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10 February 2023
Michael Gatt
Executive General Manager Operations
Australian Energy Market Operator (AEMO)

Via email: PSMGReview@aemo.com.au

Dear Mr Gatt

2022 Power System Modelling Guideline Review Consultation Paper

AusNet welcomes the opportunity to make this submission in response to the 2022 Power System Modelling Guideline Review Consultation Paper (the PSMG Review).

AusNet is the largest diversified energy network business in Victoria with over $11 billion of regulated and contracted assets. It owns and operates three core regulated networks: electricity distribution, gas distribution and the state-wide electricity transmission network, as well as a significant portfolio of contracted energy infrastructure. It also owns and operates energy and technical services businesses (which trade under the name "Mondo").

Transmission connected inverter-based loads (IBL) such as data-centres are a relatively new market development. In Victoria, data-centres have typically connected via the distribution network as loads were less than 80 MW. However, in recent years digital transformation has resulted in significant growth in the demand for and load size of data-centres (i.e. ranging from 80-200 MW) with most requiring a high degree of reliability. As a result, a dedicated connection to the transmission system is increasingly attractive to data-centre service providers. AusNet anticipates demand for transmission connected data-centres will continue to rise this decade.

In this context, AusNet understands the need for a proactive approach to amending the PSMG to account for IBL. We agree there are situations where IBL behave differently to traditional loads and that it is important to provide industry with clarity around their modelling requirements before more large IBL are connected to the transmission system.

AusNet is broadly supportive of the proposed amendments within the PSMG Review. The attachment below provides AusNet's thoughts on how AEMO can achieve the right balance between requirements which are too loose to adequately protect the power system and requirements that are too onerous which create barriers to the connection of IBL to the transmission network. We note that several questions may be better addressed through the Power Systems Modelling Reference Group due to their technical complexity.

If you have any questions regarding this submission, please contact Jason Jina, Energy Policy Lead by email at jason.jina@ausnetservices.com.au.

Sincerely,

Rod Jones
General Manager, Network Strategy & Planning

AusNet

AusNet

Attachment: Response to specific questions within the PSMG Consultation Paper

AEMO

Friday, 10 February 2023

AusNet response to specific questions within the PSMG Consultation Paper

#	AEMO Question	Comment
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?**	AusNet notes that this question was explored in detail in the recent series of AEMO Technical Requirements Review workshops, and that the outcome of these workshop discussions may be the determining factor to answer this question. In general, it is difficult to define a singular criterion to be applied across all possible circumstances in the NEM. Factors to be considered include connection voltage levels, strength of the local network, and the type of grid interface used by the proposed load (e.g., IBR, induction machine, resistive). Conversely, it is important to provide a basic level of certainty to potential customers about modelling requirements such that it can be factored into the project both in terms of time and cost. If suitable metric cannot be found, a suggested approach may be to mirror thresholds currently applied to generating systems. This may take the form of connections 5 – 30 MW in capacity **may** be subject to load modelling requirements depending on the grid interface of the load, local network specifics (e.g., voltage, strength, proximity to other IBR loads) at the connecting NSP's discretion. Currently generators up to 30 MW are eligible to apply for registration exemption hence schedule 5.2 does not apply for such generators where demonstration of compliance to performance, which includes demonstration of performance using models. Therefore, it is reasonable to exclude loads between 5-30 MW from a general threshold that require modelling. Connections above 30 MW should require modelling to be undertaken. The modelling requirements should vary based on composition of the load. Traditional power system loads should not be subject to similar modelling requirements requested for the IBR loads. Loads under 5 MW would be subject to the local NSP's connection requirements. Existing loads would not be subject to updated modelling requirements unless a material change to the type of grid interface occurs.
2	**Is the IEEE or Composite and DER Load models suitable for these types of loads or is more detail required?**	This question depends on the grid interface type and the long-term expected strength of its connection point. In general, a large power system load that is using some form of complex power electronic interface where a control system tracks fast grid-side quantities (e.g., voltage waveforms) and tightly controls the performance of the load should be subjected to more detailed modelling requirements. For simpler technology types or controllers that operate on grid-side quantities that can be reliably modelled in RMS software (e.g., RMS voltage), a correspondingly simpler model could be provided. Simplified models are suitable for traditional large power system loads to simplify the modelling and assessment requirements for such load connections.

