DISTRIBUTION OPERATIONS & PLANNING (P200)

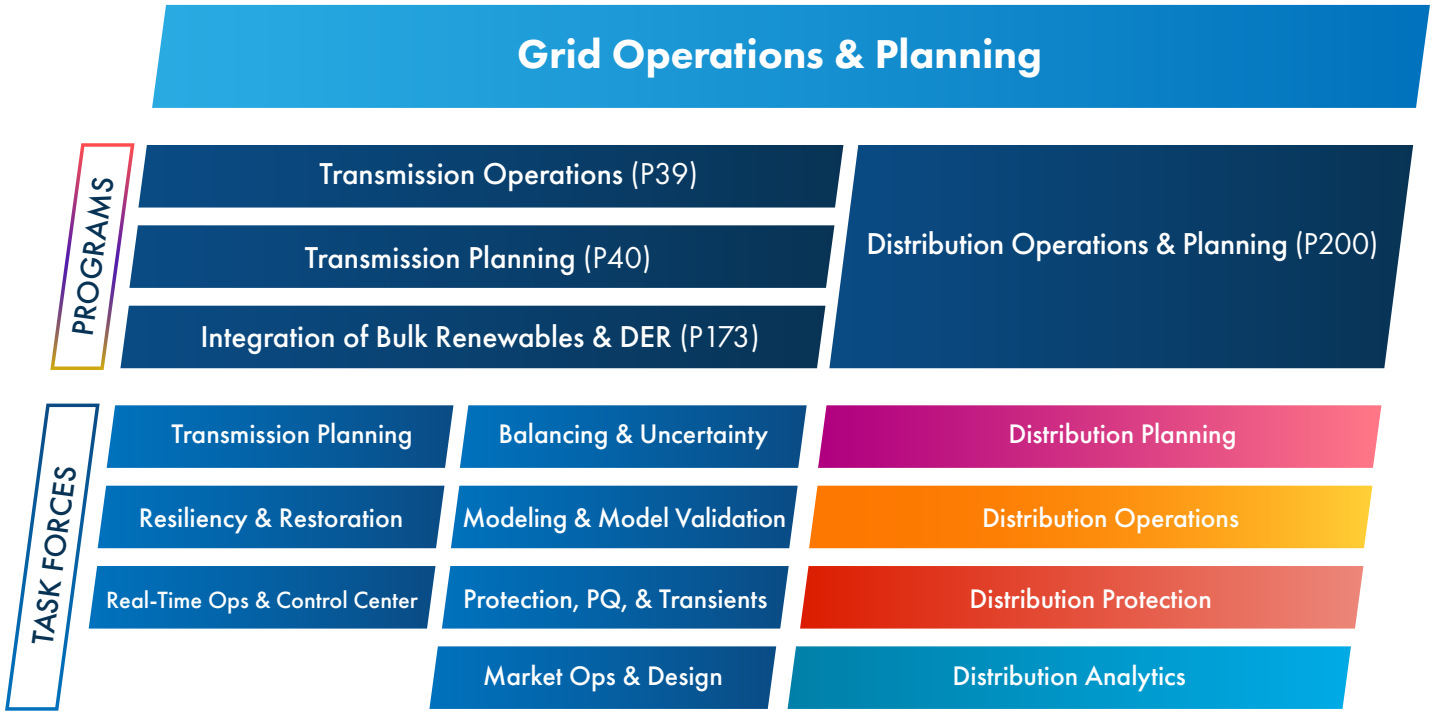
ANNUAL REVIEW

2022

GO&P OVERVIEW

EPRI's Grid Operations and Planning Area addresses both Transmission and Distribution needs through four dedicated research programs.

Task Forces provide a means for EPRI project guidance and serve as a primary vehicle for R&D technology transfer to members.



CROSS-CUTTING GO&P INITIATIVES

GRID MODELING

We are improving how engineers model new and existing assets, developing tools to identify and mitigate modeling errors, and using new data sources to effectively and efficiently create an improved "Digital Twin" of the grid

INTEGRATION OF DER INTO MARKETS

Working with ISO/RTOs, T&D utilities, and DER stakeholders, we are developing plans to efficiently and reliably integrate aggregated DER to provide market services

INTEGRATED STRATEGIC SYSTEM PLANNING

Working alongside our counterparts in other research areas, we are integrating T&D methods and tools to support long-term strategic planning considering decarbonization goals and climate resiliency

RESILIENCY & RESTORATION

The teams are developing new methods for including risk in operations and planning and developing novel methods for system restoration including use of non-traditional resources

CONTROL CENTER MODERNIZATION

From Control Center designs to situational awareness and workforce management, we are working with T&D operators to evolve the control center to meet the growing demands of the grid operator

> 100 DEDICATED STAFF
with > 1100 combined years of experience in the power industry

4 RESEARCH PROGRAMS
providing members access to cutting-edge R&D and solutions across the T&D space

11 TASK FORCES
providing members access to subject matter expertise and direct knowledge transfer

WHAT WE DO

EPRI's Distribution Operations and Planning Program (P200) develops the capabilities needed to assist distribution utilities in transitioning to tomorrow's modern distribution grid using a balanced, no-regrets approach.

P200 is focused on enabling grid modernization through the development of new planning processes, models, tools, reliability assessment analytics, and incorporating new automation, protection, and control technologies.

"Exelon has benefited from the research facilitated through EPRI P200 providing innovative methods to modernize distribution planning and operations practices and tools."

