

# The Energy Queensland Group Final Project Assessment Report

20 April 2021

## NGE Nudgee – Maintain supply to customers and address 11kV switchgear reaching end-of-life



Part of the Energy Queensland Group

### Disclaimer

While care was taken in preparation of the information in this Non-Network Options Report, and it is provided in good faith, Energex Limited accepts no responsibility or liability for any loss or damage that may be incurred by any person acting in reliance on this information or assumptions drawn from it. This document has been prepared for the purpose of inviting information, comment and discussion from interested parties. The document has been prepared using information provided by a number of third parties. It contains assumptions regarding, among other things, economic growth and load forecasts which may or may not prove to be correct. All information should be independently verified to the extent possible before assessing any investment proposal.

## Executive summary

### About Energex

Energex is a subsidiary of Energy Queensland Limited, a Queensland State Government Owned Corporation. Energex distributes electricity to over 1.5 million residential, commercial and industrial customers across a population base of around 3.5 million in South East Queensland.

### Identified Need

Nudgee Zone Substation (SSNGE) is equipped with 2 x 25MVA 33/11kV transformers and supplies approximately 3,000 predominantly residential customers, while also supplying a major customer.

SSNGE is supplied from Nudgee Bulk Supply Substation located in the same premises. This also supplies SSAPB Substation, while SSNGE supplies SSGCN Substation.

Based on a Condition Based Risk Management (CBRM) analysis of the effect of current condition and ageing on the expected life of the assets at SSNGE, the following assets have been deemed to each their retirement ages,

- 11kV circuit breakers;
- Protection relays.

The deterioration of these primary and secondary system assets poses safety risks to staff working within SSNGE due to the potential for in-service failure of the assets.

Furthermore, 3 x 11kV feeders have inadequate backup protection reach as per Network Protection Standard. This poses an ongoing risk to Energex personnel or public safety due to the potential for in-service failure of primary protection subsequent to a fault on the 11kV network.

### Approach

The National Electricity Rules (NER) require that, subject to certain exclusion criteria, network business investments for meeting service standards for a distribution business are subject to a Regulatory Investment Test for Distribution (RIT-D). Energex has determined that network investment is essential in this case for it to continue to provide electricity to the consumers in the SSNGE supply area in a reliable, safe and cost-effective manner. Accordingly, this investment is subject to a RIT-D.

Energex published a Notice of no non-network options for the above described network constraint on 26 September 2019 to declare that there are no credible non-network options to the proposed works to meet the identified need of maintaining a safe, sufficient and reliable supply to customers at SSNGE when the 11kV switchgear reaches retirement age in 2021. This determination was made under clause 5.17.4(c) of the National Electricity Rules (NER) and was published according to clause 5.17.4(d). In this regard, Energex did not publish a non-network options report for the proposed works at SSNGE.

Since the estimated project cost is below \$11 million, Energex is exempt from publishing a draft project assessment report, as per clause 5.17.4(n) of the NER.

This is a Final Project Assessment Report (FPAR), where Energex provides both technical and economic information about possible solutions and has been prepared in accordance with the requirements of clause 5.17.4(o).

Submissions in response to the report may be submitted to [demandmanagement@energex.com.au](mailto:demandmanagement@energex.com.au) and are due by 20 May 2021.

If no formal dispute is raised, Energex will proceed with the recommended development.

## Recommendation

It is recommended that Energex establish a new switchgear building and install a new 11kV switchboard, recover existing 11kV switchgear, carry out protection relay replacements at SSNGE and carry out requisite works at the remote end substations of SSAPB and SSGCN, for a total estimated cost of \$10,554,528, at 2020/21 prices. The target completion date for the recommended development is January 2024.

## TABLE OF CONTENTS

Executive summary.....	1
1.0 Existing network.....	4
1.1 Introduction .....	4
1.2 Applied Service Standards.....	6
1.3 Limitations of the existing network.....	6
1.4 Impact of doing nothing.....	9
2.0 Options analysis.....	10
2.1 Alternative options rejected.....	10
2.2 Network options .....	10
2.3 Non-network alternative options .....	12
3.0 Recommended development.....	12
3.1 Scope of proposed works .....	12
4.0 Recommendation .....	12

