# Amendment of the MASS - DER

Evergen response to AEMO

Draft MASS, Third Stage Consultation

November 2021

# 1. Introduction

Evergen thanks AEMO for the opportunity to continue to participate in the MASS review process, and we appreciate that AEMO took our previous submission seriously. It is gratifying to be able to share insights to assist AEMO and the industry generally.

We think the most recent draft issued by AEMO represents a positive outcome for the MASS process to date. It is positive that together we have all come to a point where we are revising the verification process and accommodating DER, without losing accuracy.

Evergen reiterates that we firmly believe that the move from small numbers of large generators dispatching power, to many thousands of inverter connected devices doing so as part of a harmonious system **requires new ways of thinking and new approaches** to system management.

We note that AEMO has chosen 200ms and assessment at the connection point. Evergen's preference was 1 second, assessed at the device level. We understand AEMO's responsibility to the National Electricity Objective (NEO), and to maintaining system security, and appreciate that AEMO has adjusted its position on this issue to avoid an unnecessary compliance burden where they have found it is safe to do so.

Evergen believes there remains a strong case that good verification can occur with 1 second telemetry for certain classes of FCAS provider - namely, VPPs comprising many individual DER, each separately metered.

Evergen will use this submission to reinforce arguments that coarser telemetry is acceptable for verification with VPP-based DER fleets doing FCAS, and highlight some shortcomings in the analysis conclusions AEMO has relied upon to arrive at 200ms instead of 1 second. We will also make the case for decisive action now rather than an incremental approach.

There is a strong case for adopting DER VPP specific requirements for FCAS, that are low-cost but deliver the same verification accuracy. Introducing such requirements would allow greater participation of residential DER in fast FCAS markets, opening up an untapped resource. We believe AEMO should move swiftly to implement such change decisively, to keep pace with rapid change across the NEM.

# 2. Measurement Location

We understand the arguments for retaining FCAS measurement location at the connection point. While Evergen still holds the view that the risks raised by AEMO (which almost specifically relate to concerns about competing FCAS-responsive hot water systems and batteries behind the one meter) are not significant, and are readily handled by VPP operators themselves with end-user contractual arrangements, we are satisfied that measurement at the connection point will not block FCAS participation unnecessarily for DER-based VPPs.

AEMO communicated in the November 8th stakeholder forum that so long as power is measured at or close to the connection point, it would be acceptable to measure frequency at the device. This could occur provided a process was in place to ensure synchronization of samples. Having discussed this with our hardware partners, Evergen thinks this allowance reduces barriers to VPPs participating in contingency FCAS markets under the proposed draft, and we will not further comment on this issue in this submission.

The remainder of our submission is broken into sections each contributing to the case that 1-second telemetry is sufficient for fast market verification, and that consideration of oscillatory behaviour does not create a case for requiring more than 1-second sampling.

# 3. Oscillation risk

AEMO indicated in their 2nd draft determination that 1-second time resolution was unsuitable for detecting "detrimental under-damped oscillatory behaviour". This seems to be the primary reason for rejecting 1-second sampling for FCAS verification.

Evergen notes that in the study commissioned by AEMO in support of the second draft determination, the University of Melbourne (UoM) did not reach the conclusion that 1-second sampling was unsuitable through analysis. In fact, the UoM analytical work omitted consideration of 1-second sampling. Instead, UoM determined theoretically that 1-second sampling was unsuitable, by appealing to the Nyquist-Shannon sampling theorem.

## 3.1 Control and visibility of oscillatory behaviour

In summarising the November 8 forum, AEMO states:

> *AEMO acknowledged that it was unlikely that a few devices producing an oscillatory response from a large fleet would result in an error that AEMO could measure. Nevertheless, oscillatory responses are something AEMO looks at in many contexts in the NEM, including in the context of power system security. AEMO's objective is to keep oscillatory behaviour at a minimum. Therefore, while this behaviour may not be an issue within a large fleet or where it can be contained within a network, broader issues could surface at the grid level if the behaviour is widespread and/or significant. AEMO noted that oscillatory problems are becoming more prevalent in the NEM and AEMO needs to work to minimise this at all levels.*

Evergen accepts and agrees with AEMO's objective that oscillatory behaviour is to be kept at a minimum.

