NASPI

THE NORTH AMERICAN SYNCHROPHASOR INITIATIVE

WEBINAR SERIES

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Recent BESS Oscillations: Root Cause Analysis and Wide-Area Impacts Questions and Answers

- Nguyen,Thi Ha
  - Q: What is the nameplate of BESS+PV system?
  - A: To keep confidentiality of the source site I cannot divulge the full nameplate, but it is a 200MW+ nameplate site.
- Hassan Baklou
  - Q: Does SRP have any requirements for IBRs to install PMU at their high side of the step up transformer with online access by SRP? Or all event analysis are performed on the data received by request after an event? Thanks
  - A: Yes, SRP installs PMUs at the Point of Interconnection of all third part operated IBR sites.
- Karan Kataria
  - Q: The FOs exhibits zero damping, how come the damping ratio remain unaffected? Is the contribution of BESS has anything to do with this?
  - A: From the bulk power system perspective, the zero “damping” of a FO really just indicates that the driving input to the power system is sustained. The misoperating plant controller’s behavior could potentially be characterized in terms of control theory to rigorously characterize local behavior, but that wasn’t necessary in this case. The damping that was of interest in this presentation was the damping of the interarea electromechanical modes of oscillation. As Daniel described, FOs bias the tool that BPA uses to monitor the modes.
- Hassan Baklou
  - Q: What is exactly the meaning of a compensated measurement. How it is used in the control logic?
  - A: Compensated measurements are those that are measured on that low side of the Generator Step Up (GSU) transformer and calculates the high side GSU accounting for transformer losses. Compensated measurements are also used to evaluate where the losses should be distributed between solar and battery resources and under certain conditions, such as when solar is charging the battery. How it is used in the control logic

is not known to SRP, but the telemetry from these compensated values are used by SRP and the IBR Operator for energy accounting purposes.

- Karan Kataria
    - Q: What are industry personnel views in possible FOs in near future with partial IBRs and 100% IBRS?
    - A: The industry is concerned that more and more oscillation events will occur as a result of more IBR installations. For the western interconnection, BPA identified this as a power system risk to the Western Electric Coordinating Council.
- Karan Kataria
    - Q: What oscillation detection logic is being used here? Can you please elaborate on signal and statistics of it?
    - A: BPA's detector is based on the RMS-energy detector described here: https://doi.org/10.1109/PESGM.2015.7286192. The detector splits input signals into four frequency bands and then calculates the root mean squared value. This value gets large when an oscillation is present, leading to detection. The signals that BPA monitors for oscillations (and the common causes) are: 0.01-0.15 Hz (Plant Controls or AGC); 0.15-1.0 Hz (Inter-Area Oscillations); 1.0-5.0 Hz (Local Plant Controls), and 5.0-14 Hz (Generator, HVDC or SVC).
- Vedanta Pradhan
    - Q: How the detected oscillation is categorized as FO and not a natural oscillation?
    - A: If the oscillation is **not** near one of the natural modes, the Oscillation Detection monitor typically identifies the source. If it is, near the natural modes, it is difficult to distinguish between the two during the oscillation, but post-analysis will reveal it.
- Bikal Pudasaini
    - Q: What source location algorithm is in place? Thanks.
    - A: BPA's method is to identify the source to wherever the largest magnitude of the oscillation is detected using a red asterisk.
- Marco Rodrigues
    - Q: Congratulations for the presentation. During the design phase were simulations performed to antecipate for this problem? Do you think it would help? Have you access to inverters' models?
    - A: SRP performed PSLF and EMT studies, but these problems were so niche that it would have been difficult to anticipate simulation scenarios. We believe Hardware in the Loop testing would have flushed out many of these problems.
- Vedanta Pradhan
    - Q: What is a GSU?
    - A: Generator step-up transformer
- Joe Parrilli
    - Q: Are the inverters synchronized and if so, how?
    - A: SRP is unaware of how the inverters are synchronized..this is another knowledge gap SRP is working on.
- Nguyen,Thi Ha
    - Q: are all inverters operated in Grid following mode?
    - A: Yes

