2025 Research Portfolio

P174 – DER Integration

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Program Description

The DER Integration Program develops solutions that address the challenges faced by utilities with the integration of solar, battery storage, electric vehicles, and other distributed energy resources (DER) into the distribution system. It covers the range of issues from updating technical interconnection requirements to assessing hosting capacity; handling and screening interconnection requests; grounding, protection, and metering; modeling and analyzing grid impacts; choosing grid-support functions and settings; applying DER monitoring and control systems (DERMS); and design of utility and community microgrids. The economic opportunities and challenges of providing reliable service with increasing DER levels via non-traditional approaches, such as non-wires alternatives (NWA) and flexible interconnection, are also addressed in this program.

Approach

This research is carried out with a high degree of member engagement including regular webcasts, training, and delivery of results in forms that are easy to understand and apply. The research provides practical tools and guides that can be utilized in day-to-day processes. The nature of projects includes computer modeling, lab testing, field evaluation, software development, data analytics, industry surveys, standards-support and working group facilitation. Projects aim to provide industry leadership and insights that prepare utilities for upcoming changes, both technical and economic.

The activities are organized in five project sets, each addressing specific research efforts and deliverables:

- Grid Impact Analysis of DER
- Smart Inverter and Grid Support Technologies
- DERMS and Microgrid Integration
- Practices, Programs, and Economics
- Technology Transfer and Industry Engagement

Research Value

The knowledge acquired through this research program will support members to:

- Analyze DER integration issues and make decisions about hosting capacity for various settings, control approaches, and types/combinations of DER.

- Manage interconnection queues and identify effective screening methods.
- Develop industry standards that enable efficient integration of DER into the utility enterprise.
- Predict, identify, and address grid issues caused by rising DER levels.
- Design and update systems and infrastructure in a holistic way to meet integration goals for PV, storage, EV, and manageable load.
- Determine requirements and make use of evolving standards for DER interconnection.
- Train staff on all aspects of DER Integration (smart inverters, grid edge devices, control systems, grid impacts, economic analysis, etc.).
- Develop strategies for managing and integrating customer-sited DER and microgrids.
- Assess both technical and economic aspects of DER integration with existing distribution assets.
- Use data analytics for assessment and insight into DER operation cost and benefit.

Key Activities

In 2025, this program expects to accomplish the following:

- Maintain member awareness of latest technologies, present practices, and emerging business opportunities related to DER.
- Conduct training, workshops, webinars, and discussion forums on current integration topics.
- Conduct laboratory and field evaluations of DER and DERMS
- Provide tools and methods for choosing smart inverter settings.
- Investigate technologies to improve control in grids and microgrids, and accommodate higher penetrations of DER.
- Understand the value and need of grid forming (GFM) inverters on distribution systems.
- Advance the OpenDER and EMERG Models. Understand behaviors during abnormal and transient conditions, including islanding and faults.
- Simplify DER interconnection application and screening processes, providing methods to streamline and automate where appropriate.
- Define/document DERMS requirements and implementation approaches, perform DERMS control method evaluations, and support DERMS integration with aggregators.

Accomplishments

The DER Integration program has delivered valuable tools and resources to members and industry. Examples of recent program outcomes:

- Supported utilities with the adoption of IEEE 1547-2018: provided over 100 recommendations for enhancing DER interconnection practices and protocols relevant to application management, technical reviews and utility internal infrastructure.
- Provided tools and guidelines for selecting smart inverter functions and settings.
- Applied the DER Integration Testbed to successfully test commercial DERMS and to develop improved DER control algorithms. Provided reference RFP language for DERMS.
- Critical assess and provide recommendations related to DER power system phenomena such as harmonics, grounding, ground fault overvoltage (GFOV), open phase, and islanding.
- Performed hands-on evaluation of DER for both steady state and dynamic behaviors, including smart inverter function impact on islanding risk and general islanding methods and performance, informing direct transfer trip practices.
- Created a DER resource center including a Research Results Finder, Interconnect Documents Repository, DERMS RFPs, Solar Data, Analytics and Screening Processes.
- Developed a streamlined method for finding locations within a distribution feeder that benefit and

draw value from DER-based non-wired alternatives.

- Addressed DER unique protection issues providing specific recommendations for neutral grounding, open phase, transformer inrush, flicker, harmonic interactions and island prevention.
- Developed and applied a cost-benefit analysis method for determining value for a range of program designs, including the use of advanced inverter functions to accommodate grid-connected DERs and flexible interconnection curtailment.
- Established the DER Forum, which enables members to bring up DER integration questions and receive rapid response with search capability and results archived.

Estimated Funding

$8.5M

PS174A: Grid Impact Analysis of DER

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Objective

This project set provides engineers with methods and guidance for operating and planning with a wide range of DER types (PV, Storage, EV charging management, etc.) and penetration levels. DER modelling and simulation are essential to understand and predict the impacts of DER under various grid operating conditions. Key research questions are:

- What is the best way to determine how much DER my distribution system can accommodate?
- What are the key characteristics of DER needed for accurate feeder modeling?
- What are the key protection issues for high penetrations of DER?
- How do I model the steady state, dynamic, and transient behavior of inverters on distribution systems?
- How do I assess power systems issues, such as grounding, with high penetrations of DER?
- How can I advance my planning and operational analysis capabilities to interconnect combinations of managed DER and DER aggregations (FERC O2222)?
- How is hosting capacity affected by DER advanced functions (IEEE Std 1547-2018™ or similar), and what are the best DER functions and settings for specific applications?
- What are the practical guidelines for making proactive changes to my practices related to DER as penetration levels grow?
- How can managed control of DER help to provide local distribution services and improve system reliability?
- How can DER be coordinated with traditional equipment (line voltage regulators, load tap changers, capacitor banks, etc.) to achieve an objective?

This project set addresses these questions and provides insights to grid impacts, potential benefits, and how to accommodate more autonomous and managed DER without sacrificing safety, reliability, or effectiveness.

As DER penetrations increase, it is important for distribution operators and planners to fully understand DER impacts and capabilities to maintain and/or improve overall customer service while maximizing asset utilization. This project set is focused on the development of methods, software tools, and guidelines to assess a wide range of DER considerations from determining the best autonomous functions and settings to assessing system grounding with inverter-based resources.

