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4 November 2022

Anna Collyer
Chair
Australian Energy Market Commission
GPO Box 2603
Sydney NSW 2000

By online submission

Dear Ms Collyer,

Consumer Energy Resources Technical Standards Review

AEMO welcomes the opportunity to provide a submission to the AEMC's consultation paper on its Review into consumer energy resources (CER) technical standards.

AEMO strongly supports this review as it is extremely relevant and timely given the rapid transformation towards a decarbonised, decentralised and democratised energy future. Appropriate technical standards and governance frameworks are essential for the integration of distributed energy resources (DER) on to the power system in a way that ensures consumer benefits are fully realised, and the secure, efficient and affordable operation of the National Electricity Market (NEM).

This submission discusses:

- the context and scope of the review which needs to take a broad view;
- the current compliance with technical standards;
- the need to enhance the overall governance framework as well as compliance and enforcement arrangements.

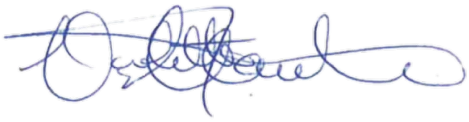
In AEMO's view the scope of this review must capture consumer and commercial grade CER/DER devices, must account for future technical standards requirements (i.e. interoperability) and must recognise the interactions between the National Electricity Rules (NER), jurisdictional and other frameworks. This review should consider and clarify roles and responsibilities under the governance framework, attributing roles and responsibilities to those parties best placed to perform functions commensurate with their capabilities and manage the risks. It is important to acknowledge that there may be limitations with respect to the extent that the AEMC can recommend roles and responsibilities be assigned to particular parties. As such this review may need to contemplate and leverage other mechanisms to clarify accountabilities.

AEMO identifies a number of measures to improve compliance outcomes particularly at the point of installation where most compliance issues arise, enhanced compliance monitoring as well as rectification and enforcement options. Fit-for-purpose technical standards and governance frameworks that drive a better compliance culture are essential given the potential implication of non-compliance on a larger scale.

AEMO would welcome the opportunity to discuss this submission and be involved in further consideration of the DER technical standards governance arrangements, given the material impact on system security, and energy markets.

Should you wish to discuss any of the matters raised in this submission please contact Kevin Ly, Group Manager, Reform Development and Insights on kevin.ly@aemo.com.au.

Yours sincerely,



Violette Mouchaileh
Executive General Manager – Reform Delivery

Attachment

Attachment

1. DER and CER terminology

Consumers' changing and increasingly important role in the energy transition, has prompted the use of separate terminology for household resources via the term 'CER'. However, with respect to related technical standards, it is AEMO's recommendation that the terminology and scope of this review encompasses CER as a subset within DER. In other words, it is critical that the technical standards and governance framework recognise and provide for all CER/DER.

DER has a broader meaning that includes CER and, additionally, encompasses other connection types beyond households such as commercial, small industrial and medium voltage connections at the distribution network and less than 5 MW. These additional categories are important to include in the context of relevant technical standards in the National Electricity Rules (NER) and compliance with them. Narrowing the scope of the review to only CER would leave a material gap in regulatory arrangements that would need to be addressed by a separate future review. Given the opportunity to consider regulatory arrangements for all generators less than 5 MW within a single review and to apply a consistent approach, this would seem to be a more efficient pathway and one that also support compliance objectives.

For these reasons, the term DER has been used throughout this submission encompassing all generation up to 5 MW including CER.

2. Context and Scope: DER Technical Standards

The NEM has experienced a rapid growth of DER uptake over the last decade that is expected to continue into the foreseeable future. DER already represents as much as 92% of generation at times in South Australia and 34% NEM wide. To date, the importance of DER technical standards has been observed across the NEM, with the development of the AS/NZS 4777.2:2020 (the 2020 Standard) seen as instrumental to addressing power system security risks identified by AEMO. Specifically, AEMO identified that distributed photovoltaics (DPV) systems (and by extension any energy system connecting to the LV grid via an inverter) can disconnect in response to power system events[1], exacerbating contingency sizes, and representing an increasing risk as DPV penetration in the NEM continues to grow. AEMO proposed a review of the AS/NZS4777.2:2015 (the 2015 Standard) to address the disconnection risk and incorporate other power system and network integration functions.[2] This Standard was specifically selected to deliver enhanced disturbance withstand capabilities, as it offered an established product testing framework including roles and responsibilities that would suitably ensure the performance of millions of consumer and commercial grade DER devices.