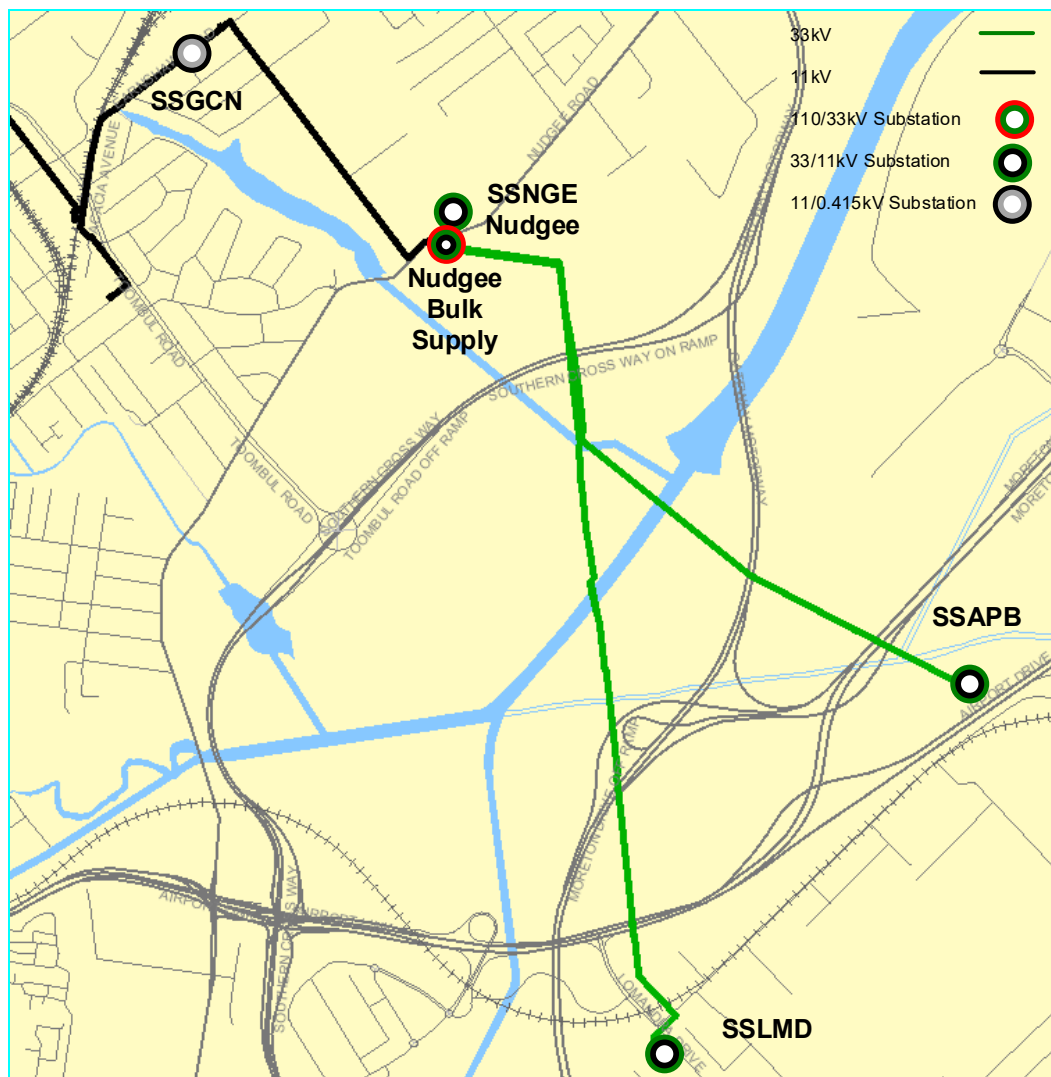
## 1.0 EXISTING NETWORK

### 1.1 Introduction

Nudgee Zone Substation (SSNGE) is equipped with 2 x 25MVA 33/11kV transformers and supplies approximately 3,000 predominantly residential customers, while also supplying a major customer.

SSNGE is supplied from Nudgee Bulk Supply Substation located in the same premises. This also supplies SSAPB Substation, while SSNGE supplies SSGCN Substation.

A geographic view and a schematic view of the area of study are provided in Figure 1 and Figure 2 respectively.



