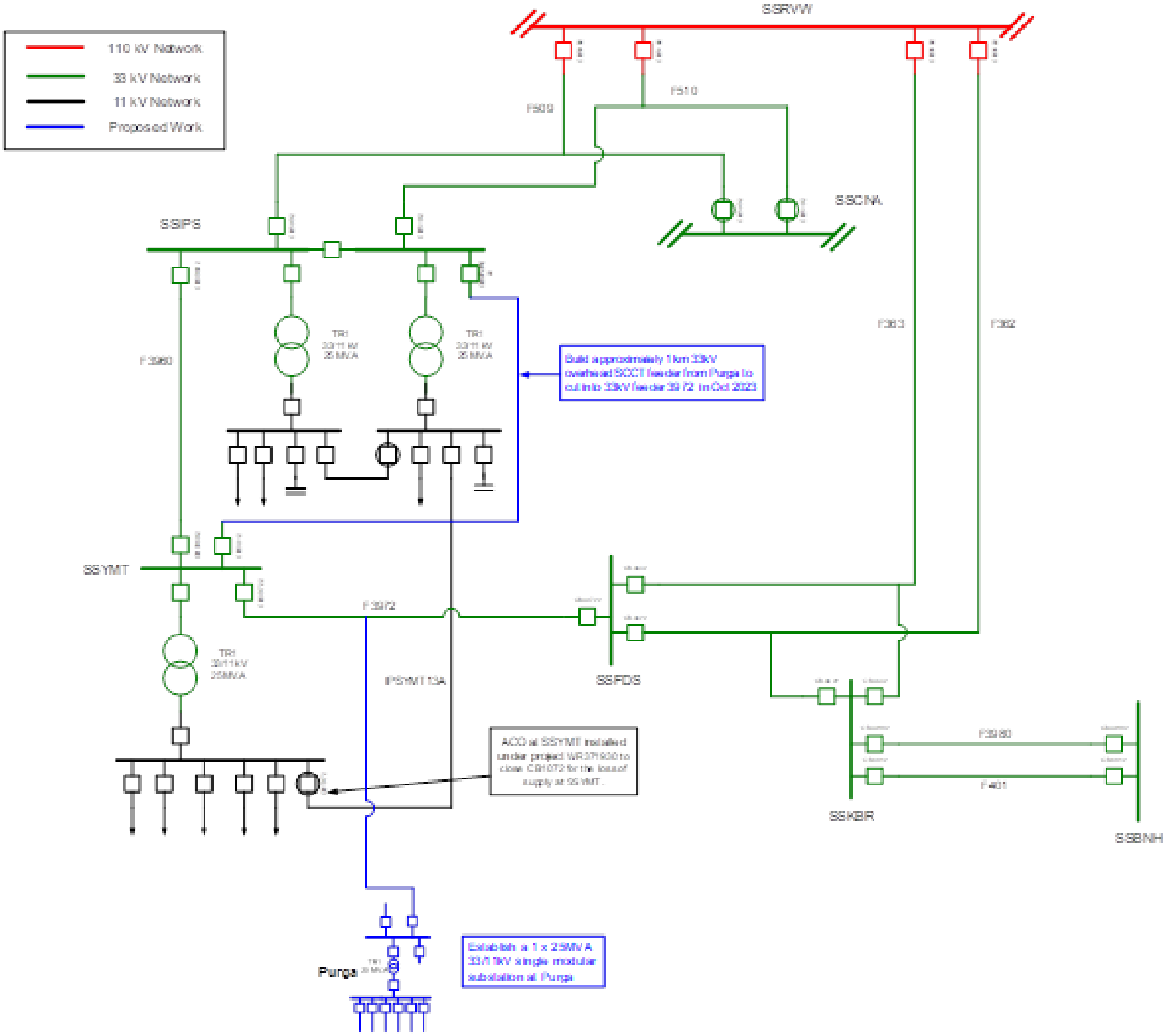

Figure 4: Option 2 Proposed Network Arrangement Schematic

The direct cost for development of the zone substation at Purga (including land establishment) is estimated at $6.5M.

Related Future Projects

To provide reliable supply to future load growth for Amberley, Ebenezer and Willowbank areas under this option:

- Oct 2025 – Replace 2 x 60MVA 110/33kV transformers with 2 x 80 MVA transformers at Raceview Bulk Supply. This will increase the substation capacity at Raceview Bulk Supply. This project is required due to the N-1 limitation at Raceview Bulk Supply for loss of a transformer; this is because Purga Zone Substation will be supplied by Raceview bulk supply and thus will put additional load on Raceview Bulk Supply Substation.
- October 2027 – Establish a 2nd 25 MVA 33/11kV transformer at Purga and install 4km of 33kV overhead SCCT feeder from Purga to Amberley zone substation. This is required to address the N-1 limitation on F365, F366 for loss of a 33kV feeder by transferring additional loads from SSABY to Purga Zone substation.

