Complying with the Voltage Management &Under Frequency Load Shedding Emergency Standards

Options screening notice

2 September 2022

SA Power Networks

www.sapowernetworks.com.au

Disclaimer

This Options Screening Notice 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 SAPS options, available nor such options which form a significant part of a potential credible option to address the identified need.

This notice 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.

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1 Purpose of this document

This options screening notice sets out the reasons why SA Power Networks considers that there will not be a non-network option, or a stand alone power system (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 the Voltage Management and Under Frequency Load Shedding Emergency Standards (VM&UFLS Emergency Standards) RIT-D, i.e., in accordance with clause 5.17.4(c) of the National Electricity Rules (NER).

It represents the first formal stage of the RIT-D assessing how to most efficiently comply with the VM&UFLS Emergency Standards. The second formal stage of this RIT-D is a Draft Project Assessment Report (DPAR) which includes a net present value (NPV) option assessment.

The introduction of the VM&UFLS Emergency Standards has been necessitated by the increase in the penetration of distributed energy resources (DER) in South Australia, and the impact that potentially presents for the continued security of power system operation. The prescriptive nature of the VM&UFLS Emergency Standards (ie, SA Power Networks is required to have specific network functionality at specific locations in the network) is the primary reason why non-network options are not able to form a viable credible option to meeting these standards.

However, SA Power Networks notes that the investments required to comply with the VM&UFLS Emergency Standards represent the foundational infrastructure required to address the issues being caused by DER – they will not solve the issues in isolation. Rather, these investments will provide a firm foundation for enabling non-network solutions to address future system security issues. By way of example, SA Power Networks is currently collaborating with the Australian Energy Market Operator (AEMO) to define a new Emergency Under Frequency Response (EUFR) service that would enable non-network options to offer this service to help support the network.[1] SA Power Networks is keen to engage with potential non-network proponents going forward, in addressing future network issues.

If you have any comments or enquiries regarding this notice, please make a submission to the following email: requestforproposals@sapowernetworks.com.au.

[1] More details of this initiative are available at: https://www.sapowernetworks.com.au/industry/tenders/.

2 The VM&UFLS Emergency Standards prescribe network investment

2.1 DER are causing system security issues for the South Australian distribution network

South Australia is at the forefront of the integration of DER in the National Electricity Market (NEM). There has been significant uptake in the extent of DER connected to SA Power Networks' distribution network, including significant growth in embedded generation such as solar PV connections.

The continued growth of DER will provide benefits for many South Australian consumers. Notwithstanding, high concentrations of DER can present serious power system security and security of supply issues for the South Australian grid if not addressed.

There are two separate but related issues currently facing the South Australian electricity grid due to high penetration of uncontrolled DER.

First, the high uptake of DER in South Australia has decreased minimum load demand, with zero operational demand conditions occurring multiple times over the last three years. A minimum amount of operational load demand is required for AEMO to maintain a secure electricity system when South Australia is operated islanded from the rest of the NEM. This lack of operational demand imposes operational risks on the system when there is a credible risk of separation of South Australia from the NEM. To continue to operate the system in a secure state it is necessary to curtail renewable generation with South Australia and place operational limits on the South Australia to Victoria interconnector flows. Without these controls the system faces stability challenges for both credible and 'non-credible' events such as interconnector separation.

SA Power Networks, along with other distribution network service providers (DNSPs) in the NEM, currently has no control over embedded generation installed at the household and small business levels. An emergency control scheme is therefore required to disconnect these rooftop solar inverters in a controlled manner when directed by AEMO. This issue is particularly pertinent in South Australia due to the NEM-leading levels of DER penetration in the distribution network.

Second, there are significant issues with the current implementation of the under-frequency load shedding (UFLS) mechanism used for managing system security. UFLS is an emergency frequency control scheme that operates as the last line of defence to managing severe frequency disturbances. It enables the disconnection of load to correct large supply-demand imbalances and reduces the likelihood of cascading failures when severe disturbances do occur.

Traditional UFLS schemes are not effective in the presence of high levels of DER generation for two key reasons:

- to be effective UFLS requires a net load available to shed to restore network frequency. However, significant growth of distributed PV has reduced the net load on the South Australia UFLS scheme, thereby reducing the load available to be shed; and
- UFLS schemes may exacerbate frequency decline when circuits are operating in reverse flows (i.e., where net load on the UFLS scheme is negative), because conventional UFLS schemes trip circuits without discrimination during frequency disturbances, where that load may be a net generator to the system – only serving to increase the prevailing load imbalance.