- Kaveri Mahapatra
    - Q: were the inverters not tested individually for specific start ups behavior after commissioning?
    - A: SRP is unaware if they were but suspect so as there was cold and hot commissioning of all inverters on site prior to synching them all up for full site test energy.
- Pavel Etingov
    - Q: What is the procedure to push a new firmware update to an IBR site? Before the plant is commissioned, there is certain field site testing required. But when the control logic is updated and new firmware is pushed, is any testing required to avoid misoperation?
    - A: During commissioning, simply a request for a firmware update which is coordinated with SRPs Generation Operators. Typically these updates are to fix issues identified curing commissioning and SRP is unaware of the internal controller tests to verify changes as those are on the developers side. There are instances where the IBR developer wants to run some dispatch tests and observe the plant output to verify controller changes.
- Hassan Baklou
    - Q: Was the magnitude of the oscillation the only indicator thta you need to decide to disconnect of an IBR unit? I.e how do you make sure that IBR that is disconnected was actually the source of Oscillation?
    - A: Yes, at that time, only the MW magnitude was used for an indicator of an oscillation to make a disconnect decision. The EMS oscillation detection logic was specifically added to the IBR plant output and thus would pick up direct IBR plant oscillations.
- Lingling Fan
    - Q: For the battery PID control logic, the input seems to be real power, what is its output for the PID control?
    - A: SRP is unaware of the exact PID control logic, but from test reports, there is a PID output MW setpoint sent to the downstream inverters.
- RAMESH SURYAVANSHI
    - Q: Interesting presentation with facts presented thanks. IBR rich grids will have complex challenges need more research to overcome issues.
    - A: Agreed.
- Colin Foote
    - Q: Does BPA have any automatic control schemes based on oscillation measurements, or is action always decided by control room operators? Or any plans to introduce automatic systems?
    - A: BPA has one that is a Remedial Action Scheme; it will insert reactive devices based on power and frequency/phase angle changes on a specific path. We have no concrete plans to add any more RASs of this type.
- Shuan Dong
    - Q: Thank you for informative presentation! Just wondering what measurements/recordings inside the IBR plant would be needed for post-event root cause analysis based on your experience?
    - A: Great question and SRP is still in the infancy of IBRs to know these specifics but we are working on that understanding.

- Mohamed Younis
    - Q: What is the time that the control takes to move between Battery only and Battery+PV? Is there any deadband or intentional delay?
    - A: The presenters don't have access to those details.
- Bikal Pudasaini
    - Q: Magnitude is risky if the frequency is close to inter-area mode. In case of resonance, the magnitude might guide you to wrong source of oscillation.
    - A: That has been BPA's experience. When this happens we usually get alarms at several sites all at once.
- Wilsun Xu
    - Q: why do you call the events especially the last one as "forced oscillation" instead of just "oscillation".
    - A: This terminology comes from taking a view of the power grid from systems theory. Whatever the cause of an oscillation at the local level, we call it a forced oscillation when it also manifests as the forced response of the system. The modifier "forced" is particularly important in making a distinction from natural oscillations that are always present in the power system due to its electromechanical dynamics. From a very practical perspective, oscillations seen in a bulk power grid are often called forced if they're caused by a particular apparatus that can be removed, whereas natural oscillations involve the interaction of many generators and can only be managed.
- Hao Guo
    - Q: Does it mean the oscillation frequency range around ~12HZ is more related to the generator controller?
    - A: BPA: I stated this incorrectly during the presentation: Oscillations in the 0.01-.15 Hz band are typically caused by plant controls or Automatic Generation Control.
- RAMESH SURYAVANSHI
    - Q: Inverters used in this RCA is Grid Forming or Grid Followers ?
    - A: Grid Following
- Bikal Pudasaini
    - Q: Did these oscillations have observed critical modes even before the oscillation was seen?
    - A: If your meaning was other oscillation modes near inter-area modes, then, yes, SRP did encounter small oscillations during commissioning and just after commercial operation, but they were not analyzed in depth to determine the frequency. SRP is working on monitoring and categorizing such oscillations for future reference and advanced warning.
- Shuchismita Biswas
    - Q: Is there any guidance going to developers to avoid using time constants around 4 s in the control logic to avoid oscillations around 0.25 Hz inter area modes?
    - A: Not as yet, and this is just a speculation, but I believe is an important topic to reach out to IBR developers to identify potential such time constants that we may want IBR operators to avoid.
- Eli Pajuelo
    - Q: Are you guys using or planning to use Synthetic Inertia ?

    - A: Not at this time.
- Amir Mosaddegh
    - Q: I believe we use term "Forced oscillation" to punctuate on the fact that this is due to some periodic forced external inputs, whereas the "Inter-area Natural Oscillation" is a natural response of the system while occur between large areas.
    - A: That is our understanding as well.
- Daniel Ransom
    - Q: What are the four frequencies monitored in the green bar-graph display?
    - A: The four bands are 0-0.15 Hz, 0.15-1 Hz, 1-5 Hz, and 5-30 Hz. See https://doi.org/10.1109/PESGM.2015.7286192 for details.