That said, any oscillatory behaviour from individual grid-connected DER will occur whether or not those DER are able to participate in the fast FCAS market.

Given that analysis of aggregated fleet-level telemetry could not detect oscillatory behaviour from individual DER in any case, Evergen's view is that it is not in accordance with the NEO to impose additional measurement requirements on DER-based VPPs participating in the FCAS market, if those additional requirements have no impact on minimising or even characterising the notional problem of oscillatory response from DER.

## 3.2 Minimal chance of fleet-level oscillation

Having good measurements is not the only requirement for detecting oscillatory behaviour. At the risk of stating the obvious, oscillatory behaviour will only be detected if there is actually an oscillation present. We note that AEMO and UoM both focused on high magnitude oscillation detection should an oscillation actually occur at the aggregated DUID level, but did not examine the likelihood that such an oscillation would ever manifest across a DUID composed of many devices.

In our previous submission we argued that there is little risk of a high magnitude oscillation ever manifesting at the aggregated DUID level for a many-plant DUID such as a VPP. This is because individual device-level oscillations are of no consequence to the aggregated output for the DUID. **AEMO acknowledged this point in the November 8 stakeholder forum, in response to Evergen's question.**

In our previous submission, Evergen also argued that even if every single device in a VPP were showing oscillation behaviour, if the oscillations of each device were not all in phase they would likely destructively interfere, resulting in no significant aggregated oscillation at the fleet level.

**Neither AEMO nor UoM addressed the arguments made in Evergen's submission on the first draft determination.**

## 3.3 Oscillation detection using 1-second sampling

Taking into account the Nyquist-Shannon sampling theorem, Evergen accepts that the sampling rate to *perfectly* reconstruct a continuous waveform from sampled data, where the waveform exhibits a maximum frequency component of *x* Hertz, requires a sampling rate of at least *2x* Hertz. This theorem is often invoked in a signal processing context.

However, AEMO is not undertaking a signal processing exercise here, as though the objective were to transmit lossless information over the powerlines. AEMO is only required to detect non-compliant provisions of FCAS.

It isn't necessary to be able to reconstruct the power response at very high fidelity, it is only important to detect that an oscillation is occurring at some magnitude. So, the Nyquist-Shannon sampling theorem is not entirely relevant, and the heuristic of requiring three samples per half period is potentially excessive as a result.

UoM presented some information that seemed to show an oscillation could not be detected with a 1-second sample rate. They included two charted examples (see Fig. 2.8 from the UoM study): a response with a 1Hz oscillation, and another with a 4Hz (0.25s period) oscillation. In both cases, the 1-second sampling appears as a straight line ramp, with no detection of the oscillation.

**This occurred in their examples only because these oscillations are a harmonic (whole-number multiple) of the 1 Hz sampling rate, and they aligned sampling so that sample points occurred where the oscillation was crossing the baseline. This is a worst case scenario.**

Fig. 1 shows 1-second sampling of an oscillatory response profile with an oscillation period of 0.769 seconds (1.3 Hz). In this case, the oscillation frequency is not a harmonic of the sampling frequency. The result is that successive samples do not always appear at the same point in each cycle.

1-second sampling is able to provide insight into the magnitude of deviation from the base case, under these conditions. This would even work for higher frequency oscillations, provided the frequency of oscillation was not a harmonic of 1Hz.

Had UoM considered the 1-second sample rate case in their study, they may have arrived at a different method for oscillation detection, and could have revealed some success in detecting oscillations even with 1-second sampling.

