Ensuring Reliable Supply for the Adelaide CBD – Hindley Street

Options Screening Report

13 October 2025

SA Power Networks

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Disclaimer

This Options Screening Report has been prepared in accordance with clause 5.17.4(d) of the National Electricity Rules (NER) for the purpose of demonstrating why SA Power Networks believes there are no credible non-network options or standalone power systems (SAPS) available nor such options which form a significant part of a potential credible option to address the identified need.

This report makes use of historic non-network option costs and contains assumptions regarding, amongst other things, economic growth and load forecasts which by their nature, may or may not eventuate. SA Power Networks advises that anyone proposing to use this information should verify its reliability, accuracy and completeness before committing to any course of action.

Whilst care has been taken in the preparation of the information contained in this report, it is provided in good faith. SA Power Networks makes no warranties or representations as to its reliability, accuracy or completeness and 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.

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1 Introduction

Hindley Street substation is one of four critical zone substations supplying the Adelaide Central Business District (CBD) and is part of the meshed 66kV metropolitan east network. It is supplied via two 66kV cables, one from Whitmore Square and one from North Adelaide / Croydon.

The existing outdoor 66kV yard at Hindley Street is extremely congested, with overhead pipework structures, strung bus and three aged bulk oil Circuit Breakers (CBs) manufactured in 1954. These are the only three of this type of CB remaining in the network.

The age and condition of the existing switchgear poses a significant reliability and safety risk to both SA Power Networks' (SAPN) personnel and the public, with thousands of pedestrians passing every day within a few metres of deteriorated CB bushings and cable terminations. Catastrophic equipment failure, or failure with an explosion or fire, is likely to result in an extended substation outage with approximately 43MW of CBD load at risk. Only 21MW of the 11kV load can be tied away to other CBD feeders. Catastrophic failure is also a significant safety risk from an oil fire and porcelain debris.

SA Power Networks has therefore commenced this Regulatory Investment Test for Distribution (RIT-D) to determine the most efficient means of ensuring reliable supply for Adelaide's CBD in and around Hindley Street. Further, SA Power Networks expects there to be significant market benefits, principally in the form of avoided involuntary load shedding, and considers the identified need for this RIT-D to be delivering market benefits. In addition to market benefits, SA Power Networks expects there will be significant safety and environmental benefits from removing the aged, oil filled equipment.

The purpose of this options screening report is to inform all Registered Participants, the Australian Energy Market Operator (AEMO), Interested Parties, non-network service providers and parties on our demand side engagement register that SA Power Networks has determined that there are no credible non-network options or stand-alone power systems (SAPS) options that are able to address in full, or as part of a potential credible option, the identified need for this RIT-D. This report has been developed in accordance with clause 5.17(c) of the National Electricity Rules (NER) and represents the first formal stage of the RIT-D assessing how to most efficiently ensure reliable supply for the Adelaide CBD in and around Hindley Street.

The second formal stage of this RIT-D is a Draft Project Assessment Report (DPAR), which includes a full net present value (NPV) options assessment.

If you have any comments or enquiries regarding this report, please send to the following email: requestforproposals@sapowernetworks.com.au.

2 Background

2.1 The scope of this report

This project seeks to address the increasing risks to safety of personnel and public and reliability to customers in the Adelaide CBD due to the poor condition of the existing 66kV outdoor switchgear and equipment at the Hindley Street substation.

2.2 Regulatory context

We have a duty to take 'reasonable steps' to ensure that the distribution system is safe and safely operated (Section 60(1) of the Electricity Act) and to maintain and operate the distribution system in accordance with good electricity industry practice (NER Clause 5.2.1(a)). Further, under the National Electricity Rules (NER), we are required to maintain the quality, reliability and security of supply of standard control services and maintain the reliability, safety and security of the distribution system. These duties require us to have regard to objectively determined standards of safety.

Within the CBD, we are additionally subject to network reliability service standard targets set by the Essential Services Commission of South Australia (the Commission, or ESCoSA) in its Electricity Distribution Code (EDC).

3 Description of the identified need

This section describes the identified need for this RIT-D and sets out the key assumptions and methodologies that underpin this need. SA Power Networks has used these assumptions in making the determination that there will not be a potential credible non-network option or SAPS option on a standalone basis, or that forms a significant part of a potential credible option, capable of meeting this need, in accordance with clause 5.17.4(c) of the NER.

