IGP TAP Transmission Subgroup

Feedback on System Security Study

10/25/2021

This feedback to HECO is based on HECO's slides and presentation on 10/4/2021 related to their system security study plans.

As with all our feedback, please consider this input as a set of recommendations for consideration – the final choices are yours of course. Some of these topics are quite complex, so the few sentences included here just scratch the surface and hopefully point in a direction we think might be helpful.

TAP members attending: Andy Hoke (NREL, Chair), Debbie Lew (ESIG), Matt Richwine (Telos/HNEI), Deepak Ramasubramanian (EPRI). Not able to attend: Dana Cabbell (SCE)

HECO presenters: Li Yu, Ken Aramaki, Addison Li, Marc Asano, Chris Lau, Leland Cockcroft, Lisa Dangelmaier

TAP feedback and comments are divided into three categories:

1. Informational – no action needed.
2. Suggest revising before November submission deadline.
3. Consider feedback for future portions of the IGP process (after the Nov deadline).

TAP comments during meeting and HECO responses

How is demand response incorporated into the system security study?

- HECO response: It is difficult to estimate how DR will actually perform. We may model only a portion of DR as responding in the study if we are not sure it will all respond at all times. Transmission planners are using data from the DR team to decide how to model DR.

When converting time-series dispatches into security study scenarios, it may be reasonable to use the 90th and 10th percentiles rather than the absolute maximum and minimum dispatches. Also see several recommendations further below.

Where do the maximum and minimum dispatches for large-scale IBRs come from?

- HECO response: These come from the production cost simulation.

The TAP understands that most IBR vendors are not able to provide grid-forming PSSE models at this time, so EMT study (e.g. PSCAD) is the only available option for simulating system security for now. We also caution against running only PSSE simulations even if/when good PSSE models of IRBs are available because the positive sequence models such as PSSE are known to miss fast dynamics that can arise in high-IBR scenarios. Although newer positive sequence models can catch some of these fast dynamics, complete reliance on only positive sequence models, or complete dependence on only EMT is not recommended. Development and use of advanced screening techniques and solutions can be leveraged

to identify scenarios where EMT is to be carried out. At least some of the most critical cases should always be run in the EMT domain.

- HECO response: EMT simulations take a very long time to run. How can we increase simulation efficiency?
- TAP follow up: Agreed. Perhaps you can rank the priority of the simulations, to prioritize studying the most critical cases in PSCAD. In addition, feel free to seek guidance on PSCAD studies from NREL or venders with experience in that. NREL can provide scripts for interacting with large PSCAD models (e.g. setting up dispatches, extracting data, running simulations in batches). Some of this is online as "PyPSCAD" – we can provide Maui-specific examples.
- TAP follow-up: Another approach to speed up simulations is to use reduced models. We used the that approach to reduce Maui and enable it to run in real time. There are several model reduction techniques published. This code can be used to reduce PSSE network models as demonstrated on the Maui system here; the reduced PSSE model can then be used to create a reduced PSCAD model.
- TAP follow-up: You could also consider running combined PSSE-PSCAD simulations with only certain elements of the system in PSCAD, provided that you can validate that they capture the key dynamics. Electranix has software for that called ETran Plus.
- TAP follow-up: You can also consider the use of screening tools to determine the region of the network to be modeled in detail, contingency to be studied in detail, location of IBR devices that are to be modeled in EMT, evaluation of instability risk, and reduction of the network to retain the essential dynamic behavior. EPRI can provide screening tools and scripts for this, if desired.

The TAP suggests avoiding hard requirements on minimum inertia and system strength in longer-term planning.

- HECO response: This is a key topic. We may create an additional TAP meeting on this.

HECO requests input on alternatives to production cost simulation for generating dispatches and scenarios for study. TAP recommendations include:

> It is recommended to see that the dispatch conditions flow from a production cost simulation so that there is a realistic basis for the dispatch conditions evaluated. It is also recommended that some statistical analysis be performed on the output of the production cost simulation to put the selected (i.e., 10^{th}, 90^{th} percentile condition) in context. We recommended showing the distribution (i.e., duration curve) from which the conditions are selected. Also, we recommend selecting other dispatch conditions to evaluate considering other metrics like max/min MW of DER, max/min generation from the IBR groups/zones, max/min ratio of IBR to synchronous machine MVA, max/min MVA of GFM resources (including synchronous generators and condensers as well as grid-forming IBRs), number of units committed in each hour, headroom available and other factors that could be used to screen for the more challenging cases, etc.. It is of course laborious to add dispatch conditions for evaluation, but you should have enough to be convinced that your subset of cases adequately covers the operating conditions that could be seen. For the first time through considering a very high IBR system, this probably means evaluating more conditions than historically typical in order to understand the trends. Examples of entities that have done this include MISO (Renewable Integration Impact Assessment) and

EirGrid (Ireland), both of whom have used PLEXOS with PSS/E. EirGrid has been working with EPRI to examine how to best pick the cases of most interest from a full 8,760 period. EPRI has an Scenario Builder Tool that may help. In addition, NREL's MIDAS tool, which has been demonstrated for Maui Island and WECC use cases, can also be used for this purpose. MIDAS can simulate scheduling, dispatch, and dynamics (in PSSE) for extended periods, including for entire days or weeks if desired, making the link between system economics and system security in high IBR cases.

For future planning cases where IBR controls are not known, proxy IBR models in PSCAD can be used, including:

- PyPSCAD contains generic PSCAD grid-forming and grid-following inverter models. They are per-unitized for easy scaling and include example systems that are stable including in 100% IBR cases. They don't contain plant controllers but do contain PLL (GFL only), current/voltage controllers, power controllers, configurable droops, programmable trip settings, and DC-side dynamics (to appear soon), etc.
- GFM-PV contains generic PSCAD grid forming and grid following PV plant models with associated plant controller, inverter level control, and dc side dynamics. Robust fault ride through behavior and stable response in 100% IBR networks have been demonstrated with this model.
- These proxy IBR models are expected to continue to develop as industry matures.

For future planning cases where IBR controls are not known, proxy IBR models in PSSE can be used, including:

- To start carrying out planning studies with grid forming devices in PSS/E, both GFM-PV along with REGC_C can be leveraged. The positive sequence PSS/E grid forming model's performance has been validated against an OEM's black box EMT model and shown to provide encouraging results. As mentioned previously, use of this model should not completely replace EMT studies, but the model's use can inform the extent to which EMT studies are to be performed.

Other TAP comments post-meeting:

Is protection planning part of the transmission planning process? (This may not be directly related to system security, but we wanted to raise the question somewhere.) At some point we would recommend analyzing how protection settings will work in high-IBR scenarios, in particular protection relying on negative sequence current and overcurrent protection. Overcurrent protection may not be a problem as long as sufficient synchronous machines (generators or condensers) are online, but would likely need to be examined if in a future scenario you consider reducing the use of condensers.