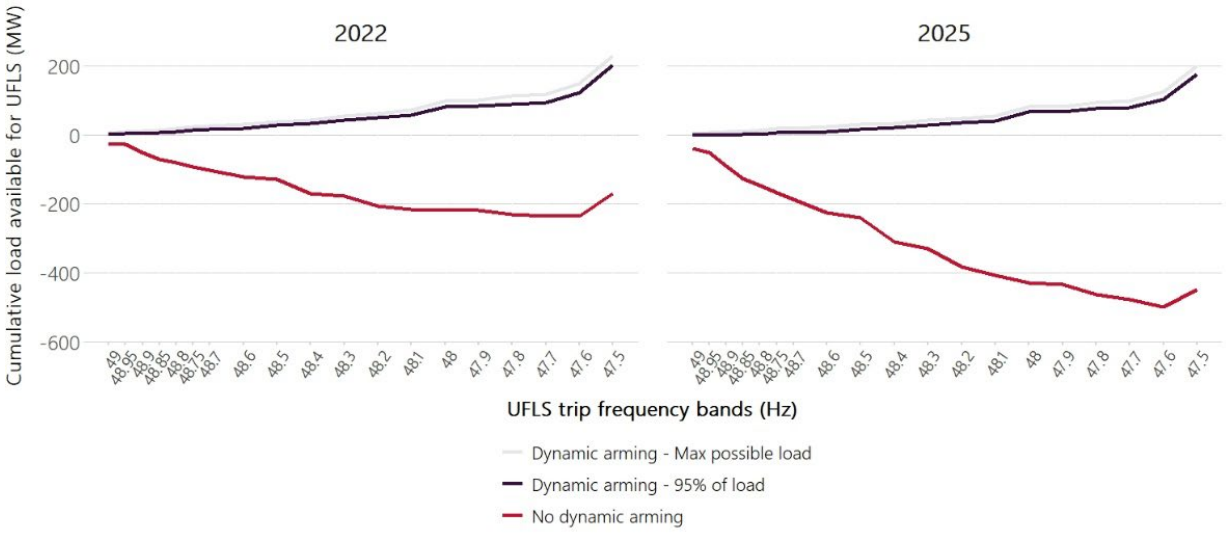
A consequence of these shortcomings of traditional UFLS schemes in the context of a high prevalence of DER is that they may escalate frequency disturbances and lead to system black events. Importantly, this risk is likely to grow because reverse flow conditions are increasing in incidence. SA Power Networks notes that over half of UFLS load blocks operated in reverse flow in some periods in 2020.

Figure 2.1 presents the cumulative load available for UFLS with and without the ability to selectively trip only those circuits that are operating as net loads, i.e. to dynamically enable and disable UFLS

depending on the direction of energy flow. This ability to enable and disable UFLS protection based on energy flow is referred to as Dynamic Arming.

It follows that without investment in capability to manage reverse flows under the UFLS scheme, projected increases in negative net load will increase system stability risks in South Australia.

Figure 2.1: Load availability for UFLS with and without dynamic arming

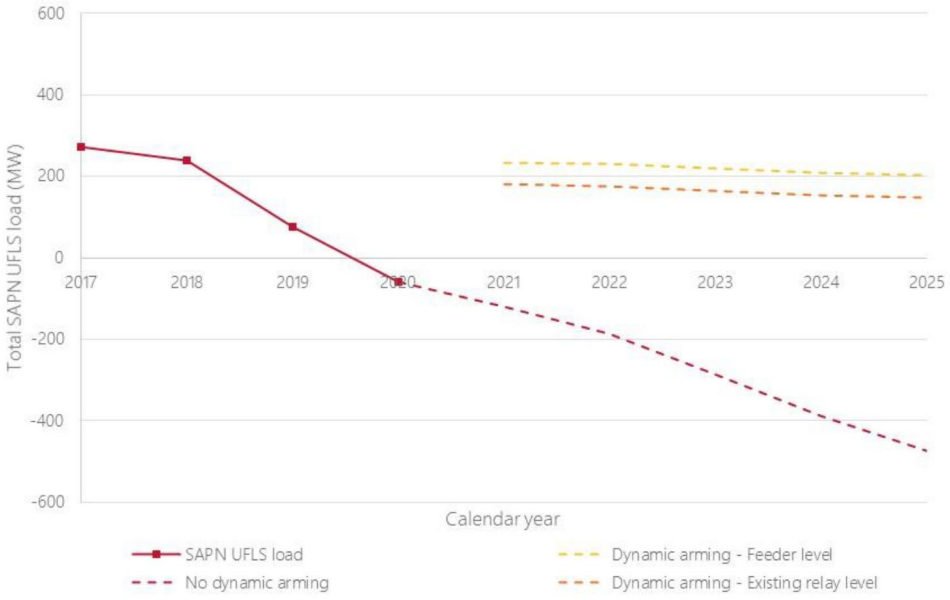


Source: AEMO, *South Australian Under Frequency Load Shedding Dynamic Arming Implementation investigation*, May 2021.

Figure 2.2 shows the total net UFLS load in South Australia on SA Power Networks' distribution network in the period of the lowest UFLS load.

In 2020, SA Power Networks' network experienced a negative net load of 60 MW – significantly hindering the ability of SA Power Networks' UFLS scheme to operate effectively. Under AEMO forecasts, this net load is projected to fall further to an estimated -120 MW to -360 MW in the lowest period in 2022.

