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16 February 2023

Ms Merryn York
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Via email: PSMGReview@aemo.com.au

Dear Merryn

SUBMISSION ON AMENDMENTS TO THE POWER SYSTEM MODEL GUIDELINES – CONSULTATION PAPER

Powerlink Queensland (Powerlink) welcomes the opportunity to provide input on the Australian Energy Market Operator's (AEMO's) consultation Paper regarding amendments to the Power System Model Guidelines (Consultation Paper). Our submission to this Consultation Paper reflects our commitment to continue to provide safe, secure, reliable and cost-effective transmission services to our five million Queensland customers.

Changes to AEMO's existing Power System Model Guidelines (PSMG) are required mainly due to the recent increase in large-scale power electronic interfaced load connection applications. Currently no specific model requirements are included for loads in the PSMG.

In developing amendments to the PSMG, Powerlink would like to highlight the following key points:

- Powerlink supports AEMO's approach for load model requirements to be included in the PSMG. Technology is evolving at a fast pace and what technology advancements will be seen in the near future is not known at this point in time. Therefore, provision for some flexibility is required when Network Service Providers (NSP) are deciding what details would be required for inclusion in a load model (whether it is a composite load model or full detailed model, if additional control and protection functions are to be modelled, etc.).
- In Powerlink's view, modelling requirements for the Inverter Based Loads (IBL) should be similar to asynchronous generator models and will be required in both RMS and EMT domain. Accurate representation of dynamic characteristic of a load for Fault Ride Through (FRT) conditions is vital to understand the impact on power system stability.
- IBL can have similar impact as from asynchronous generators on power quality. Therefore, we suggest that Power Quality Model Requirements as defined in section 4.6 of the existing PSMG are also applicable to IBL.

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- Powerlink supports the requirements for the small signal models for the Inverter Based Resources (IBR). We believe that small signal models for IBR that include details of inverter level (e.g. current control loop, PLL etc.) and plant level control would be able to provide insight into the source of any instabilities/control interactions that are being experienced in the NEM.

EMT simulations take a long time to run and not all the system and plant conditions can be simulated in EMT domain. Therefore, it is possible to miss some of the interactions amongst IBR and between IBR and synchronous plants that occur only at specific but plausible system and plant conditions. Small signal analysis using detailed models of the IBR is essential to effectively manage the complexity of the IBR connections.

These points and responses to a number of the specific questions raised in the Consultation Paper are discussed in more detail in Attachment A.

If you have any questions in relation to this submission or require further clarification, please contact Sachin Goyal.

Yours sincerely,

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Attachment A – Feedback for Amendments to the Power System Model Guidelines

1. *Consultation question 1:* What is the threshold (if any) for deciding when to model a traditional large power system load in detail for power system simulations, be it megawatt-based, location-based or otherwise?

   Depending on the location of the connection point and the other network users in the vicinity, it is important to understand the type of the load and its characteristics to analyse its impact on power system performance. Therefore, the threshold for the modelling of such load is also subject to the location and other users in the vicinity. Traditional loads that are mainly non-IBL type can be represented by a simplified aggregated model to represent its dynamic behaviour. NSP should make a decision at the time of connection agreement to request the load model.

2. *Consultation question 2:* Is the IEEE or Composite and DER Load models suitable for these types of loads or is more detail required

   Most of the non-IBL load should be able to represent using the IEEE or composite and DER load models (with the use of appropriate aggregation). However, if a load is connecting to a part of a the network which has some existing limitations or foreseen issues, a detailed model might be required. On this basis, Powerlink believes that a decision to request a detailed model if required should be left with the NSP based on network experience.

3. *Consultation question 3:* Are there any other types of large loads that have not been considered here?

   Technology continues to evolve and what technology advancements will be seen in future is not known at this point in time. Therefore, identifying load characteristics and its operation is important to decide whether it falls under IBL. For example, there could be large loads that are connected through active front end type converters which rely on tracking grid frequency/angle using a phase locked loop (PLL). This type of loads should also be considered as IBL.

4. *Consultation question 5:* What additional protection and control systems are expected to be required in the models?

   Dynamic characteristic of a load for fault ride through should be represented in the model appropriately. Therefore, it is important to model control and protection functions (e.g. voltage and frequency protection) that can affect the continued operation of a load. If the load size is significant (with respect to the network conditions), load loss during a transient disturbance and its recovery from the fault should be accurately represented in the model.

5. *Consultation question 6:* What level of detail is required for IBL in RMS and EMT domains?

