Clean Energy Council submission to the AS/NZS 4777.2:2015 Proposed Changes

The Clean Energy Council (CEC) welcomes the opportunity to provide further feedback on the changes to AS/NZS 4777.2:2015, proposed by the Australian Energy Market Operator (AEMO).

The CEC is the peak body for the clean energy industry in Australia. We represent and work with hundreds of leading businesses operating in solar, wind, hydro, bioenergy, marine and geothermal energy, energy storage and energy efficiency along with more than 6,500 solar installers. We are committed to accelerating the transformation of Australia's energy system to one that is smarter and cleaner. We have a co-regulatory role, managing voluntary industry codes in conjunction with the Clean Energy Regulator (CER) and various state and territory government agencies.

The CEC has previously provided feedback to AEMO and members of the Standards Australia committee that is responsible for AS/NZS 4777.2. A copy of the CEC submissions (dated 10 May and 24 June 2019) are attached.

Based on the discussions since June 2019, the CEC wishes to provide additional feedback on the AS/NZS 4777.2 Proposed Changes, outlined in this submission. The additional feedback relates primarily to the proposed default settings (also known as 'country codes') and their voltage set points. We also reiterate feedback previously provided with respect to DC switch disconnector requirements and residual current devices.

The CEC has appreciated the ongoing engagement from AEMO regarding the proposed revisions to AS 4777.2. We would be very pleased to arrange a workshop with CEC members in 2020, where these and other issues could be explored in depth.

1. Default settings

The CEC welcomes the proposal for four default settings under the revised AS/NZS 4777.2, comprising one setting for each of:

- The National Electricity Market (NEM),
- The South West Interconnected System (SWIS),
- New Zealand distribution networks, and
- islanded networks.

Currently, there are seven unique sets of power quality settings required by Australian distribution network service providers (DNSPs) and four DNSPs have not yet decided on their mandatory power quality settings (see Attachment 1). Reducing the number of power quality settings to three across Australia (with one for NZ) will simplify grid connection, enable manufacturers to supply the Australian market with appropriately pre-set inverters and thereby reduce the incidence of installation non-compliance with respect to power quality settings.

CEC members have expressed concerned regarding the proposed upper settings for Volt-var response, which might not reflect the actual conditions experienced on Australian networks. The AEMO proposal is for the Volt-var response for high voltage to be set at 253 V. However, currently mandated Volt-var settings for high voltages include 258 V on the Ausgrid, Energex and Ergon Energy networks; and 260 V on the Endeavour Energy network; 265 V on the Horizon Power network. The higher voltage settings could reflect the DNSPs' understanding of the voltages on their networks. Many DNSPs experience high voltages, even at night when solar exports cannot be blamed for creating the voltage issues. There are concerns that the performance of distributed energy resources (DER) could be very adversely affected if they are installed using the proposed settings on parts of the network that experience sustained high voltage. This risk could be assessed by considering the performance of inverters on parts of networks known to experience sustained high voltage (even at night) where the DNSP has adopted mandatory power quality settings close to those proposed for the revised standard. The Victorian DNSPs' settings are closest to those proposed in the revised AS/NZS 4777.2.

The proposed default settings for power quality modes would require 44% vars delivered by assets in low quality network areas. This would have a significant impact on system use in those areas and would adversely and unfairly affect customers connected to network areas that consistently operate at relatively high voltages. If this requirement is implemented without remedial changes to the relevant part of the distribution network, then DER assets will be required to manage existing network issues. This highlights the need for a broader consideration of voltage management on distribution networks and the extent to which 'smart' inverters can be expected to manage voltage issues. In other regulatory reviews and processes the CEC has called on regulators to audit DNSPs' implementation of the full range of voltage management strategies need to improve hosting capacity.

2. Battery-specific requirements

The battery-specific clauses for frequency disturbance ride-through events would autonomously direct batteries to charge and discharge based on over/ under frequency. This would be an opportunity cost for virtual power plants (VPPs) and a direct financial cost for self-consuming customer who are directed to charge.

Standards should not mandate free provision of services where a market for those services is already under development, as is the case with VPPs. Markets for distribution-level services is an active area of policy development in Australia. To ensure that the development of markets for distribution level DER services is not hampered unnecessarily the CEC recommends that storage inverters should be treated the same as other inverters and switch off. This could potentially be revisited when in the review of AS 4777.2 that is expected to commence in 2022, after the completion of the current review. By that time, we would expect that the market framework for distribution level services would be better developed and there would no longer be a need for the battery-specific clauses proposed.

