EPRI

2024 ANNUAL REVIEW

Distributed Energy Resources Integration

PROGRAM 174

Meet P174

This program addresses the challenges faced by utilities with the integration of distributed solar, battery storage, electric vehicles, and other distributed energy resources (DER). The research tackles technical issues such as: 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.

Program Value

Knowledge acquired through these activities support members to:

- Analyze DER integration issues and make decisions for various types of DER.
- Manage interconnection queues and identify effective screening methods.
- Predict, identify and address grid issues caused by rising DER levels.
- Design and update power system to meet integration goals for DER and manageable load.
- Determine requirements and make use of evolving standards for DER interconnection.
- Train staff on integration technology (smart inverters, grid edge devices, control systems etc.).
- Develop strategies for managing and integrating customer-sited DER.

For additional information, please see der.epri.com.

How it Works

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. It provides practical tools and guides that can be utilized in day-to-day processes. Relevant to research learnings the work has supported a dozen active interest, working, and users groups during 2024. Typical active engagement of members is in the hundreds of man hours. Projects and participation in standards development aim to provide industry leadership and insights that prepare utilities for upcoming changes, both technical and economic.

Research Areas

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

Featured Statistics

60+ Utility members

50:1 Funding leverage

12 Active working and interest groups

80 DER integration-related deliverables

110 Webcasts

225 Participating utility staff

1,650 Available DER integration documents

~12,500 Member engagement hours

DER Grid Impact Analysis

About 174A

Equips engineers with tools to integrate various DERs like PV, energy storage, and EV charging across different levels. Using tools for steady state, dynamic, and EMT analyses, this area focuses on DER modeling and simulation to understand impacts under various grid conditions. It also supports finding optimal autonomous functions and cost-effective DER management techniques for better integration.

Contact: Wei Ren, wren@epri.com

Member Value

- Obtain analysis methods to refine review and studies, with potential automation to keep pace with technology evolution and industry insights
- Save time and cost in determining and configuring DER settings and functions.
- Increase hosting capacity, grid utilization, and economic efficiency
- Access advanced planning methods to evaluate bulk and distribution services effectively
- Make more informed decisions to streamline and improve interconnection processes
- Understand dynamic control interactions associated with autonomous DER operation
- Benefit from state-of-the-art developments and lessons learned from other utilities
- Identify key challenges associated with higher penetration levels of DER

Key Activities

Engineering guidelines

Improved engineering efficiency through the development of engineering guidelines.

Analysis tools

Tools and automation to help engineers conduct DER-related studies more conveniently, efficiently, and accurately.

Modeling approaches

Methods and models to represent DER and distribution system characteristics in the steady state, dynamic, and transient time ranges.

DER settings

Guidance and tools to properly configure DER settings to meet overall utility objectives.

DER protection

Guidance on distribution system and DER site protection practices.

Microgrid analysis

Models, tools, and approaches to facilitate analytical studies of microgrid applications.

Analysis tutorials

Online and in-person tutorials on grid impact analysis topics to enhance member understanding.

> *I'm proud that the Duke-EPRI project team developed and demonstrated something new that is bringing positive impact to the industry.*
>
> — Kevin Chen, Renewable Engineering Manager, Duke Energy

Smart Inverter and Grid Support Technologies

About 174B

Provides insights into smart inverters, power plant controllers, power control systems, meter socket adapters, voltage regulation technologies, and industry standards for cost-effective and reliable grid interconnection of PV, energy storage, and V2G DERs. Research focuses on three areas: Technology Evaluation, Model Development and Verification, and Advancing Technology Utilization. The approach includes hands-on lab and field evaluations, DER model development and validation, analysis of new technologies, workforce training, and workshops for knowledge sharing.

Contact: Aminul Huque, mhuque@epri.com

Member Value

- Improved understanding and use of of inverter control, protection, and tgrid support capabilities
- Objective, vendor-neutral assessment of newly released inverter technologies
- IEEE standard- ready inverter model specifications and models validated through lab and field testing
- White-box validated EMT inverter models of DER
- Recommendations for DER grounding, screening, and commissioning practices
- Verification framework for steady-state and EMT black-box inverter models in commercial software
- Grid-forming inverter use cases and performance requirements for microgrid applications and inverter-based resource (IBR) dominated power systems

Key Activities

Grid forming inverters

Grid-forming inverter use cases and performance requirements for microgrid applications and inverter-based resource (IBR) dominated power systems.

