# RIT-D: Collingwood supply area

## Non-Network Options Report

## Notice of Determination under clause 5.17.4(c) of the National Electricity Rules

24 January 2022

# Contents

# 1 Summary

This document is our notice of its determination that there are no credible non-network options to address all or part of the identified need at Collingwood (B) zone substation. Our determination is made under clause 5.17.4(c) of the National Electricity Rules and is published pursuant to clause 5.17.4(d). In accordance with those provisions, we will not be publishing a Non-Network Options Report in relation to the proposed works at B zone substation (ZSS).

In summary, our reasons for this conclusion are:

- there is no opportunity to reduce the required assets and associated works at B ZSS by partially reducing peak load through demand management; and
- due to its location within the Melbourne urban area, and growing demand at risk, a demand management option will not be a feasible or cost-effective long-term solution.

## 1.1 The identified need

The identified need is to address the increasing risks to safety and reliability of supply associated with the deterioration of the switchboard at B ZSS.

The B zone substation (ZSS) was constructed in the early 1960s and most of the original substation equipment including; sub-transmission lines, transformers, switchboards and auxiliary equipment remain in service. It supplies the Collingwood and Fitzroy urban areas connected with over 6,300 commercial, industrial and domestic customers including some major customers such as Yarra Trams and St Vincent's Hospital.

Among these assets, Email Westinghouse 11KV switchboard and J18 bulk oil-filled circuit breakers (OCB) at B ZSS indicate increasing operational and safety risks due to their deteriorated condition. In addition, the existing high voltage (HV) switchgears were designed with no arc fault containment, which does not comply to the current safety standard.

In 2016, a failure on one of the OCBs at bus 4 resulted in a significant fire damage to the bus section, therefore online Partial Discharge (PD) monitoring is in place on the repaired bus 4 for continuous monitoring and early detection of a failure. The electrical insulation level of these switchgear has deteriorated and cannot be re-conditioned by maintenance. In addition, the recent PD scans on the other three bus sections have indicated low to medium level PD events within pitch filled cable boxes.

There are only limited contingency load transfers to adjoining zone substations which is a risk should a major outage occur of the switchboard; customers will be left without electricity supply for a sustained period of time until emergency repairs are undertaken.

## 1.2 Potential credible options to address the identified need

At this stage, we have considered three potential credible network options to address the identified need. While further work is required to reach a final decision, at this stage the likely preferred option is to replace existing switchboard in the same building, using temporary load transfers to facilitate replacement in 2024.

We intend to publish a Draft Project Assessment Report in March 2022 in relation to this B ZSS project, which will examine the costs and benefits of each option in further detail.

