Sub-Synchronous Oscillation System Events – System Operator Technical Session

Opportunity and impact

System Operators (SOs) met in October 2024 to present and discuss causes, detection and management of Sub-synchronous Oscillations (SSOs), which are power system oscillations occurring below the fundamental frequency of the power system. SSOs are a priority area of interest for SOs, due to the reduction of system oscillation damping resulting from greater penetration of renewable resources. By sharing information on SSO events, SOs can apply the lessons learned and best practices developed by peers.

System Operators engaged

The following SOs were involved:

- AEMO – Australia
- CAISO – United States (California)
- EirGrid – Ireland
- Energinet – Denmark
- ERCOT – United States (Texas)
- NESO – Great Britain.

Key insights

Recent SSO events

- EirGrid has experienced multiple oscillation events in recent years with varying sizes, durations and causes.
- Multiple events in Texas showed wind farms oscillating against series capacitors after both faults and planned outages. Most oscillations lasted 1-3 seconds. One 2023 event in South Texas sustained oscillations for 1.2 seconds, with a maximum swing of 1,275 megawatts (MW).

Detection and management of SSOs

- SOs have found Phase Measurement Unit (PMU) and eXtensible Measurement Unit (XMU) devices to be most effective in detecting SSOs.
- NESO has found success employing inertia monitoring tools to assist in SSO detection. NESO currently is using two tools – one is the GE Inertia PDC, and the other, provided by Reactive Technologies, charges and injects pulses to measure the system response.

- EirGrid has found Dissipated Energy Flow (DEF) useful for low frequency oscillations, but noted it can produce misleading results for higher frequency SSOs.

SSO-related challenges

- Renewable generation requires increased damping support to maintain acceptable dynamic responses as the provision through synchronous machines decreases.
- ERCOT is conducting 30-60 SSO connection studies per year, each of which requires months or years to resolve due to the black-box nature of many inverter models.
- Several of the SSOs observed by ERCOT cannot be recreated with the models received from original equipment manufacturers (OEMs), as Electromagnetic Transient (EMT) models are often not validated in the sub-synchronous domain.

Recommendations

Based on the presentations in the technical session, it is recommended that SOs:

- Carefully consider the potential for SSOs
- Evaluate measurement, detection and remediation options
- Work together to investigate detection methodologies, tools and mitigation actions.

Contact

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