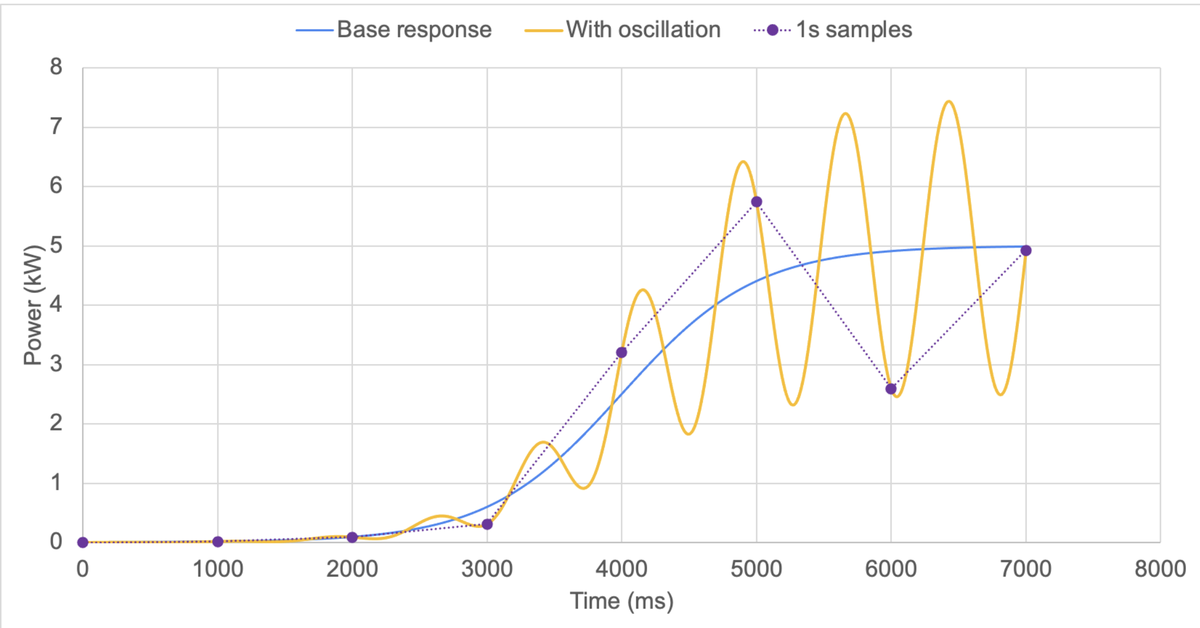


Fig. 1 - FCAS response from a 5kW device, with a superimposed oscillation of 1.3Hz. This illustrates that If the oscillation period is not a harmonic of the 1Hz sampling rate, then even 1-second sampling may provide information regarding the magnitude of any oscillation present.

In highlighting this, Evergen is not suggesting that 1-second sampling is perfect for detecting undamped oscillations. We are only seeking to emphasise that there is the possibility that 1-second sampling could detect an oscillation in many circumstances. This, combined with additional points in this section, forms a complete argument that there is, overall, very low risk presented by 1-second sampling.

## 3.4 Low Risk Overall

To sum up, the problem AEMO is seeking to avoid is that there is both:

(a) a DUID-level large-magnitude oscillation; *and*

(b) AEMO's verification process fails to detect it.

For these conditions to be met, the following would need to occur:

- Each device type in the DUID undergoes a high sampling rate frequency injection test. These tests show no oscillation, resulting in the DUID passing registration.
- A large number (or all) devices under the DUID would need to then subsequently incur some type of fault, resulting in each independently exhibiting oscillatory behaviour.
- The oscillations of each device would need to constructively interact with each other to produce a large-magnitude oscillation in the aggregate. This requires:
    - The period of individual device oscillations to be identical; and
    - The oscillations of each device to be in phase with each other.
- The overall frequency of the resultant aggregate DUID-level oscillation would need to be a harmonic of 1 Hz, such that 1Hz sampling had trouble identifying the oscillation.

**Evergen suggests that the probability of all of the above occurring so as to create a verification problem is low.**

Regardless of whether or not fast FCAS verification can detect oscillatory behaviour, DER that exhibit such behaviour will still be grid-connected and contributing risk to power system security even if excluded from fast contingency FCAS markets. For this reason, **Australian standards and commissioning requirements are a more appropriate vehicle for mitigating oscillatory response from DER**, not the verification approach for the fast FCAS market.

We would also like to reiterate comments from our submission on the first draft determination that there is scant evidence on the prevalence of oscillatory behaviour from DER inverters responding to FCAS. Later in this submission (see section on real-world data) we also comment on the pitfalls of relying on individual case studies.

# 4. Benchmark for acceptable verification

The UoM study used a synthetic benchmark. This benchmark was formed by combining AEMO's own high resolution (50ms or faster) measurements of grid frequency across real frequency disturbances, with a Frequency-Watt curve provided by Tesla to generate a benchmark FCAS power profile.

Using the "universal window" method to determine frequency disturbance time (FDT) and the trapezoidal integration method, UoM calculated the benchmark FCAS energy delivery from this profile.

