Project Set – PS173A

Display Title: PS173A: Modeling and Analytics for Emerging Technologies

Key Research Question

With increasing levels of inverter based resources (IBR) and distributed energy resources (DER), legacy transmission planning and protection models, tools and practices need to be adapted to address the challenges posed by such resources. Topics covered in this project include:

- Modeling of IBR and DER for Transmission Planning and Protection Studies
- Transmission Planning Tools and Guides
- Transmission Protection Tools and Guides
- Inverter Based Resources Interconnection Performance Requirements and Plant-Level Conformity Assessment

Objective (The Why)

The ultimate goal of this multi-year R&D effort is to support the reliable integration of inverter based and distributed energy resources in transmission planning and protection activities by:

- Developing, validating, and then making available to commercial software vendors, generic models for representing wind, PV, battery energy storage, hybrid plants, and DER in bulk system planning and protection studies and corresponding tools.
- Developing methods and tools to assist planners in studying the impact of inverter based resources on the bulk system, including a) the capability to assess integration of IBRs in weak systems, need for grid forming inverter controls and their performance requirements, b) the ability to evaluate the impact of location and size of various system strengthening devices, c) assessment of stability of networks with large percentage of IBRs, d) identify any interaction between inverter based resources and grid enhancing technologies, e) investigate the impact between inverter based resources and emerging loads, and f) develop methods and processes to evaluate fidelity and performance characteristics of generic and user defined dynamic models across simulation domains
- Developing and verifying methods of aggregating DER models in bulk system simulations, including assessment of interconnection requirements, and exploring the use of T&D co-simulation to improve modeling & verification of aggregate DER models.
- Investigating the protection system performance of power grids with very high levels of IBRs, including 100% IBR generation scenarios and a mix of grid following and grid forming IBR controls, with the objective to provide guidelines and recommendations to protection engineers for conducting relay setting and protection studies
- Developing procedures, criteria, and tools to support conformity assessment of IBRs, including IBR unit model validation and IBR plant verification
- Providing insights and guides, based on technical analysis and studies, on dynamic and fault response performance requirements of IBR and DER.

Approach (The How)

As in prior years, the EPRI team will work with EPRI's members and with the broad industry groups (WECC, NERC, IEEE, IEEE SA, CIGRE, IEC, equipment and software vendors). Using input from these groups, EPRI will develop new model specifications and validation/verification approaches that will then be communicated with commercial software vendors to ensure new models are properly implemented in the commercial tool libraries. Additionally, EPRI also develops more detailed models through this project that help portray nuances of equipment behavior. These detailed models are always available as a project deliverable as such models may not be used by all. Software tools and guides will be developed to support planning and protection engineers in conducting studies. EPRI will also engage with industry to support, through technical analysis and studies, defining requirements of IBR dynamic and fault response performance.

Research Value

The value of this research is to produce improved models, modeling capabilities and tools for the utility members and ISOs to be able to more reliably and economically plan and protect their systems as decarbonization is evolving and the generation mix is getting dominated by renewable inverter based resources. The above R&D efforts will result in the following potential benefits:

1. Technical insight on new IBR control methods such as grid forming controls and power oscillation damping to increase the percentage of IBRs
2. Technical insight on location and sizing of system strength improvement technologies and a comparison of their performance
3. Technical insight on methods to improve control and stability of IBRs in low short circuit, low inertia networks. This also includes measures for IBR self-assessment for damping
4. Methods and processes to exercise “Trust by verify” concept on simulation models provided by OEMs and GOs
5. Technical insight on methods to evaluate stability of IBRs across multiple devices and systems
6. Technical insight on assessing the risk of uncertainty in simulation models
7. Technical insight on the interaction of IBRs with other technology such as GETs and Large Loads
8. Carry out grid strength assessment and hosting capacity analysis to provide insight into capability of the transmission for new generation resources.
9. Improved reliability through improved accuracy of planning and protection studies
10. Increased grid integration of renewable energy resources through planning and protection methods and tools that assess reliability impacts of their interconnection
11. Reduced engineering labor through generic IBR and DER models that obviate the need for developing new ones, and through tools and guides that support interconnection studies
12. Reduced uncertainty about IBR plant performance from more diligent assessment of capabilities and performance of the IBR plant design, for example in conformity with industry standards
13. Recommendations on IBR dynamic and fault response performance requirements, that can be used as technical basis and reduce labor time of protection and planning engineers, as part of interactions with inverter manufacturers and plant developers for either existing IBR/DER, or proposed new ones in the interconnection queue
14. Continued improvement in the methods for validation of dynamic and short-circuit models for IBR and DER.