Option 3: Establish Plant Overload Protection Schemes (POPS) and defer installation of a new 33kV feeder and a second transformer at SSABY

There is potential to implement a series of Plant Overload Protection Schemes (POPS) schemes over time that are capable of shedding enough load to avoid tripping the entire system when the 2HEC rating is exceeded. It should be noted that for any automatic shedding scheme to be effective, there will need to be sufficient 11kV load such that enough load is shed to reduce the load below the 2-hour emergency rating. On this network, SSMBG and SSRWD only supplies 4MVA and 5MVA respectively. Furthermore, there are 2-hour breaches on each of the 33kV feeders in the network out to 2026, which will require communications between substations to enable load shedding to occur in an orderly way for each constraint.

As such, to simplify the automatic shedding scheme proposed in Option 3, when a limit is reached each feeder will be monitored and load shedding restricted to either SSKBN or SSABY given they are the only two substations with sufficient load to be shed to remove the 2-hour breach following a contingency.

It should be noted that due to the limit being caused by an overload on a 33kV feeder which will damage the asset and pose a safety and clearance issue on the feeder, direct, high-speed communications are required between these substations. Furthermore, where a third-party owns and operates the communications path, Energex will not be able to ensure that the line is available when required. As such, a third-party communications line is not suitable for this application.

The scope for this option is:

- 2023 – POPS for overload of F365/F366 for loss of either, shed locally at SSKBN.
- 2025 – Establish POPS for overload of F364 for loss of F365/F366. This option requires the establishment of a communications path between SST136, SSKBN, SSRWD and SSMBG to check and shed at SSKBN, specifically.
    - Install fibre between SSKBN and North Ipswich substation to enable a new communications pathway between SSKBN and the remaining substations in the ring. More details on the communications network in the area and the full scope of works required for Option 3 is available in Appendix I.
- 2025 - install the 2nd transformer and 11kV bus at SSABY

The direct cost associated with the POPS for overload of F365/F366 in 2023 is estimated at $70,000, and the direct cost for establishing POPS for overload of F364 for loss of F365/F366 is estimated at $1,407,888.

Related Future Projects

- 2027 – POPS for overload of F475/F3901 for loss of either, shed locally at SSABY
- 2028 - (End of life of transformers at Raceview Bulk Supply) – Replace 2 x 60 MVA 110/33kV transformers TR14236 & 14237 at Raceview Bulk Supply with 2 x 80 MVA 110/33kV transformers as they are reaching their end of life in 2028.
- 2030 – New feeder SSABM-SSABY as the load has increased beyond the safety net threshold (resultant loss of more than 10MVA for longer than 3 hours)

3.2.2 Non-network options

Energy Queensland is committed to the implementation of Non-Network Solutions to reduce the scope or need for traditional network investments. Our approach to Demand Management is listed in Chapter 7 of our Distribution Annual Planning Report which involves early market engagement around emerging constraints as well as effective use of existing mechanisms such as the Demand Side Engagement Strategy and Regulatory Investment Test for Distribution (RIT-D). We see that the increasing penetration and improving functionality of customer energy technology, such as embedded generation, Battery Storage Systems and Energy Management Systems, have the potential to present a range of new non-network options into the future.

The primary investment driver for this project is Augex, supporting customer growth and network security. A successful Non-Network Solution will be able to assist in reducing the scope or timing for this project. As the cost of options considered as part of this report is greater than $6M this investment will be subject to RIT-D as a mechanism for customer and market engagement on solutions to explore further opportunities.

The customer base in the study area is predominantly new commercial/industrial and has a medium opportunity to reduce demand or provide economic non-network solutions. While the initial load at risk (for a 33kV feeder out of service) is relatively low at 0.5MVA, this increases considerably over the regulatory period. Energex anticipate that a deferral of the project is possible, however it is likely that the feeder would be required during the 2020-25 regulatory control period. RIT-D for the project to install the 2nd transformer and 11kV bus at SSABY is likely to be conducted at the same time as the RIT-D for the project to establish a new 33kV SCCT from SST136 to SSABY, as the non-network solutions to reduce load on the 33kV network might also help in deferring the limitation at SSABY zone substation.

Expenditure for the proposed project has been modelled as CAPEX and included in the forecast for the next regulatory control period. Funding of any successfully identified Non-network alternative solutions will be treated as an efficient OPEX/CAPEX trade-off, consistent with existing regulatory arrangements.

It should be noted that depending on the outcome of the first RIT-D, Energex may undertake a further RIT-D process for the establishment of the 2nd transformer at SSABY if a network investment has already been undertaken for the new 33kV feeder from SST136 to SSABY.

3.3 Economic analysis of identified options

3.3.1 Cost versus benefit assessment of each option

The Net Present Value (NPV) of each option has been determined by considering costs and benefits over the program lifetime from FY2020/21 to FY2059/60, discounted at the Regulated Real Pre-Tax Weighted Average Cost of Capital (WACC) rate of 2.62%, using EQL's standard NPV analysis tool. The analysis demonstrates that Option 1 represents the lowest cost network option in the mean demand forecast scenario.

Table 5: NPV analysis for forecast demand scenario

Option Name	Rank	Discounted Results ($000s)		
		Net NPV	CAPEX PV	OPEX PV
1 Establish a new 33kV feeder and install the 2nd transformer at SSABY and 11kV bus	1	**-25,066**	-23,387	-1,679
2 Establish Purga zone substation	3	**-30,933**	-28,705	-2,228
3 Establish POPS and defer installation of a new 33kV feeder and a second transformer at SSABY	2	**-25,423**	-23,744	-1,679

3.4 Scenario Analysis

3.4.1 Sensitivities

Since the proposed works are driven by capacity limitations, resulting in breaches of Safety Net requirements, the options are sensitive to the growth rate of the load. Several alternative scenarios have been considered.