**Figure 1: Existing network arrangement (geographic view)**

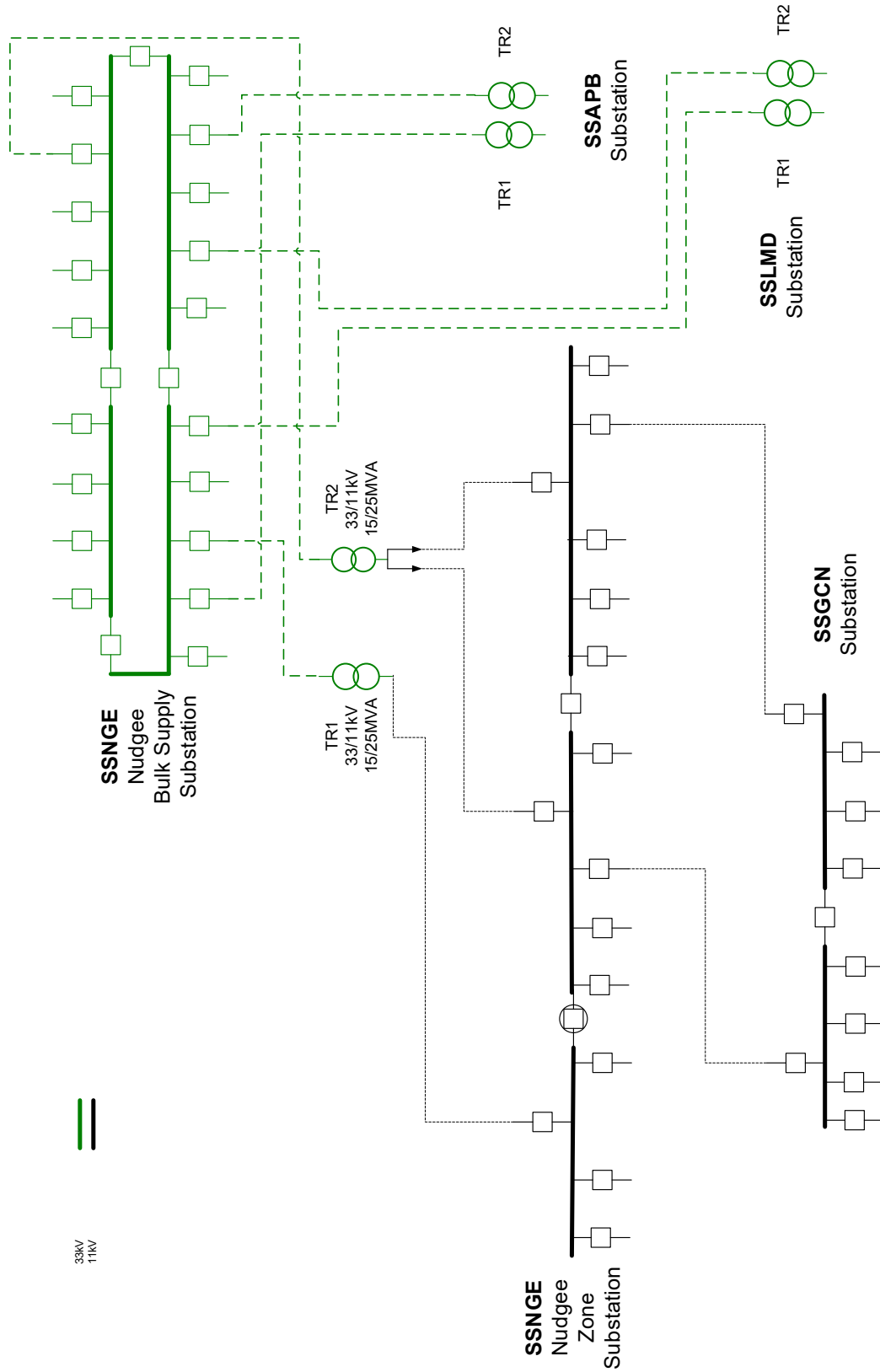


Figure 2: Existing network arrangement (schematic view)

## 1.2 Applied Service Standards

The Service Standards that are applicable to a consideration of supply constraints affecting this area of study are summarised below:

- As per *Joint Workings Protocol for Refurbishment and Replacement*, all electrical network assets that are in greatest need are identified and scheduled for refurbishment or replacement in sufficient time to prevent failure and to minimise the associated risks.
- As per Section S5.1.9(c) of the *National Electricity Rules (NER)*, a Network Service Provider must provide sufficient primary and back-up protection systems (including circuit breaker fail protection) to ensure that a fault of any type anywhere on the transmission and distribution system is automatically disconnected.
- Risk framework
  - As per *Energex Network Risk Framework*, for risks in the tolerable range, the aim is to reduce all network risks to As Low As Reasonably Practicable (The ALARP principle, as represented by the ALARP range in tolerability scales).