This project provides value to the following member types:

- Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs)
- U.S. Transmission Owners (TOs)
- International Transmission Owners (TOs) / Transmission System Operators (TSOs)
- Vertically Integrated Utilities with transmission planning and protection responsibilities.

Anticipated Deliverables

Deliverable	Objective	Value	Joint Program
Grid Strength Assessment Tool (GSAT) – Offline Version 7.0 (Software)	GSAT computes various grid strength metrics for various planning models and contingencies	Supports planning engineers to assess grid strength and evaluate risk of inverter instabilities	
Grid Strength Assessment Tool (GSAT) – Online Version 5.0 (Software)	Online version of GSAT to compute various grid strength metrics in a real-time environment	Assesses grid strength in real-time environment to evaluate risk of inverter instabilities	173B/39
Inverter Based Resource Identification Tool (IBR-IDT) v1.0 (software)	A set of scripts that can allow for identification of IBR dynamic behavior and provide the ability to compare performance of the model across simulation domains	Provides transmission planners with a mechanism to verify the performance delivered by user defined models provided by GOs/OEMs	40, 174
Coordination and Control of Hybrid Plants for Transmission Planning Studies (Tech Update)	Identify sizing requirements of various equipment within a hybrid plant to provide the necessary grid services	- Provides insight into operation of hybrid plants for bulk power system studies	
IBR Induced Oscillation Source Location (Tech Brief)	Insight into identifying when an oscillation would be an issue, can it be mitigated, and can it be simulated.	- Get an understanding of the various nuances associated with oscillations and IBRs	PS39E
Blueprint for blackstart testing: Global System Practices for Power System Recovery (Tech Brief)	Provide members with insights into best practices for live blackstart testing and challenges raised by significant recent events when blackstart units failed to deliver as expected	- Help get an understanding of changes in procedure that might be needed for blackstart and system recovery	PS39C
Role of Inverter based Resources in Restoration (Tech Brief)	Provide recommendations based on outcome of case studies and demonstration conducted to assess role of wind, solar, battery storage and DER in-system restoration	- Get an understanding of performance requirements that might be needed from IBRs for restoration	PS39C, PS39D
Screening methods and stability analysis for oscillations in an inverter rich system (Tech Update)	Insight into the various methods of evaluating IBR stability for different scenarios and configurations.	- Get an understanding of differences between Eigen values and frequency domain evaluations	PS40D
Special Assessments on Interaction of Large Electronic Loads with Inverter Based Generation (Tech Brief)	Insight into potential interactions that may arise between IBRs and Large Load	- Get an understanding of the nuances associated with interactions between IBRs and Large Electronic Load	PS40A, PS40D
Modeling and Assessment of Grid	An overview of modeling of different grid enhancing technologies for system	Get an insight into the various nuances associated with GETs	PS40A, PS40E