Low Growth

A scenario with half the expected growth rate for the Ebenezer industrial area, 0.5MVA/year, is considered to have a 20% chance of occurring. Under such a scenario, the requirement for a new feeder in Option 3 (POPS) would be pushed back to 2035. In Options 1 and 2, the initial requirement for the new feeder could be pushed back by 2 years in each case. The resulting NPVs are shown in Table 6.

Table 6: Options NPV analysis for low growth scenario

Option Name	Rank	Discounted Results ($000s)		
		Net NPV	CAPEX PV	OPEX PV
1 Establish a new 33kV feeder and install the 2nd transformer at SSABY and 11kV bus	2	**-24,577**	-22,899	-1,679
2 Establish Purga zone substation	3	**-29,512**	-27,284	-2,228
3 Establish POPS and defer installation of a new 33kV feeder and a second transformer at SSABY	1	**-24,395**	-22,716	-1,679

While this shows a slight preference for Option 1, in terms of NPV, the difference between Option 1 and Option 3 is not significant (less than 1%).

Additional Block Load

Recent discussions with EDQ have highlighted a strong chance of a large block load in the area, with options for new large industrial customers as well as other customers potentially relocating from other parts of the Energex network. This block load has been estimated at 12MVA. Discussion for new customers has ranged from 5-20MVA, while the existing customers load that may be relocated are in the vicinity of 12MVA allowing for expansion, coming online around 2023. While this scenario has only been estimated as a 10% chance of occurring, Energex views development in the Willowbank area as more likely than this over the medium term. The load at risk in such a scenario is shown in Table 7.

Table 7: EDQ Load Scenario Load At Risk - SSABY

Plant OOS	Year	50% POE Load (Incl. EDQ) (MVA)	Manual transfers available (MVA)	Mobile generation required (MVA)	Load at risk incl EDQ (MVA)
TR1 or TR2	2020	3.9	2.7	10.0	
	2021	5.0	2.7	10.0	
	2022	7.3	2.7	10.0	
	2023	21.1	2.7	10.0	8.4
	2024	22.2	2.7	10.0	9.5
	2025	23.1	2.7	10.0	10.4
	2026	24.0	2.7	10.0	11.3
	2027	24.9	2.7	10.0	12.2
	2028	25.9	2.7	10.0	13.2

Such a scenario would require the immediate building of the new feeder for when the new load connects in 2023, making the installation of POPS in Option 3 obsolete. The resulting NPVs are shown in Table 8.

Table 8: Options NPV analysis for block load scenario

Option Name	Rank	Discounted Results ($000s)		
		Net NPV	CAPEX PV	OPEX PV
1 Establish a new 33kV feeder and install the 2nd transformer at SSABY and 11kV bus	1	**-26,040**	-24,361	-1,679
2 Establish Purga zone substation	3	**-30,943**	-28,715	-2,228
3 Establish POPS and defer installation of a new 33kV feeder and a second transformer at SSABY	2	**-28,079**	-26,400	-1,679

This shows a clear preference for Option 1 in the block load scenario, resulting in at least an 80% probability of Option 1 being the best NPV option across the three scenarios considered.

3.4.2 Value of regret analysis

In terms of selecting a decision pathway of 'least regret', one of the key uncertainties is the demand growth rate. The recommended option has been selected by using a risked NPV which applies a deterministic proportional weighting to the different scenarios for demand growth including mean demand case, low growth and additional block load.

A quantitative value of regret analysis has been conducted to test whether the investment decision is robust in the outcome of each of the uncertain growth scenarios. The following table provides a summary of the analysis to determine which option minimises the maximum NPV regret across the weighted three growth demand scenarios (moderate, high and low). The methodology used in the value of regret analysis is an "expected regret" calculation which is also known as "minimisation of opportunity loss".

Table 9: Value of regret analysis for each combination of scenario and option

Value of Regret Analysis										
	Options									
	Option 1			Option 2			Option 3			
Growth scenarios	NPV	Weighted NPV	Regret	NPV	Risked NPV	Regret	NPV	Risked NPV	Regret	NPV max for scenario
Mid Growth (70%)	-25,066	-17,546	0	-30,933	-21,653	4,107	-25,423	-17,796	250	-17,546
Low Growth (20%)	-24,577	-4,915	0	-29,512	-5,902	987	-24,395	-4,879	-36	-4,879
Block Load (10%)	-26,040	-2,604	0	-30,943	-3,094	490	-28,079	-2,808	204	-2,604
Expected regret ($ NPV)			0			5,584			418	

Table 10: Value of regret analysis summary for options being used across the base, high and low growth scenarios

Options	Expected Regret (NPV $)
1 Establish a new 33kV feeder and install the 2nd transformer at SSABY and 11kV bus	0
2 Establish Purga zone substation	-5,584
3 Establish POPS and defer installation of a new 33kV feeder and a second transformer at SSABY	-418

This analysis supports that Option 1 has the "least amount of regret" or "opportunity loss" across all three growth demand scenarios. Option 3, while close in terms of NPV comparison brings risk in the event of higher demand growth. The significant cost of the POPs assets, including purpose-built communications would then have been a wasted investment. The least regret approach is to proceed with Option 1.

