2024 ESIG/G-PST Special Topic Workshop
A Deeper Look at Oscillations
Session 3: System Planning and Interconnection Studies in an IBR World

Dealing with Control System Interactions

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Outline

- Definitions and scope
- How do we learn about oscillatory control interactions
- How we generally address undesired interactions
- Recurring reasons for control interactions
- Final Comments

Control interactions under discussion

Definitions of Control Interactions

- Oscillatory phenomena in the grid with participation of control function in IBR unit control or IBR plant controller
  - Examples: Subsynchronous control interactions 8-15Hz.
  - Not same as IBR trips

Experience from

- Supporting developers and other stakeholders
- Support to GE Vernova product design (grid integration)
- Global

Technology

- IBR plants evaluations and implementations (Wind/Solar/BESS)
- IBR unit product design and validation (Wind/Solar/BESS)
- Conventional generation not discussed
- FACTs mentioned in the context of interactions with IBRs

Field recordings or simulations

How do we learn about oscillatory control interactions

IBR unit product design

- Most effective stage to address issues.
- Product performance assessment- Design or validation. IBR Plant details unknown.
- Huge number of grid conditions and disturbances considered. Simulations or tests
- Some issues are known and expected before the assessment
- Lessons learned from product to product accelerate mitigations or eliminate issues
- Issues more often in time domain simulations of extreme conditions. Frequency domain used for specific subjects.

Interconnection and system studies

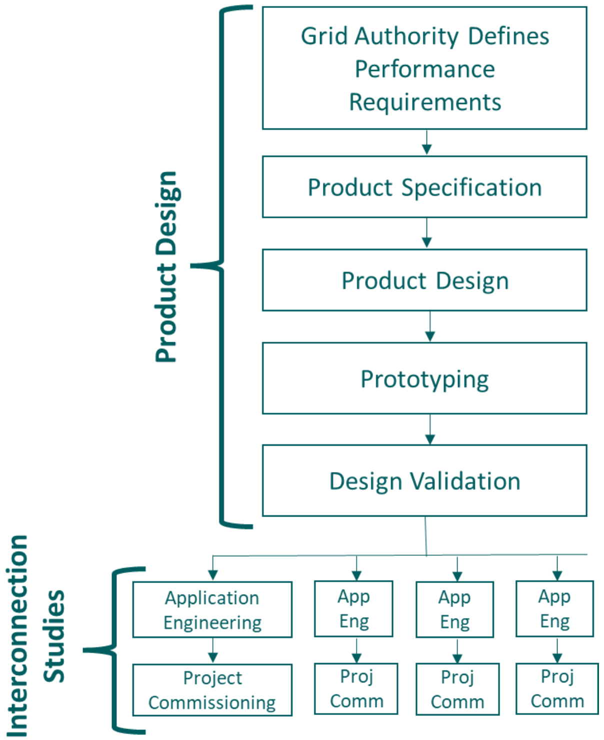
- Evaluating a new IBR plant project or group of projects
- Increasing number of simulation evaluations. Typically, time domain.
- Severe system outages conditions and disturbances often considered

Commissioning of an IBR plant or Grid code compliance testing

- Less common
- Usually related to plant control configurations with fast responses.
- Mitigated through testing and configuration adjustment procedures

Operation of an IBR plant or group of plants

- Very unusual. DFRs, occasionally plant or converter control recordings.
- Hard to tell the origin of oscillatory phenomena from a single recording
- Review of field parameterization is common.



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How do we address undesired control interactions

from simulations during an IBR plant interconnection process

System Simulations → Matrix of scenarios and disturbances → Identification of oscillatory phenomena

There is generally an expectation that issues can be solved with control modifications

Identification of issue → **Models based on products** are necessary for assessment → Simulation issue or performance issue → Characterization of frequency and quantities involved → Sensitivity simulations → Differentiation of plant control and converter control based

Identifying functions and parameters → **Converter control** involved in oscillatory phenomena can be **complex**. → Proposing parameter or algorithm changes → Rerunning problematic cases

Mitigation are usually related to proper damping on existing control functions (Not about additional damping control or PODs)

Evaluating potential unintended consequences → **Parameter changes outside typical ranges** → **Product performance and damage risk evaluation** → **Process is longer for algorithm modifications.**

Solving the issue is not end with a stable simulation result

Field Implementation → Engineering note for commissioning team with non standard parameters

This process is long. Early identification of issues reduces risks of delays

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Recurring reasons for control interactions

