

# **Simulation of 2017 Wind Farms into Series Capacitor Sub-Synchronous Oscillation Events**

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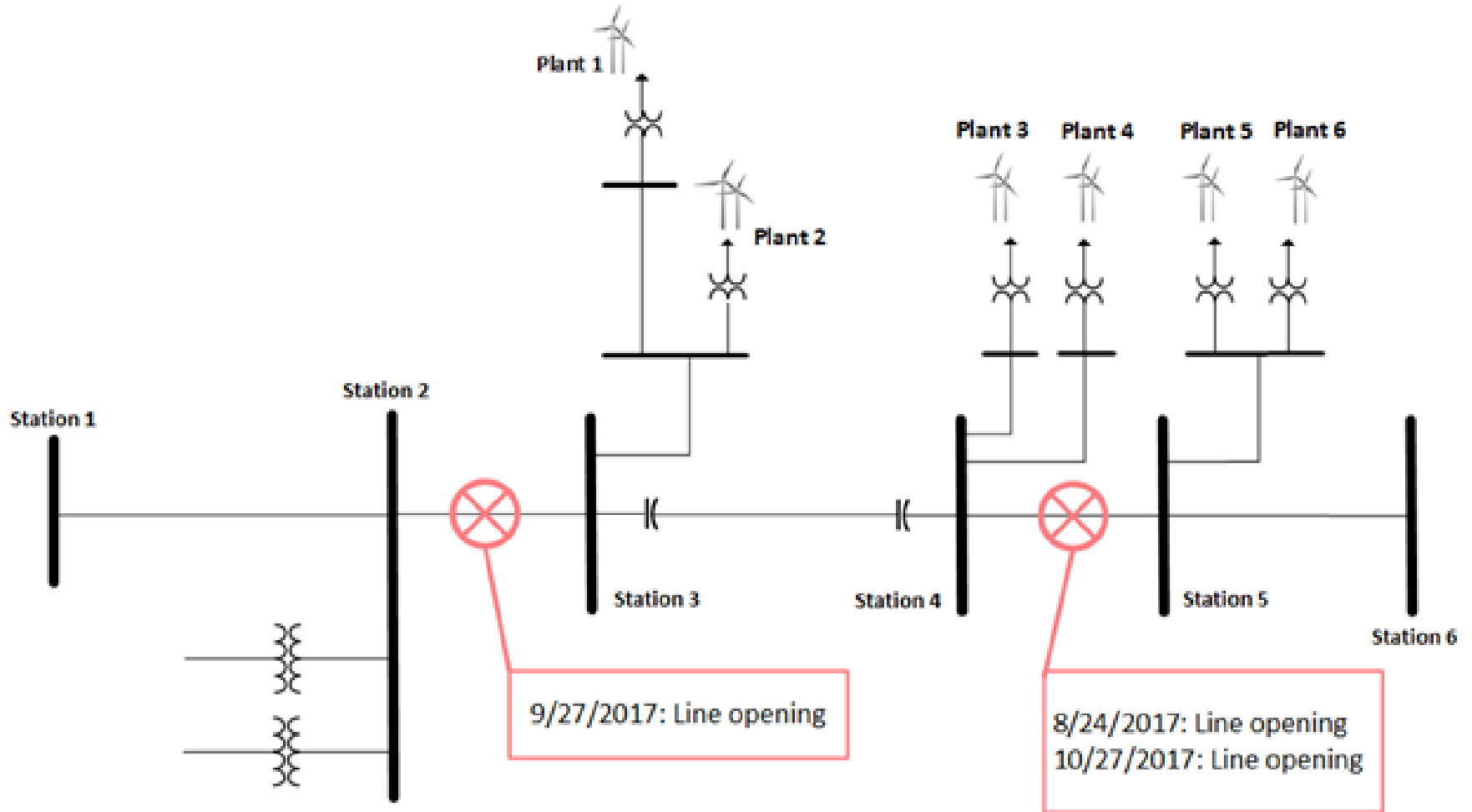
**USA**