Approach

This project set is carried out through power system studies using a range of modelling and simulation tools including steady state, dynamic, and Electromagnetic Transient (EMT) analysis. Research focuses on the best autonomous functions/settings and cost-effective DER management techniques to facilitate further integration of DER. Where possible, actual circuits of participating utilities are used in the studies and results are designed to apply to a diverse set of circuit types. Results are provided in the form of guidelines and software tools that can be easily applied by engineers for a variety of applications. Through the Accelerating Commercial Engagement (ACE) plan, this project set contributes to and coordinates findings with standards organizations and commercial vendors so that results move effectively from the research realm to the marketplace, bringing products and support to address pressing issues. Strong utility engagement is encouraged through frequent webinars and meetings focused on obtaining feedback, guidance, and knowledge sharing.

Research Value

The proposed Grid Impact Analysis of DER research is expected to produce the following value and outcomes:

- Updating analysis methods to keep pace with the rapid pace of technology evolution and industry understanding.
- Save time and cost in determining and configuring DER settings and functions to meet an objective.
- Increase hosting capacity, grid utilization, and economic efficiency.
- Notify planning methods for the evaluation of bulk and distribution services for individual DER and aggregations of DER.
- Inform decisions to streamline and improve interconnection processing.
- Access to tools and methods that automate studies and produce proven distribution analysis results.
- Investigate dynamic control interactions associated with autonomous DER operation.
- Shed light on key interconnection technical challenges and document simplified assessment approaches.
- Gain access to and exchange up-to-date information; state-of-the-art developments, lessons learned, and related information from other distribution utilities.
- Advance industry knowledge in the application of advanced DER models for distribution analysis
- Identification of the key challenges facing higher penetration levels of DER
- Support company road-mapping with knowledge, perspective, and new ideas about what future distribution systems with significant levels of DER, smart inverters, and automation will need to operate economically and efficiently.

Anticipated Deliverables

Deliverable	Value	Date
Understanding DER Grid Impacts Tutorial (Tutorial): Provide fundamental engineering training for DER integration.	• Address evolving forces that alter fundamental operating characteristics of the electric grid, from one-way central supply to bidirectional power flows caused by DER. Share leading practices related to advanced DER modelling, especially in feeder analysis.	December 2025
DER Modelling and Simulation Workshop – Sharing Leading Practices (Workshop): Half-day in-person workshop after advisory for information exchange on modelling	• Engage members who are performing DER modelling studies and share information to develop guidance for common studies.	December 2025

DER Protection Issue Working Group (DPIWG) (Working Group): Bi-monthly (or monthly) meetings to discuss distribution protection issues and practices that evolve with increasing DER penetration.	• Identify assessment methods and mitigations solutions, update general guideline, and share experiences and best practices.	December 2025
Harmonic Impacts of DER: Myth vs. Fact (White Paper): Model and simulate harmonics in realistic distribution feeders with high penetration of DER. Proposed joint deliverable with P174B.	• To demystify the harmonic impact of DER in distribution systems	December 2025
DER Modelling Recommendations and Guidelines (2025 Version) (Technical Update): Update the previous version with new learnings about DER (e.g., fault models, GFM technology, etc.)	• Provide comprehensive guidelines on DER modelling for various planning studies	December 2025
T&D Coordination of DER Settings to Improve System Reliability (Technical Brief): Evaluate aggregated behaviour of DER at the T&D interface, simulate the impact of different settings (e.g., enter service, ride through, protection tripping, frequency droop) to bulk grid operation, and develop guideline on DER settings for T&D coordination. Proposed joint deliverable with P39, P40.	• Enable DER for improved grid orchestration	December 2025
Considering System Contingencies When Studying DER Impacts (Technical Brief): Survey common switching practices and FLISR schemes, assess impact N-1/contingency states on DER hosting capacity, and evaluate potential challenges of DER to FLISR schemes	• Enhance the industry understanding the role of DER in system contingency	December 2025
Open-Source Toolbox/Automation for Advanced DER Planning Studies (Software): Unify existing and develop new Python packages to support utilities' modelling and simulation needs in DER planning such as centralized distribution control, model conversion, and DER functions beyond IEEE 1547-2018.	• Enable advanced DER planning studies with open-source python library	December 2025
System Impacts of Adopting DER LGP (Limited Generation Profiles) (Technical Brief): Interpret CA LGP policy and develop illustrated use cases to demonstrate its implementation, simulate various scenarios and evaluate potential benefits and problems, and compare against other common practices.	• Help industry evaluate different options for improving feeder hosting capacity	December 2025
DER Hosting Capacity vs Allocation: Equitable DER Adoption on High-Pen Feeders (Technical Brief): Portray conflicts between DER policy goals and technical, reliability objectives, and develop and model real-world scenarios (planned diversity of load and generation, feeders where all customers have DER).	• Improve equality in DER adoption on high penetration feeders	December 2025
Evaluating Building Load Flexibility in Grid Impact Studies (Tech Brief): Review past EPRI work on modelling building loads, conduct bottom-up analysis of certain building load to assess potential flexibility for providing grid services, and update existing flexible analysis methods to include flexible building load. Proposed joint deliverable with P204.	• Pave the path to integrate flexible building load as DER	December 2025

Past EPRI Research on Topics

Product ID	Title	Description	Published Date
3002026668	DER Secondary Analysis Toolkit (DSAT)	A convenient tool to help utilities evaluate DER impact in secondary circuit.	2023
3002028113	Developing Time-Varying Operating Envelopes to Inform DER Dispatch	A framework to help address the challenge of DSO and utilities face when taking grid services provided by DER aggregators	2023
3002027300	Guide to Protection of Microgrids	An overview of protection design approaches for common types of utility-owned microgrids.	2023
3002028554	Interconnection Analysis Methods for Mixed DER and Export Limited DER	A thorough evaluation of the feeder operation considering factors such as steady state voltage, equipment thermal ratings, protection, and voltage fluctuations.	2023
3002019323 3002021725 3002024176 3002026669	Simplified Methods for Determining Smart Inverter Functions	Updated application guidelines with lessons learned from field experience, as well as additional functions, and modelling scenarios.	2020, 2021, 2022, 2023
3002019325 3002021726 3002024197	DER Autonomous Function and Settings Assessment (DAFSA) DRIVE Module	A software tool that works with commercial power flow software to assess the best universal autonomous functions and settings for DER.	2020, 2021, 2022
3002023696	EV Fleet Charging Management and Assessing Distribution Impacts	Build methods to quantify the benefits of EV load to support integration of other DER and grid services. Determine the feasibility of supporting distribution operations through EV fleet management.	2022
3002023153	Quantifying the Technical and Economic Value of DERMS Use Cases	Develop methodologies for evaluating the technical impacts of DERMS and performing simulations and economic analysis to provide general guidelines regarding technical benefits.	2021