3.5 Qualitative comparison of identified options

3.5.1 Advantages and disadvantages of each option

Table 11 details the advantages and disadvantages of each option considered.

Table 11: Assessment of Options

Option	Advantages	Disadvantages
1 - Establish a new 33kV feeder and install the 2nd transformer at SSABY and 11kV bus	• Consistent with the future development plan • Meets security standard • Optimally utilises existing network assets. • Increases the substation capacity of Amberley zone substation. • Increases 33kV network capacity to Karrabin, Marburg, Rosewood and Amberley • Provides earlier additional capacity in the event of higher demand growth	• No obvious disadvantages
2 - Establish Purga zone substation	• Meets security standard • Provides transfer capacities between Purga and ABY zone substations. • Establishment of Purga Zone • substation will eliminate the 33 kV feeder works to build feeder from SST136-SSABY and works required to install the 2nd transformer and 11kV switchgear at SSABY	• Unlikely to be established in the required time frame • Does not provide for a lower growth scenario as major works are developed initially • Energex does not own the land required to build Purga zone substation • Brings forward the limitation at Raceview Bulk Supply • Increased cost compared to option 1

Option	Advantages	Disadvantages
3 - Establish POPS and defer installation of a new 33kV feeder and a second transformer at SSABY	• Will enable system to operate in current configuration and avoid plant overloads • Defers major 33kV feeder investment works • Good option for low demand growth scenario	• Uses load shedding to maintain supply in other areas • Reduces customer reliability of supply in the area for those that will be load-shed • Has significant risks should the demand growth be higher than forecast – asset stranding risk
Counterfactual	• Potential to defer expenditure	• Limitations not addressed resulting in breach of Service Safety Net Targets • High expenditure in contingency event and for resulting remedial works

3.5.2 Alignment with network development plan

The proposed works would ensure that Energex meets its Service Safety Net Targets obligations. It looks to proactively provide contingency capacity just in time for load growth, maximising utilisation of assets while also considering the long-term growth of the local network and customer base. The preferred option aligns with the Asset Management Objectives in the Distribution Annual Planning Report. In particular it manages risks, performance standards and asset investment to deliver balanced commercial outcomes while modernising the network to facilitate access to innovative technologies.

3.5.3 Alignment with future technology strategy

This program of work does not contribute directly to Energy Queensland's transition to an Intelligent Grid, in line with the Future Grid Roadmap and Intelligent Grid Technology Plan. However, it does support Energy Queensland in maintaining affordability of the distribution network while also maintaining safety, security and reliability of the energy system, a key goal of the Roadmap, and represents prudent asset management and investment decision-making to support optimal customer outcomes and value across short, medium and long-term horizons.

3.5.4 Risk Assessment Following Implementation of Proposed Option

Table 12: Risk assessment showing risks mitigated following Implementation

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Outage of 33kV feeder between SST136 and SSKBN F365/366, resultant load on F366/365 exceeds feeder thermal capacity, **shed up to 5,000 customers.**	Customer	*(Original)*			2023
		3 (interruption to 5,000 customers)	*3 (Unlikely)*	***9 (Low)***	
		(Mitigated)			
		3 *(As above)*	1 *(Almost No Likelihood)*	**3 *(Very Low)***	

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Without augmenting the network, the Safety Net legislated requirement as part of the Distribution Authority is not met, resulting in the regulator to be notified and improvement notice issued by regulator.	Legislated	*(Original)* *4* *(improvement notice issued by regulator)* (Mitigated) 4 *(As above)*	*3* *(Unlikely)* 1 *(Almost No Likelihood)*	***12*** ***(Moderate)*** **4** ***(Very Low)***	2023
Fault on TR1 at SSABY results in **total loss of supply of substation load for more than 12 hours** affecting more than 100 customers until MT and Mobile Plant to restore all supply.	Customer	*(Original)* *2* *(interruption >3 hours)* (Mitigated) 2 *(As above)*	*3* *(Unlikely)* 2 *(Very Unlikely)*	***6*** ***(Low)*** **4** ***(Very Low)***	2026

4 Recommendation

4.1 Preferred option

To address the emerging N-1 limitations relating to Service Safety Net Targets at F365/F366/F364/F387/F475/F3901 for the loss of a feeder and for the loss of 25 MVA 33/11kV transformer at SSABY, it is recommended that Energex undertake Option 1, as it represents the lowest cost option in all considered scenarios. In addition, a RIT-D will be completed to establish the lowest cost non-network or hybrid solution for comparison with the installation of a new 33kV feeder from SST136 to SSABY and installing the 2nd transformer and 11kV switchgear at SSABY.

4.2 Scope of preferred option

This option involves the following:

- Establishing a new 33kV feeder from T136 to SSABY in October 2023, which involves:
  - Establishing approximately 16km of new 33kV overhead SCCT construction
  - Termination to spare circuit breaker (CBSPARE22) at SSABY
  - Termination to spare 33kV CB3582 at T136.
- Installing the 2nd transformer and 11kV bus at SSABY in Oct 2025 including new:
  - 25 MVA 33/11 kV transformer (TR12) and NEX.
  - 11kV switchgear building with 1 x 11kV transformer CB, 5 x 11kV feeder CBs and 1 x 11kV bus tie CB.
  - 315kVA station service transformer.
  - 6.6 MVAR, 12kV standard capacitor bank.