# Outline

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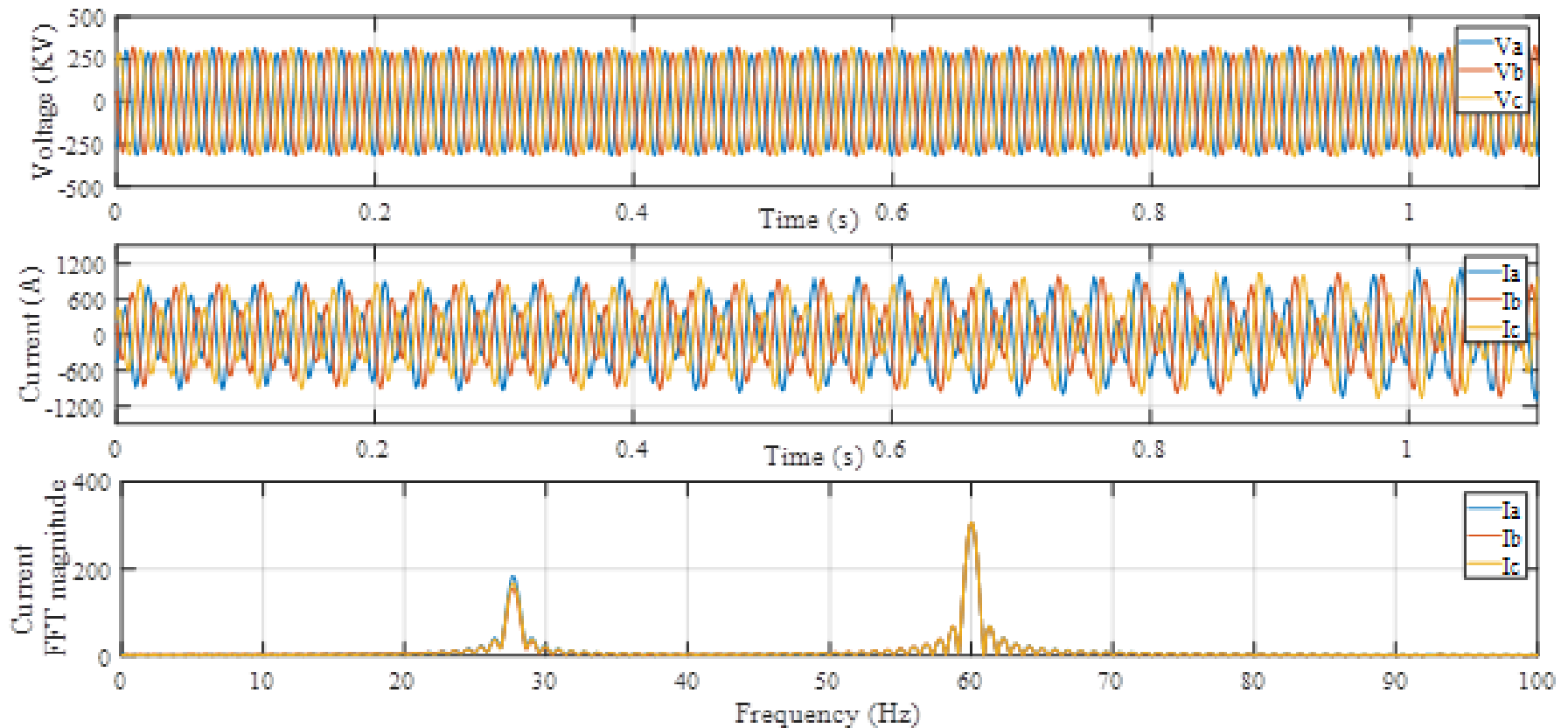
- 2017 SSO Event Descriptions
- SSO Event Records & FFT Analysis
- SSO Event Simulations & FFT Analysis
- Observations & Conclusions