3002024201	Planning for Impacts from DER Aggregations Providing Bulk Grid Services	Develop methods and guidelines for the analysis of Bulk Power System (BPS) services provided by an aggregation of DER. Define the potential services, data needs, and the analysis necessary to fully evaluate each potential service. Describe the limitations of performing a planning analysis to evaluate operational challenges.	2022
3002018617	Maximizing DER Hosting and Grid Utilization, Flexible Interconnection Capacity Solutions (FICS)	Develop methods, mapping techniques, and visualizations for evaluating Flexible Interconnection Capacity Solutions (FICS) (allowing larger DER interconnections with targeted curtailment).	2020
3002021727	Feeder Settings Analysis Calculator (FSAC)	The Feeder Settings Analysis Calculator (FSAC) is an Excel-based, simplified feeder analysis tool for assessing the voltage impacts of DER (Distributed Energy Resources) operating with volt-var and/or fixed power factor control modes.	2021
3002022649	Inverter-based Supplemental Grounding Tool (ISGT) V2.0	A tool that enables engineers to evaluate the need for a ground source to mitigate a ground fault overvoltage associated with inverter-based resources. Allows for sensitivity on several key parameters to enable confident selection of a ground source when needed.	2021
3002021728	Impact of Autonomous DER Functions on Centralized Voltage Optimization: Additional Smart Inverter and PV Scenarios at Fine Granularity	Evaluate the impact of high DER penetration scenarios on a feeder comparing the use of local voltage regulation control settings versus a centralized voltage optimization (VO) scheme, without and with selected DER grid support functions.	2021

Related Research

Coordinated with and complements the work undertaken in Bulk Power System Integration of Variable Generation (P173), Energy Storage and Distributed Generation (P94), and Distribution Operations and Planning (P200).

PS174B: Smart Inverter and Grid Support Technologies

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Objective

This project set provides an in-depth understanding of smart inverter, power plant controller (PPC), power control systems (PCS), meter socket adapter, emerging grid-edge voltage regulation technologies, and relevant industry standards for cost effective and reliable grid interconnection of Solar Photovoltaic (PV), Energy Storage (ES), and electric vehicle (EV) distributed energy resources (DERs).

Focus Area I: Technology Evaluation

This area focuses on lab and field evaluation of smart inverters and grid support technologies to characterize their steady-state and dynamic behaviors. Aims to answer questions like how accurately commercial inverters comply with IEEE 1547-2018, how they respond to grid faults, and what roles power plant controller (PPC) plays. Comprehensive DER technology assessment helps to address operational concerns of DERs. Hands-on experience of DER technologies is leveraged to develop and validate steady-state transient models.

Focus Area II: Model Development and Verification

The objective of this area is to support accurate DER model development. Example research questions include how to confirm that models in steady state and dynamic/transient analysis tools are accurately representing real hardware, how to model DER aggregations, and when electromagnetic transient analyses are needed. With validated DER models, simulation analyses are carried out to understand DER's response under various conditions, including unintentional islanding, open phase, load rejection, and ground fault.

Focus Area III: Advancing Technology Utilization

This area addresses the grid value of and technical requirements for new and emerging technologies supporting DER integration. Example research questions include whether high penetration of inverter-based resources may cause grid instability or power quality issues, what are the mitigation solutions, and what are the use cases and performance requirements for emerging grid-forming inverters in microgrid and blue-sky operations. Research in this area helps to prepare for future inverter-dominated power grid and assist utilities adopt the new technologies.

Approach

This project set performs hands-on laboratory and field evaluation and model development of solar PV, energy storage, vehicle-to-grid, power plant controller (PPC), power control system (PCS), and grid-edge voltage regulation technologies. Develops steady state and transient DER models and performs analysis to identify the need and value of new technologies and capabilities. Organizes workshop to facilitate peer-to-peer knowledge sharing and offers multiple tutorials to help utility workforce to develop in-depth understanding of the emerging technologies and their capabilities.

Research Value

This project set is expected to produce the following values and outcomes:

- Understanding of inverter control, protection, grid support capabilities, and limitations to better utilize their full potential in efficient grid integration of DERs
- Objective, vendor-neutral assessment of PV, ES, PV plus ES, and V2G inverters
- IEEE 1547-2018 ready inverter model specifications and open-source code vetted by industry user group. Model validation through lab and field testing of inverters
- White-box validated EMT inverter model for assessment of DER plant response to grid disturbances like

open-phase, islanding, or load-rejection
- Recommendations for DER grounding, screening, and commissioning practices
- Verification framework for steady-state and EMT black-box inverter models in commercial software packages
- Grid-forming inverter use cases and performance requirements for microgrid applications and inverter-based resource (IBR) dominated power systems

Anticipated Deliverables

Deliverable	Value	Date
DER Technology Testing (Tech Update): Perform in-depth performance evaluation of IEEE 1547-2018/UL 1741SB certified smart inverters, power plant controller (PPC), meter socket adapter (MSA), and vehicle-to-grid (V2G) EVSE technologies.	• Efficient utilization of DER technologies with in-depth understanding of their characteristics and capabilities	December 2025
Tech Brief Series on Frequently Asked Questions (Tech Briefs): Develop multiple short informative tech briefs on DER technology related frequently asked questions.	• Informational short materials on commonly asked DER technology related questions and concerns appropriate for upper management	December 2025
Harmonic Impacts of DER: Myth vs. Fact (White Paper): Model and simulate harmonics in realistic distribution feeders with high penetration of DER. Proposed joint deliverable with P174A.	• To demystify the harmonic impact of DER in distribution systems	December 2025
Tutorials on Grid Following (GFL) and Grid Forming (GFM) Inverter Fundamentals, Grid Support Functions, Standards, Modelling, and EMT Analysis (Online and In-person Tutorials): • Inverter Fundamentals and Grid Support Functions (8 hours; online and in-person at utility facilities) • Inverter Modelling for Dynamic, Transient, and Protection Analysis (4 hours; online) • DER Electromagnetic Transient (EMT) Modelling and Analysis (EMT) (8 hours; online) • Grid-forming Inverter (4 hours; online) – Proposed joint deliverable with P173A.	• Continued learning opportunities for existing and new utility workforce with PDH credit • In-depth understanding of DER technologies, standards, modelling, and analysis	November 2025
9th Annual EPRI Smart Inverter Workshop (Workshop): This utility only three day in-person event enables peer-to-peer knowledge sharing and conversations to better understand challenges and potential solutions to adopt smart inverters and IEEE 1547-2018 standard.	• A platform to foster peer-to-peer information sharing • Lessons learned from various smart inverter PV, ES, EV, microgrid demonstration projects	October 2025
Automated DER Plant Conformity Assessment with IEEE 1547-2018 (Software – Beta Version): Analyze existing methods and tools for DER conformity assessment and identify gaps. Develop simulation based automated verification framework to assess DER plant compliance to the interconnection requirements.	• Streamlining DER plant conformity assessment against IEEE 1547-2018 requirements	December 2025
Testing and Validation of DER Short Circuit Models for Protection Studies (White Paper): Compare accuracy of phasor and EMT domain DER short circuit modelling	• Improved understanding of commercial tools' capabilities and gaps	December 2025