When analysing various scenarios (e.g., different sampling rates, or different methods of determining the FDT) UoM compares each scenario to this synthetic, perfect benchmark to calculate verification error.

What is missing from this analysis is an indication of what is acceptable to AEMO. UoM acknowledges this:

*"Note that a small verification error in the results reported here only shows that the Fast FCAS contribution calculated with the given settings (e.g., sampling rate, frequency disturbance time assessment method) is close to the contribution calculated with the response sampled at 20/50ms, assuming that the 20/50ms response with "universal window" method is the benchmark. Thus, for a given event, a small error shown in the results of this report does not necessarily indicate that the provider would have an acceptable performance in terms of FCAS delivery as recognised by AEMO. "* - UoM, p. 8

By comparing to a perfect, synthetic benchmark the relative errors for each of the scenarios considered by UoM seem larger than if they were instead compared to a benchmark of what AEMO regards as realistically acceptable, a benchmark that would unavoidably include error of its own.

AEMO has already determined and communicated to the market what it believes is an acceptable level of accuracy. This is what is described in the existing MASS, v6.0 and accompanying verification tool:

- 50ms measurement resolution.
- 2% (of total plant output) power measurement error.
- first recorded point method for determining FDT.

- the Riemann-sums method of integration.

Rather than only comparing each scenario to the perfect case, it would be instructive to also compare each scenario to AEMO's existing benchmark, as articulated in MASS v6.0 and accompanying verification tool.

Such a benchmark could be readily added to UoM's analysis. This could be in the form of an additional scenario as follows:

- Begin with the original synthetic profile, of 20/50ms data.
- Resample this profile at 50ms, and in so doing include a random error of -/+ 2% power measurement error using the method already described in UoM's study.
- Calculate verified FCAS energy for this resampled 50ms profile, using the first recorded point method for FDT determination, and Riemann sums for integration.
- Calculate the error spread for this resampled 50ms profile vs the original synthetic benchmark.

The above scenario would provide an unbiased indication of AEMO's current standard of acceptable verification.

If all of the scenarios considered in the UoM study were compared to this benchmark, AEMO would have even greater justification for accepting a coarser sampling resolution requirement - particularly if NMI-level verification were implemented. If NMI-level verification at 1-second were shown to be **more** accurate than the 50ms resampled benchmark, that would provide a powerful argument for the suitability of 1-second sampling along with improvements to the verification approach.

# 5. Verification at the NMI level

In our submission on the first draft determination, Evergen showed that with an improved method of determining FDT and NMI-level FCAS verification, fleet-level FCAS verification error could be reduced to negligible values. This would apply even for sample rates as coarse as 1-second sampling. Indeed, with a sufficient number of devices, verification error could be **smaller** with 1-second sampling using NMI-level verification than for the current MASS's approach of 50ms sampling and aggregated verification. UoM found essentially the same result.

However, UoM's current study did not specifically address whether NMI-level verification with 1-second measurements could be more accurate than aggregated verification at 50ms, as suggested in the previous section of this submission. Nevertheless, we can still observe telling results in the data that has been provided.

Looking at the tables in Appendix B of the UoM Stage 2 study, and considering just the RoCoF method for choosing the FDT, we can see that the error ranges for 1-second sampling when there are **just 25** NMIs are similar or smaller to the error for a single device sampled at 100ms. See Table 1 and Table 2 below, which reproduce data from the UoM study.

Table 1. Reproduction of results from Table 7.3 of the UoM study, using RoCoF method, and the NSW event. Similar results for 1 site@100ms and 25 sites@1s are highlighted

| ***No. of sites*** | ***100ms*** | | ***200ms*** | | ***1s*** | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| 1 | **-3.9%** | **3.7%** | -4.3% | 4.3% | -11.1% | 13.5% |
| 25 | -1.1% | 0.8% | -1.0% | 0.8% | **-3.1%** | **3.0%** |

Table 2. Reproduction of results from Table 7.6 of the UoM study, using RoCoF method, and the QLD event. Similar results for 1 site@100ms and 25 sites@ are highlighted

| ***No. of sites*** | ***100ms*** | | ***200ms*** | | ***1s*** | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| 1 | **-4.4%** | **2.9%** | -4.7% | 2.8% | -10.8% | 9.5% |
| 25 | -1.9% | 0.1% | -2.0% | 0.2% | **-3.2%** | **2.0%** |