# Event Descriptions



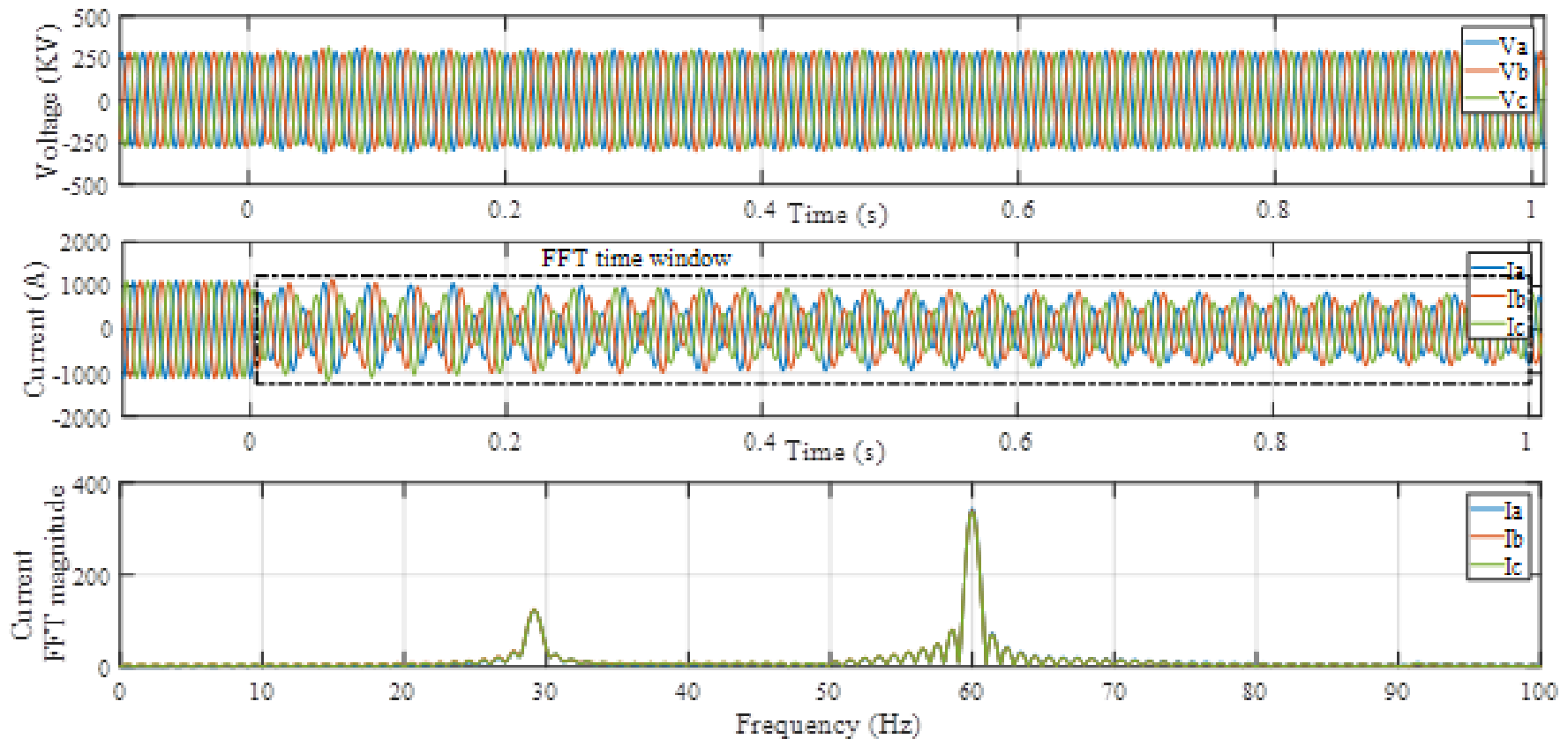
# August 24 Event Record

Post-station 4-5 line opening showing gradually increasing SSCI



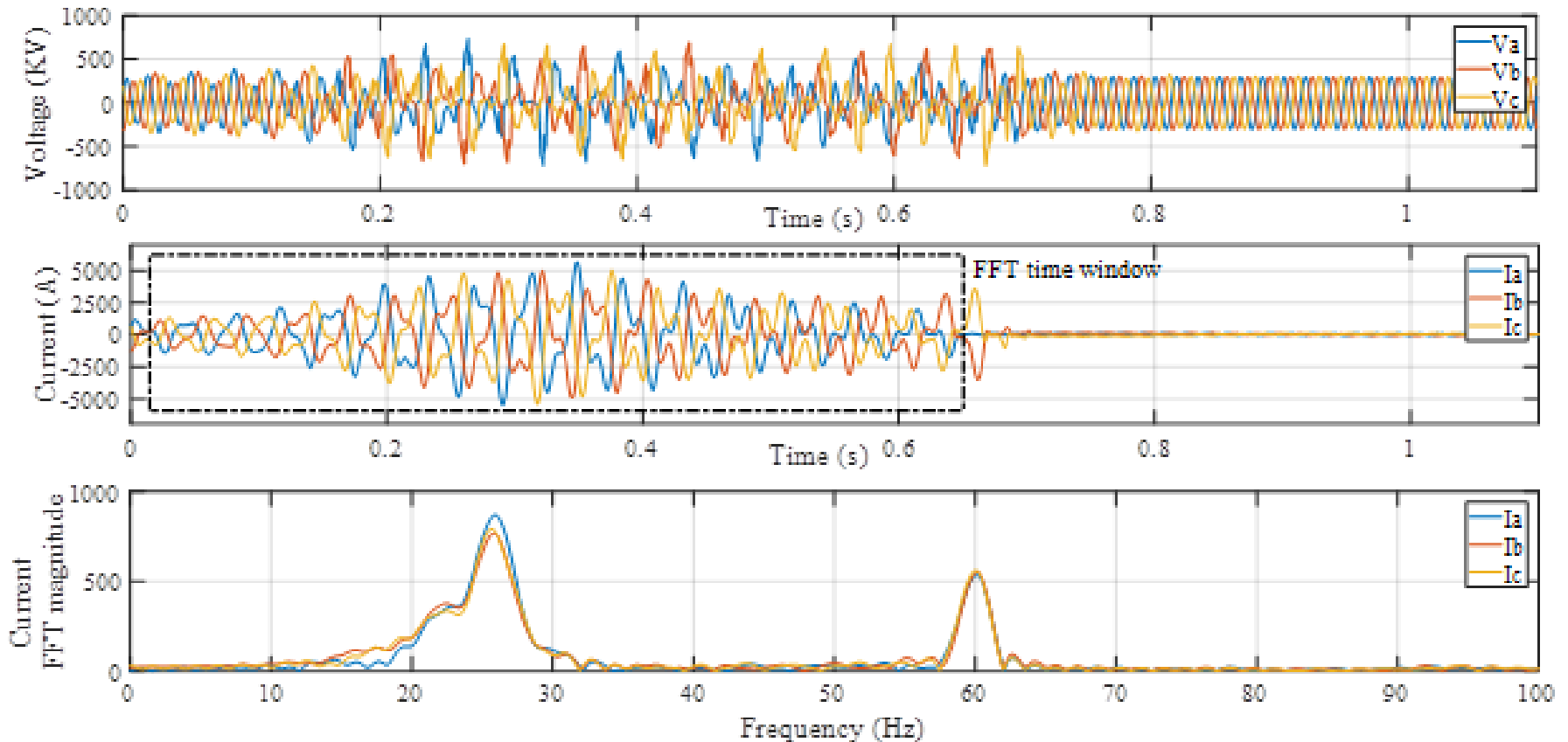