approaches in various simulation tools against lab test results. Proposed joint deliverable with P200D.	• Helping software developers to improve model accuracy	
Grid-forming DER Impacts, Performance Requirements, and Industry Interest Group DiGFI (Tech Update): Identify whether GFM DERs can have negative impacts on distribution system protection, grounding, and anti-islanding when operating in grid-parallel mode. Develop GFM performance requirements for blue-sky and microgrid conditions. Share learnings through DiGFI utility interest group.	• Comprehension of distribution protection and PQ impacts of GFM DERs • Example performance requirements language for project RFP	December 2025
Screening Tool for DER Stability Under Weak Grid Condition (Software): Develop an excel or python-based tool to assess DER stability with minimum data requirement and manual efforts. Verify the results against detailed EMT studies on real distribution feeders.	• An easy-to-use tool allowing assessment of DER stability in weak grid	December 2025
DER EMT Model Development & Validation, Interconnection Screening, and Industry Interest Group EMERG (Software and Tech Update): Enhance, validate, and develop PV, energy storage, and EV fast charger EMT models to evaluate transient and power quality impacts on distribution system. Engage industry stakeholders to develop DER EMT screening, model parameterization, and quality verification framework.	• Industry consensus on interconnection screens for DER EMT analysis, model parameterization, and quality assessment • White-box DER EMT models enabling transient and PQ assessment	December 2025
Open-Source DER (OpenDER) Model Validation, Application, and User Group DERMUG (Tech Update and Software): Validate and enhance OpenDER model leveraging lab test results of UL 1741SB certified smart inverters. Implement proposed changes in IEEE P1547 revision and evaluate potential impacts. Share findings with industry through DERMUG.	• Industry accepted validated DER model for benchmarking and accurate distribution analysis • Guidance to ongoing IEEE P1547 working group	December 2025
Assessment of DER Models in Commercial Tools: Cyme and Synergi (Tech Updates): Evaluate and identify improvements made and gaps remaining in DER models in commercial distribution analysis tools like Cyme and Synergi to accurately represent IEEE 1547-2018 requirements. Share findings with tool developers.	• Helping tool developers to improve accuracy of library DER models for more accurate circuit impact studies considering IEEE 1547-2018 grid support functions.	October 2025

Past EPRI Research on Topic

Product ID	Title	Description	Published Date
3002028373	IEEE 1547-2018 Smart Inverter Evaluation: UL 1741SB Certified Residential Energy Storage System (ESS)	Learnings from this research is expected to help utilities utilize the full potential of IEEE 15487-2018 compliant inverters to address challenges of higher penetration of DERs.	2023

3002028376	DER Performance Verification and Commissioning Guideline: Utility Current Practices and EPRI Recommendations	This report provides recommendations on types of commission tests important for utility, C&I, and residential scale DERs and shares current utility practices.	2023
3002028368 3002024431	Grid-Forming DER: Value in Grid-Connected Operation Performance requirement for Microgrid Application	These reports documents potential benefits of GFM DER in grid-parallel mode and performance requirements for microgrid applications.	2023 & 2022
3002028364 2002025896	White-box Battery Energy Storage and Solar PV Inverter EMT Models in PSCAD with IEEE 1547-2018 Functions	Generic white-box EMT models in PSCAD for a three-phase grid-following battery energy storage and solar PV inverters with key IEEE 1547-2018 functions.	2023 & 2022
3002026631 30020226203/GitHub 3002028324/GitHub	Open-Source DER (OpenDER) Model: Specifications: Version 2.1 Software Release: Version 2.0 Model Interface to OpenDSS	Objective of this research is to harmonize accurate interpretations of the IEEE Std 1547-2018 DER interconnection standard among stakeholders, including utilities, distribution analysis tool developers, and original equipment manufacturers (OEMs.	2023
3002024404 3002026632 3002026899	DER Model Verification Framework: 2nd Edition Verification of Cyme Verification of Synergi	These reports provide a verification framework to evaluate accuracy of smart inverter models in distribution analysis tools and evaluation of DER models in CYME 9.3.1 and Synergi 6.21.0 versions.	2022 & 2023
3002021716	Stability Analysis and Volt-Watt and Volt-Var Control Setting Guidelines for DERs	This white paper provides guideline for volt-var and volt-watt control settings to avoid potential voltage instability concerns. The application of the setting guideline is demonstrated on a real feeder with multiple PV plants and its effectiveness is verified via time domain simulations.	2021
3002019423	Impact of Interconnection Transformer Configuration on DER Operation	In this tech update, four types of transformer winding configurations are evaluated for the following DER interconnection concerns: • Ground fault overvoltage (GFOV)	2020

		• Open phase overvoltage/ ferroresonance when inverters cease to energize/trip • Open phase detection by inverters	

Related Research

This project set is coordinated with and complements the work undertaken in Energy Storage and Distributed Generation (P94), Information and Communication Technology (P161), Bulk Power System Integration of Variable Generation (P173), and Distribution Operations and Planning (P200).

