Hydro Tasmania

22 August 2022

Australian Energy Market Operator (AEMO)
GPO Box 2008
Melbourne VIC 3001

Submitted via email: mass.consultation@aemo.com.au

Dear AEMO,

Amendment of the Market Ancillary Service Specification (MASS) – Very Fast FCAS

Hydro Tasmania appreciates the opportunity to provide comment as part of the second stage of consultation on the proposed *Amendment of the MASS – Very Fast FCAS.*

The implementation of the Very Fast Frequency (VFF) market will be valuable to maximise potential contributions of market participants for the management of the power system frequency. Simultaneously, the VFF market will incentivise investment in faster and more flexible assets required to support the effective transition of the National Electricity Market (NEM) to higher shares of variable renewable energy.

The proposed MASS amendment predominantly focuses on newer technologies capable of providing frequency response in the prescribed 1-second timeframe, and the challenges associated with maintaining power system frequency within defined limits on the mainland of Australia as levels of inertia decline. We appreciate the rationale for this focus, but at a high-level wish to note: (1) the critical importance of mitigating impacts on pre-existing FCAS markets and FCAS providers; and (2) the nuances of frequency management in the Tasmanian power system.

1. Impact on Existing FCAS provision

The unnecessary imposition of obligations on existing FCAS providers (such as re-registration or increased metering requirements) would prove highly burdensome and disruptive, and should be avoided to the extent possible. On this basis, we strongly support AEMO's general market design principle that *"Unless there is a clear power system need to adjust the requirements for registration, the registration of existing Fast FCAS Providers should remain unaffected"*. Mitigating unnecessary burden on existing FCAS providers where possible will facilitate a more seamless implementation of the Very Fast FCAS market. The appendix notes several items that have been identified that may impact existing FCAS provision.

2. Nuance of FCAS provision in the Tasmanian Power System

As noted in AEMO's MASS Issues Paper (May 2022), the implementation of VFF may be different on a regional basis. Whilst we note and agree with the principle that any market structure for FCAS should be the same across the NEM, we note that the practical impact and implementation of VFF in the Tasmanian context has a number of technical characteristics that must be considered. For instance:

- **The suite of current constraints in Tasmania may deal with many of the issues that the VFF market may be required for in other regions.** As there is not the anticipated reduction in synchronous generation in Tasmania, the requirement for VFF response may be minimal.
- **The Tasmanian power system currently has FCAS switching settings to allow for the frequency variations experienced during interconnector power flow reversals.** This unique characteristic of the frequency management framework in Tasmania may create challenges in the implementation of a VFF service in the region.
- **Careful consideration must be given to the interactions of FCAS and power transfers between Tasmania and mainland Australia.** As a principle, Hydro Tasmania would support that interconnector transfer capability be maximised for both power and FCAS. .
- **Hydro Tasmania utilises a number of switched Fast FCAS facilities that may deliver VFF in a 1-second timeframe.** We are currently assessing the capability of these services to provide VFF and will continue to engage with AEMO as our work in this space progresses.

We look forward to continuing our work with AEMO and the Transmission Network Service Provider to ensure the ongoing supply of reliable, clean electrical energy in Tasmania as the power system evolves.

Hydro Tasmania has provided some detailed comments on the proposed MASS amendment in **Appendix A** to this submission. These comments relate to:

1. Capability of different technologies to deliver Very Fast FCAS (Section 4.3);
2. Key Parameters for Very Fast FCAS (Section 4.2);
3. Control System Requirements (Section 4.4);
4. Verification and Measurement Requirements (Section 4.5);
5. Overload Capacity (Section 4.6);
6. Impact on other FCAS (Section 4.7);
7. Revision to FCAS Measurement (Section 4.8); and
8. Contingency Event Time (Section 4.9).

If you have any queries on this submission or require further information please contact me (Prajit.Parameswar@Hydro.com.au).

Yours sincerely,

Prajit Parameswar
Manager Spot Markets

Hydro Tasmania

Appendix A: HT Comments on VFF MASS Amendment

1. Capability of different Technologies to deliver Very Fast FCAS (Section 4.3)

Hydro Tasmania appreciates AEMO's consideration of whether there are any barriers that could impact operators of certain technologies in participating in the Very Fast FCAS markets.