## 1.3 Limitations of the existing network

### 1.3.1 Substation capacity

SSNGE is equipped with 2 x 15/25MVA 33/11kV transformers. The substation capacity is limited by transformers, providing a Normal Cyclic Capacity of 52.5MVA. The 10 year 10 PoE and 50 PoE load forecasts, and the existing Normal Cyclic Capacity (NCC), Emergency Cyclic Capacity (ECC), Two Hour Emergency Capacity (2HEC), Residual Load at Risk (RLAR), available transfers and available mobile equipment, are shown in Figure 3.

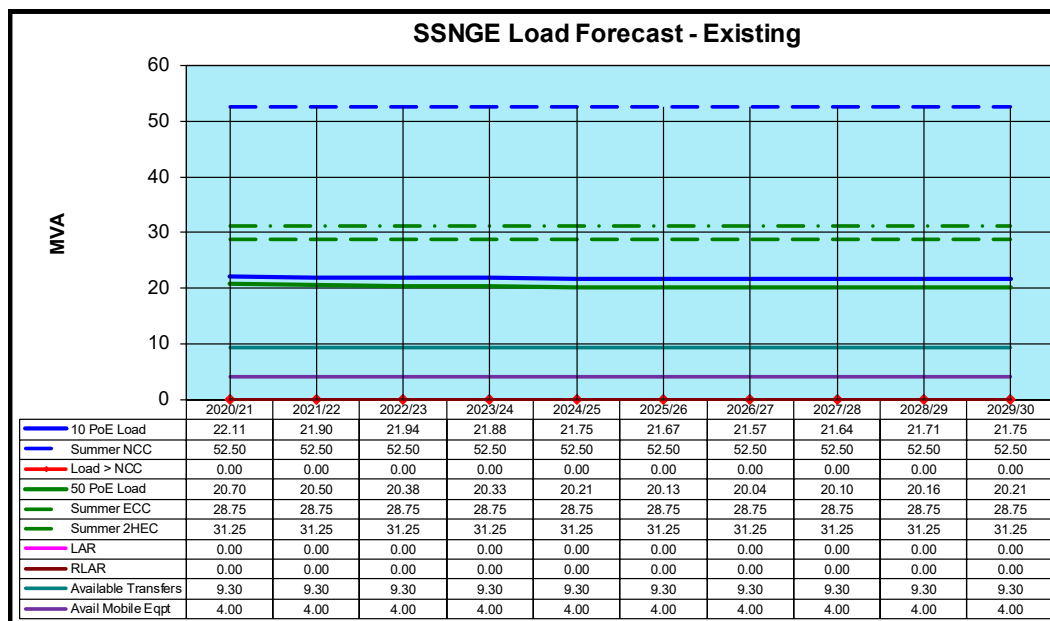


Figure 3: Substation load forecast (existing network)

As outlined above:

- There are no capacity limitations at SSNGE within the planning horizon.

### 1.3.2 Substation Load

The actual load and load duration curve for SSNGE are shown in Figure 4 and Figure 5 respectively.