PS174C: DERMS and Microgrid Integration

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Objective

The scope of the DERMS project set includes the central DERMS, the communication system and other grid edge components including DER gateways, microgrids and DER aggregation/VPP platforms. This project set is focused on supporting strategy, architecture, procurement, integration and operation of all the elements in a utility's end-to-end DER management system. It provides up-to-date information that informs of technology capabilities, breakthroughs and lessons-learned from DER management projects worldwide. In addition, the project set provides tools and test procedures to carry out independent evaluations of DERMS. It also conducts research addressing microgrid implementation challenges, including identifying various system design approaches, evaluating operational control schemes, determining technical requirements, and supporting request-for-proposals.

In addition, the project set develops strategic DSO roadmaps for utilities. It also helps develop the processes, and tools; identify enhancements and develop actionable plans with language that can be used to solicit proposals during DSO transition.

Approach

This project set performs industry engagement and leadership in the area of DERMS. It performs hands-on evaluations of DERMS products in laboratory and field environments. Activities include:

- Developing consensus technical specifications to support utility requirements documents and request-for-proposals for DERMS, DER Gateways, Microgrid Controllers and VPP Platforms
- Developing technical requirements to build utility communication networks (e.g., AMI, SCADA) and cyber security frameworks to manage DER.
- Conducting vendor surveys to track market readiness of DERMS technologies, and communication protocols.
- Creating roadmaps to help utilities transition to DSOs by identifying DSO capabilities, processes, tools, and data required to enable DER to provide services.
- Evaluate gaps to address alignment with FERC Order 2222 objectives or utility specific goals.
- Facilitating DERMS and TSO/DSO coordination working groups on emerging topics of DER management
- Participating and technical contributions to IEEE, IEC, and other relevant standards for DER management

- Facilitating interest groups for peer exchange of experiences and challenges on DERMS and VPP deployment
- Developing state-of-the-art test beds to perform hands-on evaluation of commercial DERMS.
- Leading tutorials on DERMS fundamentals and TSO/DSO coordination methods to directly answer members' questions on DER management.

Research Value

The proposed DERMS and Microgrid Integration research is expected to produce the following value:

- Save cost and time in planning and producing RFPs for DERMS, DER Gateways, Microgrid Controllers and DER Aggregation Platforms
- Establish and communicate utility's vison for a DSO and the pathway toward enabling DER to provide services to the grid.
- Accelerate product availability through industry collaboration and cohesive utility requirements.
- Simplify the process of DERMS integration through improved design plans and requirements.
- Avoiding vendor lock-in through open architecture and standards-based requirements
- Improved business decisions through up-to-date awareness of the DER management market and products
- Understanding technology readiness of DER management technologies through evaluation and immediate access to test results
- Access to test plans, tools and reference design of the testing platform to support product evaluations.
- Inform industry of best practices for microgrid design and operations
- Streamline the integration of microgrids with utility operations.
- Inform industry of better methods to analyze microgrids for resiliency improvements.

Anticipated Deliverables

Deliverable	Value	Date
How to choose a DERMS? (Tech Brief): Provides guidance on what to ask and look for when procuring and implementing your DERMS. Not all DERMS are created equal, nor are the all the best fit for your use cases. Also, every utility starting point will be different. Prime selection criteria include: use cases, utility starting point, state of other utility systems, DER under management, control programmability, scalability etc.	Recommended approach for DERMS implementation and procurement that reduces utility cost and time	December 2025
Deep Packet Inspection (DPI) for DER Operational Situational Awareness (Tech Update): For DERs connected to central utility systems, DPI algorithms can monitor the data traffic passing at the grid-edge through the DER gateways between DER and the utility control systems and validate the contents of the data packets to prevent any improper DER operation from jeopardizing the larger utility grid reliability – Proposed joint deliverable with P183.	Solutions for secure, operational situational awareness at the grid-edge in a connected DER world.	December 2025
DERMS Operator Desk (Tech Update): Develop the DERMS user interface/dashboard for operators in the control room to monitor and manage DER operations on the electric grid. The project will also provide documentation of sample user interfaces for different	De-mystify the role and functions of a DERMS user and operator. Guide DERMS deployment through industry vetted approach.	December 2025

DERMS applications, sample data to be presented to operators, historian, faceplates, definition of DERMS users (DERMS Engineers, Operators, Observers etc.,) and their access levels etc.		
TSO-DSO Coordination WG (Tech Update): Develop a menu of well-defined technical functions to address needs for ISO/DSO coordination for FERC O2222 and bulk system integration of DER. Inform functional requirements of utility back-office systems e.g., DMS, EMS, CIS, DERMS, SCADA to address such requirements	Understand the requirements of various stakeholders in the industry, and capture the current and evolving trends in facilitating them	December 2025
DERMS Operating Modes for Virtual Power Plants (Tech Update): Develop different DERMS control modes for operating VPPs. Provide a baseline set of functional requirements for DERMS products for VPPs and its specification that enables consistency in DERMS RFPs across the industry.	Clear understanding of the functions of DERMS when applied for VPPs. Saves cost and time for utilities working on DERMS RFPs.	December 2025
Role of DER Gateways in Integrating DER with Utility Operations: (Tech Update) Demonstrate the role of DER gateways in performing grid edge, utility specific functions when integrating customer's DER with the utility's DER management system. The project will also cover real-world case-studies of gateway deployments from utilities.	Provide in depth understanding on the role of DER gateways and strategies to integrate DER with utility operations using commercial gateways	December 2025
Integrating DERMS with Utility Enterprise Applications (Tech Update): To fully orchestrate and leverage the benefits of DER, DERMS must integrate and use the information in other utility enterprise applications. The project will identify the need for DERMS to use data from other enterprise solutions like ADMS, MDMS, and CIS. Document the information exchange between DERMS and these other enterprise platforms.	Help the industry address data integration challenges for DERMS with utility enterprise applications.	December 2025
Communication and Interoperability Requirements for Microgrids (Tech Update): Implementing microgrid controls requires communication integration and device interoperability that extends beyond the requirements covered in IEEE 1547-2018. This technical report recommends communication architectures and interface interoperability requirements for microgrid operations. – Proposed joint deliverable with P161.	Understand the key microgrid island control functions that are not covered by existing standards. Quickly identify interoperability requirements needed to support microgrid implementation on utility systems.	December 2025
DSO Models - Roles, Functions and Capabilities (Tech Update): This work will document key models of future DSOs enabling market access and economic value for DER while maintaining reliability of the system. Detailed functions of each DSO model for enabling DER to deliver grid services will be developed. Benchmark metrics to quantify the pros and cons of one model vs the other will be established as well.	Enable utilities determine their appropriate DSO model. Provide a roadmap for distribution utilities on their transition to DSO with detailed insights on the technical capabilities to implement, workforce to develop and the organizational process changes to be made	December 2025

