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AUSTRALIAN POWER QUALITY
AND RELIABILITY CENTRE

24th November 2020

Sarea Coates
Energy Security Board

Dear Ms. Coates,

The Australian Power Quality and Reliability Centre at the University of Wollongong welcomes the opportunity to provide a submission to the Energy Security Board (ESB) Data Strategy Consultation Paper.

Operating since 1996, the Australian Power Quality & Reliability Centre (APQRC) is a centre of excellence for research, education and consulting in distribution and transmission system power quality, reliability and renewable energy integration. The APQRC has worked closely with Australian Distribution Network Service Providers (DNSPs) and Transmission Network Service Providers (TNSPs) for more than two decades, assisting them in managing electricity network quality of supply, reliability and integration of renewable energy generation at both large and small scale. The APQRC has also developed a track record and reputation as one of Australia's premier power system research centres through scholarly publications, technical reports, delivery of research grants and participation in national and international standards committees and advisory boards. Through these activities, the APQRC has developed a deep understanding and appreciation of a range of the technical and regulatory challenges faced by network operators in undertaking their business – particularly in recent times due to the rapid uptake of small-scale distributed energy resources (DER), primarily rooftop solar photovoltaic (PV) units.

The APQRC is broadly supportive of many of the aspects of the ESB Consultation Paper, and recognises the importance of access to high-quality and reliable data in facilitating the measured transition of electricity supply to a paradigm which includes a significantly large proportion of distributed energy resource generation. In this paradigm, visibility of LV network performance is now imperative to allow optimum outcomes for both network operators and consumers. As such, the APQRC strongly supports any measures that mitigate the present difficulties in obtaining and utilising LV network data, while still maintaining customer data protection and privacy. In this context, much of the content of *Appendix C* resonated with APQRC experience.

The APQRC also notes – with interest – and strongly supports *Recommendation 11: Research impacts of current voltage levels*. There is a significant body of evidence, including outcomes of long-term power quality monitoring projects undertaken by the APQRC, that has identified voltage magnitudes within LV distribution networks are typically at the upper end of the allowable range during light load – often close to or slightly above 253 V. This leaves little headroom for connection of DER into distribution networks, and is likely having other deleterious impacts on consumers – including increased energy bills through higher power consumption, associated increased carbon emissions, and reduced consumer appliance lifespan.

There is currently little incentive (or penalty) for DNSPs to invest in programs designed to reduce voltage magnitudes within their networks. Implementing a mechanism to incentivise improved management of voltage magnitudes would not only lead to improved renewable energy hosting capacity for consumer DER export, but will also likely manifest in a range of consumer benefits, including:

- **Increased lifespan of consumer equipment:** preliminary studies undertaken by the APQRC commissioned by Energy Networks Australia have shown that continued operation of consumer appliances supplied by electronic converters at voltage levels toward the upper end and/or above the allowable range has a significant deleterious impact on the lifespan of that equipment. This study was limited to examining the impact of high and out-of-specification voltage on a single class of consumer appliance, and as such more broad and comprehensive research is required to develop an understanding of the implications of this issue across a range of consumer appliances.

- **Reduced energy consumption and carbon emissions:** the concept of Conservation Voltage Reduction (CVR) suggests that reduction of supply voltage will reduce energy consumption, and in turn provide reductions in consumer electricity bills. In a high-carbon electricity generation paradigm, reduction in energy consumption will directly reduce carbon emissions.
- **Increased appliance energy efficiency:** consumer appliances operate most efficiently when supplied at their design voltage – typically 220 V or 230 V. While these appliances still operate outside the specified supply voltage range, the efficiency of internal components and circuitry can be severely impacted; leading to overall poorer efficiency of the appliance. This behaviour has been verified by the APQRC through laboratory-based evaluation of appliance performance under varying supply voltage conditions.

In a previous submission to the AEMC, the APQRC proposed development of an algorithm to calculate a Value of Customer Voltage (VCV) metric, similar to the widely-used Value of Customer Reliability (VCR) metric. Before a robust VCV algorithm can be introduced, however, there remain a number of issues that need to be addressed and resolved, including:

- **Selection and verification of measurement devices:** at present large quantities of voltage magnitude data are sourced from smart revenue meter devices and it is likely that this will continue into the future. This data is likely to form the basis of any supply voltage magnitude assessment scheme. However, the measurement methods used in smart revenue meters do not align with the requirements of power quality monitoring standards (e.g. AS/NZS 61000.4.30). As such, due diligence to characterise and confirm the accuracy of typical smart revenue meters across a range of jurisdictions – and thus their appropriateness for use in voltage magnitude measurement – may be required.
- **Placement of measurement instrumentation devices:** a comprehensive study will need to be undertaken to understand the type, placement and number of measurement devices required to provide robust data for a VCV calculation. This is particularly important as some jurisdictions have a high penetration of smart revenue meter deployment, whereas in others penetration is significantly lower. In addition, the outcomes of the issue raised above may necessitate the use of additional specialty metering devices, and their placement to appropriately supplement other data collection devices would need to be considered. Statistical methods to determine whole-of-network performance based on a subset of measurement data (e.g. via a 'random sampling' approach) could be used to enable application of the VCV scheme to networks with less than 100% data visibility.
- **Evidence-based link between supply voltage magnitude and appliance lifespan:** comprehensive studies are required to determine a robust relationship between supply voltage magnitude and consumer appliance lifespan across the full range of consumer appliance types – expanding on the work already undertaken by the APQRC and ENA. Such studies could also be extended to include assessing the impact of supply voltage magnitude on electricity supply equipment – such as electronic relays and electronic energy meters – and the ensuing impact on DNSP operating costs through premature failure of these components.
- **Clarification of acceptable CVR values:** while there is a significant body of work describing CVR, consensus is yet to be reached on applicable values. Different CVR factors may be required for different network types or different geographic locations – clarification of appropriate values, or a framework on how to assess differences across geography or network type, would need to be prepared..

Notwithstanding the above issues, a desktop study or 'shadow implementation' of a VCV calculation scheme using existing data could be undertaken, and may provide guiding insights into the resolution of these issues.

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In the course of its research and consultancy activities, the APQRC has conducted extensive literature reviews relevant to the ‘existing studies’ component of *Question 20* of the ESB Consultation Paper. These literature reviews have informed the following responses:

- There is a scarcity of literature detailing the long-term effects of voltage close to (or just exceeding) the upper limit for LV steady state voltage on consumer appliance lifespan. Most studies investigate the short-term impacts of voltages much higher than those typically observed on distribution networks, i.e. voltages due to lightning strikes or other transients;
- There is a reasonable amount of literature which investigates CVR. However, much of the literature does not apply to the Australian context as it involves the 110 V networks used in the United States. Other studies are fragmented and do not provide holistic and robust outcomes;
- There are preliminary studies indicated the impact of overvoltage on renewable energy generation but these studies are not comprehensive and/or peer reviewed.

It is clear there is an opportunity to undertake research to provide clear and comprehensive evidence on the above issues, which would provide a strong, evidence-based foundation to address many of the issues outlined in the ESB Consultation Paper.

The APQRC understands and appreciates the value of providing comprehensive, evidence-based commentary and discourse on power systems issues, and welcome the opportunity to discuss this submission with you in further detail. Should you have any questions I can be contacted by phone on 02 4221 4737, or via email at sean_elphick@uow.edu.au.

Yours Sincerely

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