Modeling

White-box validated EMT domain inverter models and IEEE 1547-2018 ready inverter model models.

Technology testing

Objective, vendor-neutral testing of inverters, plant controllers, power control systems, meter socket adapters and grid-edge support technologies.

DER commissioning

Recommendations for DER grounding, screening, and commissioning practices.

Workshops and tutorials

Annual utility-only smart inverter workshops and online/in-person tutorials covering everything from inverter fundamentals to standards, modeling, and EMT analysis

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> *The EPRI tutorial on Inverter Fundamentals and Grid Support Functions provided a wealth of knowledge and valuable discussions. EPRI's industry expertise and authority on inverter technology play a critical role in the growth of solar energy. As ComEd continues to integrate more DERs into the grid, we look forward to further collaboration and learning opportunities with EPRI.*
>
> — Lili Tao, ComEd

DERMS and Microgrid Integration

About 174C

Explores Distributed Energy Resource Management System (DERMS) use cases, control architectures, performance, interfaces, and integration with distribution and bulk systems with the overall goal to align DERMS functionality, speed up product availability, and improve interoperability. The scope includes central DERMS, communication systems, and grid edge components like DER gateways, microgrids, and aggregation platforms, relevant to emerging Distribution System Operator (DSO) models. Both lab and field evaluations assess new products, capabilities, and architectures for DER management.

Contact: Jackie Baum, jbaum@epri.com

Member Value

- Less cost and time in planning and producing RFPs for DERMS, DER Gateways, Microgrid Controllers and other DER Aggregation Platforms
- Support of business decisions with clear DER management use cases and understanding of market offerings
- Access to industry collaboration in planning and establishing requirements for DER management
- Access to test plans, tools and reference implementations that support product and strategy evaluations
- Leadership toward open architectures and standards-based requirements
- Results that support best practices for microgrid control implementation and operations
- Inform methods to leverage microgrids for resiliency improvements

Key Activities

DERMS requirements

Performance and reference requirements for implementing DER management systems.

Control strategies

Architectures for DER management including microgrids and grid edge controllers.

Laboratory verification

Tools and testing metrics for assessment of DER management products and strategies.

System deployment

Market trends and strategies for comprehensive integration and management of DER.

DERMS value

Use cases and benefits assessment of DER management.

DER gateways

Systems and protocols for secure data exchange between DERs and control centers.

DSO models

Development and evaluation of DSO architectures enabling T&D grid services.

> *EPRI's work on grid-forming inverter performance requirements and microgrid design analysis helped PG&E to develop its Community Microgrid Technical Best Practices Guide which aims to improve the efficiency of future microgrid project deployments in our service territory.*
>
> — Alex Portilla, Pacific Gas & Electric Company

Integration Practices, Programs, and Economics

About 174D

Offers utilities practical insights to enhance operational efficiency in managing DERs by focusing on technical, administrative, and strategic practices that can optimize DER value and inform related utility strategic planning rationales. Activities include streamlining interconnection procedures to reduce costs while ensuring grid safety, providing economic guidance on DER integration scenarios, and evaluating utility DER business models and programs for flexible grid services under various rate structures and interconnection terms.

Contact: Nadav Enbar, nenbar@epri.com

Member Value

- Guidance on enhancing DER interconnection programs that comply with evolving standards, scheduling arrangements, and other grid changes
- Methodologies for building internal cost-benefit analyses that incorporate context-specific factors
- Access to tools for screening NWA projects, determining resilience value, and weighing investments in a DERMS
- Fluency in DER standards, gaps, and ongoing activities that further evolve the use and management of DER on the distribution system
- Understanding of the multiple elements relevant to successful DER (including EV) program design, implementation, and management
- Awareness of challenges and approaches to developing successor net energy metering tariffs
- Educating staff and upper management, regulators, and policymakers about business case analysis as it relates to DER integration

Key Activities

Interconnection processes

Identification and assessment of leading utility DER interconnection and grid management practices.

DER grid services

Guidance on utility DER model approaches and program structures that facilitate utility participation in the DER marketplace and the provision of DER grid services.

Resilience valuation

Frameworks and tools for determining the time and locational value of DER and informing resilience investment strategies.