# August 24 PSCAD Simulation

Post-station 4-5 line opening showing gradually diminishing SSCI



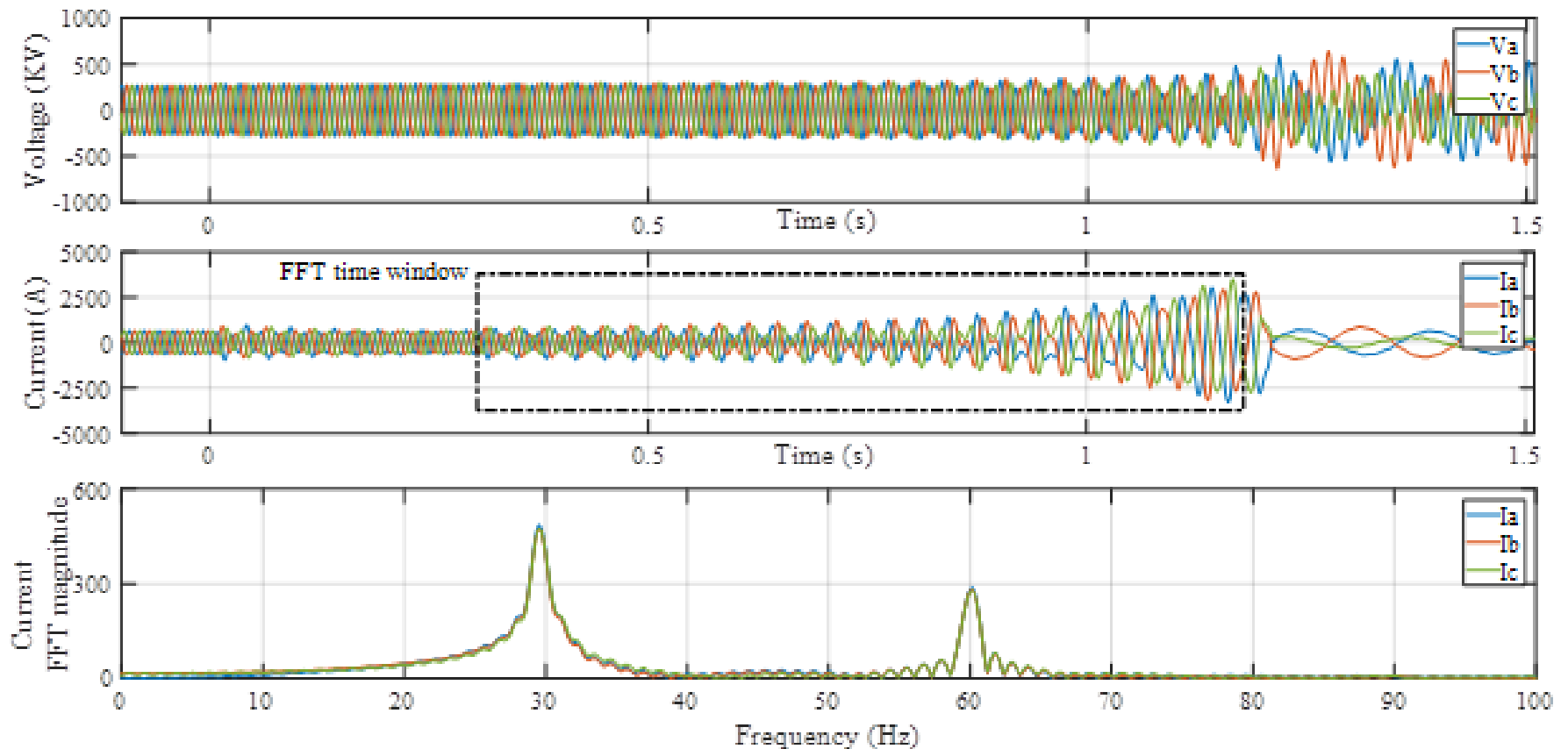
# August 24 Event Record

Post-series