3. DC switch disconnector requirements

AS/NZS 5033 covers installation and safety requirements for PV arrays. This includes the selection of components such as wiring, isolation and protection, as well as the method of installation to connect these components to the Power Conditioning Equipment (PCE).

An important safety feature specified in this Standard is the DC switch-disconnector, which is provided to isolate the PCE from the array, such that maintenance of the PCE is possible without electrical hazards.

AS/NZS 5033:2014 Clause 4.4.1.2 gives the installer one of the following options to meet their obligations:

1. Selecting a separate DC isolator and mounting it beside the PCE; or
2. Choosing a PCE with an integrated DC isolator that meets the requirements of AS/NZS 5033.

If the installer meets their safety obligations through the second option – installing a PCE with an integrated isolator – they are relying on the product manufacturer to meet the requirements of an installation standard. Manufacturers can declare that they have met the installation standards, but they are not required to prove it in the same way they would if it were in a product standard. The procedure for demonstrating compliance with the requirements of AS/NZS 5033 are not clear enough.

The CEC proposes that the requirements in AS/NZS 5033 for switch-disconnectors that are installed within PCE enclosures, be transferred into AS/NZS 4777.2. This would ensure that product manufacturers are fully responsible for the safety of integrated DC disconnectors. In addition, it will allow integrated DC disconnectors to be assessed as part of the type-testing and certification process for inverters.

The technical content will be the same as in the recently amended AS/NZS 5033 (particularly Clauses 4.3.3.4, 4.3.3.5 and 4.3.3.6), and the CEC will work with AEMO to incorporate this information into AS/NZS 4777.2.

4. Residual current devices

Residual current devices (RCDs) are mentioned many times in AS/NZS 4777.2. Inverter energy systems with PV arrays require residual current detection, in accordance with IEC 62109. Clause 9.2.5 of AS/NZS 4777.2 gives inverter manufacturers one of the following options to meet the requirement:

1. Instructing installers to install external RCDs; or
2. Making a Residual Current Monitoring Unit (RCMU) integral to the inverter.

Installers following The Wiring Rules (AS/NZS 3000) may also be required to install an RCD to protect the inverter circuit cable he/she has installed, regardless of the internal protection of the inverter.

Manufacturers are not obliged to nominate the type and rating of RCDs compatible with their inverters if they have integrated an RCMU. The internal characteristics of the inverter may affect the way in which the RCD works, so the installer needs this information to meet their obligations. Installers calling the CEC's technical hotline have asked the CEC to help get manufacturers to pass on this information, so that they can choose the correct RCD for the job.

The CEC proposes that AS/NZS 4777.2 requires manufacturers to nominate compatible RCD types and ratings for all inverters, so that installers who use additional RCDs to meet AS3000 requirements can select types that will operate with the inverter.

It should be noted that there are some circumstances (especially for multi-mode devices) where AS/NZS 4777.1 does not support the use of external RCDs as a substitute for mechanical protection.

Relevant clauses will need to be drafted in a way that does not contradict, or conflict with existing requirements.

5. Ride through requirements

The proposed settings are designed around increased ride through of faults and therefore inverter will be connected and/or energised where previously it would have tripped. The CEC has received feedback from DNSPs expressing concern regarding the potential for an island to be sustained. They have proposed that due to the increase to the non-detection zone, it would be prudent to undertake a probability assessment of how often an island would be sustained so that the analysis can be used for a safety risk assessment.

The Voltage Disturbance Ride-Through requirements states “205 < V < 260 Continuous, uninterrupted operation”. However, there is a current requirement to trip when average voltage is greater than 258 V for 10 minutes. Further clarification is required to understand how these requirements are supposed to be implemented.

6. ‘Cease to energise’ requirements

The CEC requests clarification of what “Cease to energise” means, beyond no current flowing, therefore no active or reactive power from the inverter. For example, does “cease to energise” also mean that power electronic commands for P&Q firing are blocked? Will “Cease to energise” requirements create an extra step in isolation and disconnection processes that will require clarification across the hierarchy of controls? Does the “Cease to energise” requirement have any bearing on the DRM0 function? Under the proposed changes, would a hybrid storage system that is isolated from the grid due to an outage or DRM0 activation be allowed to charge from PV generation and/or supply power to back-up loads?