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# 2 Background

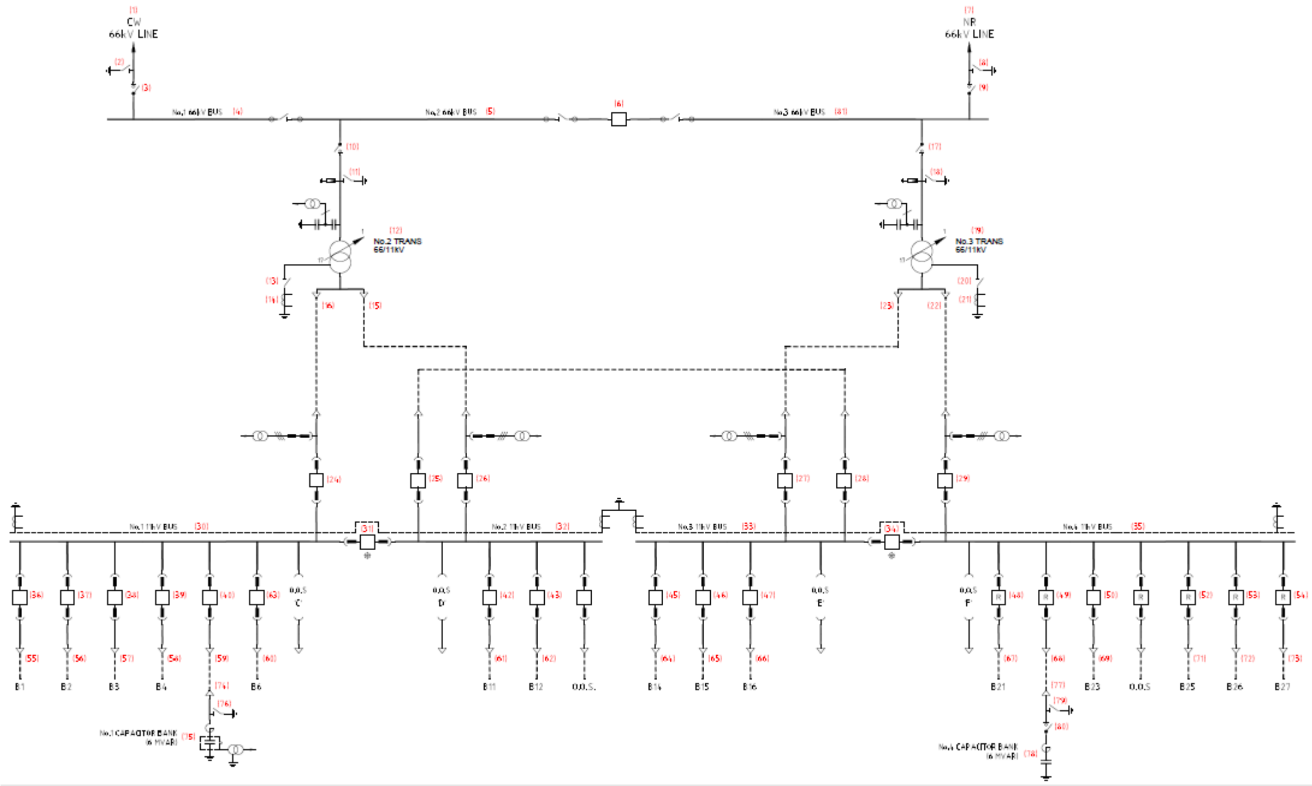
## 2.1 B Zone substation configuration

The Collingwood (B) ZSS has been in service since 1965, served by two 66KV sub-transmission lines from Richmond terminal station (RTS) in a loop with North Richmond (NR) and Collingwood (CW) zone substations.

B ZSS currently has two 20/27MVA outdoor transformers feeding four air insulated Email 11KV bus sections with twenty-five in service Email J18 OCBs. The bus section 2 and 3 are interconnected via a cable bus tie. The switchboard and control equipment are located within a single level building.

The single line diagram of the B ZSS is as shown in Figure 1.

Figure 1 B Zone Substation single line diagram



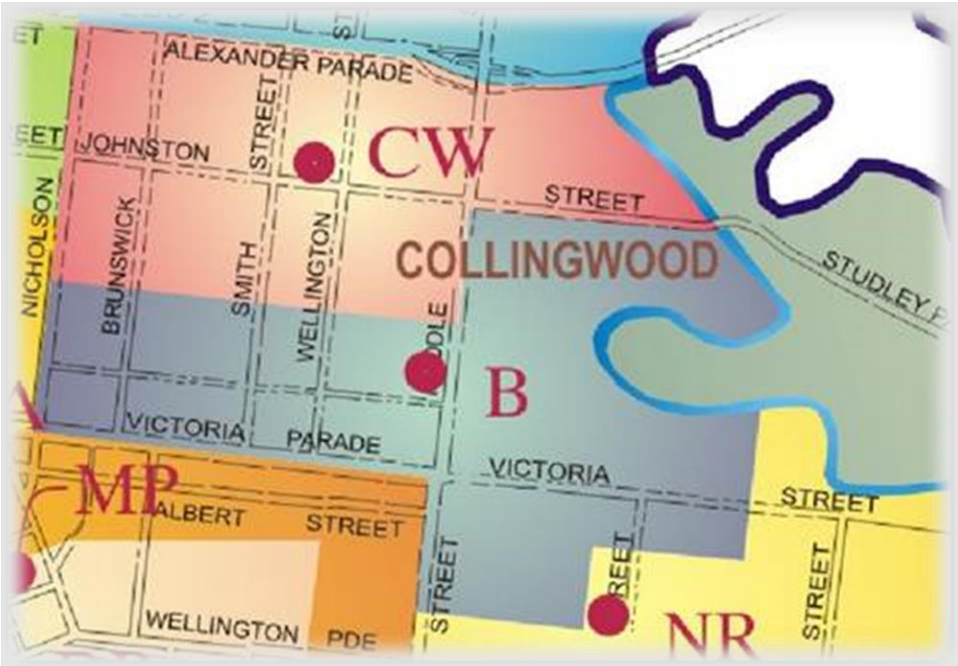

Source: CitiPower

## 2.2 Location

B ZSS is located at 178 Langridge Street at the junction of Islington Street and Hoddle Street in Collingwood as shown in Figure 2. This ZSS supplies the Collingwood and Fitzroy urban areas.

