PGRR120: Subsynchronous Oscillation (SSO) Prevention for Generator Interconnection

ERCOT Operations

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ERCOT Series Capacitor Background

- Several series capacitors help transfer West Texas renewable generation and increase generation and load transfers in the southern Rio Grande Valley.
- Many were constructed in 2013 as part of the “CREZ” renewable transmission plan.

Locations of TSP-Owned Series Capacitors	
ROMNEY	Romney Capacitor Yard 345 kV
KOPPERL	Kopperl Capacitor Yard 345 kV
KIRCHHOF	Kirchhoff 345 kV
EDISON	Edison 345 kV
OERSTED	Orsted 345 kV
GAUSS	Gauss 345 kV
CTT_CROS	CTT Cross SC 345 kV
NEDIN	North Edinburg 345 kV
RIOHONDO	Rio Hondo 345 kV
CENIZO	Cenizo 345 kV
DELSOL	Del Sol 345 kV

SSO Definitions

- Subsynchronous Oscillation (SSO)
  - Coincident oscillation occurring between two or more Transmission Elements or Generation Resources at a natural harmonic frequency lower than the normal operating frequency of the ERCOT System (60 Hz).
- Subsynchronous Resonance (SSR)
  - Coincident oscillation occurring between Generation Resources and a series capacitor compensated transmission system at a natural harmonic frequency lower than the normal operating frequency of the ERCOT System (60 Hz).
- Subsynchronous Control Interaction (SSCI)
  - The interaction between a series capacitor compensated transmission system and the control system of Generation Resources.
- Subsynchronous Ferroresonance (SSFR) – *Not defined in ERCOT Protocols*
  - The interaction between a series capacitor compensated transmission system and a saturated transformer.
- Subsynchronous Resonance (SSR) Mitigation*
  - A countermeasure that includes, but is not limited to, equipment installation, controller adjustment, or a procedure to mitigate the SSR vulnerability without disconnecting the affected Generation Resources.

*SSR Mitigation requirements can be found in Protocols 3.22.1.2(3)

ERCOT Stakeholder Meeting References

- RPG, 11/14/2017
  - https://www.ercot.com/files/docs/2017/11/10/ERCOT_Building_Near_Series_Capacitors.pptx
- ROS, 5/3/2018
  - https://www.ercot.com/files/docs/2018/05/02/10._South_Texas_SSR_ERCOT_ROS_May_2018_rev1.pdf
- RPG, 1/22/2019
  - https://www.ercot.com/files/docs/2019/01/21/ERCOT_Building_Near_Series_Capacitors_2019.pptx
- ROS, 5/2/2019
  - https://www.ercot.com/files/docs/2019/05/01/06._South_Texas_SSO_Update_ROS_May_2019.pdf

Historical SSR Events

- Real-time SSR events, including several in 2023, have occurred despite SSR mitigation being in place.
- These events have required additional studies and various mitigations, the worst being a unit in the commissioning process being taken offline for a year and a half.
- Addressing such issues could cause delays or disruptions at any stage of the generator interconnection timeline, including the planning stage, commissioning, or even during commercial operation.
- SSFR has also been observed in several studies during this time.

Year	Area of SSR Events	Number of SSR Events
2009	South TX	1
2017	South TX	2
2018	South TX	1
2023	South TX	3
	North TX	1

Key Takeaway: SSR events continue to occur despite ERCOT requirements for SSR mitigation to dampen oscillations before unit(s) trip. SSR can cause equipment damage, loss of generation, and loss of load.

PGRR120 Concept

- Prevent new generation projects from interconnecting such that they are N-1 (one Credible Single Contingency) from being radial to a series capacitor(s).
- Details:
  - Effective date of PGRR will allow some projects in progress (Security Screening Study stage) to move forward
  - Establish the timing of the determination of the number of Credible Single Contingencies
  - Generator modifications addressed
  - Real time SSO mitigation