Consultation on the Proposed Amendment of the Market Ancillary Service Specification (MASS) for Distributed Energy Resources (DER)

Enphase Energy Aust. Pty Ltd. Submission

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1.0 Introduction

Enphase Energy would like to thank the Australian Energy Market Operator (AEMO) for the opportunity to provide technical feedback on the proposed Amendment of the Market Ancillary Service Specification (MASS) for Distributed Energy Resources (DER).

Australia is a recognised leader in the adoption of DER that has accelerated the change to Australia's energy mix towards a renewable energy future. Alternative industry support for nearly 20 years has seen a transition from what was once considered a curiosity, to a commercially viable generation platform for Australia.

Renewable energy sources help meet part of, or in some regions exceed, energy demand. Consequently, grid stability issues have now emerged when favorable sun and wind conditions combine with low energy demand. When household consumption is low, the power exported to the grid can change rapidly according to weather conditions, resulting in a dynamic energy source. With the load base changing, this now presents challenges to grid stability and the provision of generation capacity via the NEM or locally.

With grid stability now the focal point of the expansion of renewable energy on the NEM, services such as frequency response and control are critical to the success of DER. The widespread deployment of DER now opens the opportunity for its participation in the FCAS market.

Although work is progressing on adopting technology standards and protocols, such as IEEE 2030.5, OpenADR, etc., it will be some time before these can be fully implemented. Enphase firmly believes that grid services, such as grid stability and dynamic connection agreements can be achieved within a much shorter timeframe with existing technology, so that VPPs are able to meet grid requirements on the residential scale without the reliance on future pending standards.

Enphase is actively involved with VPPs globally as well as in Australia through our dedicated grid services team. With the release of Ensemble[1], VPP and FCAS participation is a key area of interest for our company. Enphase has maintained an active presence in the MASS consultation stakeholder forum, providing feedback in group sessions as well as via email.

Enphase believes it is important to differentiate between FCAS and VPP participation as they can often provide different services. It with this vision that we present the following commentary on the AEMO MASS draft determination.

[1] Enphase Ensemble™ is Enphase Energy's latest grid agnostic energy system that combines all elements of PV generation, energy storage and Enpower advanced gateway functions in the one system with IEEE 2030.5 compatibility. Refer Appendix C.1

2.0 Commentary on the MASS Draft Determination

Overall, there is general agreement across the energy industry that more active market integrated DER will be a positive outcome for Australia by sending the right signals to shift passive systems to being more active. The use of DER for VPPs and FCAS will allow for more DER capacity and will increase the effectiveness of DER, on all grids across Australia.

The various gaols that AEMO set for the VPP demonstration program were largely met during the recent trials. This included the demonstration of the technical capability of VPPs to provide quality fast frequency response as reported in the public reports released for these trials. The VPP trials engaged over 6,000 customers, representing over 10 MW of FCAS DER capacity on the NEM and other marginal grids within Australia. The DER industry engaged in the VPP demonstration trials on the understanding that if the set goals were achieved then the rules of DER integration for FCASE and VPPs would follow these guidelines.

2.2 DC Coupled Vs. AC Coupled Storage Systeme

The MASS draft determination has assessments and determinations (Section 4.1, 4.2 etc) that are largely based on DC coupled systems (including Hybrid[2]). There is also analysis of older generation (AS/NZS4777.2:2015) inverters with limited AGF[3] presented that have limited relevance given the rapid development cycle of the DER industry.

Whilst DC coupled storage systems were common during the initial deployment of ESS[4] last decade, the current ESS market in Australia has swung rapidly to AC coupled ESS. Almost 90% of the domestic DER storage, installed so far in 2021, is AC coupled. By not providing equal consideration for AC coupled ESS, the MASS draft determination would effectively kill 90% of the available DER for VPP's.

There are several reasons for the shift from DC coupled systems, not the least of which is the challenge to **safely** combine a battery and inverter from different manufacturers. This involves extensive testing for DC coupled systems whereas AC coupled systems provide an already tested combination from a single vendor.