UoM's results along with analysis in Evergen's previous submission both suggest the same thing:

**With NMI level verification and a minimum fleet size of 200 devices, 1-second sampling delivers acceptable verification accuracy, on par with what is delivered by 50 ms sampling at the aggregated DUID level.**

We understand that AEMO will require some time to develop a NMI-level approach to verification. But given:

- The inherent bias of the current approach to VPPs;
- The proven redundancy of requiring so many measurements at each individual device;
- The rapid pace of change across the whole NEM, and
- The inefficiencies of slow transitions in creating a moving target for hardware designers,

**Evergen recommends that AEMO works towards implementing NMI-level verification swiftly.** Evergen would be very pleased to contribute to this work and aid where we can.

# 6. On separate verification approaches as a general principle

Evergen's arguments above suggest that AEMO should adopt a separate approach to verification that is specific to DUIDs comprising many plants. Yet AEMO seems motivated towards one process with which to assess all FCAS providers, to maintain impartiality.

We agree that FCAS assessment should be technology independent, and the market should be open and impartial to any participant or technology that can deliver adequate response.

However, building a single verification approach only offers only a thin veneer of impartiality. In practice, different technologies have different circumstances. AEMO already recognises this, which is why the draft determination divides the market into synchronous generators for which inertia calculations apply, and FCAS providers such as battery energy storage systems (BESS) for which inertia is not relevant.

As Evergen has argued both in this and our previous submission, in focussing on a verification method that uses aggregated DUID-level data, the existing MASS v6.0 is biased against DER-based VPPs as compared to single-plant DUIDs.

It is not possible to derive a completely impartial, unbiased, technology-neutral approach to verification, and AEMO can't operate under the pretense that this is possible. Instead, Evergen recommends AEMO strive for a consistent level of verification accuracy across all participants, rather than a consistent method of verification.

If a cheaper/less onerous verification approach for one technology can achieve the same benchmark for verification accuracy, that approach should be made available for that technology.

It is more in accordance with the NEO for AEMO to make principled and objective technology-specific modifications to its verification process than to create a one-size-fits-all approach, and expect many participants to incur unnecessary costs in complying with an approach that is more suited to other types of participant.

# 7. Adapting swiftly to market realities

Table 3 shows how much change has occurred with respect to grid-connected DER in Australia over the last 10 years, and the 10 years before that. Australia now has PV installations on approximately 1 in 4 homes[1]. We have the highest penetration of installed PV per capita in the world[2].

**Table 3. Showing explosive growth of Australian DER (both distributed PV and behind-the-meter BESS) over a short time frame.**

| Year | Distributed PV capacity | Number of PV systems | BtM BESS capacity | Number of BtM BESS |
|---|---|---|---|---|
| 2001 | 2.8MW[3] | ~1000 or less | negligible | negligible |
| 2011 | 1236.8MW[4] | 500k[5] | negligible | negligible |
| 2021 | ~15,000MW | 3 million[6] | ~600MW | 110-150k |

Australia has enough residential rooftop PV to contribute a significant chunk of daily generation across the NEM. On the back of this rooftop PV generation, renewables have recently instantaneously accounted for over 60% of total generation power in the NEM, and 100% for just South Australia.

Australia is seeing ongoing huge growth, with annual installations of 2,000-3,000MW per year. We install more per year now than our cumulative total behind the meter rooftop capacity 10 years ago.

From a base of essentially nothing 10 years ago, Australia now has approximately 150,000 behind the meter BESS (extrapolating from 110,000 at end of 2020, as reported by Sunwiz), with more than 30,000 added each year at present[7]. Assuming 4kW per BESS, that means Australia has approximately 600MW of behind the meter battery storage, and is adding more than 120MW per year. As a limiting case,

[1] https://www.energymagazine.com.au/australian-solar-industry-reaches-historic-milestone/
[2] https://iea-pvps.org/wp-content/uploads/2020/11/IEA_PVPS_Trends_Report_2020-1.pdf
[3] https://iea-pvps.org/wp-content/uploads/2020/01/nsr_2003_AUS.pdf (table 1, page 7)
[4] https://iea-pvps.org/wp-content/uploads/2020/01/tr_2011.pdf
[5] Assuming a typical system size of 2.5kW. https://pv-map.apvi.org.au/analyses
[6] https://reneweconomy.com.au/transformational-australia-passes-3-million-mark-for-rooftop-solar-systems/
[7] https://reneweconomy.com.au/australians-installed-31000-batteries-in-2020-led-by-households/

if all new batteries were FCAS capable and this growth is maintained or is exponential, then residential storage could deliver much of the FCAS market within a few short years.