7. Tracking of software and firmware versions and updates

Software and firmware version tracking and updates are a key area of non-compliance with the current standards, due to inadequate requirements in IEC 62109. From the results of the CEC in-market test program so far, 9 out of 14 inverters tested (64%) failed the passive anti-islanding requirements of AS/NZS 4777.2. In all cases of non-compliance, there has been a failure to adequately track version changes to software. Likewise, there has been inadequate evaluation of the consequences of changes made. In a number of cases, the inverter does not display a true version number, but shows a “shell” version number.

Changes to software can completely alter the compliance of an inverter, and uncontrolled changes should be made easy to track to ensure compliance. CEC recommend the following specific measures:

1. The Standard should include clear definitions of the following terms:

   a. “Software Version” or (firmware version) to capture all changes which may affect compliance to the Standard.

   b. A “Software changelog” document which maintains a record of relevant software changes, and associated date and version number.

2. New clause(s) under General Requirements specifying the requirements for evaluation, tracking and reporting of changes to software. Software version to be specified on the test report. An accurate changelog to be maintained by manufacturer. Reporting may be via screen display &/or through the normal inverter communications protocol.

3. Clause 7.8 “Security of Protection Settings” requires a subclause dealing with manufacturer changes to protection settings.

4. Clause 7.8 also requires a subclause dealing with changes to AS/NZS 4777.2 settings which may be required by a DNSP.

It is acknowledged that manufacturers apply many software and / or firmware changes to inverter products for functions such as monitoring, data gathering or control, which do not affect the product's compliance.

Attachment 1 – Power Quality settings

Suppliers of inverters to Australia have almost completely transitioned to ‘smart’ inverters:

- The Clean Energy Regulator has estimated that about 96 per cent of all inverters installed in 2019 have Volt-Watt and Volt-var capability,
- Effective from 1 November 2019, all new applications for listing an inverter on the CEC Approved Product List must demonstrate Volt-Watt and Volt-var capability, and
- By 1 May 2020 all inverters currently on the CEC Approved Products List must demonstrate Volt-Watt and Volt-var capabilities or they will be delisted.

Australian Standards require default disablement of Volt-var capability unless the distribution network service provider (DNSP) grid connection rules specify otherwise. The review of the relevant standards, which is currently underway, is likely to recommend default enablement. The CEC has supported this proposed approach; however, it could be quicker and simpler if DNSPs simply amend their grid connection rules appropriately.

Table 1 summarises progress to date with DNSP grid connection rules. Tables 2 to 8 describe the details of the various DNSPs’ requirements for Volt-Watt and Volt-var settings.

Table 1 – Progress with DNSP grid connection rules re Volt-Watt and Volt-var capability

DNSP	Grid connection rules with respect to Volt-Watt and Volt-var capability
Ausnet Services, Jemena, Citipower, Powercor and United Energy	Mandatory for grid connection
Energex and Ergon Energy	Mandatory for grid connection
SA Power Networks	Mandatory for grid connection
Ausgrid and Endeavour Energy	Mandatory for grid connection
Horizon Power and Western Power	Mandatory for grid connection
NT Power and Water	Not yet mandatory
Evoenergy	Not yet mandatory
TasNetworks	Not yet mandatory
Essential Energy	Not yet mandatory

Tables 2a to 2c – Mandatory settings for Victorian DNSPs

Table 2a: Mandatory volt-var response mode settings

Reference	Voltage (V)	Var % rated VA
V1	208	44% leading (exporting vars)
V2	220 (default)	0%
V3	241	0%
V4	253	44% lagging (sinking vars, 3.7% per volt, 0.9 power factor)

Table 2b: Mandatory volt-watt response mode settings

Reference	Voltage (V)	Var % rated VA
V1	207 (default)	100% (default)
V2	220 (default)	100% (default)
V3	253	100% (default)
V4	259	20% (default, 5.3% per Volt)