Cost-benefit analysis tools

Tools and methods for evaluating the economics of DER technologies, management schemes, and use cases under a range of grid and project contexts.

Non-wires alternatives (NWA) approaches

Tracking and evaluation of utility technical, operational, and financial strategies governing non-wires alternative projects.

Regulatory and policy issues

Education and direction about DER regulatory frameworks, standards/certifications compliance, and policy implications.

EPRI has provided valuable expertise and technical support to overhaul JEA's technical interconnection requirements. The revised document will improve our readiness to effectively integrate DER.

— Matt Lundeen, Strategy Manager, JEA

Tech Transfer and Industry Engagement

About 174E

The goal is to provide practical knowledge and share experiences, practices, and solutions. Resources are easy to find and use, helping utility managers and staff with distribution design, screening, troubleshooting, and safety practices for DER. Application experience is offered through webinars, tech briefs, interest groups, a DER Forum, and an Engineering Guide, all available in the DER Resource Center.

Member Value

Members gain access to DER integration and distribution engineering experience, resources and expertise. This includes collaborations and answers related to specific challenges, grid integration approaches, standards activities, new technology and learning opportunities.

Key Activities

DER Members Forum

Supports experience sharing, questions and conversation exchange.

DER interest, working and user groups

Includes public and members only sessions DER topics.

DER Resource Center

Dedicated website enables access to all of the resources currently available and from prior years. The finder, forum, calendar, and profile are searchable and up to date.

Standards

Leads and participates in standards development activities such as IEEE 1547.

Interest and Working Groups

About

The program is currently supporting 12 diverse groups to address both our members and public interest, user and working group needs related to DER Integration. Results and learnings compliment base research, support knowledge transfer as well as EPRI's public mission. Below is the list of integrations for these DER groups:

COFFEE
Common File Format Users Group[P]

DERMUG
DER Modeling Users Group[P]

DiGFIG
Distribution Grid Forming Inverters Interest Group[MO]

DSWG
Distribution Services Working Group[P]

ESFTWG
Energy Storage Functions Taxonomy Working Group[P]

FEIG
DER Field Experience Interest Group[UO]

DPIWG
DER Protection Issues Working Group[UO]

EMER
EMT DER Modeling and Analysis Industry Interest Group[P]

SISIG
Smart Inverter Settings Interest Group[UO]

VDWG
Value of DERMS Working Group[MO]

VRWG
Value of Resilience Working Group[P]

TSO/DSO
TSO-DSO Coordination Working Group[P]

> *The EPRI facilitated Field Experience Interest Group provides a valuable forum for discussion of current topics. Our company has benefited from participating.*
>
> — James Tobia, First Energy

P = Public MO = Members only UO = Utilities only

Software and Tools

Philosophy

The software tools are designed to be easy to use, customizable to specific utility standards, and specific to DER issues that are not easily addressed through commercial tool offerings. The tools are intended to fill a short-term gap in capability until incorporated into commercial software tools regularly used by utility DER Integration staff. Upon completion of a new tool, the DER Integration team conducts an Accelerating Commercial Engagement (ACE) meeting to share the tool and underlying engineering basis with interested commercial software vendors. This is an efficient approach to helping the overall industry drive towards safely, economically, and reliably integrating DER.

Tools

- **Inverter-based Supplemental Grounding Tool (ISGT)** — Supports analysis of ground-fault overvoltage risk and design of mitigation.
- **Distribution Secondary Analysis Toolkit (DSAT)** — Analyzes secondary power flow of DER and load including transformer impacts.
- **VOLTage Fluctuation Evaluation and Simulation Tool (VOLT-FEAST)** — Performs time-varying primary distribution feeder analysis to evaluate voltage fluctuations with DER present.
- **Open Wye-Open Delta DER Interconnections (OYOD)** — Evaluates loading and voltage imbalance when connecting DER to non-standard transformer connections.
- **DER Autonomous Function and Setting Analysis (DAFSA)** — Recommends the best universal DER settings based upon specific objectives.
- **Island Prevention Risk Assessment Tool (IPRAT)** — Assesses islanding risk for PV plants, based on distribution and plant detail.
- **DER Settings File Creator (SFC)** — Creates CSV files consisting of DER settings in the common file format.
- **DER Configuration Validation Tool (CVT)** — Reads and validates DER settings utilizing standard local communication interfaces using files in common file format.