DC coupled systems have a lower overall efficiency as performance is compromised using the same inverter for both PV and Battery storage. An AC coupled solution has an inverter optimised for storage or PV only, resulting in greater power output availability across the entire operational envelop.

Field experience has, in addition, long shown that relying on a single Inverter for the entire system lowers reliability by introducing a single point of failure.

[2] A Hybrid inverter is one that is designed to provide DC to AC conversion from more than one energy source using a single inverter with common electronics to perform both functions, e.g., converting PV Solar (~600 VDC) and Battery (48 - 400 VDC) to 230 VAC
[3] AGF = Advanced Grid Functions. AS/NZS4777.2:2015 mandated limited AGF. In 2018 IEEE & IEC standards introduced more prescriptive grid stability and measurement requirements. Australia currently has a mix of inverters built to 2018 standards and AS/NZS4777.2:2015 and largely accounts for the wide performance variations found during industry grid stability testing of inverters.
[4] ESS = Energy Storage Systems (IEC definition)

2.2 Externally Metered Solutions

The proposal to use 3rd party OEM metering for controlling DER also introduces additional challenges. There is a range of generic metering and control products that have been adapted for use with DER as a "quick" solution. For most, there is a real risk of early product redundancy should requirements or standards change. The PV and storage industry has a long history of companies that could not afford to provide on-going support or simply disappeared when a product failed, in order to avoid financing a full recall.

There are also some technical gaps between DER and general metering standards that will impact the integration of DER with 3rd party metering/control. All 3rd party metering products will need to be fully tested to DER standards to ensure they maintain accuracy and integrity when used with DER. There are already examples of "add on" metering products suffering from degraded accuracy when subjected to DER frequency and harmonic injection testing.

To provide the best system integrity and compliance when controlling DER, device level metering, fully integrated to the control loop, is the clear solution. The technical and accuracy requirements of the new AS/NZS4777.2:2020 standard means "Smart" DER systems with metering will meet requirements when set to provide 100 ms reporting. Using third-party metering equipment simply introduces unnecessary extra costs and risks for consumers to participate in VPPs and the FCAS market.

2.3 Multiple Agents

The AEMO MASS draft determination also raises concern that multiple agents could cancel each other out when utilising DER for VPPs and grid stability services, such as FCAS. A solution has already been trialled and implemented in South Australia.

The South Australian system uses the NMI number to identify a "Relevant agent" responsible for coordinating all DER on that site. The system ensures that each site (NMI number) has only one corresponding agent (aggregator or OEM). This ensures that all DER associated to that NMI is connected to a single energy management device to effectively control all DER assets.

3.0 Meter Measurement Resolution

The AEMO MASS Draft Determination states:
"While measurement resolution of 100/200 ms and changes to the FCAS assessment methodology may present a reasonable compromise, it is anticipated that in the time required to assess and confirm whether this is the case, advances in high-speed metering will reduce this as a barrier to entry".

During the consultation process, a metering measurement resolution of 1 second (Option 2) was used however this was found to be inadequate. The Draft Determination proposes intervals of <50 ms as Option 1 for metering however does not provide further commentary on how this resolution was arrived at.

Enphase proposes that a 100 ms would be a more viable interval rate. The University of Melbourne report[5] clearly demonstrates that a meter resolution of 100ms is a more than adequate measurement resolution vs. the 50ms interval proposed in the AEMO MASS document. A 100 ms interval has close alignment with AS/NZS4777.2:2020 measurement and calculation accuracy requirements that in most cases will negate the need for additional expensive metering equipment or R&D for product modification.

Table 2.5 — Specification for measurement and calculation accuracy

Quantity	Measurement accuracy	Measurement time	Measurement range
Voltage	±1 % $V_{nominal}$	100ms	0 to 280 V
Frequency	±10 mHz	100ms	45 to 55 Hz
Active power	±4 % S_{rated}	200ms	0 to 120 % S_{rated}
Reactive power	±4 % S_{rated}	200ms	0 to ± 120 % S_{rated}
Apparent power	±4 % S_{rated}	200ms	0 to ± 120 % S_{rated}
NOTE For the purposes of measurement accuracy, $V_{nominal}$ refers to 230 V of AS 60038.			