   IBL could have similar impact as IBR on power system performance in terms of system strength requirements, FRT performance, voltage control etc. Therefore, the accurate modelling of IBL is required and the modelling requirements similar to the requirements for the inverter based asynchronous generator models should be required in both RMS and EMT domain models.

6. *Consultation question 8:* What level of R2 validation is appropriate for different types of load models?

   For non-IBL, sufficient data (variation in active and reactive power for voltage disturbances) should be captured for model validation during commissioning and testing of the plants. Then parameters in the composite and DER model should be tuned to match the load response.

   For IBL, a similar accuracy level to current inverter based asynchronous generator R2 validation should be used.

7. *Consultation question 9:* What should the requirements for model provision in Section 7.4 be for IBL? Should it be identical to Generator data?

   For IBL, a similar model provision approach to inverter based asynchronous generators should be used, as the studies would be required to agree and finalise plant performance.

8. *Consultation question 10:* What components should be included in a new table in Appendix C for IBL? Are there any specific control systems, protection systems or other components that are specific for loads that will have material impact on power system simulations?

   Control and protection systems which are sensitive to grid disturbance should be appropriately modelled in both RMS and EMT domain models. For example, model of a large data centre should include grid disturbance protection system associated with the Uninterrupted Power Supply (UPS) backup system which performs transfer from grid supply to the UPS supply during a network disturbance to study the impact of load rejection/tripping on the power system stability.

9. *Consultation question 12:* Are there any other methods that could guarantee that models remain usable for the life of the plant despite changes to simulation tools, versions, or compiler toolchains that AEMO has not considered here?

   An escrow requiring connecting parties to supply either an open-source variant of the source code, or all relevant files, including dynamic-link libraries (DLLs), that will provide for the software to be compiled in a platform-independent manner, from the plant's OEM. A software escrow is a service that helps protect all parties involved in a software licence by having a neutral third party agent hold source code, data, and documentation until a mutually-agreed-upon event occurs. A further obligation on connecting parties (which would be passed on to OEMs) to update NSPs, AEMO and the AER with current source code at the time updates are made.
   The proposed escrow arrangement would allow release of the files to AEMO under specified circumstances, such as where the OEM has withdrawn its presence from the Australian market or it no longer operates as a going concern. The function of the escrow agent would therefore be to hold 'legal custodianship' of the files rather than to use the models themselves.

10. *Consultation question 15:* Are there any additional required modifications to the Guidelines that AEMO has not considered here?

    The following additional points are raised by Powerlink as part of the proposed changes to the PSMG.

    - Powerlink supports the requirement for a RUG for both RMS and EMT load models.
    - For large non-IBL and IBL type loads, a harmonic model should also be required. A large load might have filter banks and many harmonic generating sources and a provision for harmonic model should be specified.

- In AEMO's DMAT guideline suggests PSMG accuracy requirements for benchmarking as indicated below.

  - Model benchmarking (and assessment against consistency and/or accuracy) is undertaken for the following PSS®E and PSCAD™/EMTDC™ modelled responses:
    - 3 phase faults and voltage disturbances.
    - Overvoltage events.
    - Reference changes.
    - Phase shifts[15] and/or frequency responses.
    - Application of ramps and step responses.

  The acceptance criteria are based on demonstration of consistency in RMS responses and *Power System Model Guidelines* accuracy requirements[16] and:

  However, benchmarking between RMS and EMT model platforms is not dealt within the PSMG. Our understanding of the model accuracy requirements of the PSMG is that they relate to model accuracy in reference to measured plant data, and not between different model platforms. Powerlink suggests that specific benchmarking requirements are developed that allow for understood differences between model platforms, but have much tighter requirements for controlled actions (eg, voltage and active power reference steps should match exactly).

- The RMS and EMT models used for the studies are the aggregated models. The model accuracy requirements (as per Section 6 of existing PSMG) for aggregated models are not really able to be applied effectively at terminal level plants (i.e. inverter or turbine terminals) when large number of generating units are presented in a generating system. We propose that the applicability of this requirement at inverter or turbine terminals level be reviewed/removed.

  For example, there's not really direction as to how to compare a 2.5MW inverter (nearest or furthest) to an aggregated 100MW model.

- EMT model initialisation is defined at 3 seconds (Section 4.3.4 of existing PSMG), however the initialisation is not defined. Without a proper definition, different interpretations can be made of what is initialised. We propose that a clear interpretation be included. An example is given below:

  Point of Connection (POC) P and Q values are within specified controller dead-bands by 3 seconds, and remain within those dead-bands for the rest of the simulation, or until a disturbance or change is applied. Inclusion of an example of model initialisation in the appendix might also be beneficial.