3.1 Our performance to date

Hindley Street 66/33/11kV Substation is one of four major zone substations supplying the Adelaide CBD 33kV and 11kV networks and is part of the meshed 66kV metropolitan east network. It is supplied via two 66kV cables, one from Whitmore Square and one from North Adelaide / Croydon. A 66kV cable from Hindley Street supplies the new Royal Adelaide Hospital.

Hindley Street substation consists of three 66/11kV transformers and one 66/33kV transformer. Refer to Figure 1 below for a simplified Single Lind Diagram (SLD). The 66/11 transformers supply an 11kV CBD forecast load of 43.6MVA. Less than half of this load can be offloaded to adjacent substations, leaving 22.7MVA at risk in the event of an entire substation outage. The 66/33kV transformer supplies a meshed 33kV network, with supply also from two transformers at East Terrace substation. The entire 33kV load can be supplied from East Terrace provided both East Terrace transformers remain in service.

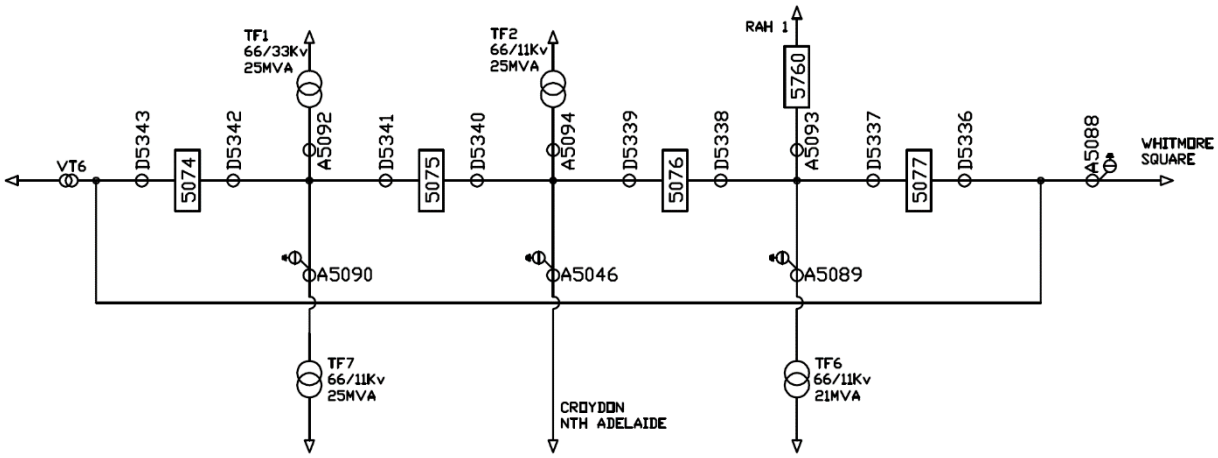

Figure 1: Simplified SLD of Hindley Street Substation

The outdoor 66kV switchyard comprises overhead flexible conductors, manually operated disconnectors with ground level operating levers and five 66kV circuit breakers. Three of the circuit breakers are a bulk oil type, in poor condition and have been in service for 70 years. Refer to Figure 2 (left).

The Substation is located close to the center of the Adelaide CBD in Hindley Street, with high pedestrian traffic directly outside the substation wall. Much of the outdoor switchyard is built above the wall height including bushings and cable terminations, posing a significant safety risk in the event of failure. Refer to Figure 2 (right).

Figure 2: Bulk oil CBs below disconnectors (Left), and close proximity to CBD Street (Right)

There are currently 15 recorded defects associated with 66kV disconnectors and 5 recorded defects associated with the 66kV bulk oil CBs. Defects include hot joints, cracked insulators, contacts not fully closed and CB oil leaks. The configuration of overhead buswork, congested layout and severely deteriorated disconnectors significantly limits the ability to isolate individual plant items. This results in deferral of maintenance and repairs and a further increase to safety and reliability risk. Accumulation of defects across multiple plant items is causing increasing risk to reliability and safety.

Failure of a single HV asset could rapidly escalate into catastrophic failure of the entire outdoor switchyard with a lengthy outage of the substation and significant CBD load loss. This is also a significant safety risk to both SAPN personnel and the public, being in a busy CBD street.

3.2 Drivers for change

The three 66kV bulk oil CBs are in poor condition after 70 years of service and increasingly likely to fail in the next 5 years. Typical service life for a CB in SAPN is around 55 years, refer to Figure 3 below. They already have the highest probability of failure of any High Voltage CB in the network, with a Health Index of 8.3[1].