> *The OYOD tool has provided PGE the ability to easily model the impacts of small-scale PV to customers served from a shared open-delta transformer bank, and has been utilized as an aid in the PV screening process. This tool will help ensure that reviews are performed in a more uniform, consistent manner.*
>
> — Frederick Harris, Distribution Operations Engineering Manager, Portland General Electric

Supplemental Projects

About

Supplemental Projects leverage EPRI's collaborative model to investigate high interest DER integration topic areas at an accelerated pace with greater depth.

Active Projects

- Developing technical requirements and methods to perform DER commissioning.
- Characterizing inverter dynamic response during grid events, faults, open circuits, phase shifts, and frequency changes.
- Clarifying responsibilities, business models, service definitions, and a strategy for integrating third-party aggregations.
- Evaluating the techno-economics of commercial DER gateways.
- Developing an econometric model for forecasting DER co-adoption.
- Conducting model-based analysis of DER functions and settings.
- Investigating how utilities can de-risk microgrid interconnection/integration while lowering the cost of implementation.
- Assessing utility DER interconnection practices and supporting utilities in the application of DER interconnection standards.
- Devising utility roadmaps for migrating protection practices and standards in ways that better recognize the impacts of growing DER penetration.

Member Value

- Guidance, training, and tools.
- Exposure to new processes, technologies, and hands-on learning.
- Empirical results based on lab/field testing, modeling, and simulation.
- Custom insights tailored to your system.

DER Integration Lab

EPRI's low voltage test facilities have supported DER inverter, DERMS and systems evaluation since 2009. The lab offers versatile capabilities, featuring both simulated and realistic DC and AC power sources with variable loading.

Unique capabilities

- Flexible platforms to integrate generation and controls.
- Staff experts in power systems and power electronics.
- Collaboration includes utilities, national and university labs.

Testing services and training

- Inverter based resources, energy storage, hybrid, and vehicle-to-grid.
- Open phase, unintentional islanding detection and fault response.
- Power Control Systems (PCS), DER management, edge-of-the-grid.
- Standards compliance and performance characteristics.
- Hands-on inverter lab tutorial, smart inverter workshops.

> *EPRI methodically worked with a wide range of TVA and LPC staff to develop a consensus-driven and informed portfolio of products that can be actively applied to help advance and standardize DER interconnection in the Tennessee Valley. The developed material, strategic roadmapping, and technical guidance are helping to put TVA and LPCs on the desired path of continuous improvement.*
>
> — Jason Krupp, Sr. Project Manager, TVA

SPIDER

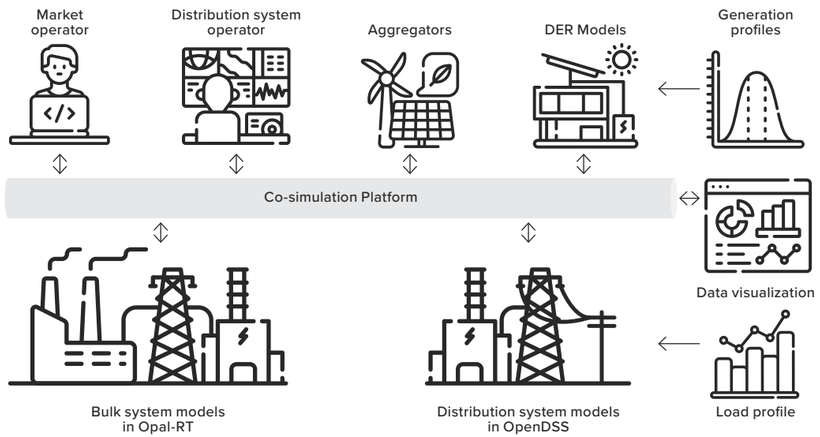
Simulation Platform for Integration of DER (SPIDER) is a unique capability that emulates an advanced distribution system from headend to edge devices.

Major components

- DERMS tools that represent utilities, aggregators, and facility-level controllers.
- DER simulators emulating PV, energy storage, HVAC, water heaters, etc.
- Protocol drivers for DNP3, SunSpec Modbus, and IEEE 2030.5 for standard-based communication.
- Distribution circuit simulators such as OpenDSS, CYME, etc.
- Grid service requesting entities such as ISOs and DSOs.