Deliverable	Objective	Value	Joint Program
Enhancing Technologies (Tech Update)	reliability studies and illustration of the impact of these devices on grid stability.	and their impact on the nearby inverter-based resources	
Modeling of Combined Synchronous Generation and Battery Energy Storage Systems (Tech Brief)	A primer on the new collocated synchronous generation and BESS facilities and how these facilities can be modeled for power system dynamic studies	Evaluation of the challenges associated with non-IBR hybrid plants	PS40A
Assessment of interactions between steam turbines and a high IBR system (Tech Update)	Identify various interaction mechanisms between synchronous machines and IBRs	Provide an understanding to both generator owners and utilities regarding the interactions that may arise	PS40D, PS219
Updates on IBR Standards, including FERC Order 901 and related NERC Work Plan for Reliability Standards Development and Revisions, and IEEE 2800 / P2800.2	Webinars	Ensures members are aware of evolving regulatory context and voluntary industry standards Provides useful information for NERC Standard Drafting Team members	PS40A,P174
IBR Short-Circuit Modeling and Fault Studies in IBR Dominated Grids (Presentation)	Summarize the latest research and developments in short-circuit modeling of IBRs and use of models for fault analysis	Ensures accurate IBR models in commercial fault analysis tools	-
GFM IBR Fault Response and Short Circuit Modeling (Tech Brief)	Investigate the fault response and develop GFM short-circuit models	Ensures accurate IBR models in commercial fault analysis tools	-
Short-Circuit Network Equivalents for IBR Dominated Grids (Tech Brief)	Summarize techniques for network equivalencing for fault and protection studies in systems dominated by IBRs	Ensures accurate fault analysis and protection studies in IBR dominated grids	-
Protection System Performance in Grids with GFM IBRs (Technical Update)	Investigate the performance of protective relaying in the presence of GFM IBRs and provide guidance to protection engineers	Provides technical insights on conducting fault analysis in IBR dominated grids Reduces labor time for protection engineers when conducting studies	-

Past EPRI Research on Topic

Product ID	Title	Description	Published Date
3002021787	EMT and Positive Sequence Domain Model of Grid Forming PV Plant (GFM-PV) v1.0	Simulation models to illustrate performance/behavior of a grid forming PV plant both in EMT and positive sequence domain. Implementation in positive sequence domain is using readily available generic models	Dec. 2021
3002020781	REGC_C Implementation in PSS/E (REGC_C PSS®E) v1.2	A user defined model to represent inverter based resource dynamic behavior in low short circuit systems. This model can also be used in 100% inverter networks.	Dec. 2021
3002020782	Grid Strength Assessment Tool (GSAT) v4.0	Updated version of the GSAT tool that automates the computation process of grid strength indexes	Dec. 2021
3002020785	Modeling of Hybrid Plants for Transmission Studies	This report outlines types of hybrid plants around the world and presents modeling approaches along with use cases and example studies	Dec. 2021
3002018152	Transmission Hosting Capacity (PSS®E) v3.0	Updated version of the THCT tool to support transmission planners by screening through multiple interconnection requests across a larger transmission footprint allowing for a better understanding of where and how much these new generation resources would impact the system - PSSE	Dec. 2020
3002018676	Grid Forming Inverters: EPRI Tutorial	Tutorial covering the basic aspects of IBR operation to assess the need and impact of different control modes designed to operate in a 100% IBR network.	Dec. 2020
3002020033	A New Operation Paradigm for a Bulk Power System with Very High Levels of Inverter Based Resources	White paper describing the concept of frequency in a future grid and potential to transform the operation of the grid wherein frequency can be assumed to be a constant element.	Dec. 2020
3002019451	Towards Prediction of Generic Parameters for Aggregated DER Model (DER_A)	Report describing the results of detailed distribution circuit studies on numerous circuits with varying DER percentages followed by developed of a generic parameter set for use in the voltage tripping characteristic of the DER_A model	Dec. 2020
3002019452	Applicability of T&D Co-simulation for Accurate Capture of Load and DER Dynamic Behavior	Report that documents results of studies both in EMT domain and RMS domain comparing the dynamic behavior obtained from detailed representation of distribution and transmission networks with the behavior of the composite load model.	Dec. 2020
3002024258	Voltage Controlled Current Source (VCCS) Model Parameterization Tool v3.0	This tool generates the numerical values of the tabular VCCS model for various generic inverter control modes	Dec. 2022

Product ID	Title	Description	Published Date
3002024260	Equivalencing Methods for Protection Studies in IBR Dominated Grids	This report documents methods to calculate equivalents in systems with inverter based resources	Dec. 2022
3002024262	Protection Guidelines for Systems with Inverter Based Resources - 2022 Update	Updated guidelines and recommendations for protection engineers when conducting fault analysis and protection studies on systems with inverter based resources	Dec. 2022

Related Research

The work under this project set is closely coordinated with and designed to complement the work being done in the Transmission Planning (P40), Transmission Operations (P39), Market Design and Operation (P246), DER Integration (P174), and Distribution Operations and Planning (P200) programs.