Source: AS/NZS4777.2:2020 Grid connection of energy systems via inverters Part 2: Inverter requirements

4.0 Meter Measurement Location

As suggested by AEMO, device level metering is required however site metering should also be deployed. Both device and site level metering should be located as close as possible to the utility meter (i.e., just after the incoming mains) to ensure that the site DER can best aid the stability of the grid.

We see that AEMO's primary concern for measurement location is to address the risk of multiple assets enabled for FCAS as well as site and device level metering providing the same outcome for VPP operators. This can be managed by utilising a single energy hub or control system that is able to control all DER onsite as well as provide control over designated loads.

Device level metering could still be deployed if site metering at the incoming mains is unfeasible due to site-specific issues. The alternative metering location could then be offset by any marginal loss factors (MLFs), as the site can no longer guarantee what is happening at the point of supply.

[5] The University of Melbourne report has demonstrated that 100ms metering measurement resolution provides a suitable solution, when combined with an update to the trapezoid method in the Verification Tool, the results of this proved a near zero error risk for verification purposes. A meter measurement resolution of 100ms is also appropriate for identifying oscillatory behaviour. A meter measurement resolution of 100ms will also align to the new AS4777.2:2020 requirements for Inverter accuracy when this standard is adopted on the 18th of December 2021.

5.0 Power System Security

The power system security concerns raised in the AEMO MASS draft determination go beyond just the security concern of VPPs and the provision of fast FCAS.

Enphase recommends that concerns be raised and addressed via a national forum and through the adoption of standards around DER security. For example:

- DEIP, Maturity Plan with the aid of the Australian Standards committee
- EL-054 – Demand response capabilities and supporting technologies for electrical products
- EL-064 – Decentralised electrical energy and grid integration of renewable energy systems
- EL-065 – Management of Network Assets in Power Systems.

The updated AS/NZS 4777.2:2020 standard for DER inverters will improve power system security with the implementation of strict VDRT and AGF requirements.

The higher accuracy resolution requirements for frequency, voltage, and power measurement will better align with grid stability requirements once mandated on the 18th of December 2021.

6.0 Cyber Security

The change from the traditional centralised distributed electricity system towards a decentralised system brings new challenges and risks from cyber security that need urgent attention.

AEMO is encouraged to support the accelerated adoption of new standards to ensure all connected DER, metering and control systems maintain a high level of security.

There are several IEC standards series published (or in TR draft) that have been developed by IEC SC/TC-8, TC-57 and ISA 99 workgroups that can be AS/NZS harmonised. Standards relevant to the energy industry in Australia include;

- IEC 61850 series (+ 2020 amendments) provides guidance for power utility automation systems and defines the communication between intelligent electronic devices in such a system
- IEC 62351:2021 provides guidance on different security objectives including authentication of data transfer through digital signatures, ensuring only authenticated access, prevention of eavesdropping, prevention of playback and spoofing, and intrusion detection.
- ISA/IEC 62443 series provide a flexible framework to address and mitigate current and future security vulnerabilities in industrial automation and control systems (IACSs).

Standards Australia’s EL-064 committee for decentralised electrical energy and grid integration of renewable energy systems is currently working through IEC SC/TC8 on a range of standards currently under development that will also be applicable.

A.1 About Enphase Energy

Enphase Australia Pty Ltd is a member company of Enphase Energy, Inc. based in Silicon Valley, California, USA.

Enphase is a provider of energy management hardware and software solutions. It is engaged in designing, developing, manufacturing, and selling microinverter systems for the solar photovoltaic and battery storage industry. Enphase invented semiconductor-based microinverters in 2008 to convert direct current (DC) electricity to alternating current (AC) electricity directly at the PV module (solar panel). Enphase is now the world's largest manufacturer of microinverters.

Enphase is now the residential market leader in the USA with ~52% of all systems (2021).

In Australia, Enphase is based in Melbourne with staff located in all mainland states. Enphase runs an online technical support centre in Melbourne linked into other global Enphase CS centres to provide 24/7 support. Enphase New Zealand is the global hardware design and testing hub for Enphase employing over 90 Engineers and technicians in Christchurch.