Situational Awareness of DER in DERMS - Utility Case Study (White aper): The project will provide an overview of approaches taken by utilities to improve situational awareness of DER in DERMS. This project will survey commercial DERMS analytical capabilities to provide the level of DER visibility required for modern grid operations. Focus will be on use cases like demand masking by solar, direct DER monitoring and forecasting.	Provides a library of reference material on different utility practices for situational awareness	December 2025
Smart Inverter Configuration Validation Function in OpenDERMS (Tech Brief and Software): Develop a proof-of-concept DERMS tool to validate smart inverter configuration settings. The objective is to specify requirements of utility DERMS that should include this capability to remotely verify DER settings throughout their lifecycle after being commissioned.	Enable a cohesive way to manage DER settings across different utility sites	December 2025
How Accurate should DERMS Network Models be in Predicting Distribution Constraints? (Tech Update): In a world of flexible DER management, DERMS will calculate system needs and convert them into DER dispatch settings for reliable and safe grid operations. However, DERMS may not have the most accurate data and models to perform such calculations. The project will explore the accuracy in network model, DER monitored and forecasted data that are essential to calculate dynamic operating envelopes for DERMS - Proposed joint deliverable with P174A.	Key insights to decide on DERMS data needs that determines telemetry, monitoring and data requirements for operations	December 2025

Past EPRI Research on Topic

Product ID	Title	Description	Published Date
3002022194	Implementing DERMS to Manage Grid Constraints (White Paper)	This paper summarizes the capability of DERMS to enable integrating higher DER capacities to the grid. It also provides an overview of current DERMS implementation options, their pros and cons, and the industry gaps that should be addressed to enable DERMS.	2021
3002025451	DERMS Adoption Pathways	This paper recognizes the need for gradual processes and lays-out a number of DERMS adoption pathways that may be considered. In addition, it recognizes that the starting point and time will differ for each utility based on their situation, including DER adoption rates, regulatory policy, and distribution system capabilities.	2022
3002018673	Applications of the Local DER Gateway	This white paper presents a range of potential uses of gateways that utilities deploy at DER sites as part of integration	2021

		systems. These gateways are ubiquitous, typically needed to connect DER to utility networks and to provide the monitoring and control that is required for interconnection.	
3002023361	Analyzing Telecommunication Systems for DER Integration	A technical approach to determine the capability of utility communication networks for managing DER was developed to help them better understand its current capabilities and limits.	2022
3002021860	Market Landscape of Commercial Utility DERMS: Utility DERMS Market Leaders Functionalities and Experience	This deliverable provides insight into a better understanding of DERMS technology offerings, its functionalities, field experience, and development roadmaps of several leading distribution utility DERMS products.	2021
3002025643	TSO-DSO Coordination Frameworks for DER Services	This report outlines various frameworks for coordination between a DSO, TSO and DER aggregator and discusses the roles and responsibilities of each involved entity and the implementation plan for enabling DER participation in electricity markets, without breaching operational limits, disturbing wholesale market operations, or reducing service quality for customers.	2023
3002025208	Laboratory Test Results of a Networked Microgrid Controller	This report details the controller- and power-hardware-in-the-loop test environments, executed test plans, and the testing results and performance analysis of networked microgrids that are physically interconnected microgrid areas with controller interoperability enabling multi-island synchronization and coordinated power sharing.	2022
3002021842	Understanding Community Microgrids	A technical primer for understanding community microgrids. It provides a foundation for understanding the components, configurations, design, and operational considerations for community microgrids.	2021
3002016527	DER Attributes and Representation in Systems of Record	This document identifies the attributes of DER that utilities may consider capturing and tracking. For each attribute, the use case, or reason why, is identified.	2019

Related Research

This project set is coordinated with and complements the work undertaken in Bulk Power System Integration of Variable Generation (P173) and Distribution Operations and Planning (P200).

PS174D – Practices, Programs, and Economics

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Objective

The aim of this project set is to improve the operational efficiency by which utilities manage DER on distribution to optimize DER value and inform related utility strategic planning rationales. Activities seek to, for example, streamline utility interconnection practices and procedures in ways that reduce costs while maintaining grid safety and reliability; provide guidance regarding the economic implications of scenario-based DER integration approaches – including those specific to non-wires alternative projects (which often hinge on time and locational value factors), resilience, and grid management approaches involving a DERMS; and qualify utility DER business models, programs, and procedures, including strategies for enabling flexible DER grid services under different rate structures and interconnection terms.

Approach

The Practices, Programs, and Economics project set for 2025 includes the following core areas of focus and associated tasks:

- **Operational and Interconnection Practices.** Identifying, assessing, and documenting leading operational practices and approaches for planning, grid integrating, and managing DERs. Focus areas include interconnection and commissioning, protection, communication, and deployment of advanced inverter functions. These practices are gathered through utility surveys, interview, and secondary research.
- **Program Design Strategies and Business Models.** Tracking and evaluating utility DER business model concepts and real-world program implementations that facilitate utility participation in the DER marketplace and the provision of DER grid services. Task activities are pursued through primary and secondary research.
- **Economic Analysis.** Conducting cost-benefit analyses of a range of DER technologies and use cases to assess their value under different grid contexts. Economic evaluation is applied through tools and methods to discern, for example, the time and locational value of DER, the merits of NWA projects, the value of advanced inverter functions, and the economic justification for leveraging DER for resilience.
- **Regulatory and Policy Issues.** Providing objective education and guidance on a range of DER regulatory frameworks and reform activities to help inform public debate. Covered topics – such as the influence of utility economics on utility DER decision making, cost allocation approaches, DER pricing mechanisms/tariffs, and potential conflicts between DER policy goals and grid reliability objectives – are based on member priority and explored via primary and secondary research.

Research Value

Proposed research is expected to produce the following value for participants:

- Objective, case study-driven and economic analyses to inform DER integration strategies.
- Methodologies for building internal cost-benefit analyses that incorporate context-specific factors (including the use of advanced inverter functions, DERMS; the value stacking of grid services).
- Access to tools for 1) screening NWA opportunities based on the time and locational value of DER, evaluating DG-based resilience value, 3) determining the economic justification of investing in a DERMS.