This project presently contributes cost-share to the following DOE-funded projects:

- NOWRDC/InnovateUK effort on developing an offshore wind blackstart framework
- "Protection-Inverter Co-Design for 100% Renewable Power Systems (PI-Co-Design)"
- NYSERDA Offshore Wind Stability Impact Study

Additionally, EPRI in collaboration with the National Renewable Energy Laboratory (NREL) and the University of Texas at Austin are co-leading a U.S. Department of Energy funded Grid Forming Inverter Consortium for a minimum period of 5 years. Activities in this P173A project set are leveraged as cost-share towards the consortium objectives.

Further, a number of industry working groups and task forces relate to this work, and the EPRI team engages with these to ensure the latest developments are included in this work, and that the EPRI work is being made visible to these relevant groups.

- ESIG working groups
- WECC Modeling and Validation Subcommittee (MVS)
- NERC, Load Modeling Working Group (LMWG), Inverter-Based Resource Performance Subcommittee (IRPS), System Planning Impacts of DER Working Group (SPIDERWG)
- Selection of NERC Standard Drafting Teams (SDTs) for new or revised reliability standards in response to FERC Order 901 (IBR Standards and Registration to Improve Grid Reliability) and FERC Order 2023 (Improvements to Generator Interconnection Procedures and Agreements)
-
- IEEE P1547.7 Working Group, developing a Guide for Conducting Impact Studies for Distributed Energy Resource InterconnectionIEEE 2800 Working Group for potential future revisions of IEEE 2800 Standard "Standard for Interconnection and Interoperability of Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems"
- IEEE P2800.2 Working Group, developing a Recommended Practice for Test and Verification Procedures for Inverter-based Resources (IBRs) Interconnecting with Bulk Power Systems
- IEEE Power System Dynamic Performance Committee (PSDPC), Wind and Solar Working Group (WSWG), Task Force on Modeling and Simulation of Large Systems with High Penetration of Inverter based Generation
- CIGRE JWG C4/C6.35/CIRED Modeling and dynamic performance of inverter-based generation in power system transmission and distribution studies
- CIGRE C4.60 WG "Generic EMT-Type Modelling of Inverter-Based Resources for Long Term Planning Studies"
- IEEE Power System Relaying and Control (PSRC) Committee Working Group C45 "Protection and short-circuit modeling of systems with high penetration of inverter-based resources", and CTF34 "Inverter Based Generation Short Circuit Current Impacts"

- CIGRE B5.65 WG “Enhancing Protection System Performance by Optimizing the Response of Inverter-Based Sources”

Project Set – PS173B

Display Title: PS173B: Operator Support Tools and Methods for Emerging Technologies

Project Lead: Miguel Ortega-Vazquez, (650) 855-8635

Objective (The Why)

Decarbonizing power systems will require extensive use of variable and distributed resources. These weather-driven resources will increase the variability and uncertainty in system operations, and since many are connected through inverter-based interfaces they may also challenge frequency control and performance. However, planned and operated correctly, these resources can also offer bulk system services that may aid system operation. Therefore, it is important for operators to learn how to effectively integrate these resources into both current and future practices.

To ensure supply-demand balancing considering aspects such as VER production, weather-dependent asset reliability, sudden load changes, and contingencies, the amount of reserve that should be carried may need to be adjusted dynamically to 1) comply with reliability standards, and 2) maintain a desired level of risk/reliability in power systems operation. Therefore, new, and improved methods are needed for optimizing balancing and contingency reserve requirements to maintain reliability while managing costs. These methods need to consider explicitly the risk (expectation of reserve shortages) preferences and exposure of system operators, while scheduling the available flexibility of the system.

To manage the frequency performance of the system with increasing penetration of non-synchronous resources, tools and methods are needed that assess frequency stability and provide operators awareness of locational inertia and frequency responsive resources in real time, or in a study/design environment. Tools and case studies that assess the impact and contribution of emerging technologies on and to system needs are needed to ensure frequency control is maintained. Other operational issues may also need to be considered, such as weak grid conditions.

