GE International Inc.
ABN 85 002 420 751
572 Swan Street
Burnley Victoria 3121
Australia

April 15, 2018

Dr Babak Badrzadeh
Manager – Operational Analysis and Engineering
Australian Energy Market Operator
Level 22, 530 Collins St
Melbourne, VIC 3000
Australia

Power System Model Guidelines – March 2018

To: Dr. Badrzadeh,

General Electric (GE) is pleased to provide our response to the Issues Paper – Power System Model Guidelines, March 2018.

GE is one of the world's leading providers of energy solutions, with over one third of all power across the planet being generated by GE technologies. The electricity industry globally is undergoing significant transformation. Complex interrelationships across the entire energy ecosystem pose challenges to power providers and consumers. GE is uniquely positioned to assist the Australian market as we offer solutions across all forms of generation as well as technologies to the TNSP's and DNSP's.

GE welcomes the review of the power system model guidelines as it is necessary, considering the increased penetration level of newer generation technologies in the power system.

GE is generally supportive of the proposed requirements in the Power System Model Guidelines, however, there are certain aspects of the guideline that we believe require further consideration to avoid the unintentional creation of barriers and/or delay to operations, as well as avoiding increased generation costs for consumers.

Specific feedback on the issues paper is attached. Below is a summary of key areas where GE recommends AEMO consider further refinements to the proposed requirements.

Key issues

- The term, "*in AEMO's reasonable opinion*", is used in several places within the guidelines. Use of such terminology should be avoided since there are commercial and financial implications for Participants based on what AEMO deems as reasonable opinion. Alternatively, "reasonable opinion" could be a defined term where the boundaries are defined.

GE International Inc.
ABN 85 002 420 751
572 Swan Street
Burnley Victoria 3121
Australia

- EMT type models may be requested for existing plant, however it should be noted that development of such models could take a few months to put together vs the 15-20 business days as proposed in the issues paper.
- In a pumped storage plant there are mode changes that cannot occur automatically (e.g. from turbine/generator to pumping/motor mode) and cannot be necessarily represented in the same model. This is especially true for variable speed hydro pumped storage plant.

Should you have any queries in relation to this response then please do not hesitate to contact Dr Emilia Nobile on +41 585065726 (emilia.nobile@ge.com) or the undersigned on +61 439630289.

GE looks forward to working with AEMO to ensure that we build resilience in the grid and ensure efficient energy security and reliability into the future.

Sincerely,

Transmitted electronically.

Ragu Balanathan
Technical Director
Onshore Wind – Asia
GE Renewable Energy

GE International Inc.
ABN 85 002 420 751
572 Swan Street
Burnley Victoria 3121
Australia

Power System Model Guidelines, March 2018
Draft for Consultation

Section 2.1 Generators
"*Furthermore, a Generator who has previously provided adequate RMS models and associated information to AEMO will be required to provide up-to-date EMT models if required by an NSP who carries out a system strength impact assessment, as these are the only types of models that will result in an accurate assessment.*"
EMT type model for existing plants involves substantial amount of investment and effort to develop due to unavailability of data requiring, in some instances, on-site testing. There is a considerable cost for the Generator/OEM if such EMT models are requested.

AEMO asks to have generator models within 15 to 20 business days in case they find it necessary under the assumptions shown in this section. The time line should be greater, and it could be anywhere between 3 to 12 months.

"*Generators should ensure that all models and other information provided to AEMO in accordance with these Guidelines remain up to date*"; this requirement places a lot on the generator manufacturers side, because every time it is decided the model is not "good enough", the cost is expected to be covered by the manufacturers.

Section 3.3 Exemptions
From table 2: the first exemption from EMT says "*≤5 MVA AND SCR>10", with "SCR>10*" the exemption should be automatic. If that's the case, the plants impact would be MINIMAL.

Section 4.2.1 Transient Stability
"*AEMO and NSPs use PSCAD™/EMTDC™ to perform EMT studies in the NEM*".
Not all OEM use PSCAD™/EMTDC™ to develop EMT type models and the use of this software to provide EMT type models should not be mandatory. It should be possible to provide EMT type models in other software platforms such as EMTP-RV, ATP or DigSiLENT.

Section 4.2.2 Switching and lightning
AEMO mentions that for temporary over voltages, the RMS model would not be able to accurately represent them if they are greater than 1.15-1.2pu. For example, this contradicts the German grid code where they accept RMS models for the analysis of OVs up to 1.3pu.

Section 5.4.1 General requirements - Model multiple operating modes and control functions
In a pumped storage plant there are mode changes that cannot occur automatically (e.g. from turbine/generator to pumping/motor mode) and cannot be necessarily represented in the same model. This is especially true for variable speed hydro pumped storage plant.

Section 5.4.2 Additional requirements for frequency stability studies
"*include any mechanical actuator limits e.g. fuel valve open/close rate of change limits, pitch limits, open/close position limits, exhaust temperature limits, internal turbine limits, active power limits or other physical limits within the control system that cause a limit on power output and/or fuel flow;*"
Information on, exhaust temperature limits, internal turbine limits, etc. are proprietary design know-how and protected intellectual property. This type of information cannot be provided without further understanding what is the purpose of such requests and preference is to provide a black box type function.