[1] The Health Index for Circuit Breakers are listed within SAPN Circuit Breaker Asset Plan.

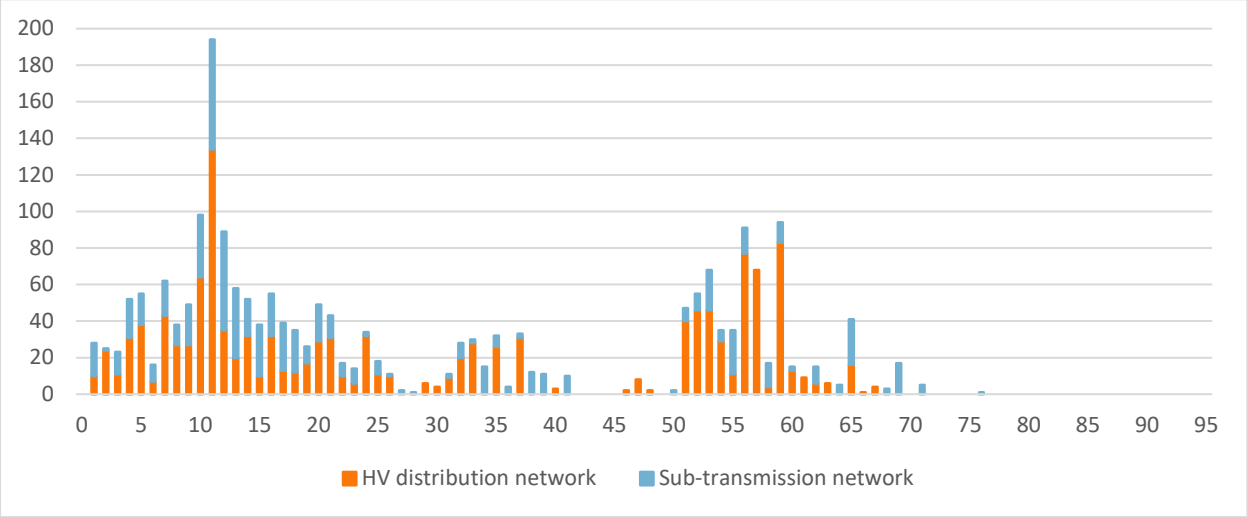

Figure 3: SAPN CB Age Profile

The overhead disconnectors are also in very poor condition, with some unable to be switched live. In most cases there is no direct repair or replacement option. Significantly more defects are forecast in the next 5 years, forcing interruptions to supply to access plant for critical defect repair and maintenance. Consequently, defect repair and maintenance are deferred, further increasing the risk of asset failure.

Future augmentation drivers also exist for the Hindley Street outdoor switchyard. These are unquantified owing to the uncertainty of their timing and include:

- enabling a future 66kV connection to a new CBD substation (nominally Eliza Street);
- enabling a future 66kV connection to the East Terrace substation; and
- meeting future 11kV or 33kV demand with additional transformers.

3.3 Industry practice

Replacing poor condition high risk CBs is common practice for Network Service Providers (NSPs). Typical service life in the NEM is significantly less than the 70 years of service the Hindley Street CBs have seen. Furthermore, most NSPs have either phased out or are near phasing out their populations of bulk oil circuit breakers; the same type as found at Hindley Street substation.

3.4 Safety Impact

Thousands of pedestrians pass by the Hindley Street Substation walls every day within a few metres of deteriorated CB bushings and cable terminations, many of which are above wall height. Catastrophic failure of any of these assets is a significant safety risk to the public from an oil fire and porcelain debris. Furthermore, much of the overhead outdoor switchyard has deteriorated to the point of being unsafe to operate live by SAPN personnel. Operational restrictions provide a means to manage this safety risk but have significant operational impact and do not fully remove the safety risk.

SA Power Networks acknowledges the safety impacts, when quantified with low likelihood, are small compared to reliability risk, though minimising safety risk is a top business priority.

3.5 Environmental Impact

All the Hindley Street 66kV bulk oil CBs are currently leaking oil. While the leak rates are slow enough to be manageable with oil top-ups, they're not practical to repair, while the leak rates are likely to increase as the CBs deteriorate further. Retrofit of oil containment is not practical, leaving the leaked oil to enter the soil, albeit in relatively low quantities.

SA Power Networks acknowledges that environmental impacts are not an assessment factor in the RIT-D process, though company policy is to minimise oil leakage.