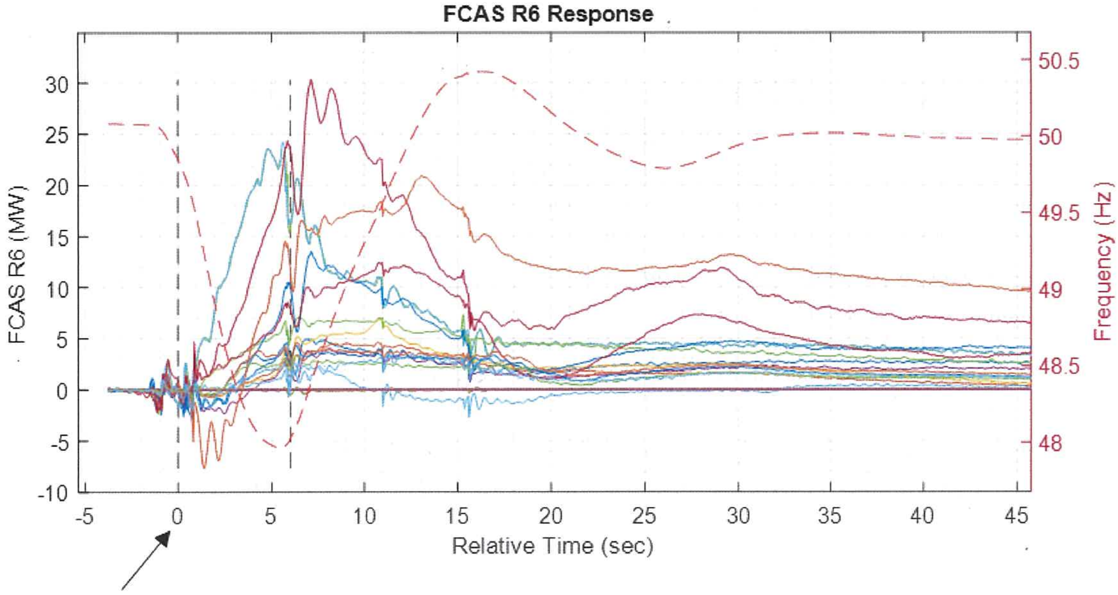
The response timeframes expressed in Table 3 of the MASS issues paper is one of the key references for AEMO to evaluate and determine the VFF capability for different technologies. We agree with the majority of the information provided in this table, however, as identified by previous respondents, the frequency response timeframe of synchronous generators will vary according to the technology.

For hydro generators, based on Hydro Tasmania's experience, the hydro machine water column acceleration time constant is typically around 1 to 2.5 seconds. On this basis, we believe that it will be challenging for hydropower units to achieve full output within a 2-second timeframe.

Table 3 Summary of potential FFR capabilities of various technologies

Technology	Time to full response	Sustained response
Synchronous Generation (including pumped hydro and compressed air storage)	2 seconds	Yes
Load	0.25 – 0.5 second	Yes
Wind Turbine	0.5 – 1 second[16]	Few seconds with recovery. Ineffective at low wind speed.
Solar PV	0.5 – 1 second	Yes, depending on the sun.
Battery Storage	0.2 – 1 second	Yes, depending on state of charge.
Supercapacitor	<0.2 second	Only a few seconds. Depends on size.
Flywheel	<0.01 second	<15 minutes
HVDC Voltage Source Converter	0.2 – 1 second	No. Depends on available energy.

To best illustrate the hydro machine VFF response capability, Hydro Tasmania has reviewed our unit responses to a significant actual system frequency event. Based on 50ms high speed data recorded, the hydro machine governor responses are illustrated in the following plot. Note, the dashed red line represents the system frequency, the other lines represent the hydro machine MW responses at the time.



Note: hydro machine response to a generator event only. Response to a load event not included.

From this event, we note that:

1. In this case, the high-speed data suggests that limited VFF injection can be observed within 1s after t0.
2. The hydro machine frequency response time constant is typically located between 1s and 2.5s,
3. The statement in table 3 that 'synchronous generation' (including hydro) could achieve full output within 2 seconds after the event may be too optimistic.

As outlined by this example and noting the fundamental hydro machine frequency response characteristics (e.g. inherent governor response and water column acceleration time constant), Hydro Tasmania believes that many hydro units will find it challenging to provide 1-second VFF response via governor action. As noted in the cover letter, Hydro Tasmania is assessing the potential provision of VFF response via switching controllers currently operational in the Tasmanian power system.

2. Key Parameters for Very Fast FCAS (Section 4.2)

The proposed 1-second arrangement will likely exclude the majority of synchronous machines, which at the moment, are still the dominant form of generation in the NEM.

