PacificHydro

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Dear Evy,

Power System Model Guidelines Issues

Pacific Hydro, as one of Australia's leading clean energy companies, is committed to maximising Australia's renewable energy opportunities while supporting regional growth and the reduction of Australia's greenhouse gas emissions. To date, Pacific Hydro has invested around $650 million in the Australian renewable energy market, $560 million of this in wind farm developments and now multiple solar farm developments.

Being an owner of distribution and transmission connected wind farms and now developing solar farms, Pacific Hydro has significant experience in the development, operation and management of wind farms and maintains strong working relationships with the NSPs, to whom the renewable energy projects are connected. Each connection brings different challenges and frequently requires careful consideration of local network issues.

As a company who recognises Australia's incredible wind and solar resources and the opportunity they create for our energy future, Pacific Hydro welcomes the opportunity to comment on the Power System Model Guidelines.

General Comments

In many areas Pacific Hydro believes that the requirements in this guideline are unworkable. The guidelines confuse the different mathematics associated with the modelling of physical elements such as the physics associated with metallurgical fatigue, thermal properties and heat dissipation. The guidelines call for a multi-physics simulation which is not an EMT type modelling problem. The guidelines appear to be attempting to capture everything that could ever go wrong, as if modelling without suitable engineering interpretation can give answers to any problem that might happen. Finally, these changes to model system guidelines are unprecedented and diverge from widely-adopted international engineering practices.

Definitions

Pacific Hydro is concerned that the definition of "Disturbance" contradicts that provided by AEMO to the AEMC in the document titled: "AEMO report updated proposed multiple fault withstand obligation" (p 7.) A disturbance must be singular, it cannot include 40,320 combinations of "disturbances" which is what is implied in the definition given in p 6 of the guideline. A singular "Disturbance" must remain by definition singular.

The inclusion of different disturbances to that provided to the AEMC is also problematic. The voltage vector phase shift is unnecessary as it will be studied in anti-islanding protection studies, and the size of changes in active power output caused by cloud cover will be dependent on the size, design and location of PV plant as to whether it would be significant. The inclusion of the words "Disturbance: "One or more of the following, in any combination"

greatly alters the meaning of what is required to be studied and it should not stray from that provided to the AEMC.
Definition provided to the AEMC:

Type of disturbances to be considered[E]		
	• One disturbance cleared by breaker-fail protection system • One long-duration shallow disturbance, e.g. 80% residual voltage for 2 s as per clause S5.2.5.4 • One deep three-phase disturbance (or two deep three-phase disturbances in parts of network where a three-phase auto-reclosing is permitted) • Remaining disturbances are unbalanced • An unsuccessful auto-reclosure is counted as two disturbances	• One disturbance cleared by breaker-fail protection system • One long-duration shallow disturbance, e.g. 80% residual voltage for 2 s as per clause S5.2.5.4 • All disturbances are unbalanced • An unsuccessful auto-reclosure is counted as two disturbances

The definition of "Applicant" is problematic as it includes "Generators, NSPs, Network Users … to whom these Guidelines apply." This captures existing *participants* and *intending participants* into the one category as if all are applying to connect. The System Model Guidelines must cover all models for the power system – not just new connections. Lumping together everyone as new participants is not suitable. This becomes problematic in the model "update" section 5.9.

Model Content

The breadth of what is being asked for in these guidelines encompasses a vast range of physical elements that have not been included in dynamic models in the past. The language used in this document illustrates a desire to cover all possible physical phenomena as if it is possible to study in detail all the possible combinations of operating conditions and events. It is not, as the number of possible conditions are infinite.

Including protection relays or settings into the dynamic model alters the use of the model. Dynamic models have always been used to inform engineers of where to set protection, by including the protection settings within the model it means that the protection of the system is being studied rather than the dynamics. The wording "all pertinent protection systems" is vague and subjective. If protection is to be included the language must be specific and state exactly what protection is required.

The model compatibility and stability section requires that the model "work for a range of dynamic simulation solution parameters rather than for specific settings only", and "be numerically stable up to a simulation time of 5 minutes". This is unlikely to be achievable given that studies are all subject to the network data in the cases.

The discussion regarding transient over voltages and the desire to cover time steps as low as 16 micro seconds illustrates a desire to bury into detailed design. Specialist studies for lightning and insulation co-ordination are not normally the purpose of the dynamic model, these are best left to design engineering and limited to specific plant models designed in detail to study travelling wave phenomena. It is illogical to provide a model that is intended to examine lightning when there has been no mention of surge arrestors. Switching studies alone would require detailed EMT models of each type of circuit breaker in the power system, including the SPAR operation and the insertion resistors.

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Multiple Voltage Disturbances

We would like to draw attention to the expectation that the EMT model can include the following:
"must account for **any** electrical, mechanical, or thermal limitations of the plant with respect to multiple voltage disturbances in quick succession, and calculate dynamically and accumulatively the impact of multiple voltage disturbances, including but not limited to the following factors:

- Heat dissipation across the dynamic braking resistors (if applicable);
- Capability of auxiliary supplies, e.g. uninterrupted power supply (UPS);
- Torsional stress and fatigue on shaft drive train and prime mover;
- Thermal design limits of the integral assembly of the plant; and
- Any other relevant electrical, mechanical or thermal protection. "

This is beyond practical engineering and will create a situation in which many reputable manufacturers may cease to provide equipment to the Australian NEM. Given the mathematics to calculate the torsional stress and fatigue on a shaft would use a completely different set of mathematics to that in EMT it is doubtful that this can be solved in the power system modelling packages. It is impractical to think that system or connection studies require this type of detail. Furthermore, it is questionable as to whether even the most skilled user of such detailed models could achieve meaningful results without a high risk of misleading the market.