- Guidance for improving the efficiency, cost, and cross-departmental coordination of DER-related utility interconnection and operational processes, including those relevant to active power management, DER scheduling, and EV integration.
- Fluency in DER standards, gaps, and ongoing activities that intend to further evolve the use and management of DER on the distribution system.
- Understanding of the multiple elements relevant to successful DER program design, implementation, and management—including those relevant to the provisioning of DER grid services.
- Peer learning specific to NWA program structures, cost-benefit assessment, operation and performance analysis, siting considerations, and reliability/resiliency experiences.
- A platform for educating utility staff and upper management, regulators, and policymakers about business case analysis as it relates to DER integration.

Anticipated Deliverables

Deliverable	Value	Date
DER Interconnection Process Guidebook, 2nd Ed. (Tech Update/Wiki): Expand reference guide on utility DER interconnection process fundamentals and considerations. Topics: app. intake/portals, screening/technical review (for IBRs, w/active power control), automation, TIRs, commissioning, infrastructure, alignment w/standards.	• One-stop destination for DER interconnection procedural best practices.	December 2025
Assessing California's Limited Generation Profiles (LGPs) (Tech Update): Examine CA's LGP arrangement; develop use cases and simulate scenarios to demonstrate implementation and assess benefits/challenges. Provide guidance to utilities on implications of similar policies. Document other flexible interconnection approaches. Proposed joint deliverable with P174A.	• Evaluation of different flexible interconnection options for improving feeder hosting capacity/grid utilization.	December 2025
DER Technical Screening Web Tool (Software): Develop user-driven online app that demonstrates scenario-based DER evaluation via interconnection screening.	• Visualized results to inform discussions on interconnection impacts and best practice review approaches.	December 2025
Interconnection Documents Repository (Database): Update/add to searchable database of interconnection materials (utility requirements, interconnection applications/agreements, state rules, etc.).	• One-stop destination for locating, comparing/ contrasting utility DER interconnection forms, rules, and practices.	December 2025
DER Interconnection Best Practices (Tutorial): Facilitate interactive course examining DER interconnection challenges, and corresponding best practices. Topics: streamlined review and technical analysis, protection practices, adoption of 1547-2018, etc.	• Training and materials for efficient/cost effective handling of DER interconnection challenges.	December 2025
Utility/DSO DER Grid Services Strategies that Support Economic Efficiency and Grid Resilience (White Papers): Detail utility technical/business strategies for enabling DER-provided grid services. Topics: trustworthiness scoring of 3rd	• Guidance on how to develop utility programs and practices that leverage DERs for grid services.	December 2025

party DER grid service providers, utility approaches for incentivizing load growth in high pen PV areas to mitigate reverse power flows.		
Non-Wires Alternatives Workshop: Showcasing Real World Project Results (Workshop): Conduct 3rd annual virtual workshop focused on real-world utility experiences planning, implementing, and operating NWA programs. Emphasis: outcomes and results. Proposed joint deliverable with P200B/P94.	• Lesson learned, collaboration w/peers engaged in developing and operating NWA programs.	December 2025
Mechanisms for Financing Non-Wires Alternatives (NWAs) (White Paper): Document novel industry approaches for financing DER-based NWA projects, including effects on benefit-cost analysis, project economics, ratepayer impacts. Case studies: avoided revenue requirement-split between utilities/BESS owners, others.	• Awareness of financing tactics that can inform efforts to quantify the value proposition of NWAs.	December 2025
Expanding Make-Ready Programs to Facilitate NWAs and Other DER Service-based Alternatives (White Paper): Evaluate "make-ready" program approaches that can/are being used to pre-develop sites (i.e., offset upfront costs) and attract 3rd-party DER-based NWAs. Considerations: cost allocation, features that reduce interconnection cost uncertainty, others.	• Strategies for directing DER-based NWA projects to identified feeder locations for grid benefit.	December 2025
Exploring the Benefit of Siting DER on Feeders with High Line Losses (White Paper): Examine the potentially meaningful benefit provided by DER to reduce high line losses during peak loading scenarios. For different load distributions, identify worst-case line losses to average losses on distribution feeders to determine range in DER benefit.	• Identification of the peak shaving benefit (variable by feeder) of using a BESS to mitigate peak loading.	December 2025
A Framework for Valuing DG-based Grid Resilience (Tech Update/Wiki): Evolve/integrate framework for estimating the cost of preventive behavior into a model-based DG resilience quantification approach; establish resilience values for different built environments tied to emerging grid/community resilience metrics.	• Refined resilience valuation method that can be applied to utility cost-benefit analyses of prospective community-scale resilience measures.	December 2025
Evaluating the Costs and Benefits of Medium/Heavy Duty EV Charging for a Utility Electrification Program (Tech Update): Assess the grid impacts, costs/benefits of a hypothetical utility program that supports EV charging, associated charging infrastructure, and proactive utility investments in electric grid upgrades to support charging requirements.	• Key insights, based on scenario-driven benefit-cost analyses, for informing EV electrification program design.	December 2025
DERMS Cost-Benefit Analysis Tool, Version 2.0 (Tech Update): Evolve CBA framework and web-based tool for assessing the value of investing in a DERMS to orchestrate a range of DER applications; demonstrate and document the tool's scenario-driven usage. Proposed joint deliverable with P174C.	• Enhanced method/tool for determining the real economic value of DERMS for individual/collective use cases.	December 2025

Past EPRI Research on Topic

Product ID	Title	Description	Published Date
3002028288	DER Interconnection Standards & Certifications in North America: Overview & Status Update	Provides a primer on the standards and certifications relevant to DER interconnection to help inform utility thinking on DER interconnection compliance pathways and considerations.	2023
3002030316	Utility Strategies and Lessons Learned from NWA Projects: 2024 Workshop Proceedings	Contains materials and key takeaways from the 2024 NWA workshop that are intended to support peer learning on utility NWA efforts.	2024
3002027409	Adapting Interconnection Review Processes for Scheduled Energy Storage Systems	Explores the necessary ingredients, emerging approaches, and future steps for operationalizing the study of DER on a fixed schedule in the utility interconnection review process.	2023
3002027231	Distribution Services Provided by DER: 2023 EPRI Research Guide	Provides an entry point into several years of EPRI research on the holistic integration of service-based DER solutions into standard utility practices.	2023
3002027903	A Framework for Evaluating the Benefits of Applications Enabled by Utility DERMS	Defines 14 DERMS-enabled applications that correspond to planning or operational processes enabled by DERMS that have a clear business purpose for the distribution utility.	2023
3002025714	Structuring the Economic Assessment of Utility Investments in End-to-End DERMS: Principles and Methods	Introduces fundamental planning principles and methods guiding investments in end-to-end utility DERMS, including DERMS software platforms. Compares pricing structures of commercially available DERMS software products across nine technology vendors.	2022
3002027407	Value of Resilience Research Roadmap	Outlines the near- and longer-term strategic R&D needs and associated learnings that can enhance industry efforts to assess and justify resilience investments.	2023
3002022432	A Framework for Calculating the Resilience Value of DER-based Solutions for Defined Built Environments	Describes an extensible approach for assessing the resilience value provided by DER in the context of extended power outages lasting days or weeks.	2023