SCOTT PLACIDE | PEPCO HOLDINGS INC

PROGRAM VALUE

Grid Modernization Strategy
Develop and adjust plans

New Resource Integration
Integrate higher levels of DER, ES, EVs

Reliability and Resiliency
Maximize improvements

Electrification & Decarbonization
Pro-actively plan for future needs

Operational Efficiency
Use data, tools, and technology effectively

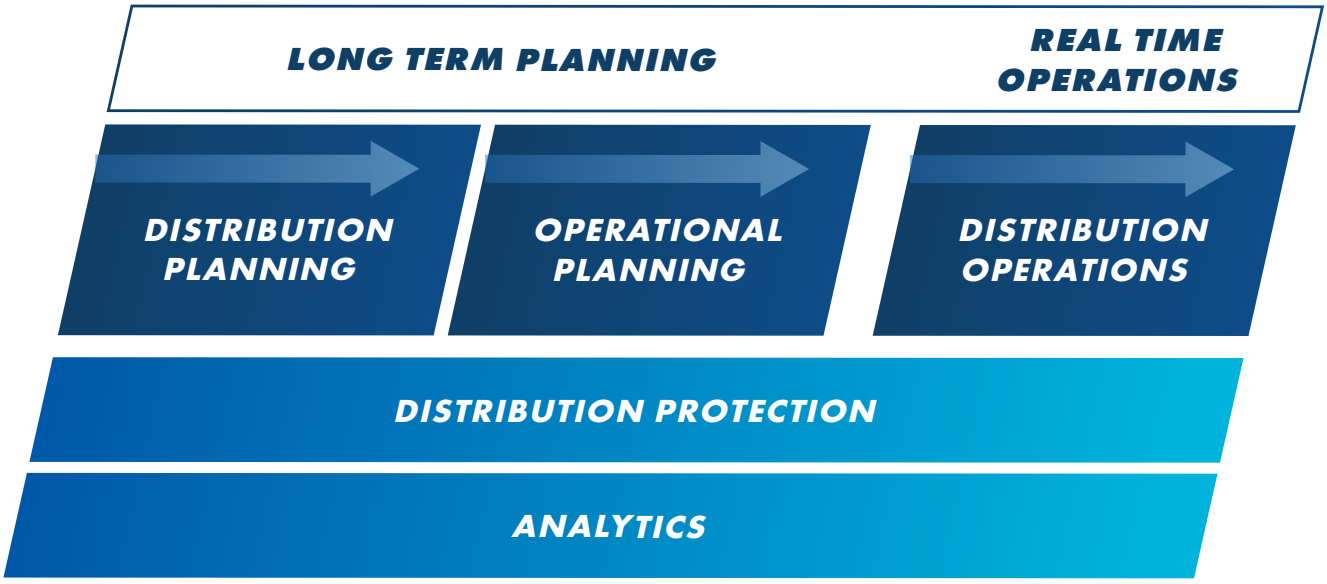
Workforce Skill Development
Identify new skills required

Leading Practices
Gain insights from utilities across the globe

HOW WE DO IT

EPRI's P200 research is delivered through five areas covering the breadth of needs across planning, operations, protection, analytics, and technology transfer. Task Forces provide EPRI project guidance and serve as a primary vehicle for R&D technology transfer to members.

The DO&P scope of R&D and team of subject matter experts span all aspects of distribution planning and operations, from real-time operations to long-term planning.



WHAT YOU GET

"P200 provides our engineers research and tools that we need to better prepare for the future of the distribution grid."

DAVE NESTLER | WEC ENERGY

59 **Leading edge research products**

10 **Cutting-edge software tools** for Distribution system modeling, simulation, and analysis comprising the planning, operation, and protection areas

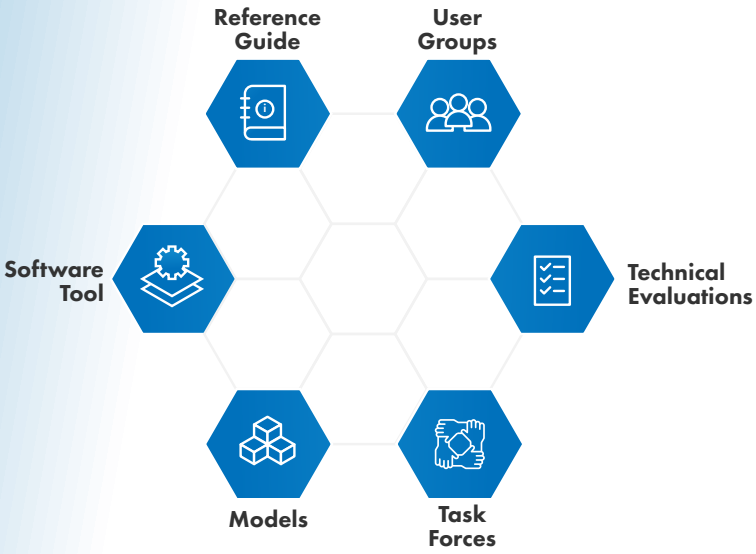
55 **Peer utilities sharing practices** providing leadership and guidance from around the world

30 **Subject matter experts** that are an extension of your staff, with a combined experience of more than 560 years in power systems modeling, simulation and analysis including world-class subject matter experts in Distribution Planning and Operations

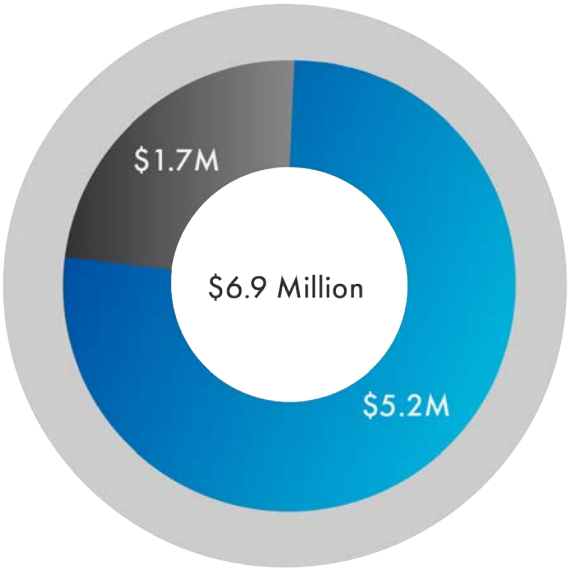
57:1 **Return on member investment** in the annual research

HOW YOU GET IT

We transfer the research value to members through deliverable vehicles such as technical reports, videos, and software; collaborative task force interactions, topical workshops and user groups, and by transferring results to commercial software vendors that supply and support member applications.