An Enphase AC coupled microinverter system differs from the classic DC coupled string inverter systems found in most installations. An Enphase PV system uses multiple panel level "AC Microinverters" parts rather than a single central DC inverter: Enphase microinverters at each solar panel, an Envoy gateway and Enlighten cloud-based software. For storage, an Enphase battery system can be installed to complete a single platform for PV generation and battery storage with full remote access and functions.

Enphase microinverters provide power conversion at the individual solar module level by a digital architecture that incorporates custom application specific integrated circuits (ASIC), specialized power electronics devices, and an embedded software subsystem. Envoy bi-directional communications gateway collects and sends data to Enlighten software. Enlighten cloud-based software provides the capabilities to remotely monitor, manage, and maintain an individual system or a fleet of systems.

AC coupled Enphase systems provide significant safety advantages over classic DC coupled systems. Rather than running dangerous high DC voltages (up to 1000 Volts) to a remote inverter that requires special protection from DC arcs that can lead to fire, Enphase directly converts low voltage DC to normal AC right at the panel. This eliminates troublesome DC Isolators that introduce safety and reliability concerns.

Enphase invented the rapid shutdown system that is now mandatory in the USA. This system enables first responders to shut the entire system from one switch in a meter board so they can conduct search and rescue safely without fear of contact from high voltage DC from an unstable roof.

B.1 Enphase Energy Australian Engineering and Technical Support

Andrew Mitchell – Product Line Manager

With 13 years of experience in the solar industry Andrew has managed projects and products that have delivered pioneering solutions from 300W portable power packs to multi megawatt micro grid solutions. His work throughout the APAC region has given allowed him to develop perspective from all stakeholders such as consumers, installers, designers, manufacturers, and network operators.

David Minchin: Standards & Homologation Engineer

"David is based in Adelaide and has over 35 years of experience in solar/storage/remote power systems in commercial, project management and engineering roles. He provides standards support and product homologation for Enphase Energy in the Asia/Pacific region. He is an active member of EL005 Storage, EL042 Alternative Energy and EL064 Microgrid Standards committees. Most recently David was engaged to formulate the test reports in the new AS/NZS4777.2 standard for new requirements including the VDRT test that is the subject of this consultation. Prior work includes managing Clean Energy Regulator (CER) inspections across Australia and engagement to perform CER special analysis."