Testbed uses

- Assess functional capabilities and performances of operational systems such as DERs and DERMS.
- Run power flow analysis using actual circuit models emulating actual field conditions with DERs.
- Test DERMS use cases and new control strategies.
- Demonstrate coordination across ISO, distribution utilities, and third-party DER aggregators for DER management, ensuring the grid's reliability and safety.
- Check interoperability at key system interfaces.



2024 Deliverables

Grid Impact Analysis of DER 174A

Aggregation Model of Demand Response Studies 3002028715	Python-based model of aggregated electric water heaters (EWH) to provide demand response services
Assessment Tool for Open-Y/Open-D Interconnection Applications (OYOD) v1.6 3002029078	Tool to allow quick assessment of interconnecting phase DER to a two-lateral distribution feeder with OYOD configuration
Survey of Reported DER-Related Distribution System Impacts 3002030584	Summary of system impacts of DER from 10 formal interviews
Guidelines for the Application of DER Advanced Functions and Settings, 2024 Edition 3002031150	Updated guide includes new and enhanced methods of evaluating DER settings impacts on feeders
Microgrid Protection Reference Guide: Protecting Your First Microgrid 3002031291	Protection guidelines for integrating a first microgrid project
The Effect of Reverse Power Flows on Substation Transformers 3002030664	Guidance on the thermal impacts of reverse power flow on substation transformers
Tutorial on Grid Impacts of DER 3002030879	Shared knowledge and experience on evaluating grid impacts of DER
DER Secondary Analysis Toolkit (DSAT) v2.6 3002029077	Tool to quickly evaluate impacts of DER and load electrification in secondary circuits
Equitable Allocation of Hosting Capacity 3002029106	Framing of technical, economic, and equity considerations for siting DER in high grid penetration areas
Utility Microgrid Design and Assessment Guidebook - Third Edition 3002031069	Updated comprehensive design and assessment guide for microgrids
Grid Impact and Screening of DER[TI] 3002031044	Summary of recommendations and considerations for conducting screening analysis for DER aggregations
Adaptive Volt-Var control[TI] 3002029650	Evaluation of universal DER control setting for voltage regulation
Demystifying DER Impacts on Voltage Regulation Equipment[TI] 3002029651	Analysis and summary of DER impacts to voltage regulation devices
DER Modeling and Simulation Workshop - Sharing Leading Practices EPRI.com	Workshop covering leading practices in the modeling of DER using both commercial and research software tools
Deploying Microgrids at Scale 3002031295	Protection strategies that can be adopted to enable successful rollout and deployment of utility microgrids at scale
DER Interface Protection Guide: POI Recloser 3002031136	Application guide for a DER POI (PCC) recloser

> *The CYME-to-PSCAD conversion tool 1) allows Duke Energy to quickly convert a CYME model into PSCAD environment to support transient simulation needs of microgrid projects, 2) improves efficiency by offering automation features in model creation, transient simulation, and post processing, and 3) set foundation to expand beyond microgrid sites to third-party PV installation in grid-connected operation mode.*
>
> — Trent Miller, Lead Engineer, Duke Energy

