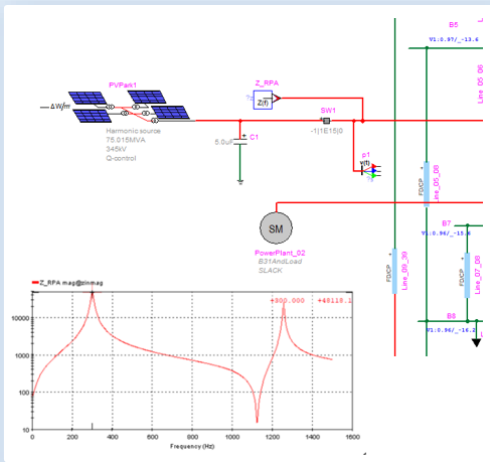


# TRANSMISSION HARMONIC AND POWER QUALITY ANALYSIS FOR CHANGING RESOURCE MIX



## PROJECT HIGHLIGHTS

- Technical guidance and tools for assessing the potential impacts of harmonic generating sources.
- Examine and quantify the existing background harmonic distortion through measurements.
- Options for mitigating impacts of harmonic generating sources.
- Assess the impact of generator retirements and future inverter-based resources on power quality indexes.

## Background, Objectives, and New Learnings

There is a growing number of inverter-based generation resources (IBR), especially transmission-interconnected solar and wind generation. Retiring traditional power plants and replacing generation with inverter-based generators may raise power quality (PQ) issues, reduce system short-circuit capacity leading to weaker grids, and exacerbate existing voltage unbalance issues.

Research has demonstrated that system responses can vary depending on location and resource mix. Therefore, it is unclear whether the grid may experience a higher level of harmonic distortion or power quality concerns. Plus, transmission systems have seen a general increase in voltage distortion levels further impacting IBR integration. This could pose challenges for industrial customers particularly those which have higher sensitivity to voltage variations at the point of interconnection (POI).

Additionally, future integration of IBR and battery energy storage (BES) facilities with distinct control operations can also impact the voltage at the POI. The dynamic behaviors of these units, their response time as well as the accurate dynamic system load models, introduces additional complexity when analyzing voltage at transmission system substations and the resilience of equipment at sensitive customer sites. Voltage enhancement technologies like static synchronous compensator (STATCOM), static var compensator (SVC) or BES could provide adequate voltage improvement for sensitive customers. However, this depends on the size and location of these units, as well as the system conditions and customer sensitivity.

The objective of this supplemental project is to assess the impact of generator retirements and future IBR connections on transmission power quality. In addition, the appropriate planning response necessary to prepare the system for the anticipated future generation resource mix will be provided.

## Benefits

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This project is expected to provide the following benefits:

- Improved understanding of the impacts of a changing bulk power system on PQ and harmonics.
- Improved understanding on the dynamic behavior exhibited by IBRs (with different control operations), BES facilities, loads, and voltage enhancement technologies like STATCOM and SVC in relation to voltage sag performance for industrial customers.
- Technical guidance and tools for assessing the potential impacts of harmonic generating sources.
- Inform future planning decisions on options for mitigating impacts of harmonic generating sources.

## Project Approach and Summary

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The following tasks are planned under this project:

1. Quantify existing background harmonic distortion through measurements.
2. Convert participating utility transmission planning and protection model into a format compatible with a harmonic/power quality analysis tool of utility choice.
3. Characterize the system impact with anticipated future generation resource mix. Impact analysis may include:
  - a. System frequency response impacts.
  - b. Area of vulnerability impacts.
  - c. Steady state and dynamic assessment to understand the impact of generator retirements, future IBR connections with different control functionalities and system developments on PQ indexes and voltage sag experienced at POIs.
  - d. Dynamic behavior and impact of voltage enhancement technologies such as STATCOM and SVC.
4. Provide analysis results to each participating utility. Results are expected to inform the appropriate planning response to prepare for the anticipated future generation resource mix.

## Deliverables

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- Periodic project webcasts or workshops to gather participant guidance and to provide updates on project progress.
- Utility-specific report providing guidance on specific system configuration under analysis, with resulting harmonic, voltage, and PQ indexes. The report will include model results analysis, and suggested mitigation and/or next steps if required

The non-proprietary results of this work will be incorporated into EPRI's R&D Programs.

## Price of Project

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Contact EPRI for scope and pricing.

## Project Status and Schedule

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This project is expected to last for 12 months.

## Who Should Join

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Utilities who are currently developing plans for expanding Inverter-Based Resources.

## Contact Information

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

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