These works have estimated direct costs of $5,543,397 and $3,025,000 and a target completion date in 2023 and 2025 respectively, based on +-50% strategic estimates.

Appendix A. References

Note: Documents which were included in Energy Queensland's original regulatory submission to the AER in January 2019 have their submission reference number shown in square brackets, e.g. Energy Queensland, *Corporate Strategy [1.001], (31 January 2019).*

Energex, *Distribution Annual Planning Report (2018-19 to 2022-23) [7.050]*, (21 December 2018).

Energy Queensland, *Asset Management Overview, Risk and Optimisation Strategy [7.025]*, (31 January 2019).

Energy Queensland, *Corporate Strategy [1.001],* (31 January 2019).

Energy Queensland, *Future Grid Roadmap [7.054],* (31 January 2019).

Energy Queensland, *Intelligent Grid Technology Plan [7.056],* (31 January 2019).

Energy Queensland, *Network Risk Framework*, (October 2018).

Appendix B. Acronyms and Abbreviations

The following abbreviations and acronyms appear in this business case.

Abbreviation or acronym	Definition
$M	Millions of dollars
$ nominal	These are nominal dollars of the day
$ real 2019-20	These are dollar terms as at 30 June 2020
2020-25 regulatory control period	The regulatory control period commencing 1 July 2020 and ending 30 Jun 2025
2HEC	Two (2) Hour Emergency Capacity
ABY	Amberley
ACO	Auto Changeover
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ALARP	As Low as Reasonably Practicable
AMP	Asset Management Plan
Augex	Augmentation Capital Expenditure
BAU	Business as Usual
CAPEX	Capital expenditure
CB	Circuit-Breaker
Current regulatory control period or current period	Regulatory control period 1 July 2015 to 30 June 2020
DAPR	Distribution Annual Planning Report
DC	Direct Current
ECC	Emergency Cyclic Capacity
EDQ	Economic Development Queensland
EQL	Energy Queensland Ltd
IT	Information Technology
KRA	Key Result Areas
kV	Kilovolts
MSS	Minimum Service Standard
MVA	Megavolt Amperes
MVAR	Megavolt Amperes Reactive
NCC	Normal Cyclic Capacity
NEL	National Electricity Law
NEM	National Electricity Market

Abbreviation or acronym	Definition
NEO	National Electricity Objective
NER	National Electricity Rules (or Rules)
NEX	Neutral Earth Reactor
Next regulatory control period or forecast period	The regulatory control period commencing 1 July 2020 and ending 30 Jun 2025
NPV	Net Present Value
OOS	Out of Service
OPEX	Operational Expenditure
PCBU	Person in Control of a Business or Undertaking
POE	Probability of Exceedance
POPS	Plant Overload Protection Schemes
Previous regulatory control period or previous period	Regulatory control period 1 July 2010 to 30 June 2015
PV	Present Value
RAAF	Royal Australian Air Force
Repex	Replacement Capital Expenditure
RIN	Regulatory Information Notice
RIT-D	Regulatory Investment Test – Distribution
RTS	Return to Service
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control and Data Acquisition
SCCT	Single Circuit
SSABY	Amberley Zone Substation
SSKBN	Karrabin Zone Substation
SSMBG	Marburg Zone Substation
SSRWD	Rosewood Zone Substation
SST136	Abermain Bulk Supply Substation
WACC	Weighted average cost of capital
YMT	Yamanto

Appendix C. Alignment with the National Electricity Rules (NER)

The table below details the alignment of this proposal with the NER capital expenditure requirements as set out in Clause 6.5.7 of the NER.

Table 13: Alignment with NER

Capital Expenditure Requirements	Rationale
6.5.7 (a) (1) The forecast capital expenditure is required in order to **meet or manage the expected demand** for standard control services.	This project is required to meet the forecast demand growth in the study area. The proposed option deals with the general and potential block load demand increases in the area and is the most economically efficient option to deal with the demand increase.
6.5.7 (a) (2) The forecast capital expenditure is required in order to **comply with all applicable regulatory obligations or requirements** associated with the provision of standard control services	The forecast capital expenditure is required to deal with Safety Net limitations that arise within the 2020-25 period. The Safety Net is a condition within Energex's Distribution Authority.
6.5.7 (a) (3) The forecast capital expenditure is required in order to: (iii) maintain the **quality, reliability and security of supply** of supply of standard control services (iv) maintain the **reliability and security of the distribution system** through the supply of standard control services	The forecast capital expenditure ensures that new demand increases can be supplied. This ensures adequate security of supply as defined by the safety net standard.
6.5.7 (c) (1) (i) The forecast capital expenditure reasonably reflects the **efficient costs** of achieving the capital expenditure objectives	The Unit Cost Methodology and Estimation Approach sets out how the estimation system is used to develop project and program estimates based on specific material, labour and contract resources required to deliver a scope of work. The consistent use of the estimation system is essential in producing an efficient CAPEX forecast by enabling: • Option analysis to determine preferred solutions to network constraints • Strategic forecasting of material, labour and contract resources to ensure deliverability • Effective management of project costs throughout the program and project lifecycle, and • Effective performance monitoring to ensure the program of work is being delivered effectively. The unit costs that underpin our forecast have also been independently reviewed to ensure that they are efficient (Attachments 7.004 and 7.005 of our initial Regulatory Proposal).
6.5.7 (c) (1) (ii) The forecast capital expenditure reasonably reflects the costs that **a prudent operator** would require to achieve the capital expenditure objectives	The prudency of this proposal is demonstrated through the options analysis conducted and the NPV analysis for each option. The lowest NPV cost option is proposed. The prudency of our CAPEX forecast is demonstrated through the application of our common frameworks put in place to effectively manage investment, risk, optimisation and governance of the Network Program of Work. An overview of these frameworks is set out in our Asset Management Overview, Risk and Optimisation Strategy (Attachment 7.026 of our initial Regulatory Proposal).