This ongoing MASS determination has the potential to allow or prevent this, and so it needs to be considered carefully.

We have heard it suggested in stakeholder forums that market participants need long time horizons (e.g. 10 years) and static regulatory/administrative conditions across these time frames to be able to develop new market offerings.

This is no longer realistic. It is naive for a market participant to expect this level of certainty given the rapid change we have seen in the last 10 years. The grid will fall over unless the industry as a whole, from market participants, to network operators to AEMO and regulators, can move quickly to adapt to the level of change we are seeing.

South Australia provides a recent stark example of our current reality: PV installers and inverter manufacturers had to adjust within months to SA regulatory change regarding inverter connection standards and behaviour in response to extreme grid issues (e.g. voltage ride through). It's tough for industry, and it costs money, but that's where we are. It is not in accordance with the NEO to move slowly on updating requirements to accommodate short-sighted business models, if in doing so valuable new participants are excluded from the FCAS market, potentially increasing the NEM-wide costs of maintaining system security.

# 8. Reasonable measurement requirements

From a helicopter view, there is something inherently disproportionate to the idea of collecting telemetry from residential-scale BESS at the same fidelity as the telemetry gathered from a multi-megawatt industrial provider of FCAS service.

In this section we present a case study comparing the Hornsdale big battery with a VPP of similar size to illustrate this.

## 8.1 Volume of measurements required

The Hornsdale big battery in South Australia is a 150MW plant, with a maximum FCAS bid of 95MW.

In order for a VPP composed of many 5kW BESS to comply with the existing same fast FCAS as the 95MW Hornsdale facility would require 19,000 BESS and 19,000 telemetry streams. It is a huge amount of data collection, all to deliver the same level of service.

For compliance with fast market measurement requirements in the existing MASS, Hornsdale would need to provide:

20 samples per second * 65 seconds = **1,300** measurement records for a single frequency disturbance.

In comparison, for a 95MW VPP:

95MW from 5kW devices = 19,000 devices.

The data burden to achieve fast market compliance across all these devices would equate to:

19,000 * 20 samples per second * 65 seconds = **24,700,000** measurement records for a single frequency disturbance, to comply with the existing MASS.

To comply with the draft determination requirement for 200ms resolution:
Hornsdale would need to record **325** measurements.
A 95MW VPP would need to record **6,175,000** measurements.

## 8.2 Power measurement error

Each power measurement must have an accuracy of 2% of total power.

For a 5kW device: -/+ **100 Watt** measurement error.

For Hornsdale: 2% of 150MW total battery power: -/+ **3,000,000 Watt** measurement error.

Summing power measurements across thousands of devices does not mean that it makes sense to sum the individual errors. Across a big enough fleet, the error distribution is normal about a mean of zero. The errors will cancel each other to an extent, and the total error across a fleet of thousands of devices will be much, much less than 100W * 19,000 = 1.9MW, diminishing close to zero.

Evergen's previous submission as well as UoM's analysis demonstrate this. It is beyond dispute that the error in aggregated measurement error across a fleet will be much smaller than a single set of measurements from one device. For this reason there is plenty of room to consider relaxing the sampling rate requirements for VPPs delivering fast market contingency FCAS.

So both the existing and the draft MASS are biased against VPPs versus DUIDs consisting of a single plant behind one connection point, in terms of both volume of measurements required, and accuracy of measurement.

**The impact of a single 5kW (roughly) size DER on the grid is negligible, and monitoring attached to that system should be commensurate with this near negligible impact.**

We need to be serious about allowing residential DER to participate in FCAS, it will add up to be a huge reservoir of FCAS capacity. Since both the VPP Demonstration program and the one VPP external to the program have already demonstrated the viability of DER-based FCAS, then AEMO should be contemplating the idea that we will be collecting telemetry streams from hundreds of thousands of systems in the near future.