cap re-insertions; SSCI increases rapidly; wind plants 3 and 4 trip



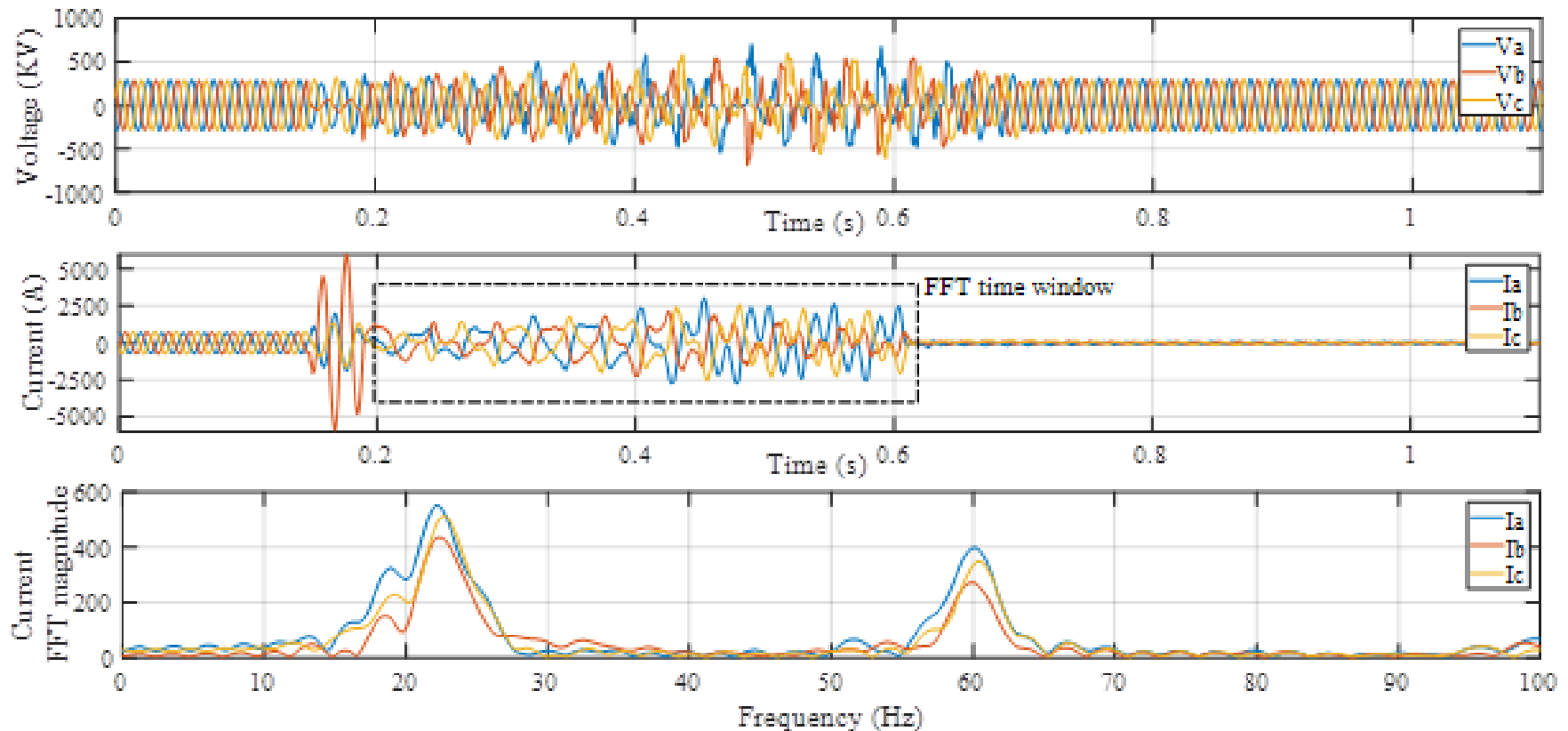
# August 24 PSCAD Simulation

Post-series cap re-insertions; SSCI