B ZSS supplies electricity to over 6,300 commercial, industrial and residential customers including some major customers such as Yarra Trams, St Vincent’s Hospital and Carlton United Breweries.

Figure 2 B zone substation supply area




Source: CitiPower

# 3 Identified need

## 3.1 Overview of the identified need

The identified need is to address the increasing risks to safety and reliability of supply associated with the deterioration of the switchboard at B ZSS.

The following issues have been identified at B ZSS:

- The existing Email LC switchboard does not comply with the current Arc Fault Containment standards (IEC62271) which is the industry best practice. An internal arc fault occurs where an electric arc is sustained following a breakdown in the insulation. The extreme heat caused during an arc can vaporise the metal conductors involved, hence an expansion of the air around the arc and the vaporised metal causes a significant pressure rise, which increases the intensity of equipment failures. This presents a serious risk to operators in the vicinity of a failure and can result in significant injuries leading to long term disability or death. Switchgear which is designed to contain an internal arc flash event includes venting the arc products away from the operators and to minimise the pressure rise within the cubicle.
- B switchboard has already experienced a disruptive failure which resulted in a switchboard fire and explosion within the building.
- The layout of B ZSS is such that the switchgear is situated directly opposite the protection and control equipment, with no form of blast control wall between them or between the bus-sections. A failure of an OCB can result in the expulsion and ignition of the insulating oil. As there is no arc fault containment within the switchgear panels, any burning oil expelled from the switchgear could be spread into the open switch room, with the potential to cause damage to the other equipment within the room. Consequently, the failure of one of these OCBs could result in the loss of all the switchgear protection and control equipment at this substation.
- Due to the long-term demand growth of the area and limited spare MVA capacity of neighbouring substations, B ZSS will need to remain in service. The future requirement for a third transformer at B ZSS requires a reliable and reconfigured switchgear within the substation.

By addressing the risks described above, we will continue to comply with our obligations under the following regulations:

- section 98 of the Electricity Safety Act[1]; and
- clauses 3.1 and 5.2 of the Victorian Electricity Distribution Code.[2]

Section 3.2 of this report provides an overview of our approach to assessing asset condition and risk. Also, sections from 3.3 to 3.6 provide further information on the condition of plant assets and future load at risk at B ZSS.

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1 Under section 98 of the Electricity Industry Safety Act, CitiPower (as a major electricity company) must design, construct, operate, maintain and decommission its supply network to minimise as far as practicable:

• the hazards and risks to the safety of any person arising from the supply network; and

• the hazards and risks of damage to the property of any person arising from the supply network.

2 Clause 3.1 of the Victorian Electricity Distribution Code requires us to manage our assets in accordance with the principles of good asset management. Under this provision, we must, among other things, develop and implement plans for the management of our assets to minimise the risks associated with the failure or reduced performance of assets. Under clause 5.2, we are required to use best endeavours to meet customers' reasonable expectations of supply reliability.

## 3.2 Asset condition

We apply the condition-based risk management (**CBRM**) methodology to certain plant-based asset classes, namely transformers, switchboards and HV circuit breakers. The CBRM model is an asset risk assessment algorithm that considers a range of inputs including:

- asset condition assessment data, such as routine maintenance data and defects;
- environmental factors, such as whether the assets are located indoors or outdoors, or coastal areas; and
- operating factors, such as the load utilisation, frequency of use and load profiles that the asset is supplying.

These factors are combined to produce a health index (HI) for each asset in a range from 0 to 10, where 0 is a new asset and 7 represents end of life. The HI provides a means of comparing similar assets in terms of their probability of failure (POF).

A HI profile gives an immediate appreciation of the condition of all assets in a group and an understanding of the future condition of the assets. We closely monitor assets with a HI in the range 5 to 7 to determine options for intervention, in the context of energy at risk. Interventions are prioritised when asset HI exceeds 5.5.

As part of the CBRM process, the consequence of failure of the asset is also calculated. The consequence of failure consists of four elements:

- network performance;
- safety;
- financial; and
- environment.