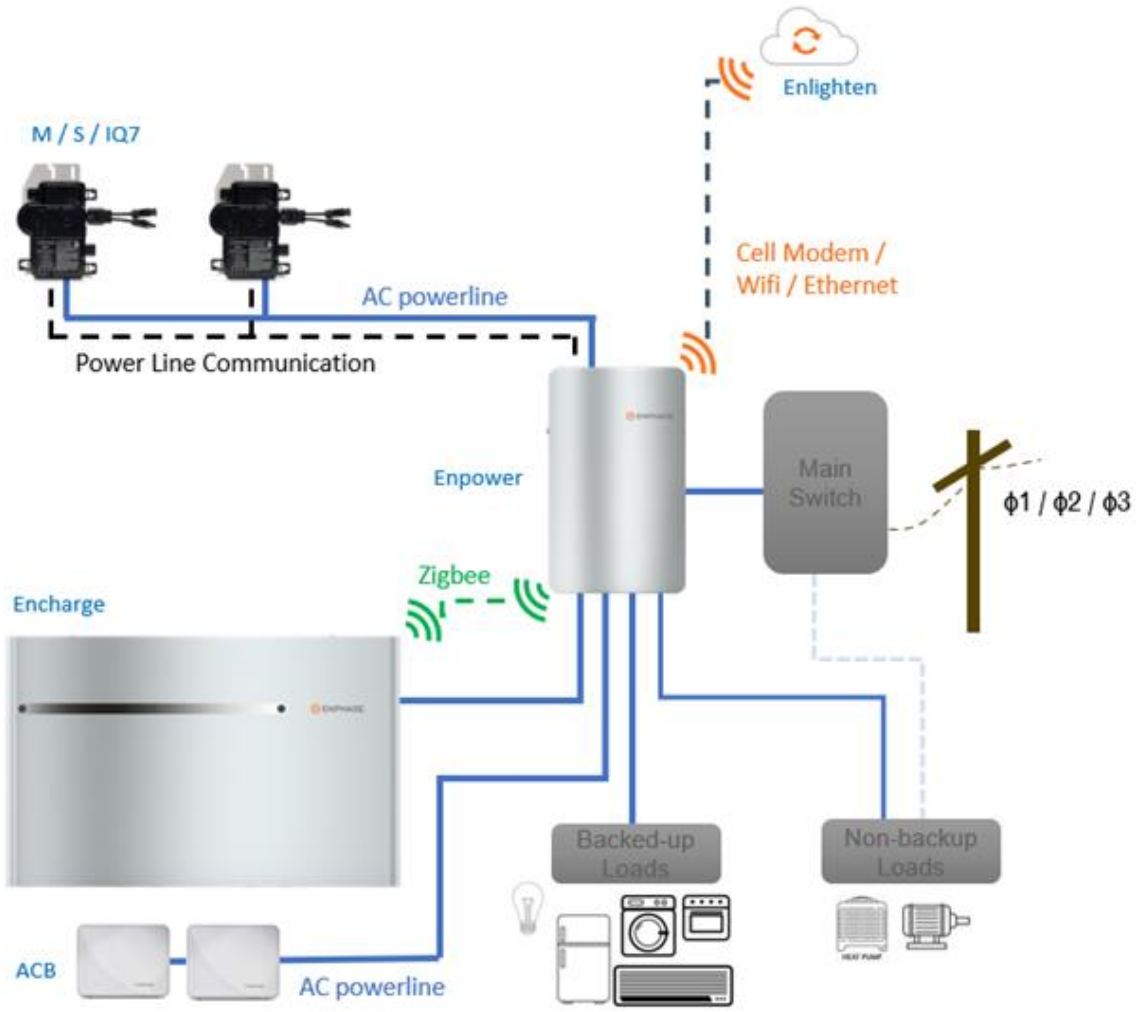
Ryan Turner: Field Applications Engineering Manager, APAC

"Ryan provides pre and post installation support for all Enphase projects in the APAC region. He is a fully accredited CEC design engineer. Ryan specialises in supporting the larger, more complex commercial and industrial projects, as well as storage integration. Prior work includes technical support/advisor for Fronius Australia and Building Energy consultant at Arup. Ryan also has an undergraduate degree in Mechanical Engineering and a master's degree in Renewable Energy and sustainability from the University of Nottingham, UK."

Wilf Johnston: General Manager, APAC

"Wilf has worked in the Australian solar industry for over 13 years, beginning with leadership of the engineering and commercial project team with SunPower Corporation, then later as the General Manager of Energy Matters and Flex. At Flex he introduced an innovative IOT platform focused on delivering energy insights and control to end customers. Wilf holds degrees in Engineering and Commerce from the University of Western Australia and has been a key contributor to industry associations including the Smart Energy Council. At the Clean Energy Council, Wilf was a founding member of both the Utility Solar Directorate and the Distributed Energy Leadership Forum, which provides policy direction to the organisation."

C.1 Enphase Ensemble™ Smart DER System



Enphase Ensemble™ is a complete DER system that combines PV generation, Battery storage, load scheduling and grid integration for small to medium size premises.

Central to the Enphase Ensemble™ is the Enpower™ Smart switch that sits between the grid and all DER consolidating all interconnection equipment into a single enclosure. This includes all control, switching, internet interface and metering of all connected ports on a single integrated platform. Enpower connects to the Enphase Enlighten cloud. Various API interfaces are available.

Enpower can also function as a microgrid interconnection device (MID) by automatically detecting and seamlessly transitioning the DER system from grid power to backup power in the event of a grid failure. This streamlines grid independent capabilities of PV and storage installations by providing a consistent, pre-wired solution for all applications.