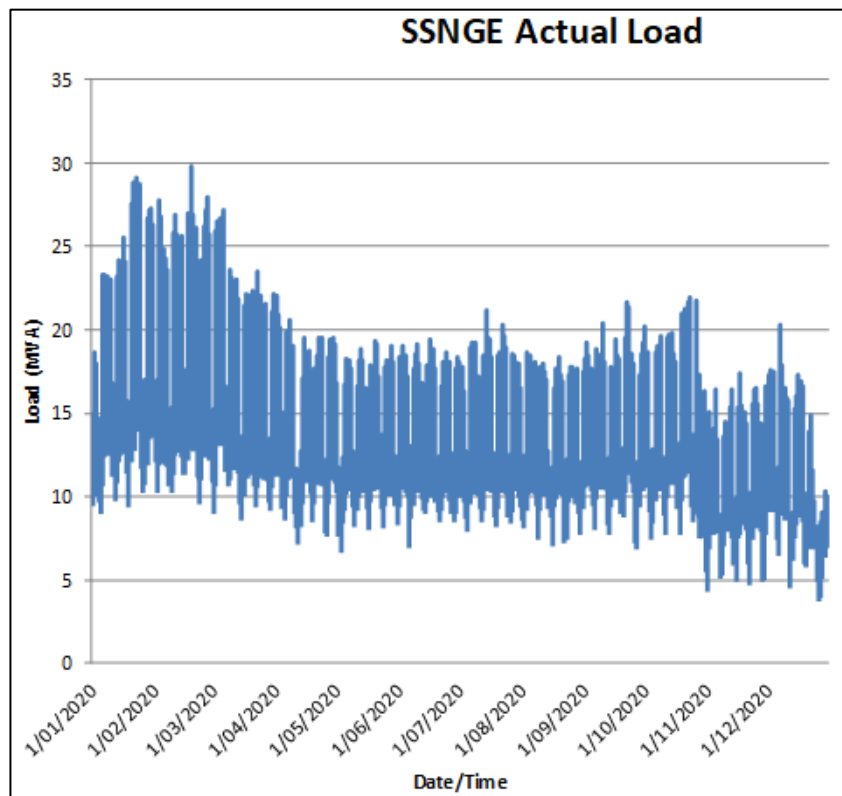


Figure 4: Substation actual load curve – SSNGE

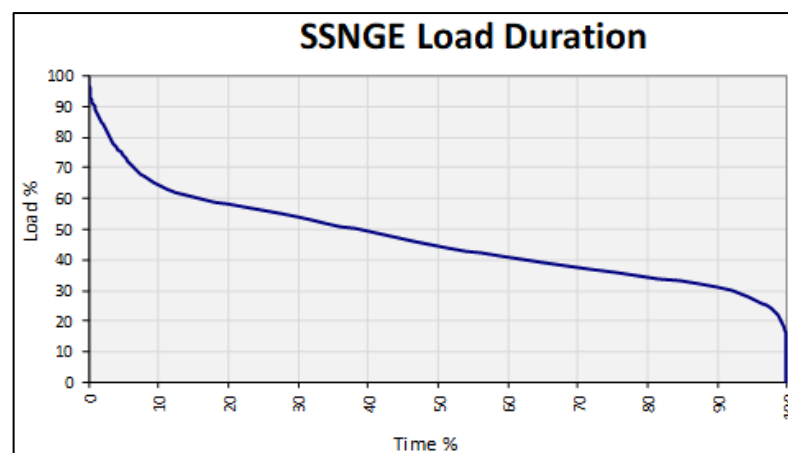


Figure 5: Substation load duration curve – SSNGE



### 1.3.3 Substation condition

Based on a Condition Based Risk Management (CBRM) analysis of the effect of current condition and ageing on the expected life of the asset, the following have been deemed to reach retirement age as follows:

- All Westinghouse J18 11kV switchgear;
- 11kV protection relays;
- 33kV protection relays.

#### 11kV switchgear

The 11kV bus at SSNGE is composed of three bus sections. BB12 and BB13 comprise Email Westinghouse J18 switchgear, manufactured in 1966. BB11 is GECHED HWX switchgear, manufactured in 1995. As per the CBRM analysis, the J18 switchgear has been deemed to reach their retirement age in 2021.

Furthermore, investigations have confirmed that the J18 11kV switchgear contain asbestos in the umbilical leads and arc chutes within the instrument chamber.

#### Protection relays

Energex has approximately 17,000 protection relays operating across its network and substations. These form an integral component of the safe and reliable operation of the electricity network and Energex recognises the need to effectively manage its protection relay assets and has developed a prioritised replacement program offering a balance among safety risks, legislative compliance, reliability and cost effectiveness. This builds upon Energex's legacy replacement programs planned for the network.

Energex faces several challenges in the near future as many older electromechanical and analogue (static) protection relays approach the end of their operational life. Similarly, the most recent generation of digital (numeric) relays, which began service in the mid to late 1990's, are starting to show signs of deterioration and mal-operation, which consequently, require replacement due to their relatively shorter life expectancy. In order to meet the challenges of the ageing relay population, this replacement program will be an ongoing endeavour.

Energex's strategy towards maintaining protection relays and the security of its network assets and personnel is to identify and target for replacement those relays considered to be of the highest risk of failure and their potential to negatively impact the network should they fail. Energex has an ongoing program of work towards the replacement of high-risk protection relays within its network, namely the 'Protection Relay Replacement' program.