AEMO notes that, beyond the performance and capability of the device, it is also important that these systems are correctly installed and configured to comply with technical standards when connected to the NEM. As such, AEMO strongly agrees that the focus of the review be on the compliance with, and enforcement of, DER technical standards, including associated roles and responsibilities.

AEMO suggests that, within the scope of the review, it should also keep in mind the growing volume of medium voltage DER connections, the changing role and nature of loads (such as hot water and electric vehicles), as well as new requirements as DER becomes more active and provides broader power system and market services (e.g. relating to interoperability at the device level, communication, and cybersecurity frameworks).

[1] AEMO Report - Behaviour of Distributed Resources during Power System Disturbances - May 2021
[2] AEMO Report -Technical Integration of Distributed Energy Resources - April 2019

3. Compliance with DER Technical Standards

At present, the DER technical standards refer to AS/NZS4777.2:2020 as referenced in Chapter 5A of the NER, which entails an obligation that they be complied with, and that such compliance be monitored and enforced as necessary.

Because of this and the importance of the new disturbance withstand capabilities, as incorporated in the 2020 Standard, AEMO implemented an ongoing program of work to monitor the behaviour of distributed inverters installed based on this new Standard. Through this program, AEMO has identified that approximately 65% of systems installed during Q1 2022 were non-compliant with the DER technical standards, with installers selecting the preceding 2015 Standard when commissioning new DER systems. Further details on these findings have been shared in the Appendix to this submission.

The analysis to date suggests that non-compliance primarily occurs at the time of installation, with installers selecting the incorrect standard, made possible by the retention and availability of legacy and international grid codes on DER inverters. This varies considerably between different manufacturers, suggesting that manufacturers have considerable influence over this process by implementing menu selection options, delivering devices with up-to-date firmware and other processes that mitigate the likelihood of installer error. Given the potential risk to power system security, in the short-term, AEMO has pursued a number of mitigating strategies and activities including the development of an installer training course[3], discussions with manufacturers to encourage improvement of their installation processes and options, and a proposed amendment to the 2020 Standard[4].

Non-compliance with technical standards has significant implications on the way in which AEMO manages the power system. For example, if a large proportion of inverters continue to demonstrate poor disturbance withstand capabilities, AEMO will need to manage increasingly large credible contingency sizes during periods of high DPV generation. This may result in:

- Considerable reductions in the transfer limits on interconnectors, affecting market operation and increasing market costs.
- In extreme periods, contingency sizes related to DPV may become so large that the limits on interconnectors may violate and AEMO will need to direct Network Service Providers to curtail DPV because there are no other options available to maintain power system security.
- Difficulties allowing planned outages to proceed (because transfer limits are further reduced during outages, and AEMO will not give permission to proceed with planned outages where forecast DPV levels would lead to a need to curtail DPV systems in order to maintain the power system in a secure operating state). This can mean that the network may be operating at elevated risk for long periods of time because essential maintenance works must be delayed until low DPV periods occur for multiple successive days (e.g. certain multi-day outages can only occur during winter periods).
- A need for larger quantities of frequency control ancillary services, to manage increased continency sizes, potentially leading to increased system costs.
- Exacerbated risks related to multiple contingency events, whereby contingency sizes are exacerbated by DPV tripping.

[3] See 'Applying AS/NZS4777.2:2020 as part of the CEC's continuing professional development (CPD) courses.

[4] The AS/NZS4777.2:2020 amendment proposal seeks to remove legacy grid codes from selection in inverter menus, this process is currently awaiting approval from Standards Australia.

