Addressing Utility-Specific Low Inertia and Frequency Response Adequacy Challenges

Project Highlights

- Determine whether certain weak grid areas of the system would impact minimum inertia criteria
- Investigate impact on the overall system frequency response if the primary frequency response (PFR) is mainly provided by a decreasing number of synchronous resources
- Identify recommended IBR performance requirements to assist with inertia and primary freq. response

Background, Objectives, and New Learnings

High penetrations of inverter-based generation resources (IBRs) present challenges for reliable operation of the power system. Ensuring adequate frequency response is one such concern as the generation mix changes with increasing penetration of IBRs and planned retirements of synchronous thermal generation. Furthermore, the proliferation of distributed energy resources will further impact the system frequency performance. The main objectives of this project are to:

1. Determine whether system wide or regional low inertia issues exist, focusing on regional aspects if system wide requirements can be met.
2. Investigate the impact on the overall system frequency response if the primary frequency response (PFR) is mainly provided by a limited number of resources.
3. Identify recommended IBR control settings to assist with meeting frequency response/minimum inertia requirements.
4. Identify if reliability-based limits are needed for PFR reserves per resource, resource group, technology type, or number of resources providing PFR.
5. Investigate how different unit commitment and dispatch profiles for a given resource mix can impact PFR.

Benefits

The project is expected to help participants:

- Improve methods and tools for bulk system transmission planners and operators to ensure adequate frequency performance as penetration levels of IBRs increase.
- Identify system reinforcements or operational solutions required to ensure frequency adequacy at high levels of IBR penetration.
- Ensure power system reliability is maintained, while allowing for increase in penetration of clean energy resources.

Project Approach and Summary

The following tasks are expected to be performed under this project:

Study Scenarios

Under this task, EPRI plans to work with the participant to identify suitable study scenarios where the challenges and opportunities of obtaining frequency performance from IBRs can be investigated. Operational or planning scenarios with high penetration of IBRs during low load periods for this study will be utilized. Such periods are expected to have lower levels of online synchronous generation and are therefore suitable for a study of this nature. It is expected that the participant will provide the base powerflow model representing such an operational or a planning scenario. As needed, the penetration level of IBRs in the powerflow case could be adjusted with both near-term and long-term projections in mind.

Dynamic Modeling

Under this task, EPRI expects to review the relevant control settings of existing synchronous generator and IBR models such as droop, deadband, P-priority, Q-priority, etc., as applicable. These settings directly impact contribution of a given generator to frequency deviations. Any new IBRs, if

added to increase penetration levels, will be represented by the 2nd generation renewable models also known as the RE models (REPC, REEC and the REGC). Also, as needed, additional models to represent the wind generator mechanical dynamics and pitch control will be included in the dynamic data for both existing as well as new IBR plants. Additionally, any shortcomings of the latest commercially available dynamic models of IBRs will be identified and recommendations for future model improvement will be provided.

Assessment of Inertia Distribution

EPRI has developed a screening methodology that can identify potential regional inertia issues in a power system without using time domain simulations. Under this task, EPRI will assess if regional inertia issues can emerge within the participant's footprint. If such regions emerge, the system will be analyzed to calculate minimum inertia (or inertia floor) for each region. This provides a basis for transmission planners/operators to screen for potential weakly coupled regions in the system and identify reinforcements or operational solutions to maintain security in key vulnerable locations.

Assessment of Frequency Response Adequacy

The overall goal of this task is to provide insights on frequency performance based on various metrics such as primary frequency response, frequency nadir, rate-of-change-of-frequency, settling frequency, and level of inertia. The analysis also aims to capture characteristics of IBRs and their potential capability to provide frequency support to the bulk system. Using the developed study scenario, dynamic simulation studies will be performed with the following main objectives:

- Impact of changing generation mix on both inertial and primary frequency response of the system.
- Impact on the overall system frequency response if the primary frequency response is provided by IBRs. Sensitivities will be performed to assess impact of different active power control strategies of IBRs.
- Impact of remote locations of frequency responsive IBRs on frequency response in any of the scenarios.
- Impact of weak grid conditions on IBRs ability to provide desired/designed frequency response.

In addition to performing dynamic studies, EPRI will also investigate how different unit commitment and dispatch profiles for a given resource mix can impact PFR. EPRI has developed a situational awareness tool, the Frequency Response Adequacy Display Tool, that calculates resource-by-resource or/and system-wide PFR based on droop setting, headroom/floor-room, deadband, etc. and can help identify whether additional commitment or redispatch of generation is required for adequate frequency performance.

Deliverables

Each participant will receive:

- Interim technical report for each of the tasks with modeling assumptions and analysis results.
- Webcasts, presentations, and discussions on interim results.
- Final technical report and presentation.

The non-proprietary results will be incorporated into EPRI's Transmission Operations and Planning R&D programs.

Price of Project

The price of the project is $130,000. An additional $20,000 will be required if the required data in not available in suitable form.

This project qualifies Self-Directed Funding (SDF) or Tailored Collaboration (TC) funds. Funding can be paid over two years.

Project Status and Schedule

The anticipated duration of the project will be 8–12 months.

Who Should Join?

RTOs/ISOs, Balancing Authorities (BAs), and utilities should join the project to understand frequency response issues in the system as the resource mix changes.

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

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