Table 2c: Sustained operation for voltage variation

Reference	Voltage (V)
V nom-max	258

Tables 3a to 3c – Mandatory settings for Queensland DNSPs

Table 3a: Mandatory volt-var response mode settings

Reference	Voltage (V)	Var % rated VA	Power factor
V1	207	44%	0.9 leading
V2	220	0%	1
V3	240	0%	1
V4	258	60%	0.8 lagging

Table 3b: Mandatory volt-watt response mode settings

Reference	Voltage (V)	Max value (P/P_{rated}), %
V1	207	100%
V2	220	100%
V3	253	100%
V4	260	20%

Table 3c: Sustained operation for voltage variation

Reference	Voltage (V)
V nom-max	258

Tables 4a to 4c – Mandatory settings for SA Power Networks

Table 4a: Mandatory volt-var response mode settings

Reference	Voltage (V)	Var % rated VA
V1	207 (default)	31% leading (sourcing vars, 2.4% per Volt)
V2	220 (default)	0%
V3	248	0%
V4	253	44% lagging (sinking vars, 8.8% per volt)

Table 4b: Mandatory volt-watt response mode settings

Reference	Voltage (V)	Var % rated VA
V1	207 (default)	100% (default)
V2	220 (default)	100% (default)
V3	250 (default)	100% (default)
V4	265 (default)	20% (default, 5.3% per volt)

Table 4c: Sustained operation for voltage variation

Reference	Voltage (V)
V nom-max	258

Tables 5a to 5c – Mandatory settings for the Ausgrid network

Table 5a: Mandatory volt-var response mode settings

Reference	Voltage (V)	Var % rated VA	Power factor
V1	207	60% leading	0.8 leading
V2	220	0%	1
V3	248	0%	1
V4	258	60% lagging	0.8 lagging

Table 5b: Mandatory volt-watt response mode settings

Reference	Voltage (V)	Max value (P/P_{rated}), %
V1	207	100%
V2	220	100%
V3	248	100%
V4	258	20%

Table 5c: Sustained operation for voltage variation

Reference	Voltage (V)
V nom-max	258

Tables 6a to 6c – Mandatory settings for the Endeavour Energy network

Table 6a: Mandatory volt-var response mode settings

Reference	Voltage (V)	Var % rated VA
V1	207	60% export[1]
V2	220	0%
V3	248	0%
V4	260	60% import[1]

Table 6b: Mandatory volt-watt response mode settings

Reference	Voltage (V)	Var % rated VA
V1	207	100%
V2	220	100%
V3	255	100%
V4	265	20%

Table 6c: Sustained operation for voltage variation

Reference	Voltage (V)
V nom-max	258

[1] If the inverter is not capable of 60% reactive power (0.8 power factor) adjustment then it shall be set to the limit of the inverter capability which shall be at least 30% or greater

Tables 7a to 7c – Mandatory settings for the Horizon Power network

Table 6a: Mandatory volt-var response mode settings

Reference	Voltage (V)	Var % rated VA
V1	207	60% leading
V2	230	0%
V3	240	0%
V4	265	60% lagging

Table 6b: Mandatory volt-watt response mode settings

Reference	Voltage (V)	Var % rated VA
V1	207	100%
V2	220	100%
V3	254	100%
V4	265	20%

Table 6c: Sustained operation for voltage variation

Reference	Voltage (V)
V nom-max	258

Tables 8a to 8c – Mandatory settings for the Western Power network

Table 8a: Mandatory volt-var response mode settings

Reference	Voltage (V)	Var % rated VA
V1	205	30% (vars source)
V2	220	0%
V3	235	0%
V4	250	30% (vars sink)

Table 8b: Mandatory volt-watt response mode settings

Reference	Voltage (V)	Var % rated VA
V1	207	100%
V2	220	100%
V3	250	100%
V4	265	20%

Table 8c: Sustained operation for voltage variation

Reference	Voltage (V)
V nom-max	258

Tables 9a and 9b – Mandatory NEM-wide settings proposed by AEMO for AS 4777.2

Table 9a: AEMO proposal for mandatory NEM-wide volt-var response mode settings

Reference	Voltage (V)	Var % rated VA
V1	208	44% (leading)
V2	220	0%
V3	241	0%
V4	253	44% (lagging)

Table 9b: AEMO proposal for mandatory NEM-wide volt-watt response mode settings

Reference	Voltage (V)	Var % rated VA
V_{W1}	253	100%
V_{W2}	260	20%