2022 R&D Funding



- Supplemental Projects
- Annual Research Portfolio
- Total

KEY HIGHLIGHTS from 2022

DISTRIBUTION RESILIENCE

As the economy electrifies and decarbonizes, energy grid reliability and resilience will be paramount. EPRI's READi initiative was created to bring together the industry and develop a standardized and consensus-based framework to inform infrastructure investment and deployment in order to enable society's electricity decarbonization and climate resilience needs. EPRI's DO&P team is working across both operations and planning to inform this process. This year, two whitepapers were written that outline existing processes and methods in both planning and operations that enable improved resilience. These papers also identified the gaps and research needs that exist. In 2023, the focus of this effort will be to further develop metrics, methods, data utilization, and process improvements that can lead to a more resilient distribution system.

DIGITAL TRANSFORMATION

Recognizing increasing challenges to managing and leveraging growing amounts of data, EPRI's DO&P team has been working on developing tools and processes to support operators and planners. Focusing on advancing beyond the manual approaches of today, the DO&P team has been focused on enabling more efficient methods and intelligent utilization. Working with the Information Communication Technology team, we have defined grid model data requirements across operations and planning uses cases. A framework has been further developed that lays out processes to create, validate and verify grid models in an automated fashion. Data quality metrics have also been identified to enable ongoing management and maintenance. The EPRI team has worked to automate this process through a tool. This year efforts focused on enabling consistency between the operations and planning models and providing tools to support utilities in this process. Together, these efforts reduce the engineering time spent developing models and provide utilities with the methods and tools to turn data into an operational asset.

ENABLING ELECTRIFICATION

EPRI's DO&P team is addressing challenges and solutions to enable electrification on the distribution system in a number of ways. The team, working alongside the Electric Transportation program, have developed new methods and analytics to enable electric vehicle integration and consideration within the planning processes. These new capabilities are being applied with a number of members on their system to understand the impacts of fleet electrification in their territory. In 2022, a tool was developed to enable wide-area assessment of the grid impacts for fleet EV on the distribution system. In addition, several efforts this year addressed the range of impacts expected from electrification including looking at the impacts of residential EVs at the secondary/service level as well as the impacts of changing load profiles on the substation transformers. These efforts aim to provide guidance on changes to planning design and criteria used. Next year these efforts will continue.

MODERNIZING DISTRIBUTION OPERATIONS

Distribution operations is undergoing a significant transformation. In order to meet the needs of tomorrow, the distribution control center, including staffing, processes, and tools need to evolve. EPRI's DO&P team has been working with members to enable this transformation by defining the new roles, data, tools, and processes required to operate a system with high levels of DER and automation. We are providing guidance on designing a modern control center including considerations for pandemic response. We are working to address gaps in operational tools and analytics by developing and testing new capabilities for commercial implementation. Whitepapers this year helped further define operational planning roles as well as analytics that may be needed to manage DER. Finally, we are defining new roles and skill sets that will be required to operate a modern grid including laying out the requirements to be a certified DSO. The DO&P team is working alongside the TO&P team to address the changing requirements as the transmission operator and distribution operator evolves.

Planning 200B

Advances the planning tools, methods, and practices needed to realize the modern distribution system. Methods and tools derived are cost-effective and lead to more informed system design and investment decisions.

Contact: Jouni Peppanen, jpeppanen@epri.com

KEY ACTIVITIES

Strategic Planning

System Design

Electrification

Non-Wires Alternatives

Forecasting

Scenario Planning

Resilience

MEMBER VALUE

- *Inform capital investment decision making*
- *Minimize economic & technical risks*
- *Develop design practices that account for higher levels of DER, electrification, and extreme weather scenarios*
- *Support planning decisions with efficient evaluation of a changing system (NWA, DA, etc)*
- *Enable planning processes to address increasing uncertainties and risks*

"P200 has enabled Dominion Energy to be on the forefront of grid modernization and is a highly valued partner guiding our efforts to modernize our distribution grid planning processes."

RICK SIEPKA | DOMINION ENERGY

Analytics to Support Operational Decisions

Tools to enable planners to assess system configurations and support operator decision making of a more flexible system

Non-Wires Alternatives

Analytics, tools, and guidance to evaluate NWAs alongside traditional alternatives

Electrification

Methods and models to assess the impact of changing load profiles and increased electrification in the planning process

Strategic Planning

Framework and guidance for evaluating strategies to optimize system utilization and costs

System Design Practices

Guidance on design practices for enabling high penetration DER & EVs

Forecasting

Guidance on evolving forecasting requirements including how to account for extreme weather events and changing technology adoptions

Operations 200C

Develops and demonstrates new technologies, tools, techniques and training methods to enable DCC managers and operators to meet the challenges of tomorrow. These capabilities will enhance operational processes, implement new analytics, and increase the resilience of the control center.

Contact: Brian Deaver, bdeaver@epri.com

KEY ACTIVITIES

Control Center

Distribution Automation

DMS Applications

Real-Time Optimization

Operator Role/Function

Sensing & Measurement

Cyber Security

MEMBER VALUE

- *Maximize the reliability improvements-per-dollar invested*
- *Improve situational awareness in the control center, resulting in improvements in reliability & safety*
- *Support utility plans to deploy DMS & evolve DCCs*
- *Enhance training of new & existing operators to meet evolving needs*
- *Develop operational techniques and processes necessary to ensure customer reliability in a decarbonized system*

"We have made meaningful improvements in the design of our new Control Center and in the development of our System Operator recruiting and training program."