3	**Are there any other types of large loads that have not been considered here?**	The load-types indicated in the consultation (data centres, hydrolysers) are consistent with AusNet's recent experience.
4	**Is the Composite and DER Load model sufficient to model data centres in RMS and EMT domains?**	*In addition to IT devices behind the UPS, generally cooling equipment are controlled by decentralised variable speed drives (VSD) with filters.* Where the majority of load is being fed through the UPS and VSD, RMS & EMT models of the UPS and VSD are required. UPS and VSD models can be aggregated appropriately in the site-specific model.
5	**What additional protection and control systems are expected to be required in the models?**	Similar to protection and control systems modelled in the generating system models, events that may cause undue tripping due to an upstream disturbance such as RoCoF, under and over frequency , under and over voltage , faults (inc. multiple faults), large phase angle shift, loss of phase, excessive harmonics, uncontrolled instability, commutation failure, etc.
6	**What level of detail is required for IBL in RMS and EMT domains?**	Again, similar to what is expected for generation, potentially with an additional clarification that if harmonic emission limits will be adequately addressed by some other means, then EMT average models are acceptable (i.e. fully switched models not needed). Models can be aggregated appropriately based on the configuration of the load. Much like generators, the RMS model will likely only be capable of representing the response of the protection and control systems that act on quantities representable by the RMS domain. While the EMT model will be expected to represent more accurate protection and control systems consistent with the with the actual controllers which are relevant in terms of impact to the wider grid.
7	**What are the black start simulation model requirements for large power system loads (if any)?**	Very large loads are unlikely to be picked up during the early stages of black start which most black start simulations cover. That is, unless that load is capable of providing Restoration Support Service by operating in a special mode or with capability that it would otherwise not operate with. For example: constant power, rampable, controllable, providing voltage support. In this case a full load meeting the requirements of a black start study would be valuable, but there would likely need to be some form of Restoration Support Service contract in place (or intent to tender). Unless a large power system load intends to enter into a Restoration Support Service contract, RMS and EMT models do not require explicit additional modelling for black start simulations. Auxiliary loads of SRAS providers should be explicitly required by the guidelines (e.g., Induced Draft Fans, Boiler Feed Pumps, etc. of coal plants).
8	**What level of R2 validation is appropriate for different types of load models?**	As far as practicable during or immediately following the commissioning, validation should occur against the load's performance standard, with ongoing permanent monitoring to validate the model's response to system disturbances throughout the life of the plant. R2 validation report (model validation) and commissioning report (performance validation) may be submitted as a single report within a reasonable timeframe following commencement of commercial operation.
9	**What should the requirements for model provision in Section 7.4 be for IBL? Should it be identical to Generator data?**	If the intent is to collect IBR load models that have similar capability and detail to that of generator models, then the same requirements should apply to load models. If simpler loads are adequately representable by composite or ZIP models, then the requirements should be relaxed. Essentially if the only way to properly represent the load's performance is with detailed RMS & EMT models, then similar requirements need to apply.

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?**	AusNet does not have a firm opinion at this stage, other than the expectation that this should be determined by the Power System Modelling Reference Group and drawing on any specialist consultants used during the guideline update process.
11	**Are there any other issues relating to model requirements for large loads that AEMO has not considered?**	No comment.
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?**	AusNet agrees the external DLL method is most desirable. A brief summary of our position with respect to each of the identified methods is provided below: • **Fully open model with no custom components** – Not desirable, as it creates potential for translation-error (similar to what we see for PSSE models which are re-written in FORTRAN). Additionally, as the library components have been well 'pressure tested' by all PSCAD users for decades, any software implementation bugs that may exist in the real code would likely be corrected by the use of the robust and well-tested inbuilt library components. There is also a high risk that OEM IP would be exposed. • **Blackboxed PSCAD model** – For the reasons stated in the consultation paper, this method is not desirable. Additionally, although a Blackboxed PSCAD model has the highest chance of protecting OEM IP, it creates distrust by the user as anything could exist behind that black box – even an ideal voltage source. There is no way of knowing. This would reduce confidence that the model is actually representative of plant. • **PSCAD model with external static library** – For the reasons stated in the consultation, this method is not desirable. • **PSCAD model with external dynamic link library (DLL) –** This is the most viable option, with explicit linking. However, it would be important to ensure that the environment that DLL is expecting is future-proofed to the extent possible (i.e., 64-bit as a minimum) with required external libraries included. This would ensure excessive redistributable package installations are not required. In terms of model longevity, AusNet invites AEMO to consider holding the source-code of both the real device and EMT model in escrow. This is described within CIGRE Technical Brochure 881 (section 3.7.1.1.2).
13	**Would there be any issues with developing a DLL to conform with a standardised explicit linking routine?**	This appears to be an interesting and potentially viable proposal, but it would be for OEMs and the EMT software vendor to comment. The proposal would also need to be reconciled against any international standards (IEEE or CIGRE) for EMT modelling standards currently being developed. AusNet welcomes such a cutting-edge approach if it can overcome the obsolescence problem the market is currently experiencing.
14	**Are there any issues with the proposals made under "Other matters"?**	• **Inclusion of remedial action schemes** – AusNet generally supports the inclusion of remediation action schemes but has a number of questions. How can the models be tested and validated or would they be exempt? In PSSE, should it be provided as a Python script? And in PSCAD, built from library components only? • **Inclusion of integrated energy storage systems in the Guidelines** – AusNet supports the inclusion of IESS in the Guidelines. Treatment should be consistent with other technologies referenced in the guidelines. • **Updates to loadflow model requirements –**AusNet supports updates to loadflow model requirements and the inclusion of voltage droop table as a requirement.

		• **Requirements for legacy plant models** – In regards to the question surrounding the use of generic models, AusNet believes it should be first demonstrated to the satisfaction of AEMO and the NSP that the cost, time or effort to obtain the actual legacy plant model is disproportionate to the benefit it will provide before approval is given to use generic models. Furthermore, if the use of a generic model is approved, there must be consideration given to install permanent high-speed monitoring at appropriate points within the plant (if it does not already exist) as it could take years if not decades to secure enough data to correctly tune the model. AusNet does not yet hold a firm opinion on the proposal to split the modelling of control system componentry in the EMT model of legacy plant, as this is likely to be specific to the plant to be modelled, and the interaction between the main control loops may be unknown. AusNet intends to engage further on this matter through the Power System Modelling Reference Group. • **Small signal modelling** – AusNet is supportive of the proposal to reinforce the need for accurate and detailed block diagrams suitable for development of a linearised small signal model.
15	**Are there any additional required modifications to the Guidelines that AEMO has not considered here?**	Are there any changes needed to PSSE dynamic model source code or structures if the industry moves to compiling in 64-bit to be able to use PSSE v35+? AusNet recommends AEMO reconcile any changes against the DMAT, to ensure there are no contradictory elements.

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