The risk is calculated by combining the POF of the asset and the consequence of failure of the asset. CBRM is used to calculate how the risk is likely to change in future years. In this way, the CBRM analysis provides:

- a preliminary indication of the likely optimum timeframe for an asset intervention; and
- a foundation or starting point for further detailed economic assessment.

The determination of the optimum timing for an asset intervention will be modelled in the Copperleaf (C55) model with detailed economic assessment.

## 3.3 11 kV switchboard and OCBs

The B ZSS switchboard and OCBs have been in service since 1965. In 2016, a disruptive failure of the B23 feeder circuit breaker resulted in damage to the no. 4 bus section, requiring the B23 and B24 circuit breakers to be decommissioned and their loads transferred to spare feeder positions. The decision to repair (and not replace) the switchboard was a practical response to the immediate problem of the reduced system security resulting from the unavailability of part of the switchboard. As the switchboard type is obsolete, the repairs had to be carried out using reclaimed parts from another decommissioned switchboard; as such there cannot be any form of manufacturer's guarantee for the repaired assets. In order to provide a level of assurance as to the integrity of the repaired insulation, a decision was made to install an EA Technology UltraTEV Monitor system onto the No.4 bus. This provides 24/7 monitoring of PD activity of this bus section.

The PD scan completed in 2021 on bus section 1,2 and 3 has detected three pitch filled cable boxes with low-medium level PD events. Whilst fit for service, these results indicate that the repairs are not long-term solutions. Other considerations that are relevant to the intervention of the switchboard and OCBs include:

- due to age, slow operation of an OCB during a fault clearance may result in damage to the bus and potential sustained interruption to customers;
- spare parts are no longer available for aged components, which means that any failure of a critical component will require re-engineering of the parts and delayed restoration;
- the CP/PAL asset strategy is to reduce the oil filled circuit breaker population and transition to Vacuum or SF6 type switchgear to maintain network reliability at minimum efficient cost and improve personnel safety;
- the existing high voltage switchboard is not arc fault contained or vented, therefore an arc failure of the switchboard or an OCB exposes personnel to safety risk, while other assets in the station will be exposed to the risk of consequential damage;
- the 11KV switchboard is air insulated but cable box construction is pitch filled. The cable box repairs are difficult and time-consuming. In event of a damage to the bus, the likely duration of the repair will require alternative supply arrangements for the affected customers until the repairs are completed; and
- a catastrophic failure of a 1-2 or 3-4 bus tie circuit breaker may result in a sustained outage to the customers connected on those bus sections, due to limited load transfer capability of neighbouring zone substations.
- The CBRM model has determined that HI of bus sections 1,2 and 3 will be rising to 5.34 and bus section 4 will be rising to 5.94 over the next 5 years. The HI of OCBs will be rising to 5.34 in the next five years.

## 3.4 66KV sub-transmission, Transformers and 11kV cables

The 66KV sub-transmission lines at B ZSS have not been modelled in our CBRM to predict their intervention timing. They are currently maintained with 6 yearly isolator and earth switch maintenance and yearly thermal imaging to identify defects. To date, there has not been a major intervention in relation to these assets. However, the possible addition of a third transformer to the B ZSS may require an upgrade of these assets to ensure they are able to withstand the capacity increase of the substation.

The CBRM model has determined that the HI of transformers 2 and 3 will be rising to 6.53 and 6.79 respectively in the next 5 years. Transformers 2 and 3 have been maintained and tested satisfactorily in 2021 and oil leak repairs undertaken. Annual oil analysis data indicates that the transformers will not require a further intervention during the current regulatory period.

11KV paper impregnated lead cables (PILC) from transformer 1 and 2 cable boxes to the switchboard incomers run through cable trenches under the transformer bay and the switch room. The routine cable inspection and tests have not indicated an intervention requirement. These cables have been terminated at existing switchboard incomers in pitch filled cable boxes. Replacing these old cables with XLPE cables would be required to suit the new air insulated cables boxes if the switchboard is replaced.

## 3.5 Protection and control equipment

B ZSS has a significant number of old electro-mechanical protection and control equipment in service from the 1960s. This equipment is limited in function and creates difficulty of replacement due to obsolescence. The existing protection relies on ageing supervisory controls with an increased risk of protection failure. Such failures would require the installation of modern equipment and costly modifications of existing secondary system to integrate with new equipment.