Evergen recommends against a verification scheme that applies such disparate verification burdens, or one that requires such a copious and unnecessary amount of data from individual residences each with only ~5kW impact on the grid.

# 9. Alternatives for determining FDT

In our previous submission, Evergen explained the shortcomings with AEMO's existing method ("first recorded point" method). We described two alternative methods ("midpoint", "twin points average" as labelled by UoM). UoM confirmed that these methods are preferable to the existing method, and also provided a 3rd, even more accurate method (the "RoCoF" method).

Evergen appreciates that AEMO took our response seriously, confirmed it, and is now proposing to update the verification approach accordingly. Our aim in contributing is to be collaborative, and work with industry and AEMO to assist DER to participate where it is sensible to do so, and it is gratifying to jointly make progress like this.

We noted that in the forum of 8 November, that one stakeholder suggested that they had previously examined the measurement resolution question and concluded that more coarse than 100ms was not acceptable. Even without detail on this study, and assuming it is completely robust and accurate, if this study did not make use of the RoCoF method for FDT determination nor use the trapezoidal method for integration, then it is no longer a relevant study. The same applies for any other previous studies on this issue that do not consider these new methods.

At the very least, the 2021 MASS review has uncovered these new approaches to calculation which offer improved verification at little or no cost, a win for AEMO and a win for the market.

# 10. On using real-world data

Following feedback from the November 8 forum, AEMO has recently made a broad request for additional real world data, presumably to diversify the analysis presented by UoM, which uses only synthetic data.

Given the theoretical underpinnings for AEMO's result that 200ms is acceptable for non-intertial DUIDs such as those providing FCAS from BESS, and the additional result (which was supported by both UoM and also by Evergen's previous analysis), that even 1-second resolution is acceptable if verification is done at the NMI level, Evergen does not expect studies with new data to have any tangible impact on the results presented by UoM regarding verification error. It's possible though that AEMO might be presented with additional case studies of oscillatory response.

There is often a base assumption that real-world data is somehow preferable for assessing impacts, because it captures real world nuances that do not appear in theoretical data. There is definitely truth to this. However, there are also drawbacks from using real world data, and Evergen would like to emphasise these here, to pre-empt some of the additional analysis that may result.

## 10.1 Measurement error

Real world data involves the taking of measurements. These are inextricably linked with measurement error. Despite the inclination to treat 50ms real-world data as an error-free benchmark, it is simply not the case, and neglecting to properly handle this error risks skewing an analysis. As stated above, Evergen believes that the omission of a 50ms resampled case has the effect of accentuating the error attached to UoM's considered scenarios. These scenarios would all appear to have a more muted error if compared to a 50ms resampled benchmark that includes measurement error.

The sensitivities around measurement error become especially acute when examining individual response profiles as case studies. This is because individual case studies can no longer assume that measurement error matches the design specification of the measuring equipment. For individual case studies, whether the measurement equipment itself is faulty is a consideration, and additional analysis should be employed to verify that this isn't the case.

We are invited to treat such case studies - such as the single oscillatory response profile provided by Reposit in their first submission - on face value as being a perfect representation, ignoring any measurement error. But how can we determine whether or not the measurements were taken by a properly functioning measurement device? How do we distinguish between:

A. A faultless measuring device taking measurements of a faulty inverter, where the inverter really is delivering an FCAS response with oscillatory power response

B. A faulty measuring device taking measurements of a faultless inverter, where the apparent oscillations evident in the measurements are just an artefact of faulty measurement, and not something that is really happening at all.

Evergen recommends AEMO remain mindful of this when assessing the real-world data provided for this last stage of the MASS Review process.

Presentation of additional individual devices presenting oscillatory responses could be verified by replacing the measurement hardware for such devices and observing whether the same behaviour occurs. This would minimise the chance that the oscillation is an artefact of faulty measurement equipment rather than an actual inverter power output occurrence.

# 11. An assessment of current API-based DER industry capability

Evergen is not a hardware company, and we do not install additional Internet-of-things (IoT) devices for every DER we intend to orchestrate, though it is true that in the company's early years we did so. Our approach to VPP orchestration now requires no additional hardware or expense for the end user. This approach has allowed us to scale quickly to more than 6,000 DER, and ongoing rapid growth into the future.

