Generator Modelling

July 2024

Part of Energy Queensland

Networks and Large Connections

Each connection to the electrical network has an effect on the performance of the network for all users. For small connections, such as a household or small business, this effect is considered minor, and so very light-touch performance requirements are imposed on those connections, with standardised performance for small generating systems.

Larger connections will have a greater impact and are usually connected at high voltage to ensure they can be better accommodated. One of the ways which a large connection (particularly a large generator) can affect the network is in terms of system stability and system strength. System stability describes how the system responds to disturbances, and system strength is a measure of that resilience to an event. Generators can influence the way the network responds after a disturbance, and therefore there are additional performance requirements for larger generators. To understand this performance, modelling is used.

Why Use Equipment Models and Modelling?

Engineers use equipment specific models within overall network modelling to predict and analyse how something will act in the real world, which can inform appropriate design and risk mitigation choices. One type of modelling utilised is electro-magnetic transient (EMT) modelling, which examines interactions that occur in milli- and micro-second timeframes. This modelling can identify where the control system of a generator is not doing the right thing, or interacting with another device, which could lead to power system instability, disturbances and potential collapse.

When Do Models Need to be Provided?

EMT modelling is conducted where there is a credible risk of interaction, or it is anticipated that interaction will occur as more inverter-based generation is installed in an area. Using a risk-based approach, we have standardised this requirement in our generation standards STNW1174 and STNW1175.

Class A1 generation or LV-connected generation –1.5MVA and less

Generally, EMT modelling is not required for a generator of this size, as the risk of severe interaction is low. The exception is where the network the generator is being installed in is particularly sensitive, such as a remote area with low system strength and if so, full details will be provided in the Technical Assessment. If required, the Proponent may need to provide a manufacturer-developed equipment EMT model of the embedded generating unit(s) with relevant site-specific settings for insertion into the overall network EMT model.

Class A2 generation – 1.5MVA to <5MVA

Generation over 1.5MVA has a greater impact on the network and is therefore more likely to interact with other generators, or faults on the system. For these generators, considerations for the settings and tuning of the generator must be made, beyond standardised settings that exist for smaller generators. For the Network Service Provider (NSP) EMT modelling of the system is needed to check the risk of interaction with other generating systems, and to ensure this can be checked in the future (if for example, a larger generator is installed next door). Getting an equipment specific model of the generating system at the time it is installed ensures the Proponent can obtain the model during contractual confirmation with their supplier, rather than trying to access a model many years later when a risk emerges, which would require additional cost and work.

Class B generation – 5MVA and larger

Under the National Electricity Rules, generators 5MVA and larger are required to be Registered as Generators, unless an exemption is sought from Australian Energy Market Operator (AEMO). The models for these generators will be assessed within the Queensland model by both the NSP and AEMO, for a wide range of scenarios, before the generators are allowed to connect (even if the system is exempt from registration).

What Needs to be Submitted?

Site Specific EMT Model – Less than 5MVA

If the Proponent is required to submit a site-specific EMT model, this will be in a format that can be used by a software package called PSCAD. The model forms part of an application package, which will include a report detailing the settings used and the reasoning for those settings, performance standards, data sheets, and single line diagrams. Site-specific control strategies such as, voltage control, or for a nil-export site how the active power is controlled to prevent unacceptable voltage fluctuations, are also required as part of the application package.

The PSCAD equipment-specific model must be sourced from the inverter or generator manufacturer with site-specific details such as number of inverters (as applicable) and the proposed control system settings including any gains, limits, ramp rates etc. If a volt-var response is used at the site for example, this must be enabled in the model so that the model, the settings, and the voltage control report are all aligned.

Rotating Machines – non-registered

For rotating machines that aren't registered, a PSCAD model isn't required, but instead modelling information is required in the form of something called "block diagrams". Block diagrams of the relevant control systems, including excitation system, over and under-excitation limiters, voltage controller, governor and any site controller (if applicable) are required. These are available from the generator manufacturer.

Additional Information

Additional information can be found in the following fact sheets:

Class A1 Application Checklist

Class A2 Application Checklist

Modelling information for non-registered generating systems