SCOTT PIFER | DTE ELECTRIC

Advance DMS Applications and Automation

Algorithms to unlock value of DER and manage active system including improvements to existing applications and development of new capabilities

Future DSO Requirements

New processes and tools enable DSO including the new roles/responsibilities (operational planning) required

Operational Visibility

Guidance and analytics to achieve least-cost means for operational visibility

Modernizing DCC

Guidance and leading practices to design and manage a modern DCC including guidance to improve situational awareness

Reliability & Resilience

Analytics & tools to evaluate reliability improvements and maximize their potential benefits as the system evolves

Future Operator Training

Training, curriculum, and certification guidance to enable the operator of the future

Protection 200D

Develops new methods for protecting the modern distribution grid and take advantage of new grid modernization capabilities. Distribution protection engineers will use the methods and protocols developed to evaluate protection schemes and philosophies, including the impacts of DER.

Contact: Aadityaa Padmanabhan, apadmanabhan@epri.com

KEY ACTIVITIES

Automated Analysis

DER Modeling

Microgrid Protection

Reliability & Resilience

Adaptive Protection

New Technologies

MEMBER VALUE

- *Significantly reduced effort for protection analysis and monitoring*
- *Clear understanding of DER response and modeling for grid disturbances*
- *Secure and reliable protection of distribution grids with DA, DER and electrification*
- *Improve grid reliability through reduced protection mis-operation and use of new technologies*
- *Improve operator situational awareness of protection operation and fault location*

"Using the same criteria as our protection assessments, DPAT completes hundreds of assessments in the time it would take me to assess one device."

FORTIS ALBERTA

Automated Protection Analysis

Tool to automatically perform protection studies, identify credible protection issues and propose mitigations

Guidance for Mitigation Impacts of DER on System Protection

Guidance for modeling DER and load in protection studies as well as guidance to mitigate impacts

Microgrid Protection

Guidelines for safe and cost-effective microgrid protection design

Evolve Protection Design Practices and Technologies

Guidance on evolving protection of distribution grids with high amounts of DER and electrification including leveraging new technologies

Protection Data Management

Clear understanding of and guidance on deploying the methods and tools to store and manage protection configuration data

Automated Event Analysis

Operator and protection decision support tools to automatically perform event visualization, root-cause analysis, fault location estimation, and event record analysis

Analytics 200E

Provides engineers with the analytics necessary to modernize how existing assets and new resources are modeled and simulated for grid analysis. Distribution engineers will use these capabilities to effectively and efficiently streamline complex analytics, consider emerging technologies, and leverage new data streams.

Contact: Matthew Rylander, mrylander@epri.com

KEY ACTIVITIES

Hosting Capacity

Device Modeling

Grid Modeling

Data Analytics

Wide Area Distribution Assessments

MEMBER VALUE

- *Time-saving analytics for wide area distribution assessments to inform distribution planning*
- *Intelligent integration and utilization of data as a system asset*
- *Increased confidence and consistency in operations and planning models used in tools such as DMS, planning tools, etc.*
- *Identification of gaps in existing tools for analyzing system impacts*

"Decarbonization and electrification in Seattle demands a modern distribution grid that is a massive data-generating and -processing machine. EPRI's research to establish a dedicated data management and model maintenance engineer to efficiently address all these dependencies is proven brilliant at City Light."

KINCHEIU WEI | SEATTLE CITY LIGHT

Enhanced Grid Modeling

Framework and automated methods for verification of grid model data availability, validation of grid models, & grid model correction & quality tracking

Planning for Fleet Electrification

Tool to assess distribution electrification potential based on managed and un-managed EV charging patterns

Integrating Measurement Data in Operations & Planning

Methods to leverage AMI data to improve operations and planning models and analytics

Hosting Capacity

Advancement to and guidance on hosting capacity methods, tools, and application in planning and operations

Wide-Area Distribution Assessments

Tools to enable wide-area analysis of potential system limitations and mitigation alternatives for future planning scenarios

Technology Transfer 200A

Provides high-impact resources that cover topics relevant to distribution operations and planning for technology advancement and industry issues.

Contact: Lindsey Rogers, lirogers@epri.com

KEY ACTIVITIES

Interest Groups

Grid Modernization Playbook

Program Explorer

Newsletters

"The Program Explorer helped improve knowledge transfer internally at Alliant and enabled easy navigation and sharing of deliverables."

STACY VAN ZANTE | ALLIANT ENERGY

"The Playbook saved time in creating an initial roadmap and showing alignment between organizational goals and engineering projects."

UZMA SIDDIQI | SEATTLE CITY LIGHT

2022 Deliverables

Grid Modernization Playbook 3002024809	Further developed a framework to help utilities develop strategies to meet the evolving requirements of a modern grid including how it can be applied to develop company-specific strategies for grid modernization
Managing Flexibility on Distribution System 3002025065	Detailed the analytical capabilities needed to understand system constraints and manage DER through dynamic operating envelopes
Distribution Operational Planning 3002025412	Provided understanding of capabilities and responsibilities of an operational planner in the distribution control center

INTEREST GROUPS

Operations and Planning Interest Groups provide control center managers, planners, and engineers the opportunity to discuss and share experiences, learn from other utilities, and identify gaps and opportunities.

OPERATIONS

- Distribution Control Center
- Staffing & Training
- Operations Practices
- DA & DMS
- DER

PLANNING

- Tools
- Methods
- Forecasting
- DER Interconnection
- Criteria & Practices

WHAT PEOPLE ARE SAYING

"The Distribution Operations Interest Group has proven to be a great avenue for different utilities to share operational knowledge and safest/best practices and I am extremely impressed with what the EPRI team has done."