3.6 Failure scenarios for the calculation of unserved energy

If investment is not undertaken, there will be significant unserved energy (USE) risk in SAPN's network because the asset condition will continue to deteriorate increasing the likelihood of CB failure. However, the extent of load at risk depends on the nature of the failure. SAPN has therefore considered two significant failure scenarios.

Scenario 1

A single CB (e.g., CB5076, refer to the SLD of Figure 1) fails in a non-catastrophic manner (i.e., without explosion or fire) that renders it unable to be returned to service. E.g., internal failure with the fault cleared via fast protection. In this example, the two adjacent CBs, CB5075 and CB5077, would operate to clear the fault.

Consequences

Immediate loss of 66kV lines to Croydon and RAH1, 66/11kV transformers 2 and 6. Transformer 7 will be the only 66/11kV transformer remaining in service, resulting in immediate loss of 9.91MW of 11kV CBD load.

The initial loss of 11kV load can be restored by staged switching to adjacent substations within 24 hours, leaving Transformer 7 operating at its emergency rating of 33.7MVA. If Transformer 2 or 6 cannot be restored, additional load would need to be transferred to adjacent substations to reduce the load on Transformer 7 to its normal rating.

Restoration of Transformer 2, 6, and the 66kV lines relies on successful isolation of CB5076 via disconnectors. Due to defects and the difficulty in accessing these disconnectors for repairs and maintenance, it may not be possible to operate these disconnectors. In this case, a larger forced interruption would be required to disconnect the CB by unbolting the connections.

Scenario 2

Explosive failure of one CB resulting in collateral damage to adjacent equipment, rendering the 66kV yard inoperable.

Consequences

Immediate loss of the entire Hindley Street substation; 43.61MW of 11kV CBD load.

The maximum load able to be transferred to adjacent substations is 20.85MW. This will be achieved by staged switching within 24 hours, leaving 22.76MW of unserved energy on the 11kV CBD network. Existing contingency plans will be enacted to establish a temporary overhead 66kV line to Transformer 2 via installation of poles along Hindley Street. Most pole footings for this contingency have already

been installed. Estimated construction time to enact this contingency is 2 weeks. Once Transformer 2 is restored there will be no unserved energy at risk.

The two scenarios have been assessed in accordance with SAPN's Risk Assessment Framework and are presented in Table 1 below.

Table 1: CB failure risk assessment

ID	Risk Scenario	Consequence Description	Consequence Category	Consequence	Likelihood	Risk Level
1	CB Failure (non catastrophic)	Multiple CBD feeders outage	Network	3 (Moderate)	4 (likely)	High
2	Catastrophic CB Failure resulting in damage to most of the 66kV yard	Entire substation outage, CBD feeder outages >24 hours	Network	4 (Major)	2 (unlikely)	Medium
		Multiple injuries to staff or public	Safety	4 (Major)	2 (unlikely)	Medium

3.7 Calculation of the unserved energy if action is not taken

The cost of unserved energy has been calculated using the following parameters:

Common parameters

- VCR = $47.69/kWh (using the AER's VCR method published December 2022, accounting for location and type of load supplied by the Hindley Street Substation)
- Mean probability of failure = 2035 (i.e. CBs 81 years old at mean time of failure)

Scenario 1 parameters

- Weighting of scenario 1 = 95%
- Full restoration of load within 24 hours via staged switching to adjacent substations
- Disconnectors able to be operated to allow isolation of the defective CB (required for restoration of 66kV lines and 66/11kV transformers.

Scenario 2 parameters

- Weighting of scenario 2 = 5%
- Restoration of 20.85MW load within 24 hours via staged switching to adjacent substations
- Temporary 66kV line installed in 2 weeks
- No damage to Transformer 2
- No damage to indoor equipment including the protection panels and 11kV switchboard.

Unserved energy for access, maintenance, and defect repair

Due to the deteriorating condition of the 66kV disconnectors, it's highly likely they will be unable to be safely operated while energised. This has become a recent increasing trend prompting an increase in Repex for Substation Disconnectors. However, in the case of 66kV disconnectors at Hindley Street substation, there is no direct replacement owing to the bus design and lack of space. There are 15 disconnectors in the 66kV bus with a total of 15 current defect notifications assigned. Typical defects are hot joints, contacts not fully closed and cracked insulators. Consequently, an increasing number

of the 66kV disconnectors require de-energisation prior to operating which interrupts supply due to a lack of capacity to transfer load to adjacent substations.