Approach (The How)

This project set focuses on methods, tools, case studies, and documentation that address the issues identified in the action plan associated to scheduling, forecasting, and active power control. Software tools and algorithms are designed and developed to calculate various key metrics and parameters, including operating reserve requirements and frequency response adequacy. EPRI works with project set members to apply these models and tools to their system, and to demonstrate the value and economic efficiency that can be derived from their utilization. The project set also develops guidelines for operators to implement new and improved methods and shares leading practices in the area. Emerging challenges are identified and worked on based on results from previous years, newly identified issues in industry, and member feedback and prioritization.

Research Value

This project set delivers value to members with innovative models and algorithms, software tools, clear examples of use cases highlighting the benefits of the research produced:

- **Reserves and Scheduling**: Equips operators with tools and methods to dynamically parametrize different operating reserve products for continuous (e.g., regulation, flexibility) and discrete events (e.g., contingencies):
    - Risk-dependent reserve parametrization of operating reserves for systems with deep penetrations of variable renewable energy sources.
    - Risk-dependent reserve parametrization of contingency reserves for systems under extreme weather conditions (increased likelihood of failure)
    - Risk-dependent operating and contingency reserve repartition across multiple sharing areas.
    - Contingency reserve parametrization and allocation with post-contingency deliverability guarantees.
- **Forecasting and DER integration**: Provides information about the latest developments in forecasting of renewables and integration of DER into operations.
- **Frequency Response**: Provides situational awareness, modeling insights and analysis tools related to adequacy and delivery of frequency response with high levels of inverter-based resources.

Anticipated Deliverables

Deliverable	Description	Date
DynADOR - CMD	A GUI-free version of the DynADOR tool that would allow system operators and planners to invoke it from a command line or script. This version will allow the exploration of multiple scenarios and sensitivities without user intervention through the GUI.	Dec. 2025
Innovation in flexibility reserve requirements and uncertainty management for operations	This technical update will showcase the various enhancements on methods to parametrize flexibility reserves considering multiple sources of uncertainty (e.g., historical data or probabilistic forecasts). As well as extensions to for precise risk parametrization using different explanatory variables.	Dec. 2025
Bulk System Frequency Performance and Assessment Under High Levels of Variable Generation: Deliverability of Primary Frequency Response and Regionalization for Frequency, Voltage and Grid-Strength		Dec. 2025
Grid Strength Assessment Tool (GSAT) - Online Version v5.0		Dec. 2025
Role of AGC with High Penetration of Variable Generation		Dec. 2025
Frequency Management in High Inverter based Systems - Allocation and Delivery of Operating Reserves		Dec. 2025

Past EPRI Research on Topic

Product ID	Title	Description	Published Date
3002027270	Software: Inertia Estimation Toolbox (IET) – Joint with 39E	Tool that estimates and monitors system and regional inertia in real time. Joint with P39E	Dec. 2024
3002027151	Technical Update: Frequency Performance under High Levels of Variable Generation	Insights on delivery of frequency response over weak grid	Dec. 2024
3002027272	Technical Update: Real-time Inertia Estimation and Monitoring: Algorithm and Case Studies - Joint with 39E	Insights on inertia monitoring applications	Dec. 2024
3002027153	DynADCR v2.0	This new version of the of the tool will focus on deliverability of contingency reserves in grid-constrained systems.	Dec. 2023
3002027155	DynADCR Video	A video describing the methods behind the DynADCR tool, the data requirements, the running process, and some illustrative results	Dec. 2023
3002026307	DynADOR v5.2	This new version of the tool will feature enhancements to existing models, and extensions requested from users.	Dec. 2023
3002027152	Locational Contingency Reserve Requirements	This deliverable will focus on a case study to demonstrate the importance of sourcing contingency reserves in a way in which it can be effectively deployed after a contingency.	Dec. 2023
3002027268	Online Grid Strength Assessment Tool v3.0 (software, joint with 173A)	Computes various grid strength metrics in a real-time environment	Dec. 2023
3002027559	Frequency Response Adequacy Display Tool (FRADT) v7 (Software)	Calculate frequency response available, and assess emerging sources of frequency response	Dec. 2023
3002027270	Inertia Estimation Toolbox (IET) v3.0 (Software, joint with 39E)	Tool that estimates and monitors system and regional inertia in real time using available data	Dec. 2023
3002027151	Bulk System Frequency Performance and Assessment under High Levels of Variable Generation: Deliverability of Primary Frequency Response (Technical Update)	Insights on delivery of frequency response over weak grid	Dec. 2023
3002027272	Real-time Inertia Estimation and Monitoring: Algorithm and Case Studies ((Technical Update)	Insights on inertia monitoring applications	Dec. 2023