KEVIN REESER | CONSUMERS ENERGY

"The Distribution Planning Interest Group is the single most valuable thing I participate in each year."

KIMBERLY GAUNTNER | PPL UTILITIES

"The relationships and information gained through participation in DOIG are invaluable. It's a great forum for sharing the unique challenges of control center operations. I appreciate EPRI's leadership in bringing utilities together."

JASON ACOSTA | GEORGIA POWER

"EPRI's ability to bring utilities from across the continent & world together to share experiences is one of its key value drivers. DPIG is a great example of this."

JUVAL BOTHE | ENMAX

YOUR NEEDS INFORM EPRI RESEARCH

Beyond information sharing these interest groups provide critical insights into the challenges utilities are facing and inform the research we do in the program throughout the year.

SOFTWARE TOOLS

EPRI develops software to implement, test and refine the planning, operations, and protection research results created. This allows members to utilize the methods and algorithms developed in a direct way that can support their day-to-day functions. It is a vehicle for quick transfer of the R&D to application, with potential to save engineering time and reduce costs associated with operating and planning. The DO&P team has an expanding toolset to help utilities assess complex problems while continuously improving our workforce impact.

DRIVE™

Being used by 35 utilities worldwide to enable an effective means for assessing location-based impacts of distribution resources that can consider the breadth and depth of a utility's system

MITIGATION ASSESSMENT TOOL

Enables automated assessment to determine location-specific solutions (grid-side and customer-side) to mitigate the constraints that limit the ability to accommodate DER and increased load

OPTIMAL DA SWITCH PLACEMENT TOOL

Enables the evaluations of the optimal placement of switches on the distribution system

DISTRIBUTION PROTECTION ANALYSIS TOOLKIT (DPAT)

Enables protection engineers to perform wide-ranging protection coordination checks in an automated fashion

FLEET EV ASSESSMENT TOOL

Enables assessment of the impacts of fleet electrification on the distribution system to improve grid utilization and identify mitigations

AUTOMATED SYSTEM CONFIGURATION ASSESSMENT TOOL (ASCOT)

Enables assessments to quickly identify feasible and beneficial load transfers under a given set of operational conditions

ALARM VISUALIZATION AND ASSESSMENT TOOL (AVAT)

Enables operators to automatically diagnose a large flood of alarms to their root cause and baseline the alarm system

AUTOMATED DISTRIBUTION ASSESSMENT PLATFORM AND TOOLS (ADAPT)

Enables the evaluation of traditional and non-traditional planning alternatives in an automated fashion

OPENDSS

Open-source tool developed as a key resource for EPRI research and is used throughout the industry to develop new methods and analytics for simulating distribution systems

WHAT PEOPLE ARE SAYING

*"**DRIVE** has helped fast track dozens of applications, reducing interconnection application processing time by ~10x."*

ANDRÉS VALDEPEÑA | IDAHO POWER

---

*"The **Mitigation Assessment Tool** enabled wide-area screening of the distribution grid to efficiently find mitigation solutions to serve projected DER growth helping plan infrastructure upgrades and rate structures."*

RICARDO GARCIA | FORTIS ALBERTA

---

*"**DPAT** enabled PPL to successfully identify and prevent a misoperation and improved engineering analysis time."*

MYCHAL KISTLER | PPL UTILITIES

---

*"The **DA switch placement tool** reduced engineering time by providing a baseline for studies and displaying results in a heat map to determine benefits of alternate switch locations."*

JUSTIN GRAFF | PORTLAND GENERAL

FROM RESEARCH TO APPLICATION AND COMMERCIAL ADOPTION

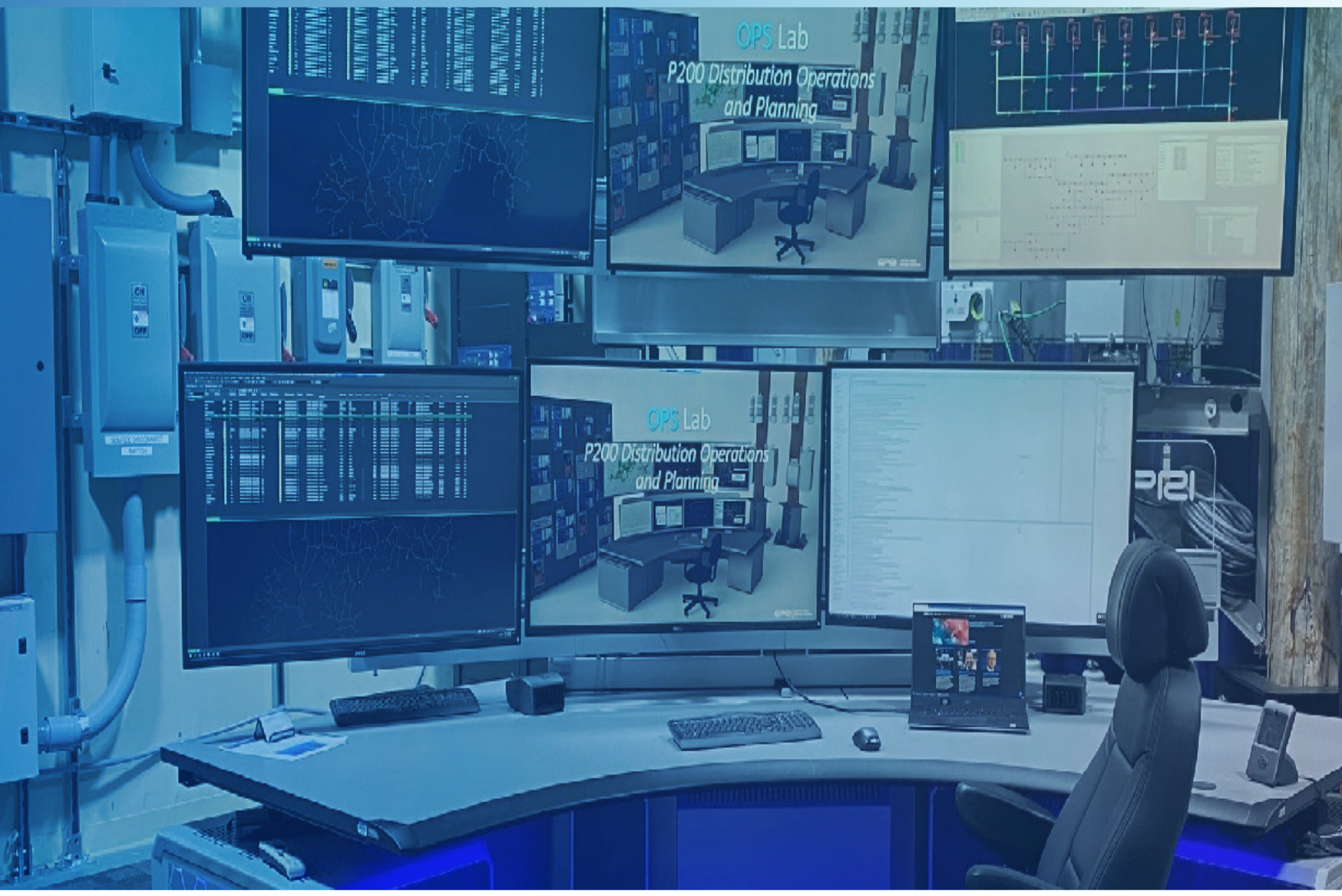
EPRI has technology transfer plans in place for all software to ensure the methods developed in R&D can find its way into user hands and commercial applications.