Routine CB maintenance is scheduled every 6 years, with 5 CBs on site. Assuming the maintenance and defect repair of all CBs can be bundled to minimise disruption, this would result in four 8-hour outages every 6 years for maintenance purposes. That is, one outage to isolate and earth a work area for maintenance, and another to restore every 3 years. The cost of unserved energy for these outages is averaged across the period.

The Hindley Street substation load duration curve is presented in Figure 4 below. In estimating the load at risk, SA Power Networks has used the average load from 2018/19 because more recent data does not accurately represent future loads due to the effects of COVID-19 and mild summers. 50% of the time the load is found to be at 37.7% or more of the peak load. This is used in the calculation of unserved energy for access, maintenance and defect repair.

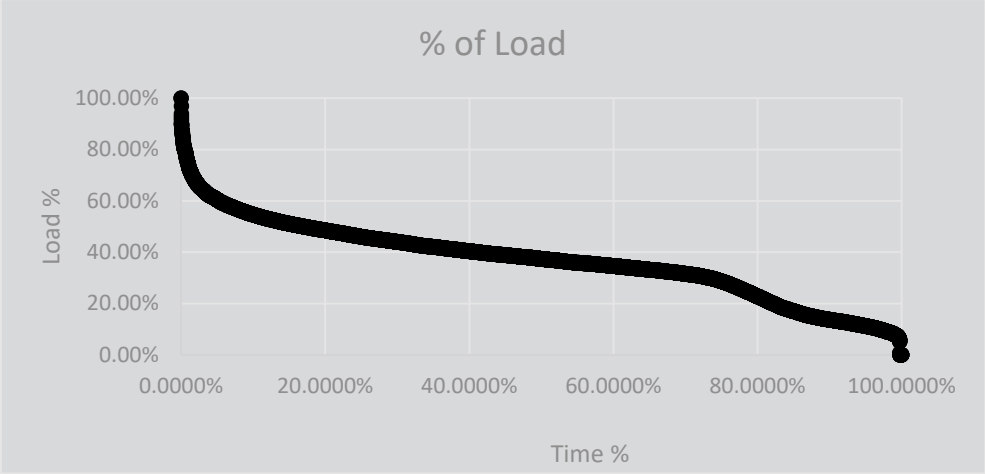

Figure 4 – Hindley Street Substation load duration curve (2018/2019 data)

Summary of Unserved Energy

A summary of the calculated unserved energy is presented in Table 2 below.

Table 2: Summary of unserved energy

ID	Unserved Energy
Scenario 1	9.91MW x 24 hours
Scenario 2	43.61MW x 24 hours 22.76MW x 168 hours
Access for maintenance and defect repair	22.76MW x 16 hours x 1/6 years

3.8 Responding to Customer Feedback

The Hindley Street substation 66kV switchyard is in very poor condition, a high failure risk and in need of replacement. The reliability risk is very significant, with up to 21MW of load unable to be supplied from an alternative substation. The safety risk is also very high to both our personnel and the public, being located close to the center of the Adelaide CBD with high pedestrian traffic.

In considering potential responses to this driver, we engaged with our customers on their desired service level outcomes balanced against price outcomes.[2] We also considered our applicable regulatory obligations / requirements. As a result of these considerations, the identified need is described as follows:

a. to respond to customers' concerns,[3] identified through our consumer and stakeholder engagement process, regarding their explicit service level recommendations that we:
   - maintain reliability service performance by geographic region;
   - invest sufficiently to maintain and improve CBD reliability to comply with ESCoSA's jurisdictional network reliability service standard target in 2025-30; and
   - maintain safety service performance in aggregate – driven by a desire to not see deterioration in the safety risk posed by the network;

c. to maintain the reliability service performance of our network; and

d. to maintain the safety performance of our distribution network in relation to the risks of harm to workers, and the community.

[2] This was undertaken in an aggregate way across all of our potential network asset replacement activity, with the specific circumstances of the Hindley Street Substation not covered directly.

[3] This is pursuant to Clause 6.5.7(c)(5A) of the NER, which requires regard to be had to the extent to which forecast capex seeks to address the concerns of distribution service end users identified by the distributor's engagement process.

4 Proposed network options to meet the identified need

4.1 The options considered

Two options were considered in addition to the base case of recurrent expenditure. Capex is $2025 exclusive of overheads.