In addition to the above observations, the secondary equipment is installed on asbestos boards that require removal to eliminate personnel exposure to asbestos and to improve the safety standard across the sites.

## 3.6 Demand forecast and load at risk

B ZSS is forecast to remain a summer peaking substation, with forecast load growth reflecting its inner urban location. The load supplied by the substation is approximately 54% commercial, 30% industrial, with the remainder being residential.

B ZSS has Summer N-1 Cyclic rating of 29MVA and Winter N-1 Cyclic rating of 32.2MVA. For B ZSS Load forecast for next 10 Years refer to Figures 3 and 4 below. As noted in our Distribution Annual Planning Report (DAPR) 2020, we estimate that by 2025 there will be 5.7MVA of load at risk and for 50hrs B ZSS will not be able to supply all customers if there is a failure of one of the transformers.

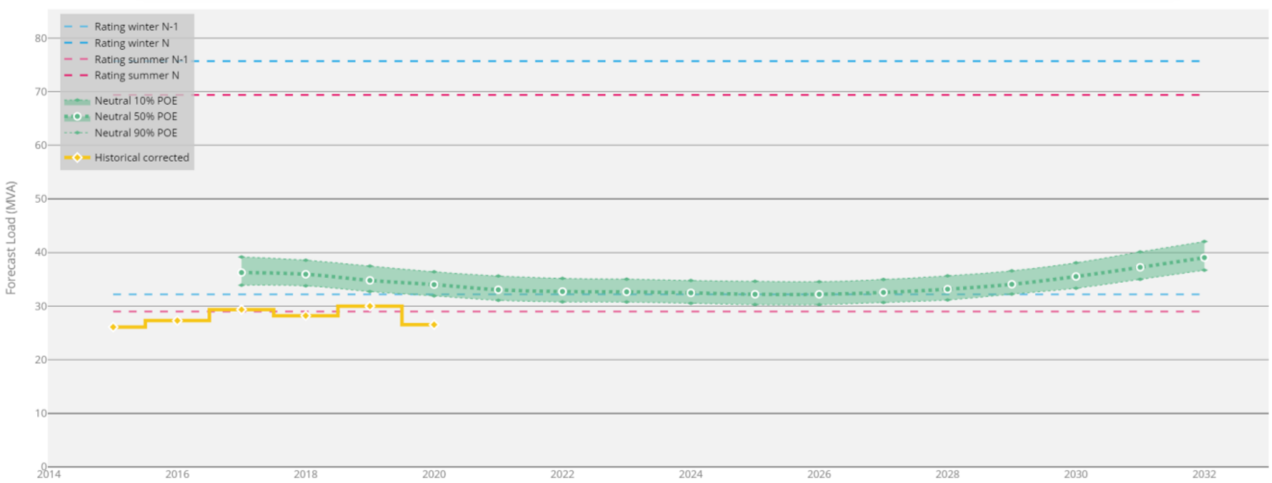
To address the anticipated system constraint at B ZSS, we consider that the following network solutions could be implemented to manage the load at risk;

- Contingency plan to transfer load away via 11kV links to adjacent ZSS of CW and NR up to maximum transfer capacity of 8.3MVA;
- Establish a 3rd Tx at B ZSS; and
- Establish an 11kV link with the ZSS in NR to permanently transfer load.

At this stage, our preferred option is to establish a 3rd transformer at B. However, given that the forecast annual hours at risk is low at 50hrs, this project is not expected to occur during the current 2021-26 regulatory control period. Although the expected demand will exceed the station's N-1 cyclic rating, the use of contingency load transfers will mitigate the risk in the interim period as B ZSS has up to maximum transfer capacity of 8.3MVA to CW ZSS and NR ZSS which can cover the approximately 5.7MVA of load at risk under N-1 in 2025.