OPS LAB

The goal of the OPS lab is to bridge the gap from planned deployments to field-ready applications. From the operator to the device, the OPS lab provides capabilities to emulate a complete distribution system and assess innovative solutions.

*"**National Grid** was able to rapidly iterate through different FLISR programming and test new ideas, improve designs, and validate stability of FLISR logic without the need for field work and lab/field tests."*

CHRISTOPHER LAMOTHE | NATIONAL GRID



Our OPS Lab is about assessing and maximizing use of new technologies that can help transform distribution and is a key resource enabling P200 research.

DMS AND DA TESTING

Utilities are very limited today in their ability to test complex DMS/DA algorithms prior to field implementation. The OPS Lab enables testing of all DMS functions (e.g. Volt/VAR, FLISR, DSSE) against a synthetic "real world". The OPS lab enable a range of scenarios to be explored including the ability to manipulate loads, DER production, voltages, faults, etc. to evaluate DMS/DA algorithm response and performance.

OPERATOR TRAINING

Present DMS Operator Training Simulators are more focused on the operator learning how to use the DMS software and basic activities. Using the OPS Lab utility, trainers and managers will be able construct realistic but complex scenarios, including multiple contingencies, control failures, device failures, communications failures, and variations in loading, DER production, and voltage during the training exercise.

PROTECTION TECHNOLOGIES

New technologies present opportunities for improving operations and protection of the grid, but there is also an increase of complexity. The OPS lab enables the evaluation of new protection technologies, logic and approaches to enable safe and reliable deployment.

SUPPLEMENTAL PROJECTS

Projects are focused on implementing and demonstrating new methods/tools, leveraging collaboration to increase the pace and depth of research accomplished

EPRI works with utilities on supplemental efforts to apply latest research advancements, accelerate adoption of new technology, and provide member specific results. In some cases, EPRI works with member utilities to create a multi-funder supplemental where a subset of members work together in a collaborative to advance specific capabilities.

In other cases, EPRI works 1-on-1 with a member utility through application services projects to support individual utility needs through studies, tool application, or demonstration. Regardless of approach, these efforts can be funded leveraging the self-directed funds set aside for each utility.

WHAT CAN WE DO?

MEMBER VALUE

From research to application, supplemental projects allow utilities to:

- Gain hands-on experience
- Implement new processes with utility SMEs
- Prove out technology and integration
- Get results specific to your system

WHAT PEOPLE ARE SAYING

*"The recommendations derived from EPRI's **Voltage Conversion Study** will allow LADWP to confidently take the next steps in modernizing its distribution system in response evolving load growth, while optimizing costs and maintaining reliability"*

PETER LIANG | LADWP

---

*"The collaborative work led by EPRI has **helped policy makers** in the Commonwealth **better understand** the **complex nature of the electric distribution network** and the challenges associated with the two-way flow of power and information on a system heavily saturated with distributed energy resources."*

SAMER ARAFA | NATIONAL GRID

---

*"The Distribution Operations team at EPRI have provided ESB Networks with invaluable insight and expertise on the interface **design requirements for our ADMS implementation** programme."*

RONAN MOORE | ESB NETWORKS

EXAMPLE PROJECTS

WIDE-AREA DISTRIBUTION ASSESSMENTS TO INFORM DISTRIBUTION PLANNING

Performed wide-area assessments to determine system constraints and potential mitigations to enable future DER, EV, and load scenarios

VOLTAGE CONVERSION EVALUATION INITIATIVE: LADWP VOLTAGE CONVERSION STUDY

Investigated strategic options for converting existing 4.8-kV system to a higher voltage class to meet future system demands

FLEET ELECTRIFICATION PLANNING AND ASSESSMENT

Supported utilities in planning and preparing the grid for fleet electrification using advanced analytics and tools

OPTIMAL DA SWITCH PLACEMENT

Developed and applied tool for optimal placement of DA devices to maximize reliability improvements