Table 3: Summary of options considered

Option	Description
The base case – Business as Usual	Continue business as usual. Maintain equipment in accordance with established routines. Accept increasing risk of failure and the corresponding consequences of possible long-term loss of supply to a major portion of the CBD and potential serious injury or loss of life. Capital Cost: $0 (maintenance and refurbishment costs captured as BAU)
Alternative options	
Option 1 – New 66kV GIS Switchboard	Replace all existing outdoor 66kV switchgear and bus arrangement with a modern indoor GIS switchboard. This option will eliminate all the identified reliability and safety risks and provide a foundation for future augmentation, including increased meshing of the 66kV network via connections to East Terrace and the future City Central Eliza Street substation. Capital Cost: $32M
Option 2 – Discrete CB and Termination Replacement	This option includes replacement of the three aged CBs and a set of 66kV cable terminations, reducing the reliability and safety risk of a catastrophic failure. It does not remove the operational, safety and failure risks associated with the existing overhead bus and disconnectors, which are not practical to replace with a modern equivalent due to space limitations. Capital Cost: $5M

5 Assessment of non-network solutions and SAPS

SA Power Networks has determined that there is unlikely to be a non-network option or SAPS option that could form a potential credible option on a standalone basis, or that could form a significant part of a potential credible option for this RIT-D.

This section sets out the assessment behind this determination, which draws on the assumptions outlined in the sections above, and considers the required technical characteristics that a non-network option or SAPS option would need in order to meet the identified need.

5.1 Requirements that a non-network option or SAPS would need to satisfy

A viable non-network option or SAPS that maintains supply to the CBD must be capable of reducing the estimated shortfall in the supply capability of the network in the event of a failure of the Hindley Street 66kV switchyard. It should also be capable of providing the entire peak demand of the area to provide security of supply to the network as it operates in contingent conditions.

As discussed in section 3.5, there are number of failure scenarios that will affect the size of load reduction or additional supply required from a non-network option or SAPS option. SA Power Networks considers that any non-network option or SAPS option must be capable of alleviating the shortfall in supply in the worst-case scenario, i.e. Catastrophic CB Failure resulting in damage to most of the 66kV yard (Scenario 2). Non-network options or SAPS options must therefore be able to address this failure scenario to be able to address the identified need. Being able to address the complete loss of the Hindley Street 66kV switchyard would also ensure that any non-network or SAPS option could manage the other failure scenarios.

This section therefore focuses on the requirements that a non-network option or SAPS would need to satisfy in the event of a complete loss of the Hindley Street 66kV switchyard.

5.1.1 Requirements to address complete loss of the Hindley Street 66kV switchyard

Under Scenario 2, there will be an immediate loss of 43.61 MW of 11 kV CBD load and 22.76MW of unserved energy after staged switching over 24 hours. Any non-network or SAPS solution would need to be located within or geographically very close to the Hindley Street substation to have access to the 11kV cable network. This area of the CBD is highly congested and surrounded by universities, public buildings and high residential traffic sensitive to noise and other pollution.

5.1.2 Consideration of SAPS options

Recent changes to the NER, RIT-D and RIT-D application guidelines require SA Power Networks to consider whether a SAPS option can fully or partly address an identified need. In practice, this relates to consideration of whether an identified need could be fully or partly addressed by converting part of SA Power Networks' distribution network forming part of the interconnected national electricity system to a regulated SAPS.[4] Regulated SAPS are set out in section 6B of the National Electricity Law (NEL), which defines a SAPS as a system that:[5]

- generates and distributes electricity; and
- does not form part of the interconnected national electricity system.

SA Power Networks considers that there is not a SAPS option that could form a potential credible option on a standalone basis, or that could form a significant part of the credible option, in this RIT-D. In particular, the load requirements of the Adelaide CBD interconnected network are significant in a very small area where land is premium. This load could not be supported by a network that is not part of the interconnected national electricity system with the ability to draw on grid-connection generation services.

6 Conclusion

The Hindley Street substation is a critical node in the Adelaide CBD electrical distribution network. The condition of its switchyard has deteriorated to the extent that there is a material risk of asset failure, which has the potential to lead to significant levels of unserved energy for customers in the Adelaide CBD. Addressing these condition issues will avoid involuntary load shedding.

Based on the extent of load reduction or additional supply required in the event that there is a complete failure of the Hindley Street 66kV switchyard, non-network or SAPS options are not considered feasible in terms of forming a potential credible option on a standalone basis, or forming a significant part of a potential credible option for this RIT-D.

[4] See definition of 'SAPS option' in the NER.
[5] Section 6B(6) of the NEL.