Related Research

The work being done in this project set is closely coordinated with and designed to complement efforts in other EPRI programs, including Transmission Operations (P39), Distribution Operations and Planning (P200), Integration of DER (P174), Energy Storage (P94), and other programs and activities across EPRI.

Project Set – PS173C

Display Title PS173C: Flexibility and Resource Adequacy Assessment

Objective

The resource adequacy (RA) problem can be loosely defined as assessing whether a resource mix has a high probability of meeting customer demand at any moment, while both supply and demand vary with some randomness. RA studies are conducted to assess whether projected resource buildouts meet planning criteria, e.g., 1 in 10 LOLE standards. Several factors are changing coincidentally, requiring a fresh approach to resource adequacy assessments. Increasing VER/DER penetration requires increased operational flexibility. At the same time, technologies are emerging that can support system adequacy, including new forms of energy storage, technologies allowing for demand-side flexibility, and integration with the heat and transportation sectors.

Updated methods are required to assess whether enough resources exist to meet reliability needs and to understand the contribution of different resources to reliability. When planners do identify a potential reliability deficit, the expanding range of solution options and consumer expectations requires a new approach to determining best fit solutions in planning. The objective of this research is to identify, create, demonstrate, and transfer methods and tools to assess resource adequacy to ensure future power systems continue to meet society's reliability standards.

Ongoing changes to the resource mix pose several questions related to resource adequacy and system flexibility. With increases expected in the levels of wind, solar, and distributed energy resources, what new or enhanced metrics and tools might be needed so that planners ensure adequacy? How do planners ensure that systems will have enough operational flexibility manage future ramping needs? How do new and emerging resources on the supply and demand side compare to existing resources in their contribution to adequacy and flexibility? How to consider other energy systems that are increasingly integrated with power systems? How to ensure that future scenarios are adequately developed for reliability studies? How do we assess all these issues while balancing computational time and level of detail required in studies and accuracy of the answer? These are just some of the research questions being addressed in this project set.

Approach

EPRI has developed a holistic approach towards addressing resource adequacy challenges for power systems navigating the energy transition. The specific contributions and risks associated with new resource types or new conditions are assessed, and gaps in current tools and approaches to adapt to emerging technologies evaluated to determine specific areas to address from year to year. This project's activities focus on developing tools, methods, metrics, scenarios, and data to support RA practitioners navigating global changes affecting adequacy.

Planned activities under Project Set 173C include the continued development of the EPRI Resource Adequacy Knowledge Center, continuing the development of tools to develop scenarios for adequacy assessments, continuing the development of methods and frameworks to capture the impact of new technologies on resource adequacy, and the application of machine learning techniques to accelerate unit commitment studies. The focus on the demand side will shift from behind the meter resources and tariffs, to examining the role of rapidly electrifying demand (e.g., heat pumps, data centers, industrial electrification, etc.). Based on member prioritization, additional activities will be incorporated. These could include the development of a data sets suitable for study in resource adequacy assessments, the assessment of water-related common mode outage risk, further analyses on the impact of extreme events on resource adequacy, or representation of neighboring systems.

The tools and approaches developed by EPRI, as well as innovative third parties, will be demonstrated in case studies to understand how these approaches affect resource adequacy assessments. Guidelines and application guidelines will be developed to support practitioners adopt new methods into practice. Methods are first

implemented in EPRI research-grade software tools, with the objective of transferring those algorithms to commercial tools or making them available to members for direct integration into tools and processes.