MODERNIZING DISTRIBUTION PLANNING

Defined, developed and demonstrated new planning processes and tools to enable assessment of NWAs and traditional solutions

ALARM MANAGEMENT

Applied alarm management philosophy to enable utilities to prioritize alarms and improve operators situational awareness in the DCC

2022 Deliverables

Planning 200B

GUIDES

Reviewing Thermal Ratings with Changing Load Profiles 3002024068	Provided guidance on changes to transformer thermal ratings and improvements to asset utilization
Distribution Planning Guidebook 3002024069	Updated chapter on traditional planning process and capabilities required
Assessing Residential EV Impacts to Secondary Grid 3002024810	Developed guidance on EV charging characteristics and new considerations for secondary design and service transformer planning standards
Analysis of Capacitor Placement and Controls 3002024811	Investigated conventional capacitor placement strategies and potential improvements in the coordination of DER and cap banks
Integrating Customer Adoption into Distribution Planning 3002024449	Demonstrated method to derive technology propensity estimates and apply feeder level forecasting including requirements and limitations
Activating Smart Inverter Functions: Technical Merit and Economic Valuation 3002024065	Provided guidance on coordinating traditional assets and DER to improve system performance and utilization through a NY case study

PROCESSES

Defining a Distribution Planning Framework for Resilience 3002023951	Defined distribution planning actions and role in specifying and implementing overall system resilience efforts as well as identified gaps requiring further R&D
Integrated System Planning: A Distribution Perspective 3002024091	Detailed integrated planning process and the role of distribution planning including the capabilities required
Distribution Strategic Planning 3002024092	Defined a framework for evaluating strategic objectives and provided guidance on how distribution planners can ensure alignment of strategic and tactical planning
Emerging Integrated System Planning Methods 3002025566[TI]	Documented the experiences of a set of electric companies that are performing integrated system planning activities across G, T, D, and C including the diversity in processes depending on their unique environments

R - *Reference Guide* **TI -** *Technology Innovation* **P -** *Public*

WORKFORCE

Distribution Planning for Reliability 3002025666	Developed training videos on applying reliability metrics, methods and calibration as well as optimal DA/switch placement

TOOLS

Automated System Configuration Assessment Tool (ASCOT) Software - 3002024090 Video Summary - 3002025573	Updated tool and training to investigate planning guidelines for automated distribution systems that leverage flexible topology and adaptive regulation/protection
Automated Distribution Assessments & Planning Tool (ADAPT) 3002025461	Developed tool to evaluate complex system temporal behaviors with multi-year technical and economical evaluations of traditional and non-wires alternatives
Development of Utility Hazard Zones for Distribution Resilience 3002024690[TI]	Developed a targeted approach using intelligent layers known as hazard zones in the GIS system to inform distribution planners of the right resilience designs for distribution lines

KEY PROJECTS IN 2023

Evolving Planning Criteria and Objectives with High Electrification and DER

Forecasting | Placement, Profiles, and Aggregate Annual Growth

System Design Practices | Substation and Voltage Class Upgrades for High Penetration of DER and Electrification

Strategic Distribution Planning

"EPRI's ADAPT tool will allow APS to efficiently review multiple system upgrade options and technologies, efficiently and comprehensively providing results for various modern distribution system plans."

MICHELLE RODRIGUEZ | ARIZONA PUBLIC SERVICE

2022 Deliverables

Operations 200C

GUIDES

Improving Resilience through Distribution Operations 3002024370	Documented key operational practices and analytics that support improved resilience on the distribution system as well as identifies research needs
Application of Energy Storage to Support Distribution Operations 3002025636	Evaluated single install versus fleets of energy storage and resulting considerations on distribution operations including integration within DMS applications
Analysis of Capacitor Placement & Controls 3002024811	Investigated conventional capacitor placement strategies and potential improvements in the coordination of DER and cap banks
Guidance on Operations and Planning Grid Models 3002024833	Developed methodology for comparing grid model requirements and benchmarking model repositories across planning studies and operational applications
DA Investments: Impact on the DSO 3002024372	Summarized potential impacts of infrastructure investments projects on DSOs and ways to minimize the impact
Demand Flexibility for Grid Reliability and Resilience: Considerations for Successful Grid Operation 3002025480[TI]	Summarized implications and considerations for successfully operating the grid while leveraging emerging demand response models

PROCESSES

Determining the Future Value of CVR 3002024357	Summarized case study and lab testing of how CVR benefits are being impacted by end-use efficiency measures and electrification
Comparison of Clearance Practices 3002024369	Documented current clearance practices and identified new procedures that can help improve efficiency and safety
Use of AMI for Strategic Load Shedding 3002024673[TI]	Summarized the potential benefits, challenges, and requirements to implement the use of AMI for strategic load shedding during extreme events

R - *Reference Guide* **TI -** *Technology Innovation* **P -** *Public*

"Enabled HydroOne to re-examine our alarm philosophy with an open mind, new perspective, and to consider meaningful changes due to the high penetration of the renewable resources and the integration of the new SCADA controlled devices."