increases rapidly; wind plants 3 and 4 trip



# September 27 Event Record

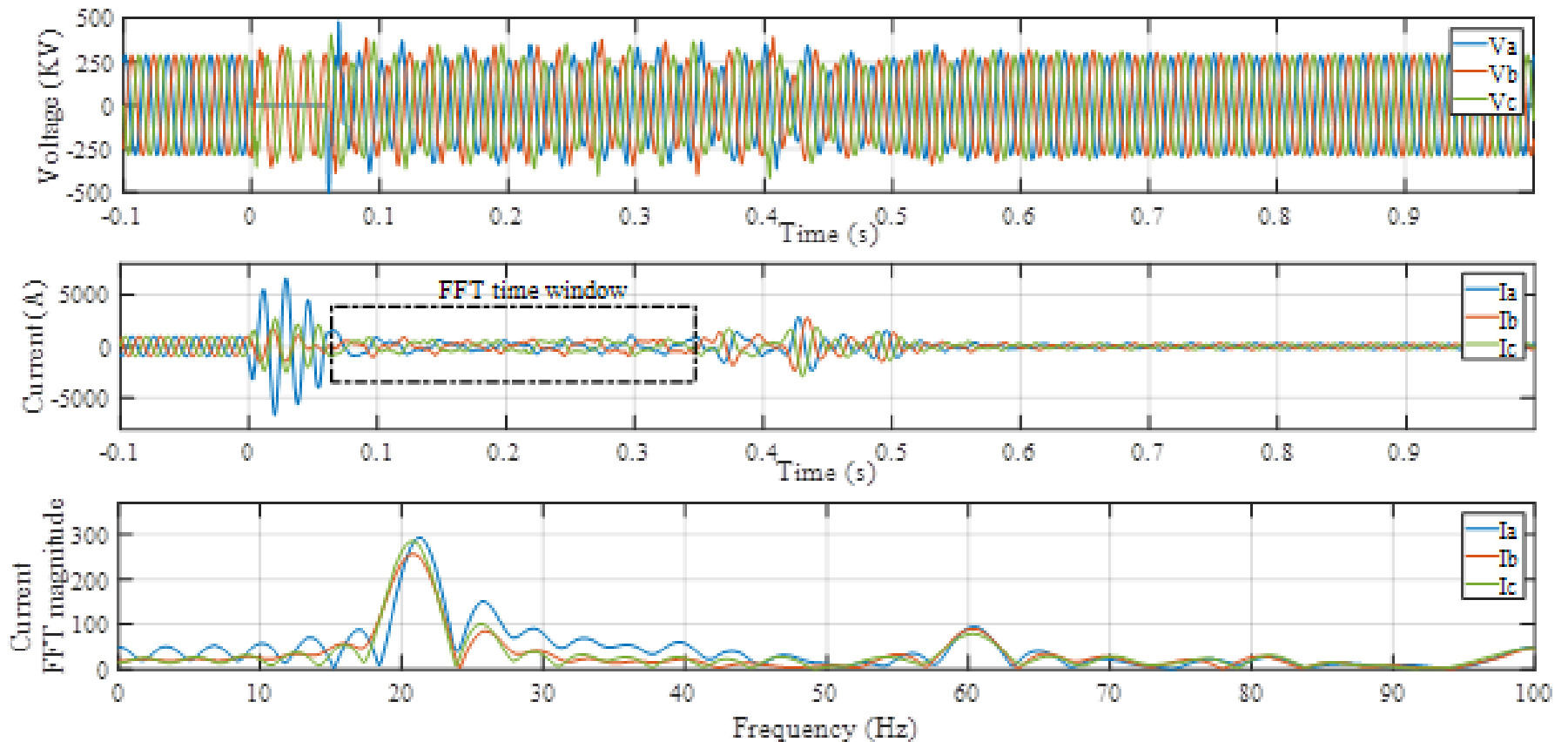
Line 2-3 fault-trip; SSCI not suppressed; wind plants 1 and 2 trip