Related Research

The research in this project set is closely coordinated with and designed to complement the work undertaken in the following EPRI programs: Energy Storage and Distributed Generation (P94), Understanding Electric Utility Customers (P182), Bulk Power System Integration of Variable Generation (P173), and Distribution Operations and Planning (P200).

PS174E – Technology Transfer and Industry Engagement

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Objective

The aim is to deliver practical knowledge and enable sharing of experience, practices, and solutions related to DER. Utility managers and staff can immediately use the knowledge provided to improve distribution system design, screening, troubleshooting, and safety practices relative to DG. DER application experience is provided by webinars, tech briefs, interest groups, DER Forum, DER Engineering Guide, and web-based materials in the program Members Center. These allow for easy access to program knowledge, discussions, and staff. Typical questions that this program answers are:

- What are the current trends in DER technologies and deployments?
- Are there DER integration-related problems where solutions to be shared or enhanced?
- What standards and practices need to be considered with increasing penetration?
- What's needed for DER built-in protection and control responses to be sufficient and coordinated?
- What lessons-learned and new practices can be shared and applied?

Approach

Technical transfer is designed to facilitate information exchange and problem solving among members via the DER Forum, webcasts, email communications, advisor meetings and project reviews on topics of current interest. Its scope is to consolidate useful knowledge, highlights of best practices, and lessons learned into software and engineering resources that are readily available and regularly updated. Examples of technology transfer resources and tools include:

- A web-based DER and Energy Storage member's forum, periodic summaries of issues and covering interesting exchanges and key learnings (joint activity with P94, Energy Storage and Distributed Generation Program).
- Regular webcasts on DER topics of interest and periodic member visits
- Program advisory meetings, periodic workshops/symposiums, with mid and end of year program updates via webcast to address progress on deliverables.
- Technical briefs and/or white papers to assist members on specific integration technical issues or in communicating grid considerations to utility customers, regulatory bodies, and DER developers.
- DER Field Experience Interest Group discussions including lessons-learned, findings and identification of current practices (via surveys/polling) and issues requiring further investigations.

Research Value

Members gain access to DER integration and distribution engineering experts to address specific challenges in a timely manner and stay informed on key technical developments. The project includes the following:

- Answers to questions about new technologies and grid integration approaches.
- Engagement in key standards activities.
- Access to learning across Integrated-Grid projects.

- Knowledge sharing among members.
- Problem solving via research collaborations and working with individual members.

Anticipated Deliverables

Deliverable	Description (one sentence)	Date
Program WebExs providing updates on current topics	Current issues and research summaries are provided along with EPRI feedback and perspectives from industry events. Updates, Review of relevant topics, standard developments, new technology or learnings and industry events (via WebExs or workshops).	Held as needed in addition to project set Webex, high interest topics varies, ~ monthly
DER Field Experience Interest Group	Sharing of DER field experience includes surveys and polling of utility practices (joint with energy storage, P1).	Held monthly
Engineering Guide for Storage and Distributed Generation	Updated overview on interconnection issues and integration practices, includes planning, tools, and DER technologies (joint project with P94, on-line via member's center).	December 2025
DER Integration Resource Center	One-stop destination for all program information as well as handy tools and sample utility and jurisdictional documents in following repositories; Results Finder, Connection, DERMS RFPs, Solar Data, Analytics, Screening Processes and DER Forum links/search.	Maintained and updated with materials approximately semi annually
Distributed Energy Resources and Energy Storage on-line DER Forum.	Conversations addressing technical topics of interest with questions and answers as well as opportunity to add on points or further inquiries, available at derforum.epri.com (Proposed joint deliverable with P94).	Maintained daily, available 24 hours with and archiving all prior discussions

Past EPRI Research on Topic

Product ID	Title	Description	Published Date
3002028406	Utility DTT Practices Survey	DER Deployment and Island Prevention Survey includes 80 utilities input on practices, Behind the Meter (BTM) and Front the Meter (FTM)	2024
3002028373	DER Active Power Management	Provides an update on options for active power management including curtailment and DERMS	2024
3002027231	DER Interconnection Research Guide	Distribution Services Provided by Distributed Energy Resources (DER) 2023 EPRI Research Guide	2023
3002023483	DER and Energy Storage Engineering Guide	A comprehensive guide, 5th edition, intended for utility engineers facing increasing levels of distributed generation and storage, with higher expectations for grid support, more settings and control options. Includes links to DER Forum.	2022
3002024662	2022 Summary of Integration Field Experience and Standards	This document summarizes and highlights the distributed energy resource (DER) field experience interest group discussions in 2022. Topics and objectives are presented from the regularly held webcasts covering a variety of DER interconnection experiences.	2022
3002020344	Grid Considerations for Microgrids	Covers grid considerations for microgrid interconnection and protection. It includes reference to, and gaps in, standards.	2021
3002020130	Grounding Practices	Report addresses effective grounding, basic principles, ground sources, and the role of DER transformer connections, load types and tripping response of inverters. DER capabilities such as negative sequence compensation are covered.	2020
DER Forum in Resource Center	DER and Energy Storage Forum	This resource provides results from questions on DER grid integration, energy storage, issues, trends, and state of technology.	Current
DER Resource Center	DER Resource Center	10 libraries of DER integration program content. Includes Results Finder, Forum, Data samples, Program Calendar, Dashboards as well as utility interconnection practices and suggestion box.	Current

Related Research

This project set is coordinated with and complements the work undertaken in Energy Storage (P94) Bulk Power System Integration of Variable Generation (P173) and Distribution Operations and Planning (P200).