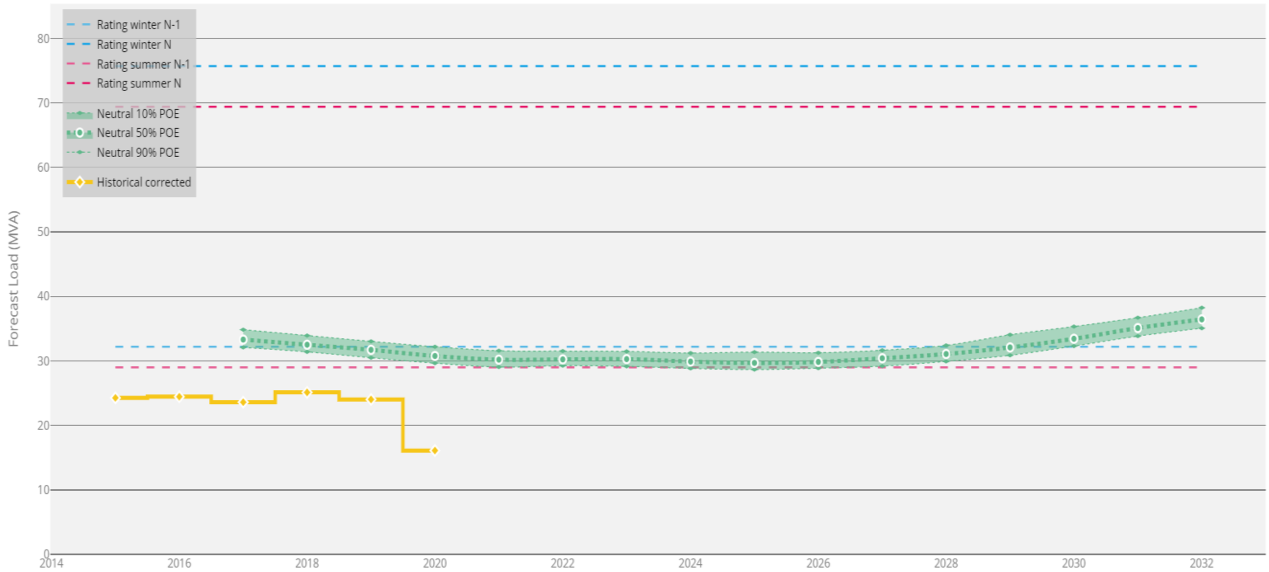
The Probability of Exceedance (PoE) demand forecast for Summer and Winter scenarios is shown in Figure 3 and Figure 4 respectively.

**Figure 3 B zone substation summer forecast demand**




Source: CitiPower Load Forecast Tool

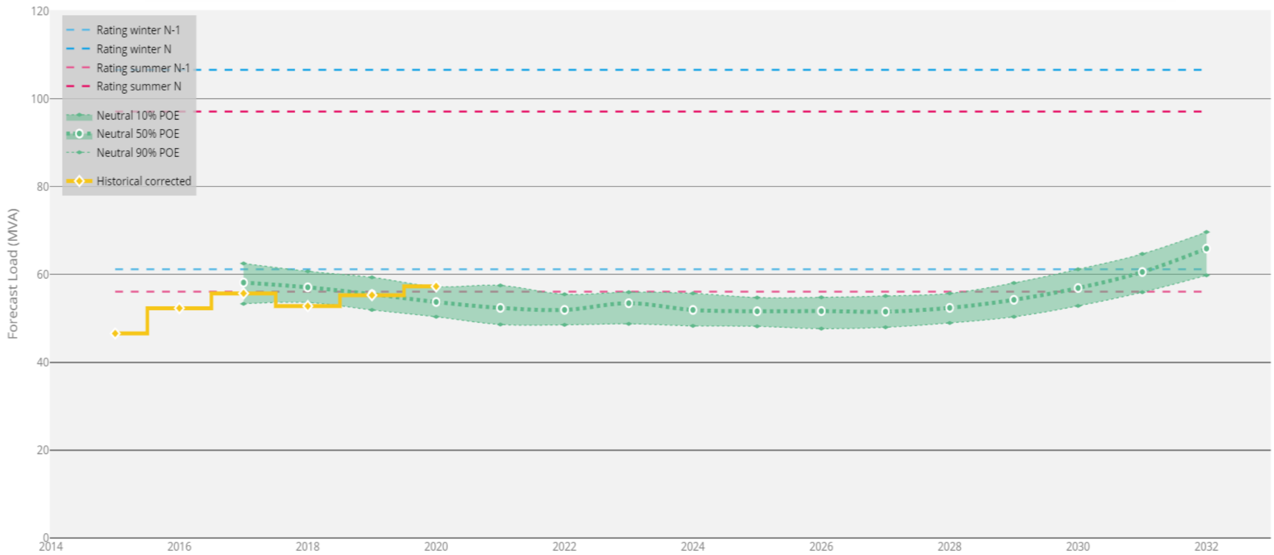
Figure 4 B zone substation winter forecast demand




Source: CitiPower Load Forecast Tool

The Probability of Exceedance (PoE) maximum demand forecast for neighbouring NR ZSS is shown in Figure 5.