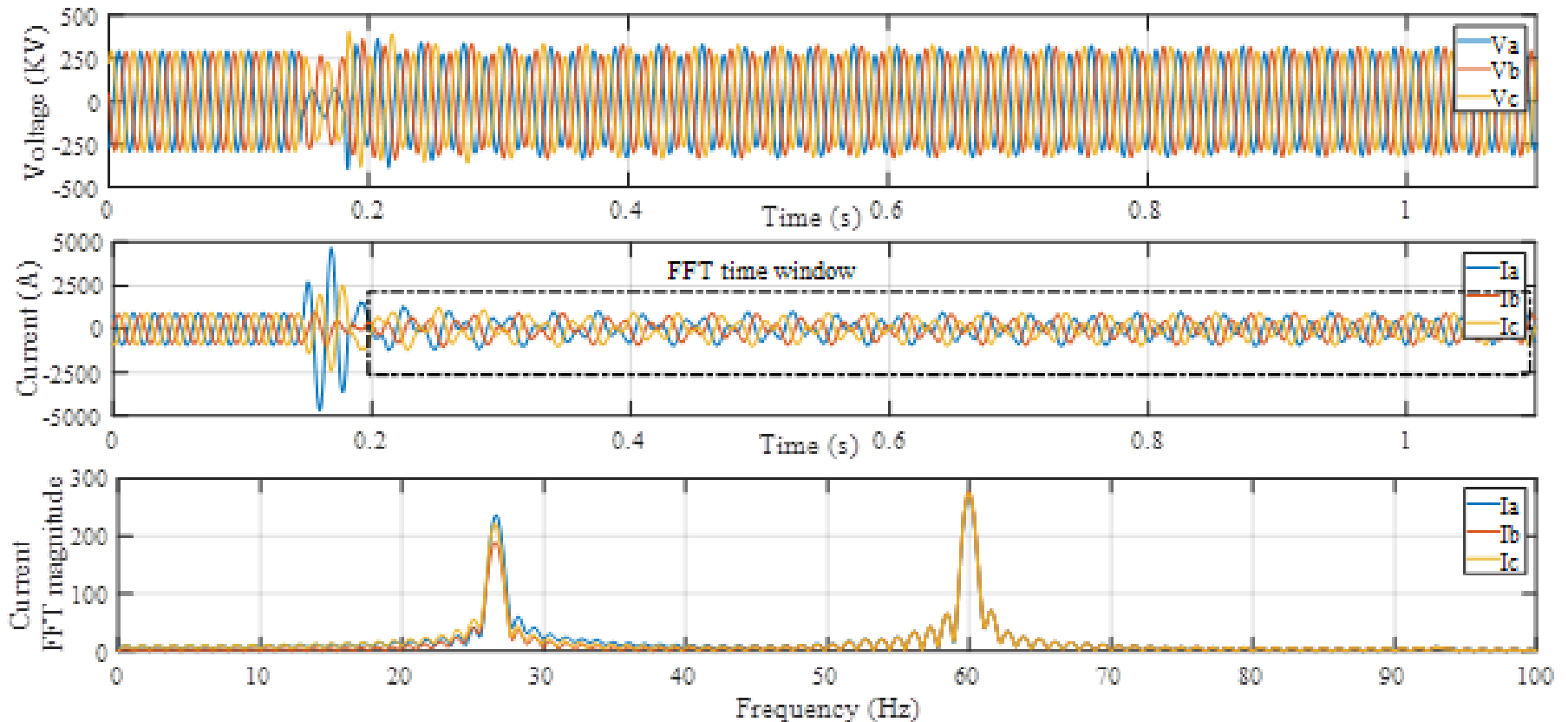
# September 27 PSCAD Simulation

Line 2-3 fault-trip; wind plants 1 and 2 suppress SSCI and do not trip



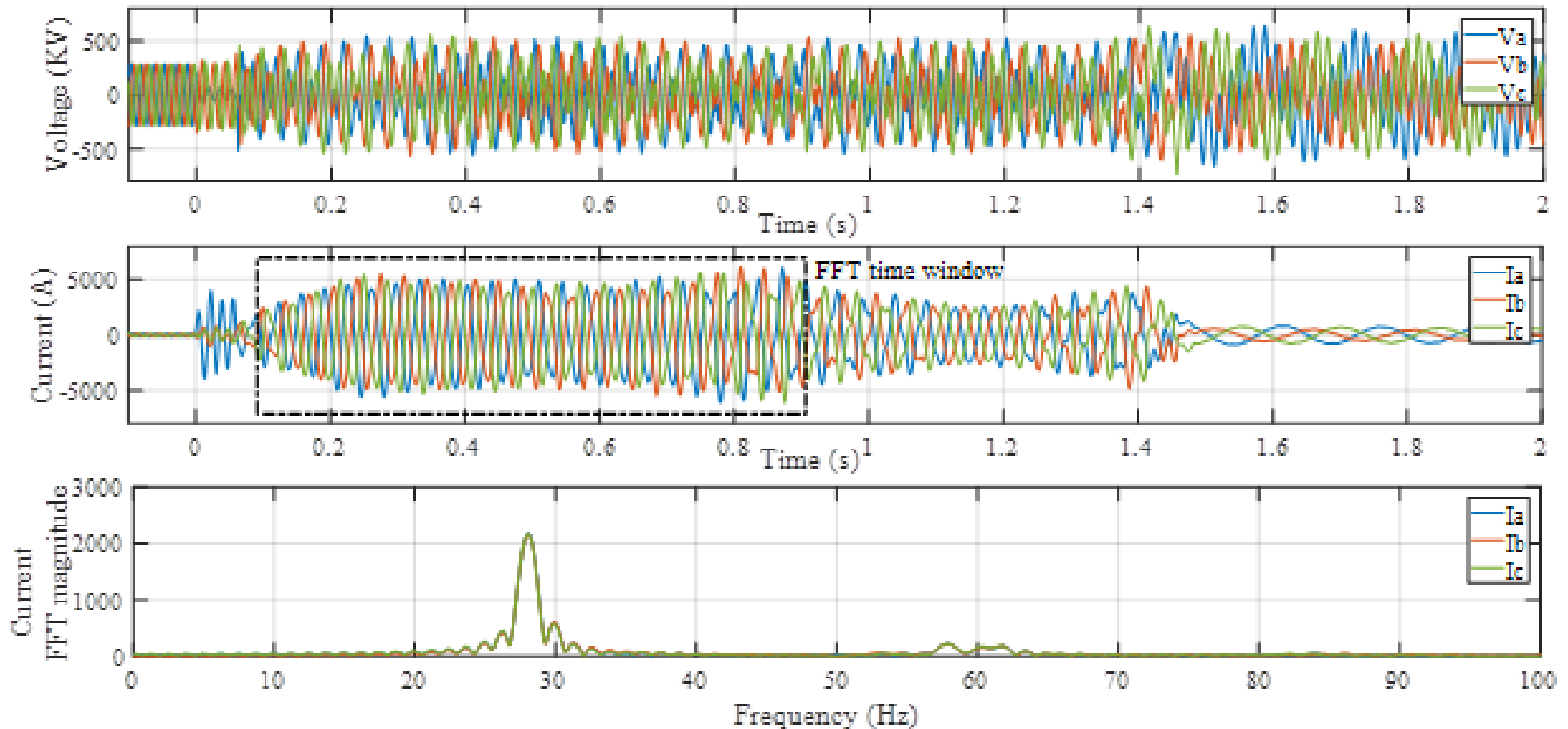
# October 27 Event Record

Line 4-5 fault-trip; SSCI damps out gradually; wind plants 3 and 4 do not trip



# October 27 PSCAD Simulation

Line 4-5 fault-trip; SSCI increases rapidly; wind plants 3 & 4 trip sequentially



# Observations & Conclusions

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- Failure of originally devised SSCI mitigations
- EMT modeling found inadequate to replicate frequency, magnitude, damping of observed SSCI
  - Work continues with plant owners & manufacturers on accurate EMT-level modeling, assurance of effective SSCI mitigation
- High SSCI sensitivity to wind project initial MW/MVAR
  - Effective SSCI mitigation must encompass wide range of system, wind plant conditions

# Reasons to get this resolved quickly

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- General reliability unease over sub-synchronous currents
- Inspection of high-speed recordings necessary to determine that SSCI is present and a cause of any consequent bypass or tripping
  - System operators cannot know proper response