These implications highlight that the cost of non-compliance may lead to system and market wide costs that are ultimately borne by all consumers not just those with DPV systems. If compliance can be addressed at the time of installation, the costs are expected to be negligible to both the DER device owner (and where relevant, any agents) and all consumers.

4. Governance of DER Technical Standards

AEMO agrees that there is currently confusion with relation to the roles and responsibilities of parties involved in DER technical standards. AEMO has recently pursued a number of near-term activities to address concerns with the compliance of systems to the 2020 Standard. Through this process, AEMO has identified several gaps in the current frameworks.
At present, while Chapter 5A of the NER provides for connection agreements between the customer and relevant Distribution Network Service Providers (DNSPs), current arrangements for DER compliance monitoring are limited and enforcement is challenging and impractical. Specifically, many DNSPs have voiced concerns that technical standards non-compliance can only be enforced through disconnection at the customer connection point. While AEMO is unaware of any DNSPs having undertaken such action, it may be deemed unreasonable because, among other things, consumers are not generally the cause of the non-compliance and they are not well placed to rectify the situation.

Understandably, the review focusses on DER technical standards as they relate to the remit of the AEMC and market participants. However, AEMO sees a greater role for other parties such as installers, manufacturers and data providers (such as metering coordinators), such that issues around roles and responsibilities should be considered within the broader legislative and regulatory frameworks that encompass DER technical standards. It is essential that this review delivers an effective framework for governance of DER technical standards that aligns across industry, and establishes clear roles and responsibilities for compliance beyond the device-level. To achieve this, the AEMC may need to contemplate and leverage other mechanisms. There are already a number of regulatory instruments that reference the 2020 Standard and AEMO suggests investigating leveraging these where possible, to better achieve DER technical standards compliance and enforcement including:

- AS/NZS3000 Electrical installation (wiring rules) as mandated through state-based electricity safety installation rules – safety regulators already administer existing inspection and licensing requirements and penalty regimes (that are funded through State electricity licensing revenues), the scope of which extends beyond DER; these schemes are currently focussed on electrical safety, but could be uplifted to incorporate specific DER technical standards compliance and enforcement.
- State based incentive programs (such as Victorian solar homes) – where existing, many such programs already include inspection schemes and enforcement mechanisms as part of their installer accreditation schemes; these programs could be uplifted to include technical standards compliance however they are finite and not applicable across all NEM regions.
- The federal *Renewable Energy (Electricity) Regulations 2001* (Cth) administered through the Clean Energy Regulator's Small-scale renewable energy scheme (SRES)[5] – DER technical standards have already been incorporated voluntarily as part of this scheme's inspection program; the existing accreditation, penalty and demerit regimes administered by the Clean

[5] Please note that the CER is currently pursuing actions following their *Integrity Review of the Rooftop Solar PV* sector that will address some areas of installer eligibility, DER device (i.e. inverter) requirements and solar retailer obligations. See here for further details:
https://www.cleanenergyregulator.gov.au/RET/Pages/About%20the%20Renewable%20Energy%20Target/Rooftop-Solar-Sector-Review.aspx

Energy Council (CEC) are targeted at accredited installers (specific to DER systems) and could be enhanced to capture non-compliance with the technical standards under review.

- NER distribution connection requirements – clarity on the obligations (and recoverable costs) of DNSPs to monitor, and means in which to enforce compliance with, and rectification of, settings is required; further, while these requirements are on the individual DNSPs, the NER could and should also promote some level of central coordination that ensures consistency across the NEM.

In the near-term, there needs to be a more explicit requirement on installers in the configuration of devices to meet technical standards and clearer compliance enforcement by DNSPs.
In assessing DER technical governance more broadly, the AEMC should consider existing parties that already have a role in compliance (at a variety of stages such as installer training, compliance monitoring, rectification and enforcement). AEMO is also open to the review investigating the establishment of an encompassing national technical regulator that collaborates with existing parties to consider these functions. This review should also consider how roles and responsibilities of the compliance framework are placed on the most suitable party that can achieve these functions and is commensurate with their capabilities.