Figure 5 NR ZSS maximum demand forecast




Source: CitiPower Load Forecast Tool

### 3.6.1 Load transfer capacity to adjacent substations

Existing contingency plans estimate that load transfers could be used at B ZSS to transfer approximately 8.3MVA via 11kV links to nearby CW and NR zone substations.

With summer peak demand of around 40MVA in 2032, the station N-1 rating at 29MVA and the use of 8.3MVA of load transfers would leave residual demand of nearly 2.7 MVA not met during the summer peak load. Potential demand management solutions may reduce this demand by up to 5MVA.

Accordingly, a third transformer at B ZSS is unlikely to be required during the 2021-26 regulatory control period, and may not be required in the subsequent period. Nevertheless, at this stage we consider it prudent to allow for three transformers in the station design.

# 4 Potential credible options

This section provides a description of the network options that have been identified as potentially addressing the identified need. In our RIT-D Draft Project Assessment Report, the assessment of these options will include a comparison of the net economic benefits compared to a ‘do nothing’ approach.

**Option 1: Replace existing switchboard in the same building using temporary load transfers to facilitate replacement in 2024 in stages**

The scope of work includes:

- install a transportable switchboard, and transfer distribution feeders and transformer incoming cables from the existing switchboard to the portable switchboard;
- relocate the transformer protection, communications and pilot wires;
- decommission and remove existing bus sections and secondary equipment in stages, including disposal of hazardous materials;
- install new bus sections and secondary equipment in stages, according to our technical standards for design and layout, and commission;
- transfer distribution feeders to the new switchboard; and
- reinstate the building and surroundings affected by work.

The total estimated cost of work is $8.3M. This option is considered to be feasible.

**Option 2: Refurbish the existing B switchboard**

The scope of work includes:

- shutdown bus sections in stages, inspect and test switchboard to assess integrity;
- overhaul, replace and/or re-engineer switchboard components as required; and
- retrofit existing OCBs with state-of-the-art new circuit breakers.

Although this option aligns with our strategy to replace old OCBs, it involves complexities associated with limited spare parts availability and the requirement to re-engineer critical components with potential delivery risks. We also note that the completed works may not be fully complied with arc fault containment standards. In order to complete the required works, B ZSS customers may need to be transferred away for a long period, which will expose neighbouring substations to increased load at risk. For these reasons, this option is not considered to be credible.

**Option 3: Offload B Zone substation to NR substation**

In order to completely offload B to NR a total of 15 feeders at B ZSS would need to be transferred across to NR in order to address the identified need.

This option is not a credible option, as the NR ZSS load forecasts indicate that the load will exceed N-1 capacity over next 10 years, as shown in Figure 5 in section 3.6. Installing a 4th Transformer at NR may not be sufficient to supply the full NR ZSS and B ZSS load under N-1 conditions.

In addition to the capacity issues, the estimated cost of this work is $14.6M , which is approximately double the cost of replacing the switchboard within the existing building at B. Whilst this option would address the identified need of removing the ageing switchboard, it is not cost effective.

# 5 Consideration of non-network options

The identified need at B ZSS is to address the increasing risks to safety and reliability of supply associated with the deterioration of the switchboard. In this case, we have concluded that there are no credible non-network options for the following reasons:

- non-network solutions, such as embedded generation, photo-voltaic cells or battery storage, would not provide a solution to the identified need, which is to address the deteriorated 11KV distribution switchboard at B ZSS;
- there is no opportunity to avoid the replacement of the switchboard by reducing peak load through demand management at B ZSS; and
- there is no opportunity to combine load transfers to adjacent zone substations with non-network options that would avoid the need for the required works at B ZSS.

# 6 Determination

For the reasons set out in this notice, pursuant to clause 5.17.4(c) of the National Electricity Rules, we have determined that there are no credible non-network options to address the identified need at B ZSS. Therefore, in accordance with clauses 5.17.4(c) and (d) of the National Electricity Rules, CitiPower will not be publishing a Non-network Options Report in relation to the proposed works at B ZSS.

We intend to publish the Draft Project Assessment Report in March 2022 in relation to this project, in accordance with clause 5.17.4(i) of the National Electricity Rules.