As the DER sector has progressed, we have seen the inverter manufacturers themselves convert their products into IoT devices. This makes sense, because by allowing remote monitoring and control, hardware vendors can more readily assist end users to monitor their systems for faults, do maintenance tasks such as firmware updates, and collect data to guide future development.

We are a software-as-a-service (SaaS) company. We saw this clear and strong trend towards inverter vendors developing integrated monitoring and control capabilities. Our business model is to use rather than duplicate this capability. We make linkages between system suppliers, hardware partners, VPP owner-operators and consumers of grid services (AEMO, retailers, DNSPs) to facilitate remote monitoring, optimisation and control using the existing capabilities of inverter manufacturers.

Evergen is currently integrated with nine DER inverter companies, with more integrations under development. Our portfolio of integrations includes both residential and commercial-scale DER, both battery and solar inverters. Our roadmap includes integrations with Electric Vehicle charging stations, and other DER such as air-conditioning control systems.

We believe this approach is the future for residential scale DER monitoring and control, and therefore think that our perspective on the impact of the draft determination on FCAS capability for Evergen and its hardware partners is useful to AEMO in understanding the market impact of its determinations. Evergen itself has the infrastructure and capacity to monitor and control devices according to the MASS requirements, provided our hardware partners are able to comply.

- Of our current partners, **none** currently offer Evergen the ability to deliver FCAS with 200ms (5 samples/second) or faster sampling via API. In the immediate aftermath of the draft determination being made final, Evergen would be excluded from participating in the fast FCAS market with our current hardware partners - except for our involvement in transitional period FCAS fleets.
- Should the 200ms requirement become final, we expect that **one** of our hardware partners will be able to comply in the short term by rolling out firmware updates only.
- Two hardware partners who had already developed FCAS capability at 1-second will not be able to achieve 200ms compliance at existing installations, even with firmware updates. There is no economic opportunity or plan to retrofit these installations with new hardware to allow 200ms verification, so these systems would be excluded from fast FCAS.
- Across our remaining hardware partners, some (not all) already include metering hardware compatible with 200ms sampling. However metering hardware is but one facet of capability. None have yet communicated concrete plans for doing the additional work (local data handling, storage, comms, cloud, databases and servers, APIs) to deliver 200ms data recording in a way that allows remote orchestration and measurements for fast FCAS. We may see more clarity once the current MASS Review process is finalised.
- One hardware partner has indicated they are targeting 200ms capability via API by Q3 2022.
- Several seem open/positive to exploring what might be required - they have not ruled out developing 200ms capability, but nor have they provided any commitment.
- One of our hardware partners focuses more on commercial/industrial level battery installations. Compliance with the draft determination is less pressing, since the installation of 3rd party metering solutions is a comparatively smaller percentage of cost relative to battery costs and FCAS income at this scale.

# 12. Recommendations

Evergen recommends:

- 1-second sampling for DUIDs comprising many individual DER (eg. 200 minimum) is acceptable, provided DER types pass one or more frequency injection tests at high sample rate, to exclude DER types that have significant undamped oscillatory response as part of nominal operation, if any.
- Australian Standards and commissioning requirements are a more appropriate vehicle for controlling the potential oscillatory response of DER, rather than ineffectually using fast FCAS measurement requirements for this purpose.
- AEMO works towards implementing NMI-level verification swiftly.
- AEMO develops DER/VPP-specific requirements for FCAS, that allow low-cost compliance but deliver the same level of verification accuracy.
- AEMO should move swiftly and implement such change decisively, to provide industry with certainty and keep pace with rapid change across the NEM.

Evergen presents this submission in the spirit of open collaboration, and a genuine desire to continue innovating and accelerating the energy transition with the Australian energy industry for the benefit of all Australians.

# About Evergen

Evergen is leading the charge using software to enable decentralised energy systems of the future. Founded in collaboration between AMP Capital and the CSIRO in 2015, Evergen has invested in some of the smartest, curious and most capable minds across the industry. Evergen now works with many retailers and network operators in Australia, in Europe, and Latin America. Evergen's mission is to kill a coal-fired power station in 10 countries by powering the transition to a resilient, renewable, decentralised energy system of the future.

For more information, visit https://evergen.energy/

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