5. Improving compliance and enforcement arrangements

As identified in the AEMC review, there is a diverse range of roles and responsibilities across the lifecycle of DER devices that can influence technical standards compliance more broadly. AEMO therefore also suggests that the AEMC consider these roles and responsibilities and/or associated functions as part of this review.

5.1. Point of manufacture

As identified, the high non-compliance observed as part of the implementation of the 2020 Standard occurred in part due to the retention and availability of legacy grid codes on DER inverters, highlighting an opportunity for obligations on inverter manufacturers to design out the risk of non-compliance in the way they deliver their firmware. This offers a ‘safety in design’ approach, that would be the means to guarantee compliance, noting that there may be limitations in international manufacturers serving a global market.
AEMO is already pursuing options such as a proposed amendment to the 2020 Standard seeking to remove legacy Australian grid codes.

5.2. Time of installation

Options to improve compliance at installation can be considered through enhancing existing activities across installers, manufacturers and through connection processes.

AEMO sees communication and training as important channels for installers to both understand their obligations and efficiently commission new systems. Currently, the CEC communicates updates to DER installers via email and requires participation in their accreditation program to be eligible to participate in the SRES scheme. The accreditation for installers requires annual professional development, but there are otherwise minimal specifications on the required content of the Continuing Professional Development (CPD) courses undertaken, with no requirements on DER technical standards. Mandatory training on DER technical standards should be a minimum requirement for installers to meet their accreditation given the growing impact of their role on network and power system security.

Further, the CEC’s installer accreditation program operates a ‘demerit points’ scheme where installers who have been found to incorrectly install a DER system ‘lose’ points which can lead to accreditation suspension. This scheme primarily covers electrical safety and SRES eligibility requirements. The more serious the ‘fault’ in the installation, the higher the number of points lost.

There are also inspection programs as part of the jurisdictional electrical safety requirements that provide state-based licensing for electricians. These programs are similarly limited in focus on electrical safety and not technical standards.

AEMC should explore these schemes and the feasibility of expanding them to cover incorrect inverter settings, which should be ranked highly given the significant impact that this type of non-compliance can have on the power system.

5.3. Connections processes

Pathways to address compliance could be incorporated as part of the connections process. Initiatives such as the work by Victorian DNSPs in developing commissioning sheets for DER connections highlight a potential avenue that seeks to require confirmation by the installer that the correct technical device settings are in place at the time of commissioning[6,7]. AEMO considers that activities such as these mandatory commissioning sheets should be required by all DNSPs as part of the registration and connection process feeding into the DER register, and eventually become an automated process between the DER device and DNSP facilities directly. Such automation would involve the development and establishment of minimum standardised data formats for manufacturers to provide their inverter data in a consistent manner for review and approval upon connection.

5.4. Compliance monitoring and assessment

AEMO considers mechanisms to monitor and assess compliance as a critical aspect of DER governance and, ultimately, power system security, considering compliance with applicable technical standards is an ongoing requirement beyond installation and commissioning. In other words, compliance needs to be ensured not only at the time of installation, but also in terms of ongoing inverter behaviour to ensure it remains compliant and operates satisfactorily in the field for the life of the installation.

AEMO currently assesses the rates of compliance, through a combination of both technical settings on devices (including voluntary manufacturer remote querying of settings, and the CER's on-site audits of technical settings) and through field analysis (such as volt-var analysis by DNSPs using smart meter data, and post event analysis using third-party data sources).

AEMO views these datasets as important, noting that while technical settings data provides an indication of DER behaviour, data on its actual physical response in the field is necessary to validate its actual behaviour in practice. This will become increasingly important with increasing coordination and management of DER devices, where reported settings may not be consistent with actual performance. The AEMC's review should consider how to ensure that necessary data to assess compliance is available across the lifecycle of the device, and that appropriate data is captured and accessible with roles and responsibilities ascribed to the most suitable party, with consideration about their level of independence. The AEMC should also consider the scope for which these data sources can be legally used for rectification and enforcement purposes.