Capital Expenditure Requirements	Rationale
6.5.7 (c) (1) (iii) The forecast capital expenditure reasonably reflects a realistic expectation of the **demand forecast and cost inputs** required to achieve the capital expenditure objective	Our peak demand forecasting methodology employs a bottom-up approach reconciled to a top-down evaluation, to develop the ten-year zone substation peak demand forecasts. Our forecasts use validated historical peak demands and expected load growth based on demographic and appliance information in small area grids. Demand reductions, delivered via load control tariffs, are included in these forecasts. This provides us with accurate forecasts on which to plan.

Appendix D. Mapping of Asset Management Objectives to Corporate Plan

This proposal has been developed in accordance with our Strategic Asset Management Plan. Our Strategic Asset Management Plan (SAMP) sets out how we apply the principles of Asset Management stated in our Asset Management Policy to achieve our Strategic Objectives.

Table 1: "Asset Function and Strategic Alignment" in Section 1.4 details how this proposal contributes to the Asset Management Objectives.

The Table below provides the linkage of the Asset Management Objectives to the Strategic Objectives as set out in our Corporate Plan (Supporting document 1.001 to our Regulatory Proposal as submitted in January 2019).

Table 14: Alignment of Corporate and Asset Management objectives

Asset Management Objectives	Mapping to Corporate Plan Strategic Objectives
Ensure network safety for staff contractors and the community	EFFICIENCY ***Operate safely as an efficient and effective organisation*** Continue to build a strong safety culture across the business and empower and develop our people while delivering safe, reliable and efficient operations.
Meet customer and stakeholder expectations	COMMUNITY AND CUSTOMERS ***Be Community and customer focused*** Maintain and deepen our communities' trust by delivering on our promises, keeping the lights on and delivering an exceptional customer experience every time
Manage risk, performance standards and asset investments to deliver balanced commercial outcomes	GROWTH ***Strengthen and grow from our core*** Leverage our portfolio business, strive for continuous improvement and work together to shape energy use and improve the utilisation of our assets.
Develop Asset Management capability & align practices to the global standard (ISO55000)	EFFICIENCY ***Operate safely as an efficient and effective organisation*** Continue to build a strong safety culture across the business and empower and develop our people while delivering safe, reliable and efficient operations.
Modernise the network and facilitate access to innovative energy technologies	INNOVATION ***Create value through innovation*** Be bold and creative, willing to try new ways of working and deliver new energy services that fulfil the unique needs of our communities and customers.

Appendix E. Risk Tolerability Table

<table>
<tr><th colspan="5">Network Risks - Risk Tolerability Criteria and Action Requirements</th></tr>
<tr><th>Risk Score</th><th>Risk Descriptor</th><th colspan="3">Risk Tolerability Criteria and Action Requirements</th></tr>
<tr><td>30 – 36</td><td colspan="4">Intolerable
(stop exposure immediately)</td></tr>
<tr><td>24 – 29</td><td>Very High Risk</td><td rowspan="5">*ALARP
Risk in this range managed to As Low As Reasonably Practicable</td><td>Executive Approval
(required for continued risk exposure at this level)</td><td>May require a full Quantitative Risk Assessment (QRA)
Introduce new or changed risk treatments to reduce level of risk
Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
<tr><td>18 – 23</td><td>High Risk</td><td>Divisional Manager Approval
(required for continued risk exposure at this level)</td><td>Introduce new or changed risk treatments to reduce level of risk
Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
<tr><td>11 – 17</td><td>Moderate Risk</td><td rowspan="2">Group Manager / Process Owner Approval
(required for continued risk exposure at this level)</td><td rowspan="2">Introduce new or changed risk controls or risk treatments as justified to further reduce risk
Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
<tr><td>6 – 10</td><td>Low Risk</td></tr>
<tr><td>1 to 5</td><td>Very Low Risk</td><td>No direct approval required but evidence of ongoing monitoring and management is required</td><td>Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
</table>

Figure 5: A Risk Tolerability Scale for evaluating Semi-Quantitative risk score

Appendix F. Safety Net Obligations

Safety Net Criteria

Network planning criteria is a set of rules that guide how future network risk is to be managed for and under what conditions network augmentation or other related expenditure should be undertaken.