Fast response time requirements

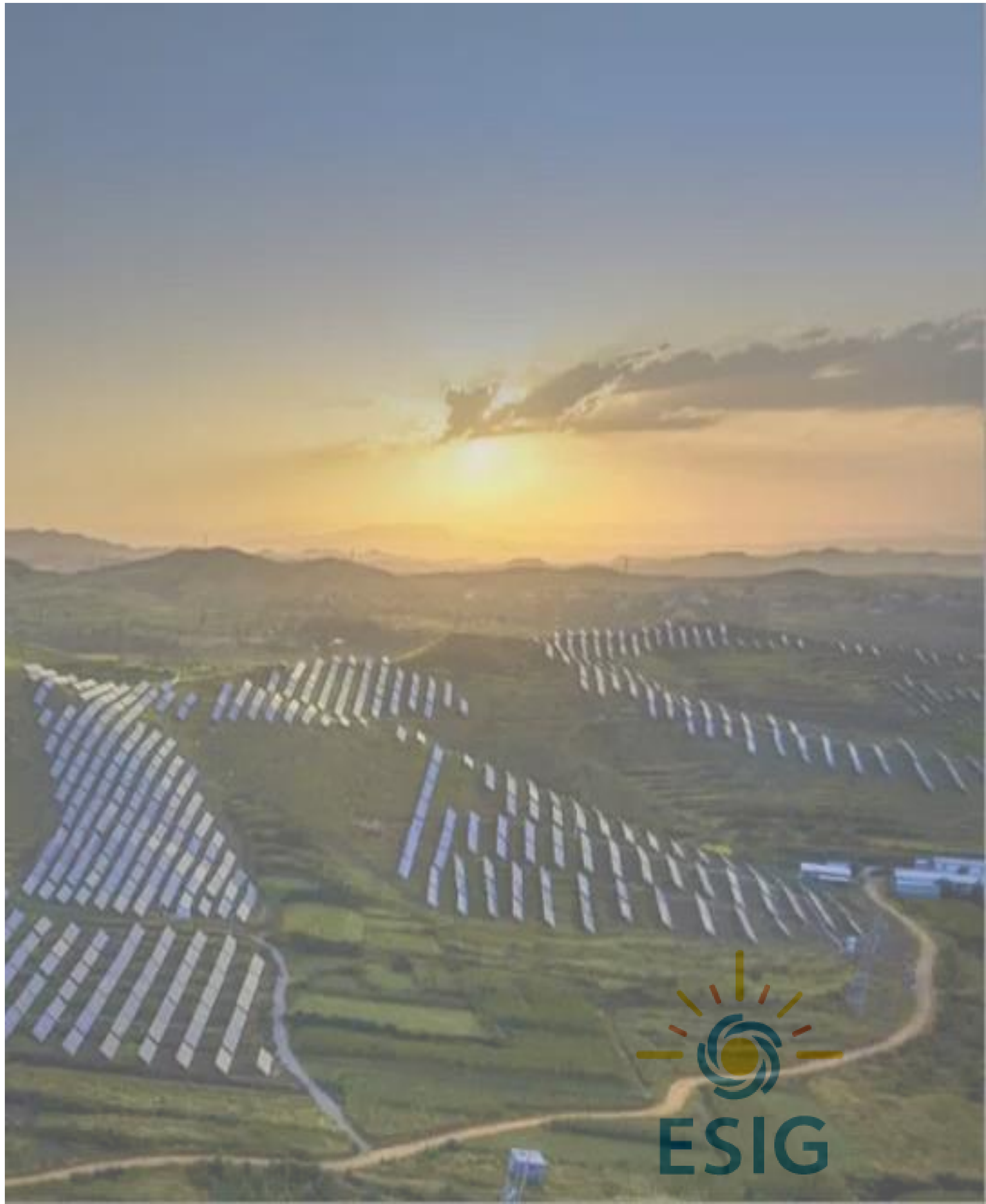
- New IBR plant with neighbor IBR plants or FACTS devices tuned with fast response to stronger grid conditions
- Fast reactive current settling requirements can lead to disabling stabilizing functions and oscillatory behavior
- Fast response time on plant controls for commissioning conditions

Series compensated systems

- Many applications over last 15 years and proven methods
- Considered in product design test conditions
- High controllability for small-signal events. Limited controllability for certain fault events

Weak systems

- Fast active current recovery requirements after fault in weak systems is problematic
- Large SCR variation in a single contingency
- Many enhancements over last decade considered in new products



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Final Comments

- IBR units generally have high capability for damping oscillations
  - Damping capability is limited by equipment ratings (volts, amps, bandwidth)
- IBR design processes and legacy of challenging applications are used to reduce oscillation risks in IBR plant projects
- Interconnection studies can present unexpected oscillatory behavior
  - Identifying causes of issues is challenging
  - Solving problems include verifying unintended consequences of changes in controls and implementation of changes in the field
  - Time and availability of expertise can be a challenge
- Solving a problem identified in a simulation requires simulation tool skills, electric power systems and IBR product expertise… and following up to field implementation
- Faster IBR response times are not necessarily better

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Q&A

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