GE International Inc.
ABN 85 002 420 751
572 Swan Street
Burnley Victoria 3121
Australia

Section 5.4.3 RMS model-specific requirements
"*models must be rigorously tested within a NEM-wide simulation for integration compatibility for large-scale power system studies. Experience has shown that SMIB simulations do not always reveal new models' adverse interactions with other models in the system*"
It is not clear how the Generator/OEM can test the developed model in a NEM-wide simulation? Please provide details on how this would be done and what participation is required of the Generator/OEM.

Section 5.4.4 EMT model-specific requirements
"*have the full representation of switching algorithms of power electronic converters for power system harmonic studies*"
The OEM of the power plant may have purchased the converter equipment from a sub-supplier and therefore have no access to the proprietary design of switching algorithms of power electronic converters. In such case it is not possible to provide full representation of switching algorithms. Please advise what are the alternatives.

"*allow model re-entry (e.g. PSCAD™/EMTDC™ snapshot) to facilitate integration into larger system models*". Please provide detailed explanation to the meaning of model re-entry.

"*clearly identify the manufacturer's EMT model release version and the applicable corresponding hardware firmware version*"
Not all hardware firmware upgrade will impact the functionality/performance of the EMT model, therefore only relevant and major hardware firmware upgrade will only mandate an EMT model release version update.

Section 5.4.4 Multiple voltage disturbances
"*Torsional stress and fatigue on shaft drive train and prime mover*"
A reduced lumped mass shaft drive train model can only be provided as the full shaft drive train model is OEM proprietary information

Section 5.4.6 Model outputs – Synchronous machines
"*External protection relay(s) status*", please provide detailed explanation as to what is meant by this output.

Section 5.4.8 RMS model source code
There are instances for which a source code, or part of it, cannot be disclosed in an unencrypted/open format (e.g. if controller, or portion of it, is protected by IP rights, etc.). Exceptions and allowance for black box or simplified model should be granted for such cases.

Section 5.4.9 RMS model format
A manufacturer may not have access to more than one RMS-type simulation tool, and duplicating the same model in a different software has significant cost and time implications.

Section 5.5.1 Black start model requirements
Modeling all auxiliaries can be an issue. There are simply too many individual components. We recommend they make a simplification or assumption and see all auxiliaries as ONE value. It would come from manufacturer side to guarantee that the auxiliaries would behave in the way the assumption specifies it.

Section 5.9 Models and plants updates

GE International Inc.
ABN 85 002 420 751
572 Swan Street
Burnley Victoria 3121
Australia

Models should be updated only in case of changes that significantly impact performance. There are considerable costs associated with such requests which should be taken into consideration.

Section 7.3.2 Pre-connection model confirmation
Information on system fault level – pre-fault and post fault should be provided by AEMO or NSP. Depending on how much in advance such models are to be submitted, it may not be possible to provide identical control system settings as to the one being installed.
If would be helpful if AEMO or NSP provide the range of operating conditions including pre-disturbance active and reactive power levels for the tests to be carried out.

Section 8.3 Provision of information and models to third parties
If models provided by an OEM are under a Non-disclosure agreement, the OEM must agree to the release of the models to any third parties. Alternatively, the Generator should be able to provide a black box model in situations where this model is required to be released to other Connection Applicants, ie. other Participants.

Appendix C. modelling component requirements - C.1.1 Protection systems
Only relevant and existing protection system models can be provided. In addition, not all details of the torsional stress protection can be provided.

Appendix C. modelling component requirements - C.6 Synchronous machines and generators
AEMO's need for EMT transient stability simulations is fully understood, given the increasing number of converter-based generation connected to the Australian grid. For conventional generation technology though, RMS models are generally adequate to represent the plant dynamic behavior. Particularly for turbine/governor systems, the dynamic response is time-decoupled from fast phenomena normally captured by EMT simulations; adding them to an EMT simulation would significantly increase the computation time, especially on a system-wide model.
We appreciate an EMT model of conventional power plant's components might be necessary in some instances but, given the cost and effort to put together these models, these circumstances should be evaluated carefully and the EMT model be requested only if strictly necessary.

General comments and suggestions
Many of the proposed requirements have a significant cost impact on new generation and might put manufacturers in a difficult position.
RMS vs EMT models - Many types of the control equipment use only the RMS & sequence values. This is correct for Governors, PSS, Excitation and Excitation limiters, etc. Furthermore, some of this equipment operate a discrete control based on a certain time step. This type of equipment can be modelled only by RMS-type models. However, these RMS-type models can be implemented in both RMS-analysis and EMT-analysis software. Implementation in the EMP-analysis software do not add any accuracy on the top of the purely RMS-analysis. Classifying this type of models as EMT might be a bit mis-leading. AEMO may consider a more flexible re-use of the RMS-type models in both types of analysis. For example, for more efficient cost sharing between all involved parties, more flexible interfaces for inclusion of the RMS-models into EMT-analysis software may be developed, e.g. by AEMO initiative. Another option is co-simulation platforms for more efficient running of purely EMT-processes versus purely RMS-models.
We believe the overall development may benefit from more alternatives in cost-benefit options.