Energex

The Safety Net is effectively a deterministic security standard, requiring Energex to meet a set of threshold criteria following an N-1 event on the sub-transmission network. Energex has a legislated requirement to “design, plan and operate its supply network” to meet the Safety Net “to the extent reasonably practicable”.

The Safety Net Targets are outlined in the Distribution Annual Planning Report, and aim for the following:

Table D1: Safety Net targets – load not supplied and maximum restoration times following a credible contingency

Feeder Type	Targets
CBD	• Any interruption in customer supply resulting from an N-1 event at the sub-transmission level is restored within 1 minute
Urban – following an N-1 event	• No greater than 40 MVA (16,000 customers) is without supply for more than 30 minutes; • No greater than 12 MVA (5,000 customers) is without supply for more than 3 hours; and • No greater than 4 MVA (1,600 customers) is without supply for more than 8 hours.
Short rural – following an N-1 Event	• No greater than 40 MVA (16,000 customers) is without supply for more than 30 minutes; • No greater than 15 MVA (6,000 customers) is without supply for more than 4 hours; and • No greater than 10 MVA (4,000 customers) is without supply for more than 12 hours.

Short Rural Safety Net Interpretation

Demand Range	Allowed Outage to be within Safety Net
>40MVA	No outage
15-40MVA	30 minutes OK
10-15MVA	4 hours OK
<10MVA	12 hours OK

Appendix G. Reconciliation Table

Reconciliation Table Conversion from $18/19 to $2020	
Business Case Value	
(M$18/19)	$8.57
Business Case Value	
(M$2020)	$8.94

Appendix H. Load Forecasts

Table 15: Amberley Zone Substation Load at Risk

Substation	Plant OOS	Year	50% POE Load (MVA)	Summer ECC (MVA)	Summer 2HEC (MVA)	Auto Transfers Available (MVA)	Remote Transfers Available (MVA)	Manual Transfers Available (MVA)	Mobile Generation Required (MVA)	Security Standard Load At Risk (MVA)
SSABY (Amberley)	TR1 or TR2	2020	3.9	0.0	0.0	0.0	0.0	2.7	10.0	
		2021	5.0	0.0	0.0	0.0	0.0	2.7	10.0	
		2022	7.3	0.0	0.0	0.0	0.0	2.7	10.0	
		2023	9.1	0.0	0.0	0.0	0.0	2.7	10.0	
		2024	10.2	0.0	0.0	0.0	0.0	2.7	10.0	
		2025	11.1	0.0	0.0	0.0	0.0	2.7	10.0	
		2026	12.0	0.0	0.0	0.0	0.0	2.7	10.0	
		2027	12.9	0.0	0.0	0.0	0.0	2.7	10.0	0.2
		2028	13.9	0.0	0.0	0.0	0.0	2.7	10.0	1.2

Table 16: Limitations on F364, F365 and F366

Feeder	Plant OOS	Year	50% POE Load (Amps)	Summer ECC (Amps)	Summer 2HEC (Amps)	Auto Transfers Available (Amps)	Remote Transfers Available (Amps)	Manual Transfers Available (Amps)	Mobile Generation Required (Amps)	Security Standard Load At Risk (Amps)	Security Standard Load At Risk (MV.A)
F364-1 (MBG - RWD)	F365/ F366	2020	130.0	155.0	194.0	0.0					
		2021	138.0	155.0	194.0	0.0					
		2022	147.0	155.0	194.0	0.0					
		2023	168.0	155.0	194.0	0.0		17.0	0.0		
		2024	179.0	155.0	194.0	0.0		17.0	7.0		
		2025	189.0	155.0	194.0	0.0		18.0	16.0		
		2026	199.0	155.0	194.0	0.0		19.0	25.0	5.0	0.3
		2027	209.0	155.0	194.0	0.0		19.0	35.0	15.0	0.9
		2028	221.0	155.0	194.0	0.0		20.0	46.0	27.0	1.5
F366-1 (T136-366-1)	F365	2020	660.0	800.0	818.0	0.0					
		2021	701.0	800.0	818.0	0.0					
		2022	743.0	800.0	818.0	0.0					
		2023	785.0	800.0	818.0	0.0					
		2024	827.0	800.0	818.0	0.0		91.0		9.0	0.5
		2025	867.0	800.0	818.0	0.0		93.0		49.0	2.5
		2026	911.0	800.0	818.0	0.0		96.0	15.0	93.0	4.7
		2027	953.0	800.0	818.0	0.0		98.0	55.0	135.0	6.9
		2028	1000.0	800.0	818.0	0.0		101.0	99.0	182.0	9.2
F365-1 (T136-365-1)	F366	2020	659.0	746.0	871.0	0.0					
		2021	700.0	746.0	871.0	0.0					
		2022	742.0	746.0	871.0	0.0					
		2023	784.0	746.0	871.0	0.0		91.0	0.0		
		2024	827.0	746.0	871.0	0.0		93.0	0.0		
		2025	869.0	746.0	871.0	0.0		95.0	28.0		
		2026	914.0	746.0	871.0	0.0		98.0	70.0	43.0	2.2
		2027	957.0	746.0	871.0	0.0		102.0	109.0	86.0	4.4
		2028	1008.0	746.0	871.0	0.0		106.0	156.0	137.0	6.9

Appendix I. Communications Network Limitations

Communications Network Limitations

It should be noted that due to the limit being caused by an overload on a 33kV feeder which will damage the asset and pose a safety and clearance issue on the feeder, direct, high-speed communications are required between these substations. Furthermore, where a third-party owns and operates the communications path, Energex will not be able to ensure that the line is available when required. As such, a third-party communications line is not suitable for this application.