Research Value

This project set delivers value in the following ways:

- **Resource Adequacy and Flexibility Metrics and Practices:** Provides up to date information on metrics and practices for resource adequacy and flexibility assessment methods.
- **Resource Adequacy Technology and System Component Modeling:** New and enhanced models to capture the evolving nature of supply and demand resources as well as the impact of networks for adequacy studies.
- **Scenario Planning for a Decarbonized Future:** Supports planners in developing scenarios capturing potential future grid conditions in the context of near 100% renewables scenarios.
- **Resource Adequacy Methods:** Identifies and improves on state of the art in modeling for adequacy assessment including improvements in computational performance.
- **Energy Systems Integration:** Provides support for sector coupling modeling as power systems decarbonize.
- **Enabling Data:** Provides geographically and temporally extensive and coherent data sets for resource adequacy studies.

Anticipated Deliverables

Deliverable	Value	Date
Impact of Electrification and Large New load Integration on Resource Adequacy *(Technical Update)*	Provides methods to account for rapidly electrifying sectors in resource adequacy and investigates adequacy risk mitigation strategies in load growth scenarios.	Dec. 2025
Should Flexibility be a Part of Resource Adequacy?: The Impact of Flexibility Constraints on Capacity Accreditation *(Technical Update)*	Investigates whether flexibility should be a part of resource adequacy and provides methods for accounting for it in adequacy assessments. Explores the impact of flexibility constraints on accreditation.	Dec. 2025
Resource Adequacy Knowledge Center *(Website)*	Provides up to date information on resource adequacy and flexibility assessment methods and practices for practitioners and stakeholders.	Dec. 2025
Resource Adequacy Forum *(Webcast Series)*	Topical deep-dive webcast series on leading RA modeling practices to support practitioners.	Dec. 2025
Accelerating Production Cost Models Through Artificial Intelligence *(Technical Update)*	Ensures that detailed simulations can be carried out in a reasonable time for adequacy studies.	Dec. 2025

Past EPRI Research on Topic

Product ID	Title	Description	Published Date
	Resource Adequacy Knowledge Center	Provides up to date information for practitioners on leading resource adequacy and flexibility assessment methods.	Continuous update
3002027245	Demand-Side Resources in Resource Adequacy: 2021 - 2023 Research Compilation	Provides frameworks to support practitioners in modeling a range of DER and demand flexibility categories in resource adequacy assessments.	Dec. 2023
3002027246	Accelerating Production Cost Modeling: 2023 Update	Reviews the state-of-art methods for improving and speeding up PCM solutions and AI methods employed to solve unit commitment problems. Introduces test system for benchmarking AI algorithms for solving unit commitment.	Dec. 2023
3002027720	Integrating Resource Adequacy and Capacity Expansion: 2023 Update	Bridges the gap between capacity expansion and resource adequacy processes by evaluating several capacity accreditation methodologies and their impact on buildouts and adequacy risk.	Dec. 2023
3002028252	Demand Flexibility for Grid Reliability and Resilience: Planning Tool Integration of Demand Flexibility – Phase II	Analyzes the challenges and opportunities related to flexible load integration across four different planning functions: capacity expansion, resource adequacy, transmission planning, and distribution planning. The work focuses on electric vehicles and smart thermostats.	Nov. 2023
3002027251	Rapid Electrification: Load Materialization Timelines and Implications for Planning	Examines four key sectors predicted to rapidly grow/electrify in the coming years: transport, data centers, industrial heating, and electrolysis and outlines growth uncertainties and potential adequacy risk.	Dec. 2023
3002027248	Scenario Generation for Adequacy Studies	Develops guides and tools to construct an appropriate set of scenarios to assess adequacy and resilience considering a wide spectrum of influencing factors.	Mar. 2024
3002027010	Capacity Accreditation: Key Principles, Evolution, and Philosophy	Summarizes various capacity accreditation methods and discusses their strengths, weaknesses, and overarching principles.	Mar. 2024
3002027830	Modeling New and Existing Technology and System Components in Resource Adequacy: EPRI Resource Adequacy Assessment Framework	Provides information on options for modeling utility-scale resources, demand-side and customer-scale resources, networks, and other energy carriers in resource adequacy.	Nov. 2023
3002027831	Data Collection for Resource Adequacy Analysis: Guidelines to Address Existing and New Technologies	Provides a review of the quality and abundance of data requirements for modeling technologies and system components in resource adequacy.	Nov. 2023