Several 11kV and 33kV protection relays at SSNGE have been identified as nearing their retirement age.

## 1.3.4 Legislated requirements

### Back-up protection

Section S5.1.9(c) of the NER specifies that a Network Service Provider must provide sufficient primary and back-up protection systems (including circuit breaker fail protection) to ensure that a fault of any type anywhere on the transmission and distribution system is automatically disconnected.

Energex typically employs overcurrent protection on a radial distribution network (11kV level), with the backup protection provided by a slower graded upstream protection scheme which is typically a substation transformer LV overcurrent relay. The concept of operating (reach) factor is used to assess the adequacy of primary and backup protection on a distribution network.

Remedial actions are recommended where a feeder has been reviewed and found to have a reach factor below the minimum threshold.

The existing backup protection at SSNGE does not meet the minimum target reach factor for three of the 11kV radial feeders (NGE4B, NGE7 and NGE12).

## 1.4 Impact of doing nothing

The “do nothing” option is not acceptable as the following do not comply with the applied service standards detailed in section 1.2:

- Continuous operation of the existing Email Westinghouse J18 11kV switchgear that have been deemed to reach retirement age at SSNGE poses an ongoing risk to Energex personnel safety due to the potential for in-service failure of the assets.
- Continuous operation of the existing Email Westinghouse J18 11kV switchgear that have been deemed to reach retirement age at SSNGE poses an ongoing risk to customers due to the reduced capacity and reliability of supply for an extended period in the event of an in-service failure of the assets.
- Continuous operation of the existing 11kV feeders that have been identified as not having sufficient back-up protection reach at SSNGE poses an ongoing risk to Energex personnel or members of the public safety due to the potential for in-service failure of primary protection subsequent to a fault on the 11kV network.
- Continuous operation of the existing 11kV feeders that have been identified as not having sufficient back-up protection reach at SSNGE poses an ongoing risk to Energex due to the potential for in-service failure of primary protection subsequent to a fault on the 11kV network and thereby breaching the requirements of NER Section S5.1.9(c).
- The level of risk will increase over time, particularly as these assets continue to age and deteriorate.

## 2.0 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.

### 2.1 Alternative options rejected

For clarity, the following alternative options were considered but rejected as they were not practicable alternatives for the reasons indicated in Table 1.

Alternative option	Reasons for being rejected
Do nothing	<ul style="list-style-type: none"> <li>– The option of doing nothing is not acceptable since the risk of the switchgear failing in service impacts on the safety of staff and the reliability of supply to the customers at SSNGE.</li> </ul>
Transfer SSNGE load to adjacent substations	<ul style="list-style-type: none"> <li>– Limited available 11kV feeder transfer capability.</li> <li>– Limited number of spare 11kV feeder circuit breakers at adjacent substations for new 11kV feeders.</li> <li>– Limited available 11kV feeder routes in a congested network.</li> </ul>
Replace the Email Westinghouse J18 11kV switchgear in-situ	<ul style="list-style-type: none"> <li>– Increased network risk due to longer outages required thereby prolonging project duration for staging over an estimated three-year period.</li> <li>– Increased safety risk to staff due to the need to clean asbestos dust from the J18 switchgear for preliminary works and temporary works required for staging.</li> <li>– Inability to supply load during the replacement of the switchgear.</li> </ul>

**Table 1: Alternative options rejected**

### 2.2 Network options

In addition to the following option that has been assessed as meeting the identified need, no other practically feasible and economically equivalent option has been identified in this analysis.

#### 2.2.1 Preferred option: Replace 11kV switchgear at SSNGE

This option involves establishing a new building for the new 11kV switchgear, recovering and disposing the J18 11kV switchgear, carrying out the protection relay replacements at SSNGE and carrying out requisite works at the remote end substations of SSAPB and SSGCN. Figure 6 provides a schematic diagram for this option.