Model Output

The section on model outputs appears to extend the requirement to the provision of a complete wind or solar farm model in the following passage, "in addition...models should provide access to the aggregated network and point of connection or unit transformer LV and HV to demonstrate the complete generating system performance." If AEMO is no longer seeking a lumped model but wants to investigate the full model, this becomes a much larger modelling issue and one that will not work in the system model due to the number of nodes and complexity. Furthermore, the full model extends to behind the meter performance for which the participant is responsible. Not only is there no justification provided for requesting this expansion to the modelling information, but it is also confusing as this request contradicts the section on model aggregation.

Updates to models

There is an inherent inefficiency caused by the layers of testing and retesting that AEMO expects. AEMO often update the version of the software (PSS/E is now going to v 34) and the decision to alter the software version can cause model issues. This should not trigger a cost allocation to participants as the manufacturers provide updated and tested models. If issues are found with those models the bugs are corrected.

Updated models for existing *participants* should not trigger additional cost as *participants* pay for AEMO to conduct the engineering work required to operate the power system. Maintaining the system model is included in the market fees. Issues with models that occur as part of connection studies and achieving a working model should be covered by the *intending participant*.

The onerous requirements in section 5.9.2 that cover "firmware" updates requiring a trigger for re-commissioning and new R2 data testing is excessive, expensive and highly problematic as it will discourage all participants from undertaking any upgrades to their control systems. The intrusive nature of this requirement will lead to a continued decline in the reliability of the power system as there is already a reluctance to undertake control system upgrades. The market needs a collaborative approach to control system upgrades that does not lead to excessive costs and high regulatory risk on existing participants.

Continuous monitoring of disturbances

There is an expectation that "continuous monitoring" can be undertaken for what sounds like all disturbances – this is again an unrealistic, expensive burden to place on participants. It is possible to undertake such analysis during the period in which accuracy for R2 and post commissioning is being proven. However, to undertake this type of analysis on a continuous basis is expensive and unnecessary.

The response of the plant will depend on the system conditions present at the time of the event. System snapshots from the OPDMS are not actual representations of the network but an approximation due to time delays in the capture of data, perfect overlays to accuracy requirements will not be possible. In order to "overlay" the actual measurements with a model output would require a significant amount of work. It involves taking the connection point measurements and converting them into the vectors (voltage and current) to inject them into the model without the system influences. This is often referred to as the "playback method" and it is not a straightforward task. It is excessive to expect that every system disturbance will trigger a system overlay report. Pacific Hydro considers that the intent of this section should be clarified and limited to the validation and periodic checks, particularly after any model update, and proposes that this section is reviewed with this intent in mind.

Non conformance

Section 7.4 calls for the application of operational constraints to be imposed until the modelling issues can be resolved. This requirement must have some sensible limits to what constitutes a "modelling issue" as models can have mathematical anomalies that do not occur in reality. The power system simulation studies are approximations and should be treated in that manner; the more detailed the modelling more likely it is that anomalies will occur. Applying operational constraints would need to be based on true electrical control problems and not on modelling anomalies. Unnecessarily applying operational constraints will penalise participants with significant financial consequences.

Provision of information

Section 8.3.1 states on page 49 that AEMO will "never provide the entire network model to a Registered Participant", however, participants do receive the NEM cases (RMS – PSS/E) which represent the network model for the entire NEM for Summer and Winter cases. This is necessary in order to conduct studies, particularly for connection studies. The intention of this section needs to be clarified. Is it the full EMT network model that will not be provided, will limited EMT models be released?

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Conclusion

Pacific Hydro is concerned that the inclusion of protection settings and relay information to be provided into the dynamic models illustrates a focus on detail that risks distracting from the overarching need to study the power system.

The greater the complexity of the power system model the more likely it is to produce abnormal or inconsistent results. Such a model is no longer a study of the system dynamics but rather a study of the protection systems. Using large, complex EMT modelling will make it extremely difficult to achieve reasonable stable results over the longer time periods that are asked for – such as up to 5 minutes. It is not clear whether all models must run for up to 5 minutes and the guideline needs to be clearer about how long the high frequency sample rate models are expected to remain stable: eg: micro second sample rates are more likely to fail to converge over longer periods.

There is an enormous amount of detail being called for and the inclusion of elements into the model that have not been included before have not really been justified. Another example of this is requirements for details of "VTs and CTs feeding protection mechanisms".

Pacific Hydro is concerned that the increased volume of data, the detail of the EMT combined with the onus of proof and accuracy requirements in these guidelines will eliminate many manufacturers from providing equipment to the NEM and be a significant barrier to entry for new technology. This will increase costs and decrease competition, clearly an undesirable outcome.

Yours sincerely

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