System frequency control is not just a matter of frequency response speed, but also response coordination and overall system stability. Synchronous machines frequency response performance has been well proven over time, and in particular, the response reliability in events combined with system voltage depression and distortion. Conversely, there is currently limited operational experience and understanding of Inverter Based Resources and their capability to withstand and provide Low Voltage Fault Ride Through (LVFRT). We understand therefore that AEMO would comprehensively consider the delivery of VFF under different system event scenarios to ensure overall system integrity.

Another issue to consider, particularly in the Tasmanian context, is the interconnector transfer capability and the interrelation with a new 1-second VFF market including issues such as the allocation of local or global FCAS. As a principle, Hydro Tasmania would strongly support that the interconnector transfer capability be maximised.

3. Control System Requirements (Section 4.4)

Noting that AEMO is proposing not to restrict switching controllers in the VFF window, Hydro Tasmania suggests that consideration be given to the following points in implementation:

1. Switching response is typically considered in the latter stage of an event where there is a challenge to arrest system frequency within the Frequency Operating Standard (FOS) band specified. Introducing switching response immediately after a system frequency event could complicate system frequency coordination and control.

2. In the Tasmanian case, the frequency switching response is typically restricted due to the frequency disturbance introduced by an interconnector power reversal.

4. Verification and Measurement Requirements (Section 4.5)

At the conclusion of the 2021 consultation, AEMO adopted a tiered measurement regime for Fast FCAS. The MASS applies a discount factor to Fast FCAS delivered by Aggregated FCAS Facilities made up of DER that meet certain criteria. In the Issues Paper, AEMO considered that the same approach could be applied to Very Fast FCAS. It also mentioned that the proposed Very Fast FCAS must respond six times faster than Fast FCAS, which means that measurement times with a resolution of 200ms or 100ms might not be adequate for measurement of its provision. Very Fast FCAS providers would have the option of capturing data at a higher resolution to avoid the application of the discount, or use their Fast FCAS metering installation knowing that a discount will apply to their delivered quantities.

A discounting regime is necessary to avoid the need to procure additional Very Fast FCAS to offset the potential verification errors arising from data captured at a lower measurement time resolution. AEMO acknowledged that the applicable discount must be reasonable.

In addition to the measurement sampling rate, the allowable error and accuracy must be sufficient for AEMO to assess whether Very Fast FCAS has been delivered in accordance with the MASS. In the Issues Paper, AEMO proposed to specify:

- For power measurements, an allowable margin of error at 2% and resolution of 0.2%, which means that all types of Contingency FCAS would have the same requirements in this area.
- For frequency measurements, AEMO considered that a balance needs to be reached between sufficient accuracy and the relative cost of compliance.

Regarding the proposed ≤100ms metering requirement for Aggregated FCAS Facilities comprised of ≥25 FCAS Facilities, Hydro Tasmania is concerned that this requirement may create an undesired barrier to business Virtual Power Plants (VPP) which are likely to have fewer FCAS facilities (i.e. >25), compared to other VPP operators who may target residential customers.

In a hypothetical situation where 26 identical FCAS Facilities with variable controllers, totalling 3MW in capacity are aggregated into one DUID, this portfolio can bid capacity into Very Fast FCAS without the requirement to install expensive high speed metering equipment. If split over two identical DUIDs of 1.5 MW each (13 FCAS Facilities each), these assets would not be able to be bid into Very Fast FCAS unless expensive metering equipment is installed. This is despite these assets having an identical response and therefore no impact on system security if they were all bid in to Very Fast FCAS as part of 1 DUID or as part of 2 DUIDs. The more costly metering requirements for portfolios of less than 25 FCAS Facilities is therefore less desirable in this situation (and similar situations), and will make it harder for aggregators to 'onboard' and bid new assets and provide VFF response at a lower cost.

5. Overload Capacity (Section 4.6)

Hydro Tasmania agrees with AEMO's conclusion that further consideration is required to assess whether the overload capacity of an FCAS facility should be counted as Very Fast FCAS. We support AEMO's decision to consider this as part of a future review, and we would like to make the following observations.

The overload capacity typically refers to generating units overload thermal withstand capacity. Based on our understanding, for semiconductor based IBRs (e.g. BESS), the overload capacity is typically specified between 1.2 p.u. to 2 p.u. with the sustainable interval typically between sub seconds to seconds (could be longer with special designs). In contrast, a synchronous machine normally has a much higher overload capacity due to its thermal structure as well as its need to deal with fault conditions, e.g. withstanding the sub-transient fault current which could be up to 3-8 times of the rated current. For a synchronous machine, the overload capacity sustainable interval varies from a few to tens of seconds.