Given the number of DER installations that already exist, plus projections for significant further growth, compliance frameworks should seek to leverage automation processes to efficiently handle

[6] Powercor Commissioning sheet process. Available at: https://www.powercor.com.au/industry-partners/connections/solar-connections/smart-inverter-settings/

[7] United Energy Commissioning sheet process. Available at: https://www.unitedenergy.com.au/partners/solar-installers/smart-inverter-settings

the volume of data involved and ensure the widest possible coverage. There is much that can be learnt from the data analysis and tools AEMO currently undertakes with voluntary confidential data[8].

5.5. Rectification and enforcement

Rectification and enforcement of DER technical standards are considered together as they are both means towards ensuring compliance with DER technical standards. Rectification is a function of enforcement and should be an independent role that is consistent across the NEM and takes into account appropriate consumer protections. For example, where non-compliance results in DER disconnection, consumer protections must be established to determine how quickly and how many attempts must be made to reconnect the device and how this takes place. This scenario demonstrates how the party responsible for rectification should be independent of developing enforcement functions, otherwise consumers may be exposed to sub-standard rectification actions.

From the work to-date it is known that some manufacturers have the capability of making changes to remotely connected inverters already installed in the field. This pathway could help to address non-compliance in the field, at a low cost and minimal effort, however it has been identified that unreliable internet connectivity of DER devices and manufacturers' limited visibility of their fleet are current barriers to be overcome to effectively rely on this pathway in future. There are no requirements for manufacturers to make changes to inverters that are identified as non-compliant. Recent work undertaken by Victorian DNSPs have sought to include requirements within their model standing offers that enable DNSPs to contact manufacturers on behalf of customers to rectify non-compliant inverter settings. This has now been done by all Victorian DNSPs with the changes approved by the Australian Energy Regulator. Note this does not compel manufacturers to co-operate with DNSPs or create the capability to remotely revise settings, but it removes a significant barrier and increases the likelihood of participation.

The AEMC should consider establishing roles, such as for manufacturers to develop visibility of technical settings and the capability to rectify non-compliant existing DER installations, while the responsibility to pursue this action is placed on the installer. In pursuing such activity, consideration should also be given minimising other operational risks such as:

- Unintended consequences – a review and log of changes should be established and monitored by manufacturers to ensure that setting changes and firmware updates do not inadvertently introduce non-compliance with technical standards. Consideration should also be given to governance frameworks for remote interactions with devices, including determining the roles and responsibilities of relevant parties[9] to ensure that firmware updates occur in a controlled manner that does not introduce new power system security risks (e.g. the application of revised settings for cybersecurity or the accidental disablement of critical settings across a large proportion of NEM DER devices, where AEMO and NSPs do not know that a change has a occurred and a risk has been introduced.)
- Warranty replacements – where a 'like-for-like' replacement is not possible, there should be clear guidance to ensure that the settings of replacements not only meet relevant technical standards, but are also consistent with any pre-existing connection requirements.

[8] See Project MATCH. ARENA funded collaboration between , AEMO, UNSW, and Solar Analytics. https://www.ceem.unsw.edu.au/project-match

[9] See AEMO's Engineering Framework Action Item A44, which highlights this as a critical action to achieve high penetrations of instantaneous renewables. Available at: https://aemo.com.au/-/media/files/initiatives/engineering-framework/2022/nem-engineering-framework-priority-actions.pdf

5.6. Interpretation of Standards

During the implementation and testing process of inverters to the 2020 Standard, it was consistently identified by manufacturers that there is no single party responsible for a uniform interpretation of the Standard potentially causing inconsistent performance between DER devices.

Currently, the 2020 Standard sees DER devices manufactured, tested and certified based on the interpretation of individual subject matter experts/businesses. With the current practice of Standards development, it is difficult to capture all possible manufacturer use-cases. This also means that it is difficult, in the long term, for the 2020 Standard to be able to address particular non-compliances and be updated constantly.

