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Australian Energy Market Operator

Lodged via email: 2024_security_consultations@aemo.com.au

AEMO's Amendments to the Inertia Requirements Methodology consultation paper

Transgrid welcomes the opportunity to respond to the Australian Energy Market Operator's (**AEMO**) Amendments to the Inertia Requirements Methodology consultation paper, which was published on 5 July 2024. The consultation paper introduces key changes to the Inertia Requirements Methodology which considers system-wide inertia level to support the NEM.

As the NSW TNSP, Transgrid must plan for, build, maintain and operate the backbone of this new grid while meeting our obligations to maintain the safety, reliability and security of the transmission system in accordance with the National Electricity Rules (**NER**). A new suite of technologies, services and products will be required to maintain safe, reliable and secure power system operations as the energy system transforms. Ensuring that the right methodologies are in place is vital to maintain these key aspects of the system.

Transgrid is supportive of AEMO's proposed approach as outlined in the consultation paper. The update to the current methodology is important to reflect recent Australian Energy Market Commission (**AEMC**) rule changes.

Attachment One contains specific comments on several questions contained in the methodology.

We appreciate the opportunity to provide a submission to the consultation on amendments to the Inertia Requirements Methodology. If you would like to discuss this submission, please feel free to contact Zainab Dirani

Yours faithfully

Robbie Ahern
General Manager System Resilience

Attachment One

The table below provides specific comments from Transgrid on several questions presented in the Inertia Requirements Methodology consultation paper.

AEMO question	Transgrid comments
NER requirement: System-wide inertia level and inertia sub-network allocation	
Do you consider the proposed high-level methodology for determining the system-wide inertia levels and inertia sub-network allocations is appropriate?	We support the methodology set out by AEMO and believe it is broadly appropriate. Step 3 proposes higher FFR is needed to be purchased for lower inertia operations. We would encourage AEMO to clarify whether the technologies, as the source of FFR, is mostly invertor based. It would be prudent to assess the dynamics of Active Power injection from different sources of energy (e.g. BESS versus Synchronous Generators), which may change the contracted FFR service.
If not, what specific alternatives or additions might better address the NER requirement, and why?	If the above point has not been considered in AEMO's assessment, we believe it would be beneficial to test a diverse range of dynamic responses to check the sensitivity of required FFR for operation with lower inertia.
Are there any other issues relevant to the system-wide inertia level and inertia sub-network allocation methodology that AEMO ought to take into account	Transgrid would encourage AEMO to consider the following points. • Line trips that have associated generator transfer tripping, e.g. Wagga – Darlington Point 330 kV line contingency that will require the trip of several generators in southwest NSW. • Managing non-credible events including multiple generator trips have not been an issue historically because there was plenty of inertia in the system. However, with the proposed inertia services approach, it is unlikely that there will be an excess of system inertia available in the future. Therefore, it is worthwhile for AEMO to assess the outcomes in the event of multiple generator trips, interconnector trip events, etc. to test the ability of the network to withstand them or avoid cascading failures, as well as confirm the ability of under-frequency load shedding or over-frequency generator tripping to manage them. If not, there needs to be a focus on special protection/control schemes to manage these.

AEMO question	Transgrid comments
	• Consider interconnector transfer limits in the sub-network inertia allocation.
NER requirement: process for determining sub-network islanding risk	
Do you consider the proposed factors for classifying sub-network islanding risk are appropriate?	We support the suggestion to consider inertia assessments for a multi-region island as the factors mentioned appear to be appropriate.
If not, what additional or alternative factors should also be included in this assessment, and why?	No comment
NER requirement: inertia network services specification	
Are the proposed parameters and requirements for a service to qualify as an inertia network service appropriate?	Transgrid has used the following proposal to assist proponents to better understand sufficient levels of headroom for system strength services from GFM BESS. AEMO may be able to use this regarding footnote 21 on page 18 if it is found useful. *"The headroom for Active Power must be selected in such a way that generator would not reach its maximum active power (whether continuous rating limit or optional overload limit), for a 1.0 Hz/s event as the highest ROCOF for a credible contingency in Frequency Operating Standard [6]. As the response from the battery is considered to be dependent on the swing equation modelling, the required headroom can be back-calculated from the swing equation which is a function of constant inertia for the highest ROCOF identified in [6], being 1.0 Hz/s for Mainland. The AEMC may revise this value of ROCOF in the Frequency Operating Standard, and if so, then the amount of headroom will need to be amended by the Proponent accordingly."*
If not, what specific additions or alternatives should be included, and why?	No comment

AEMO question	Transgrid comments
Which of the approaches outlined for estimating the inertia level provided by non-synchronous equipment do you consider most appropriate, and why?	• In the reference that explains the method of calculation for IBR, it has correctly referenced to the impact of D being damping factor which is a tuneable parameter in IBRs. However, it has the assumption behind it that the D factor is programmed to be the multiplier of Δf which is not the case for all the GFM technologies. There are technologies that the D factor becomes a multiplier of the second order component of the swing equation due to the effect of filtering (it gets multiplied by S operator in the frequency domain). So, it would be good if AEMO could comment what should be done for those conditions. Transgrid, in the GFM specification, has recommended that for simplicity of planning that if swing equation is implemented, it must be implemented exactly as the synchronous machine to avoid this non-linearity. What this additional filtering can also add is non-linearity between RoCoF and inertia constant because of the ratio I_total on page 19, will have S in its formula which means unlike Synchronous generators, GFM technologies may have different synthetic inertia at different RoCoF. • We believe it would be appropriate for AEMO to explore what the status of Frequency control including PFR and FFR should be when all of these tests are undertaken for calculating the synthetic inertia.
Are there any alternative approaches to estimating the inertia level provided by non-synchronous equipment which AEMO should consider?	We recommend that the GFM OEM be provided with the control block diagram. This will allow us to back calculate the swing equation from the block diagram into the swing equation format to understand the exact inertia numbers. Transgrid would be keen to provide AEMO an example if AEMO sees this to be beneficial. We believe this exercise would allow the comparison to the inertia value that is calculated from PSCAD studies. Alternatively, the PSCAD tests recommended in the reference of AEMO publications should be done across a wide range of RoCoF to confirm the consistency of the linearity.
Are there other issues relevant to the inertia service specification that AEMO should consider?	Transgrid would encourage AEMO to consider the following points:

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	• There could be limitations in the GFM BESS technologies such as how many times full charge or discharge can occur in the event of frequency disturbances within a limited window of time. • There could also be limitations of providing fault current during a system fault (voltage disturbances) which is concurrent with a frequency disturbance such as a Synchronous machine fault which leads to a trip of the synchronous generator. The tests must ensure that the same inertia is provided if the voltage and frequency disturbances are happening simultaneously. • In some country grid codes, the use of virtual impedance in the GFM technology is not allowed. It would be great if AEMO could clarify its position about that and more specifically mentions it in the specification. • Another specification that may need to be considered is the post fault behaviour. In some batteries which are programmed to provide synthetic inertia, it has been observed that post a fault that is associated with a frequency drop, there has been significant Active Power disturbance which adversely impact the nadir. It might be worth emphasising that such observation will not be acceptable. • Considering that inverters typically function under active or reactive current priority, under some conditions system strength service (reactive power) and inertia service might have aligned interest. • It is worth investigating the effect of System Strength over the Inertia service to understand if there is a direct or indirect influence. • Can AEMO also discuss if the approval is fully dependent on the modelling prior the connection or this approval is conditional to the proving of results during the Commissioning and operation. Considering the lack of maturity of the industry in this area, Transgrid recommend specific commissioning, R2 model validation and more onerous ongoing

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	compliance monitoring is applied for the projects which provide these services.
Methodology improvement: redispatch assumptions	
Do you consider the proposed amendments appropriate for the calculation of secure inertia levels in each inertia sub-network?	We agree with AEMO's proposal to consider generators above their minimum stable operating level.
If not, what additional or alternative changes might better address the NER requirement, and why?	No Comment
Are there any other issues relevant to the secure inertia level requirements that AEMO ought to consider?	No comment
Methodology improvement: credible events leading to island formation	
Do you consider the proposed amendments appropriate for the calculation of satisfactory inertia levels in each inertia sub-network?	We agree with the proposal to amend the contingency events considered.
If not, what additional or alternative changes might better address the NER requirement, and why?	No comment
Are there any other issues relevant to the satisfactory inertia level requirements that AEMO ought to consider?	In a recent observation, one of the OEM batteries equipped with Synthetic inertia, for a given 2 second window from the beginning of a disturbance, the BESS provides 27% of the total energy injected in the first second (first half) and the rest in the second half. For a synchronous generator, the same ratio is about 58% in the first half and the rest in the second half. This may not be problematic but only an observation to Transgrid; however, this raises a question whether the rate of response throughout 1-2 seconds would matter or not for the system if many large-scale Synchronous Generators are replaced by large scale batteries with the noted behaviour.

AEMO question	Transgrid comments
Methodology improvement: additional modelling considerations	
Are the proposed future system conditions appropriate to consider as part of forward-looking inertia studies?	Transgrid supports including future network and generation developments. However, the consistency of the data specifically in relation to the forecast load that are delivered from DNSPs need to be taken into account prior to commencement of the work in this area. We would like to suggest that AEMO, in consultation with the NSPs, create a template for load forecast data exchange, so that everyone takes advantage of accessing consistent data. It is also worth considering the consistency of the location of future IBRs. Clarification is sought regarding the Multi Mass Models (MMM) of the generators, if this only applies to synchronous generators or it is expected that other types of generators such as Wind Turbines also provide their MMM? If so, does this apply to existing operational generation or only future projects? It must be noted that modelling Multi Mass Models may introduce new types of oscillations to the NEM models that might be hard to investigate. So, careful consideration for modelling requirement and accuracy of that must be taken.
If not, what additions or alternatives should AEMO consider in forecasting inertia requirements?	No Comment
Methodology improvement: other amendments and updates	
Do stakeholders have any other concerns or additions to the proposed minor amendments introduced to maintain consistency with the broader changes in the Amending rule?	Transgrid has the following additional comments. 1. Page 4 of "Amendments to the Inertia Requirements Methodology", Section 3.6- Transgrid suggest that in the 10-year planning, we add Future IBRs including REZes Generations a) Transgrid also suggest that AEMO releases the PSSE model of their 10-year planning available to the TNSPs. 2. Page 8- point 1 refers to ROCoF limit following any credible contingency event. Considering the RoCoF after the contingency event is the function of remained inertia within the system, and also the fact that the most onerous contingency in this condition could be tripping of one of the synchronous

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	machine, is this requirement always referring to RoCoF under N-1? We would appreciate further clarification on this point. 3. Page 8- point 4 refers to AEMO's approval of the service based on the specifications defined in inertia service specifications. Considering the timeframe Dec 2027 that TNSPs must meet this requirement, what is the timeframe of this specification publication?