TI = Technology Innovation

Smart Inverter and Grid Support Technologies 174B

DER Settings Database (DERSETTINGS) v3.2 3002029173	Updated DER Settings database enabling the upload, download, and validate of standardized DER settings files
Solar PV Smart Inverter Evaluation 3002031097	Lab testing results of an IEEE 1547-2018/UL 1741SB certified solar PV inverter to provide grid support capabilities
Open-Phase Detection Technology Evalution 3002030938	Performance evaluation results of open-phase detection capability of a UL 1741SB certified inverter and SEL's open-phase detection logic
Vehicle-to-Home (V2H) Backup Power Performance Evaluation: Ford F-150 Lightning 3002029045	Analysis of the performance and safety of a V2H backup system comprising of Ford F-150 Lightning EV and Sunrun Home Integration System
Inverter EMT Model in MATLAB v1.0[P] 3002030527	White-box three-phase grid-following inverter EMT model with IEEE 1547-2018 functions
DER Plant Grounding 3002030960	Summary of DER plant grounding options and their impact on interconnection transformer configurations and system grounding compatibility
OpenDER Model Version 3[P] 3002030962	Updated documentation of the open-source DER (OpenDER) model specifications
Grid-Forming Inverter Tutorial[P] 3002030941	Tutorial covering fundamental information regarding grid-forming inverters
DER EMT Modeling and Analysis Tutorial Link	Tutorial and training on performing EMT studies with DERs
Inverter Modeling and Analysis Tutorial Link	Tutorial on the types of dynamic and transient simulations and their applications in distribution system analysis
Value of Grid-Forming DER in Grid-Connected Operation 3002030961	Use cases and value of grid-forming DERs under blue-sky conditions
V2G Power Conversion Topologies 3002031095	Overview of the power converter topologies, standards, and capabilities essential for V2G
CYME 9.4.1 DER Model Evaluation 3002030939	Evaluation summary of CYME's DER model accuracy against IEEE 1547-2018 definitions
Synergi 6.25.0 DER Model Evaluation 3002030940	Evaluation summary of Synergi's DER model accuracy against IEEE 1547-2018 definitions
White-box PV Inverter EMT Model 3002030963	2nd generation white-box EMT model for three-phase grid-following solar PV inverter
White-box BES Inverter EMT Model 3002030964	2nd generation white-box EMT model for three-phase grid-following battery energy storage inverter
Aggregated DER Modeling 3002030965	Comparison and guidelines for lumped vs detailed BTM DER model usage
DER Short Circuit Models 3002031280	Comparison of phasor domain DER short circuit models against lab test data
DER EMT Analysis Screens 3002031156	Screening criteria to determine when detailed EMT studies are recommended for DER interconnection
Selective UFLS Avoiding Generation Loss[TI] 3002029635	Novel under-frequency load shedding approach at the customer level using smart circuit breakers
Microgrid Black with Small-Scale GFM DERs[TI] 3002029641	Survey of practices and mechanisms for microgrid black-start using multiple small-scale grid-forming inverters.
EPRI 8th Smart Inverter Workshop 3002030864	Utility-only workshop for peer-to-peer experience sharing of smart inverters in the field

P = Public TI = Technology Innovation

2024 Deliverables

DERMS and Microgrid Integration 174C

Assessment of Aggregator DERMS Provider Landscape 3002031087	Functionalities, field experience, and development roadmaps of leading aggregator DERMS platforms
Highlights from Testing a Distributed Energy Resource Management System (DERMS) 3002030471	Performance summary of commercial DERMS against pre-defined metrics during normal and abnormal grid conditions
Utility Strategies for Implementing Distributed Energy Resource Management Systems (DERMS)[P] 3002031038	Summary of utility strategies for deploying DERMS
Electric Vehicle Simulator Development[TI] 3002030290	EV Simulator that enhances testing and optimization of DERMS services
EPRI's Reference Implementation of a DER Gateway[P] 3002031043	Prototype DER Gateway implemented on ruggedized hardware for benchmarking and pilot deployments
Grid DERMS Requirements[P] 3002031036	Detailed list of DERMS requirements necessary for specific use cases
Electric Vehicle (EV) Fleet Charging with Flexible Distributed Energy Resources (DER) 3002031045	Assessment of EV Fleets to mitigate curtailed energy from DER operating under flexible interconnection agreements
Key Insights: Interconnecting BTM Microgrids 3002031062	Summary of operational, commissioning, and product certification insights related to the interconnection of BTM microgrids
Utility Microgrid Controller Lab Test Results 3002031035	Evaluation of vendor microgrid controller's ability to meet feeder-level island performance objectives
Aggregator DERMS—Use Cases and Requirements[P] 3002031037	Detailed requirements list that supports RFP when seeking ADERMS vendor
Evaluation of DSO Models for Enabling DER Grid Services[P] 3002031042	Implementation findings of EPRI's four reference DSO Models in a HIL environment

Practices, Programs, and Economics 174D

DER Interconnection Process Guidebook 3002030968	One-stop destination for DER interconnection procedural best practices.
Demonstrating Energy Storage System Taxonomy & Operating Matrix 3002030942	Summary of EPRI's ESS taxonomy and matrix and pilot for assessing application in real-world interconnection processes
DER Interconnection Decision Pathways Prototype Tool[TI] 3002030341	Educational tool to help utility staff explore hypothetical DER configurations and address interconnection challenges
Key Insights: Interconnecting BTM Microgrids[P] 3002031062	Summary of operational, commissioning, and product certification insights related to the interconnection of BTM microgrids
Utility DER Integration Best Practices Database 3002030456	Database and analyses of real-world utility DER integration practices based on continuous data collection
Equitable Allocation of DER Hosting Capacity 3002029106	Framing of technical, economic, and equity considerations for siting DER in high grid penetration areas
Strategies for Encouraging Flexible EV Charging at Scale 3002030967	Interconnection and management strategy, underpinned by economic analysis, for integrating EV fleets into distribution
Harnessing DER to Manage Contingencies in T&D Systems 3002030416	Exploration of needs, requirements, strategies for procuring DER-provided reserve services