The AEMC should consider convening a single body to promote and ensure that matters of interpretation with respect to the NER can be reviewed and addressed without the ambiguity of multiple interpretation and scenarios. Such a body would ensure that technical requirements are not wilfully misinterpreted, and that the intent of the 2020 Standard is upheld. This could also offer interim requirements where Standards do not yet exist or scenarios specified. AEMO is open to investigating the establishment of a national technical regulator to guide interpretation of standards and undertake monitoring and enforcement activities.

5.7. Interoperability and Cyber-informed engineering

AEMO recommends the review must contemplate a holistic approach to compliance and thus encompass how it will be achieved with future technical standard requirements. As the AEMC is aware, the Energy Security Board (with strong support from industry) has recommended an interoperability protocol (Common Smart Inverter Profile-Australia (CSIP-Aus)) be mandated for all new DER installations at a date currently under industry consultation. Consequently, the technical standards and governance framework ought to also consider roles and responsibilities for the effective implementation of CSIP-Aus and how to most efficiently ensure compliance with this minimum interoperability standard across the DER fleet. This functionality, once mandated, is an ongoing capability that is critical to managing distribution network and bulk power system operations, which means that any non-compliance with the protocol would have a significant impact.

Compliance with CSIP-AUS, primarily, involves ensuring a DER device is physically responding to a request for its generating output to be dialled up or down. It is this *physical* response that must be monitored for compliance and thus requires the AEMC to consider which party can most efficiently deliver this service or perform this role. The review should also consider leveraging the certification arrangements already in place in the US as part of the IEEE2030.5 device certification (noting that CSIP-AUS is a modification of IEEE2030.5).

In making this assessment of the responsible party, principles of cyber-informed engineering must be applied. As demonstrated by the recent spate of cyber attacks in Australia, it is critical that new energy sector control systems integrate a cyber security posture at the design phase.

Recently, the US Department of Energy released a report on cyber-informed engineering[10], which provides learnings for the CSIP-Aus implementation and compliance management. Cyber-informed engineering posits principles that *assume compromise* in energy sector controls and data exchanges and implementation of a *zero-trust architecture*. When applied to compliance monitoring the AEMC must therefore consider how independent data– that is data not coming from the DER operator or the device itself (to *assume compromise*) – and an independent party evaluating this data (*zero-trust architecture*) is integrated into the DER compliance monitoring framework.

[10] This report was developed over 5 years and cost approximately A$17 million. The Report was required to develop cyber informed engineering techniques for the design of new and existing energy sector industrial control systems. Available here; https://www.energy.gov/sites/default/files/2022-06/FINAL%20DOE%20National%20CIE%20Strategy%20-%20June%202022_0.pdf

Appendix

AEMO's analysis to date indicates:

- Based on tests carried out under laboratory conditions, most inverters with the new AS/NZS4777.2:2020 applied correctly appear to behave as required and demonstrate the necessary disturbance withstand behaviour.
- However, it appears that most manufacturers have retained the old AS/NZS4777.2:2015 standards in their installation interface with some inverters requiring a firmware update to access the 2020 Standard options which may be inaccessible due to poor internet connectivity. So, installers are defaulting to selection of these older standards during the installation process.
- Following collaboration with ten major DER inverter manufacturers that were able to remotely query their inverters, AEMO was able to ascertain the level of compliance during Q1 2022 of systems that represented about 70% of all installations during this period. This showed that:
    - 45% were set according to AS/NZS4777.2:2020
        - 35% were set to the correct 2020 Standard on installation/commissioning
        - 10% were remotely changed to the correct settings
    - 50% were non-compliant having been set to the superseded AS/NZS4777.2:2015 Standard
        - Estimate from manufacturer reporting that even where inverters are not set to the 2020 Standard, 25% may still achieve disturbance withstand as these capabilities are incorporated in revised firmware.
        - 25% expected to exhibit poor disturbance withstand capabilities, similar to legacy inverters.
    - 5% were set to an international grid code (and uncertain behaviour to ride-through capabilities and other technical settings).