Figure 2.2: Total SA Power Networks UFLS load in the lowest UFLS load period



Source: AEMO, *South Australian Under Frequency Load Shedding Dynamic Arming Implementation investigation*, May 2021.

2.2 New emergency standards have been introduced to address these issues

The lack of control at the distribution network level of DER generation, in combination with a power network originally developed for dispatchable generation, means that DNSPs are ill-equipped to ensure system security in the absence of tools to manage network flows from DER loads responsively.

In light of these concerns, the Office of the Technical Regulator in South Australia has prepared the "*Technical Regulatory Emergency Standards – Voltage Management and Under Frequency Load Shedding"* (VM&UFLS Emergency Standards), which were published on 21 December 2021.[2] Although prepared by the Technical Regulator, the VM&UFLS Emergency Standards are the outcome of an extensive process of research, modelling and industry consultation between SA Power Networks, AEMO and representatives from the Office of the Technical Regulator.

The VM&UFLS Emergency standards apply solely to SA Power Networks and have been designed to address two distinct power issues associated with DER. These are:

- the need for emergency capability to disconnect embedded generation including roof top solar quickly during periods of high DER generation coincident with low demand load, so as to maintain a minimum operational demand on the power system; and
- the need to facilitate load shedding during under-frequency emergency events while also ensuring circuits that are net generators of power are not disconnected.

To address these issues, the VM&UFLS Emergency Standards require SA Power Networks to:

- implement and maintain a scheme of last resort that enables the effective curtailment of DER via management of distribution network voltage levels. This scheme of last resort must be available to automatically control network voltages within the SA Power Networks electricity infrastructure listed in Appendix 2 to the VM&UFLS Emergency Standards;
- amend or install relays within the SA Power Networks electricity infrastructure listed in Appendix 3 to the VM&UFLS Emergency Standards, so that the relays have the following characteristics:
  - are able to measure the power system frequency;
  - have the ability to measure the direction of power flow with a minimum sampling rate of not less than one measurement every five minutes; and
  - are programmable such that they will only automatically disconnect a circuit in an under-frequency event if the circuit is a net load with respect to the overall power system; and
- amend or install relays within the specific SA Power Networks electricity infrastructure listed in Appendix 4 to the VM&UFLS Emergency Standards so that the relays have the following characteristics:
  - are able to measure the power system frequency; and
  - can disconnect feeders at such frequency as determined in consultation between SA Power Networks, the Technical Regulator and the Australian Energy Market Operator (AEMO).

[2] Regulation 55H(1) of Division 1A of the *South Australian Electricity (General) Regulations 2012* empowers the Technical Regulator to publish technical and operational standards that must be applied so that electricity infrastructure and electrical installations are installed, maintained and operated in a manner that facilities the taking of effective emergency action. These are referred to as emergency standards.

It follows from the above requirements that the VM&UFLS Emergency Standards place prescriptive substation site-specific requirements on SA Power Networks, i.e., they specify the installation or amendment of relays to provide specific functionality at specific substations and trip points within those substations (designated as either the feeder, bus, or line level within that substation site). SA Power Networks' existing network infrastructure does not satisfy these requirements. In particular:

- the substation voltage control relays were principally electromechanical relays that were incapable of receiving a remote controlled setpoint to adjust the substation voltage. These relays have required replacement with modern electronic equivalent relays to provide the necessary voltage control functionality;[3]
- the UFLS scheme currently in service principally uses relays that are incapable of measuring the direction of power flow and cannot be programmed to trip for a given direction of power flow – these relays will need to be replaced with modern electronic equivalent relays to provide the necessary functionality;
- many existing UFLS relays in service only operate at the bus level within the substation, or at the line exit of a transmission connection point, meaning for those substations that require feeder level tripping the existing relays will need to be removed from service and replaced with compliant protection relays on each of the specified feeder exits; and
- for those substation sites where there is an existing protection relay in service that meets the minimum requirements, it will need to be re-configured and re-commissioned to deliver the required functionality.

Investment in SA Power Networks' distribution network is therefore necessary to comply with the VM&UFLS Emergency Standards. Accordingly, SA Power Networks considers the identified need for this investment to be a 'reliability corrective action' under the RIT-D since investment is required to comply with an applicable regulatory instrument.[4]

Further, compliance with the VM&UFLS Emergency Standards requires network investment, i.e., amending or installing relays at specified locations in the network, due to the specific nature of the standard. SA Power Networks therefore considers that there will not be a non-network 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 the VM&UFLS Emergency Standards RIT-D. SA Power Networks also considers that identified need cannot be partially or fully addressed by converting parts of the distribution system into a regulated SAPS because of the prescriptive nature of the VM&UFLS Emergency Standards.

[3] SA Power Networks has already incurred this expenditure and it is currently subject to a cost pass through application to the AER. It has been included in this RIT-D to demonstrate that the voltage component comprises part of the preferred solution. The interaction between the cost pass through application and RIT-D process will be more fulsomely discussed in the DPAR.

[4] Reliability corrective action is defined in clause 5.10.2 of the NER, while applicable regulatory instrument is defined in chapter 10 of the NER.