Hydro Tasmania understands the overload capacity only reflects the generating units thermal withstand capacity, and doesn't necessarily mean additional power injection for the purpose of frequency correction. Effective overload delivery capacity can be vastly different based on different technologies.

It is worthwhile to point out that from the system security perspective, in a case where the system frequency event is combined with voltage depression, the attempt to utilise the generating units overload capacity for the purpose of VFF response could restrict the system reactive power reserve and adversely impact on the system resilience. This is particularly true for a grid operating with high non-synchronous penetration, where reactive support and voltage restoration has to be prioritised after an event to facilitate the IBRs achieving successful commutation. Given this, Hydro Tasmania would encourage a conservative approach to utilising the overload capacity for Very Fast FCAS purposes.

Hydro Tasmania acknowledges the complexity of this topic, especially with respect to the primary source and injection mechanism, and as noted is supportive of AEMO deferring this topic for a future review.

***6.* Impact on other FCAS (Section 4.7)**

Hydro Tasmania agrees with AEMO's assessment that introducing the new VFF provision is unlikely to impact on the other FCAS categories, as long as the existing evaluation procedures, assumptions and response configurations remain the same.

Hydro Tasmania

7. Revision to FCAS Measurement (Section 4.8)

Hydro Tasmania understands the 'multiplier effect' raised by AEMO and acknowledges the challenge of the current FCAS measurement methodology, which basically uses a time average of energy to reflect the FCAS demand and contribution in a market environment. However, from the system 'power balance' perspective, this approach as AEMO illustrated, could be impacted by the facility frequency response power trajectory, hence experiencing a discrepancy between the anticipated and actual FCAS delivery. Hydro Tasmania understands that the multiplier has been introduced since the establishment of the NEM FCAS markets and has been applied to all six FCAS contingency services.

The concern is that along with the uncertainty this creates, there is the potential of significant expense and effort with the rework involved in re-evaluation, and re-registration as well as altering operational systems to facilitate these proposed changes. This is of particular concern to Hydro Tasmania with approximately 40 generating units registered for FCAS services. In light of this, Hydro Tasmania proposes the potential revision of the 'multiplier' be treated as a structural change of the MASS, and therefore would highly recommend AEMO to de-couple this matter from the current VFF response MASS consultation.

8. Contingency Event Time (Section 4.9)

Hydro Tasmania agrees with AEMO that the Frequency Disturbance Time (FDT) is more preferable to use than the Contingency Event Time (CET). This is because it is difficult for FCAS providers to easily determine the CET independently of AEMO.

Similar to the 'multiplier effect', Hydro Tasmania suggests that the proposed 'adjustment to the pre-disturbance baseline' requires further consideration, and should be de-coupled from this consultation, noting the rapidly approach 30 September 2022 due date for this final MASS amendment. With the proposal of capturing the machine PFR impact in the FCAS response by introducing an 'adjusted MW' value, there are a few issues that Hydro Tasmania suggests require clarity:

1. Whether or not the t0 adjustment from CET to FDT could potentially cause the machine FCAS trapeziums to be less conservative and more likely exposed to a non-compliance. Based on our experience, the FCAS trapeziums have been created based on FDT, the area 'A1' illustrated in the AEMO presentation effectively provides a safety margin. If the t0 is adjusted to FDT as the same as the trapeziums, this margin would be diminished.
2. Whether or not the averaged frequency measurement between FDT-20 and FDT-8 is a meaningful technical definition, to reflect the machine general PFR droop response prior to the event. Unfortunately, at the moment we don't have any study or reference with regards to this 'averaged frequency' concept.
3. If the frequency excursion pre and post the event is opposite, it is unclear whether or not the 'adjusted value' could negatively offset the FCAS delivery and expose the machine FCAS response to non-compliance. Note, as a standard process, the FCAS trapezium development is created based on a constant pre event output, i.e. the pre event PFR impact is effectively ignored.

In summary, Hydro Tasmania supports a clear, practical and simplified (wherever possible) evaluation approach. We expect this approach should incorporate both FCAS evaluation and FCAS trapezium development and ensure the overall outcome is technically conservative from both system security as well as FCAS provider delivery compliance perspectives.