P = Public TI = Technology Innovation

Dynamic Interconnection Limits 3002030420	Introduction to dynamic interconnection limits, their implementation, and impact on utility oversight of DER bulk system services
Grid Services Provided by DER, Vol. 1: Jurisdictional Scan & Analysis[P] 3002031320	Summary of findings from a canvassing of efforts in North America and Europe that are leveraging DER for grid services
Interconnecting DER for Grid Services Provided by DER, Vol. 2[P] 3002031319	Key considerations for DER interconnection, including the need for additional analysis and the role of flexible interconnection in providing grid services
Utility Strategies for Accessing Grid Flexibility from Aggregated DER 3002030457	Strategies to leverage aggregated DER for distribution grid services with coordination of upstream bulk systems as a prerequisite
Utility Strategies and Lessons Learned from NWA Projects 3002030316	Case study insights and strategies employed in developing and operating real-world NWA programs
Reliability/Availability Considerations for NWAs 3002030991	Framework for assessing needed NWA availability to assure reliability for grid deferral and other use cases
DRIVE "DER Grid Deferral Value" Module (NWA Screener Tool) 3002030953	Tool for initial screening of NWA opportunities based on time and locational values
Case Studies Applying EPRI's DERMS Cost-Benefit Framework and Analysis Tool 3002030990	Case study experiences applying EPRI's method for determining the economic value of DERMS for individual and collective use cases
An Expanded Modular Template Framework for Valuing Resiliency 3002030969	Modular Template Framework and accompanying Resilience Value Extraction Tool for calculating the resilience value of a range of preventative measures
Characterizing Resilience Metrics, Their Status, and Application to Valuing DER 3002030971	Summary of ongoing activities to develop industry-wide resilience metrics and application for valuing DER
Valuation of Utility-Scale vs. Aggregated Customer-Side Storage for Substation Transformer Deferral 3002030970	Economic analysis of transformer upgrade deferral comparing customer-sited vs utility-scale energy storage

Technology Transfer and Industry Engagement 174E

At A Glance: Distributed Energy Resources (DER) Integration 3002030403	Program summary for reference or for orientation
DER Resource Center (DER) v7.0 3002028910	Members access to research materials, forum, calendar, suggestion box, practices share and individual profiles
Generic Technical Interconnection and Interoperability Requirements (TIIRs), 2nd Edition[P] 3002030551	Updated reference guide and template for documenting individual utility interconnection and grid integration requirements
Hot Line Tags: Developing a Comprehensive Strategy 3002030783	Guide with procedures for working distribution circuit with operating DER
DER Forum (FORUM) v5.1 3002028958	Member open conversations on DER issues by searching or adding to the ~500 topics
Making DER Connections in Low Voltage Networks 3002030289	Summary of field experience integrating DER in LV spot and area networks in urban areas
Community Power Smart Inverter Experiment[P, 3002030686	The Community Power Smart Inverter Experiment is a field demonstration of smart inverters utilizing volt-var curves at New York City Housing Authority (NYCHA) campuses.
Analysis of Mixed Resources (DER and E-mobility)[GOV] 3002031176	This report examines the impact of large-scale electric vehicle (EV) deployment on distribution grids, with a focus on medium and heavy-duty vehicle fleets.

P = Public TI = Technology Innovation GOV=Government

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Overall distribution related research, program, or strategy-related topics

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Distribution system modeling, DER settings, power flow, dynamic, and transient analysis.

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Smart inverters, grid supportive devices. Steady-state and transient DER modeling, laboratory and field testing

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DER interconnection practices, DER-provided grid services and non-wires solutions, cost-benefit analyses

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Microgrid controls, intentional islanding, DERMS, and controller requirements.

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DER impact studies, microgrid planning, modeling, control design, deployment, and operation, real-time HIL simulation/testing

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Distribution system modeling, DER settings, power flow, dynamic, and transient analysis

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