Related Research

The work being done in this project set is closely coordinated with and designed to complement efforts in other EPRI areas, including EPRI's Resource Adequacy for a Decarbonized Future project, Transmission Operations (P39), Transmission Planning (P40), Integration of DER (P174), Energy Storage (P94), Customer Technologies (P170), Resource Planning for Electric Power Systems (P178), Distribution Operations and Planning (P200), Energy, Environmental, and Climate Policy Analysis (P201), Electricity Market Design and Operation (P246), and other programs and activities across EPRI.

Project Set - PS173D

Display Title PS173D: Technology Transfer

Objective

With the rapidly changing landscape for renewable and DER integration into the bulk system, broadly applied deliverables are needed to support industry practitioners. Webcasts, short summary reports, and videos can enable project set members to share with and learn from other's experiences, issues, and solutions. Utility and ISO transmission and resource planners, protection engineers, and operators can leverage this technology transfer to quickly assess the present industry status of renewable integration and understand their own context compared to other regions. These activities also help identify research and collaboration opportunities

Approach

This project provides regular and easy-to-access information from EPRI's Bulk System VER/DER integration research program to members via short updates, advisor meetings, webcasts, and email communications. Examples of technology transfer resources and tools include regular webcasts on renewables integration topics of interest, periodic memos/technical updates summarizing renewables integration information, and more detailed surveys and studies. It also ensures EPRI can engage in industry activities such as standards development and technology watch (e.g. offshore wind in recent years.

Research Value

- This project set delivers value in the following ways:
- Guidelines: Provides guidelines and maturity model for understanding of impacts of renewables/DER
- Technology Information and Insights: Improves planner and operator high level considerations of various new topics such as offshore wind integration
- Briefings and Insights: Provides technology transfer and information about high renewables/DER and regular updates on leading practices being used around the world

Anticipated Deliverables

Deliverable	Description	Date
Operator/Planner Maturity Model for High Renewables/DER (Technical Update).	Provides guidance and supports assessment of maturity in integrating renewables	Dec. 2025
Review of recent and ongoing interconnection standards development (Quick Insight)	Provides insights to standards being developed and reduces uncertainties related to resource performance	Dec. 2025

Past EPRI Research on Topic

Product ID	Title	Published Date
3002027745	Guidance on Numerical Weather Prediction Datasets: Data Sources and Use Cases	Dec. 2023
3002024374	Transmission Operations Guide for High Penetrations of Variable Energy and Inverter-Based Resources	Dec. 2022
3002024375	Guidance on Weather Data for Studies	Dec. 2022
3002021786	Operator Guidelines for High Penetrations of Variable or Distributed Energy Resource (VER/DER)	Dec. 2021
3002022661	Energy Hubs	Dec. 2021
3002012300; 3002017874	Energy Storage in Resource Planning and Wholesale Markets	Dec. 2021
3002020483	Generation Interconnection Queue Process	Dec. 2021
3002014970	Implications of Reduced Inertia Levels on the Electricity System: Technical Report on the Challenges and Solutions for System Operations with Very High Penetrations of Non-Synchronous Resources	Dec. 2019
3002011528	Global Interconnection Requirements for Variable and Distributed Generation: 2018 Update	Dec. 2018
3002012734	The Integrated Grid: Mid-Year Report 2018 Initiative Demonstrations	Dec. 2018

Related Research

The work being done in this project set is closely coordinated with and designed to complement efforts in other EPRI programs, including Transmission Operations (P39), Transmission Planning (P40) Electricity Market Operations and Design (P246), Integration of DER (P174), Energy Storage (P94), Customer Technologies (P170), Resource Planning for Electric Power Systems (P178), Distribution Operations and Planning (P200), Energy, Environmental, and Climate Policy Analysis (P201) and other programs and activities across EPRI.