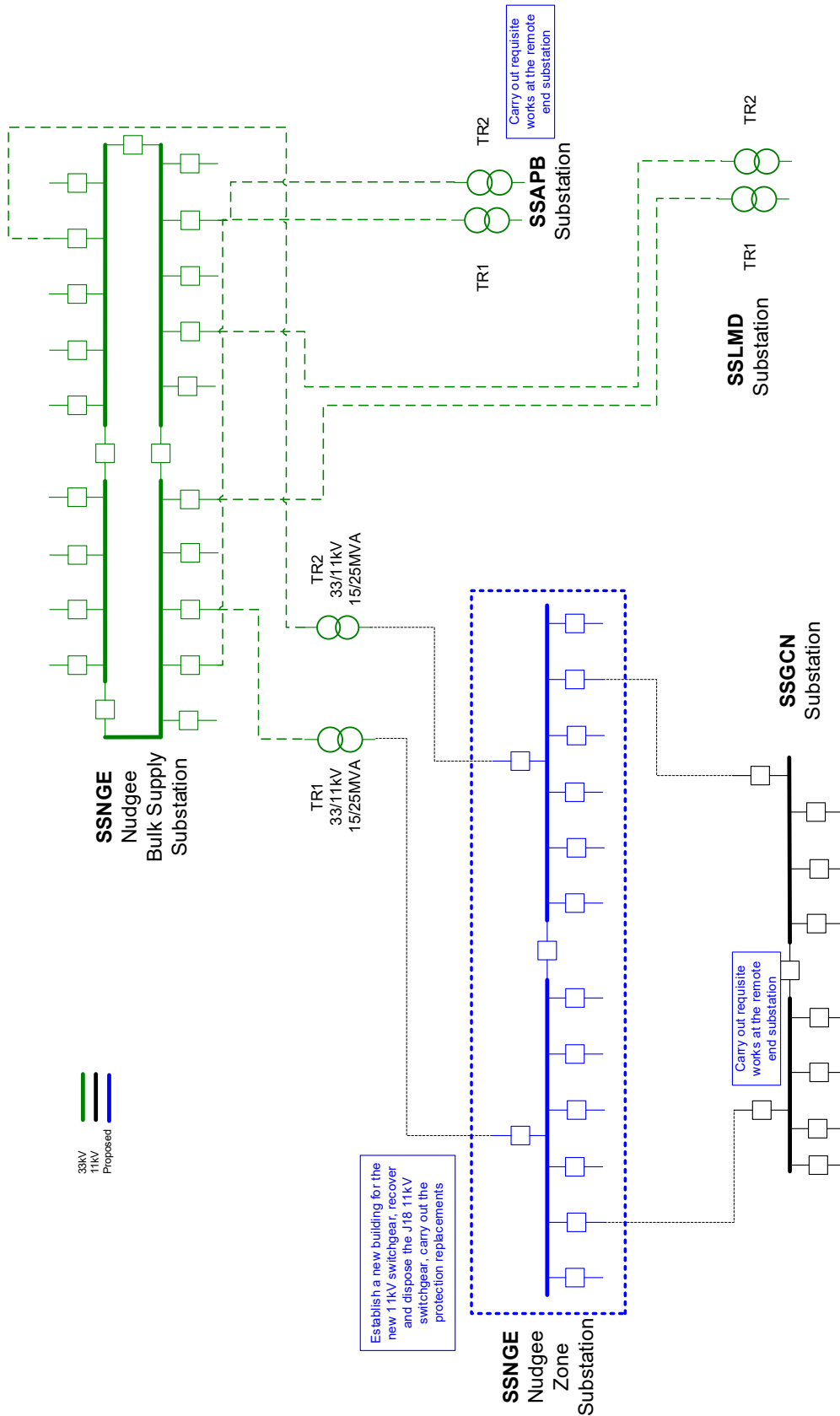


Figure 6: Proposed network arrangement (schematic view)

## 2.3 Non-network alternative options

In addition to the above network options that have been assessed as meeting the applied service standards, no non-network alternative options have been identified in this analysis.

## 3.0 RECOMMENDED DEVELOPMENT

### 3.1 Scope of proposed works

#### 3.1.1 Description of works

To address the limitations at SSNGE, it is proposed to:

- Establish a new building and install new 11kV switchgear, recover and dispose the J18 11kV switchgear, carry out the protection replacements;
- Carry out requisite works at the remote end substations of SSAPB and SSGCN

Figure 6 shows the proposed network on completion of the recommended works.

## 4.0 RECOMMENDATION

It is recommended that Energex establish a new switchgear building and install a new 11kV switchboard, recover existing 11kV switchgear, carry out protection relay replacements at SSNGE and carry out requisite works at the remote end substations of SSAPB and SSGCN, for a total estimated cost of \$10,554,528, at 2020/21 prices. The target completion date for the recommended development is January 2024.