Energex currently do not have a direct communications link between SST136 and SSKBN.

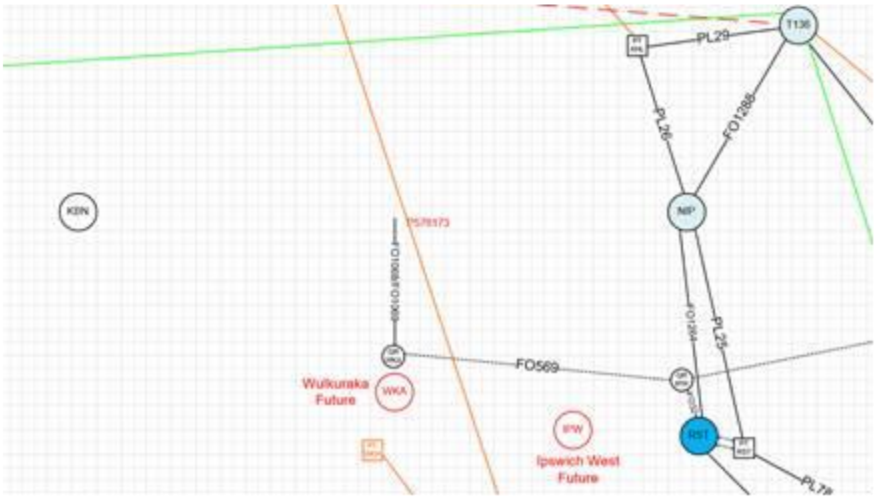

Figure 6 shows a diagram of the existing communications network in the region, with both substations circled in red on the figure.

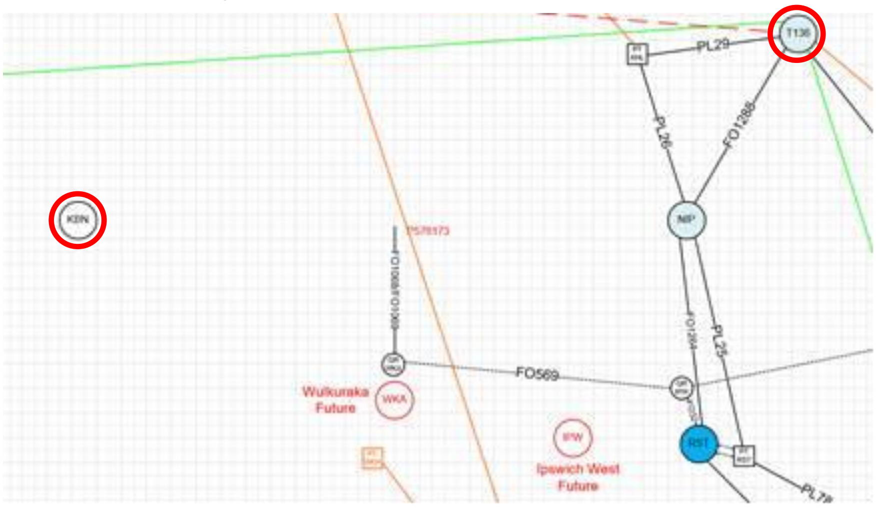

Figure 6: Existing Communications Network Arrangement

Due to the height restrictions associated with the air base being in close proximity to the supply area, wireless communications towers cannot be built to sufficient height to provide communications between Karrabin, Rosewood, Marburg and Amberley substations. As such, a fibre or ADSS solution is required to provide communications between these substations. The full scope of works to support Option 3 POPS schemes is outlined as follows:

Install fibre between SSKBN and SSNIP (~8.4km ADSS/OPGW + 100m UG fibre for both subs)

- Reconductor 7/3.75 Mars OHEW on F475 with 11mm OPGW from P740782 to P740724 (new pit at base of P740271) (~0.2km)
- String new span of 11mm OPGW from P740724 to P56731-A (~50m).

- Reconductor 7/3.75 Mars OHEW on F365 with 11mm OPGW from P56731-A to P56713-A (~0.25km)
- String ADSS under KBN15A from P56713-A to P38139-A (~1.6km).
- Install 11mm OPGW on F365 from P38139-A to P27210-C (~6.1km). Install new OHEW risers as required on poles (all Pluto construction).
- String new span of 11mm OPGW from P27210-C to P18573-B (~20m).
- Reconductor 7/.080 Copper OHEW with 11mm OPGW on F370 from P18573-B to P22425-C (new pit at base of P22425-C) (~0.2km).
- Install 50m 1 x white conduit and fibre from new pit to KBN patch panel (worst case distance)
- Install 50m 1 x white conduit (road crossing) and fibre from new pit to NIP patch panel (worst case distance)
- New 33kV Feeder Prot Panel SST136
- New 33kV Feeder Prot Panel SSKBN
- SACS Build at SST136
- SACS Build at SSKBN
- 8400m / average 80m spans = 105 poles – Allow replacement of 20 poles (33kV)