EIMAN AHMED | HYDRO ONE

WORKFORCE

DSO Operator Certification 3002024367	Defined proficiencies necessary to become a certificated DSO and initial set of training requirements
Human and Organizational Performance Podcast 3002025213	Recorded podcast that informs control center managers on human performance and ways to mitigate mistakes
Alarm Management Training 3002025382	Developed computer-based training for DCC professional to provide foundational knowledge to plan and implement alarm management improvements
Naturalistic Decision Making in Transmission and Distribution Control Centers 3002024393	Provided a case study with control center operators exposing how experience is gained over time and how automation impacts this process
Trip Saver Conductor Burndown 3002025847	Developed training to understand how faults can create burn downs and how these can be minimized

TOOLS

FLISR Performance Testing & User Training 3002024355	Investigated the mechanisms required to validate the effectiveness of FLISR systems using independent distribution system simulations
DER Forecasting for Distribution Operations 3002024360	Demonstrated the creation and use of real-time forecasts to disaggregated load and DER in DSO applications
Optimal DA Switch Placement Tool 3002024834	Improved tool by incorporating lateral device placement and spatial reliability performance into assessment framework
Alarm Visualization & Assessment Tool 3002024420	Continued improvements of alarm management – work towards a tool for root cause analysis of alarm data and control center information
Modernizing Distribution Ops Capabilities—DMS Function Assessment in Lab Environments 3002024064[TI]	Outlined use of lab environments to simulate complex operational scenarios and conduct extensive testing to boost confidence in DMS functionality and accelerate its adoption in operational settings

KEY PROJECTS IN 2023

Active Network Configuration Management

Operator Training

Application Guide for Operational Situational Awareness

Testing of Initial DA/FLISR Deployments to Support Implementation

2022 Deliverables

Protection 200D

GUIDES

Protection System Modifications Prior to Performing Work on an Energized System 3002024381	Worked with utilities, vendors to identify gaps in existing practices; roadmap to better integrate systems
DER Impact on Protection Performance and Potential Mitigations 3002024388	Updated guidance on impacts of DER on protection including model-free feeder screening for protection issues and existing utility practices
Protection Preparation for DER and Evolving Grid Designs 3002024390	Developed actionable roadmap to enable proactive protection design for high penetrations of DER and protecting new grid topologies
Modeling DER for Protection Studies 3002024391	Updated guidance on modeling DER based on case studies including model-free feeder screening for protection issues and existing utility practices
Distribution Protection Technologies and Innovative Solutions 3002024392	Provided summary of examples of new protection technologies, their readiness level, and experience implementing these technologies to date
Microgrid Protection Design Methods, Practices, and Studies 3002024990	Updated guidance to enable straight-forward modeling and design of microgrid protection including case studies

"Successful in helping meet both Centerpoint and the customer's needs by providing a safe and reliable solution [low-cost alternative to DTT] while also saving valuable time and money."

GLEN CALLAGHAN | CENTERPOINT

PROCESSES

Protection Settings Management Workshop Proceedings 3002024384	Documented workshop proceedings on current approaches/methods for protection data management
Distribution Protection Data Management 3002025860	Outlined strategies for migrating to an integrated protection data management system and current readiness of standards

WORKFORCE

Trip Saver Conductor Burndown 3002025847	Developed training to understand how faults can create burn downs and how these can be minimized

TOOLS

Utility Experience and Technologies for Event Analysis and Fault Location 3002024378	Enhanced DPAT fault location algorithm to enable and improve location accuracy, mitigate underlying causes of momentary faults, and improve operator post-fault analysis
Distribution Protection Analysis Toolkit for CYME (DPAT) v4.0 3002025235	Further enhanced tool to automatically perform protection coordination studies including improved visualization and ability to suggest settings to resolve issues identified
Distribution Protection Analysis Toolkit for Synergi (DPAT) v4.0 Toolkit, Synergi 3002025594	Further enhanced tool to automatically perform protection coordination studies including improved visualization and ability to suggest settings to resolve issues identified

KEY PROJECTS IN 2023

Distribution Protection Analysis Toolkit

Protection Preparation for High Penetration of DER and Evolving Grid Design Practices

Protection Data Management

Distribution Grid Protection and Extreme Weather, Wildfires, & Aging Infrastructure

2022 Deliverables

Analytics 200E

GUIDES

Hosting Capacity Guidebook: 2022 Edition 3002024682	Updated guidebook explains the evolution of hosting capacity, fundamentals to the assessment, guidelines to apply the results, and utility applications
Guidance on Operations and Planning Grid Model Requirements 3002024833	Developed methodology for comparing grid model requirements and benchmarking model repositories across planning studies and operational applications
Guidance on Measurement Data Processing for Expanded Utilization 3002025503	Developed a framework to guide the processing of measurement data considering its end-use application including identifying erroneous data
DER Modeling and Simulation Workshop	Held workshop to share leading practices on DER impact studies
Wide-Area Distribution Assessment Methods for Strategic Planning 3002024678	Detailed methods for performing wide-scale studies to inform strategic planning including data and tools needs

PROCESSES

Measurement Data and Use Case Repository for Grid Modeling 3002024709	Documented currently available measurement data and its uses in grid modeling for ops and planning applications
Geo-Locating Distribution Assets with Measurement Data 3002024713	Developed method for improving grid model fidelity through use of AMI data to geolocate on-ground distribution assets in the secondary system
Framework for Grid Model Verification and Validation 3002024832	Updated document further improving methods for verification, validation, and data quality tracking and updates use cases to enable improved internal workflows
Grid Modeling Workshop Materials	Held workshop to share current processes, gps and needs cross utilities for developing and maintaining grid models
Planning for Impacts from DER Aggregations 3002024201	Developed guidance on screening and study process when evaluating DER aggregations including data and model requirements

WORKFORCE

Python Training Materials	Conducted training to enable better utilization of python scripting capabilities in vendor planning tools

TOOLS

Wide-Area Distribution Assessment: Mitigation Module 3002024679	Updated automated mitigation tool including consideration of time-base customer mitigations and alignment for integrated planning applications
Wide-Area Distribution Assessment: Fleet EV Module 3002024680	Developed tool to efficiently assess grid impacts of fleet electrification and improve grid utilization
DER Model Verification Framework 3002024404	Updated framework to test and improve DER models in vendor planning tools

KEY PROJECTS IN 2023

Electric Vehicle Assessment Tool

Enhanced Grid Modeling: Framework for Model Verification, Validation, & Data Quality Tracking

Analytics Training

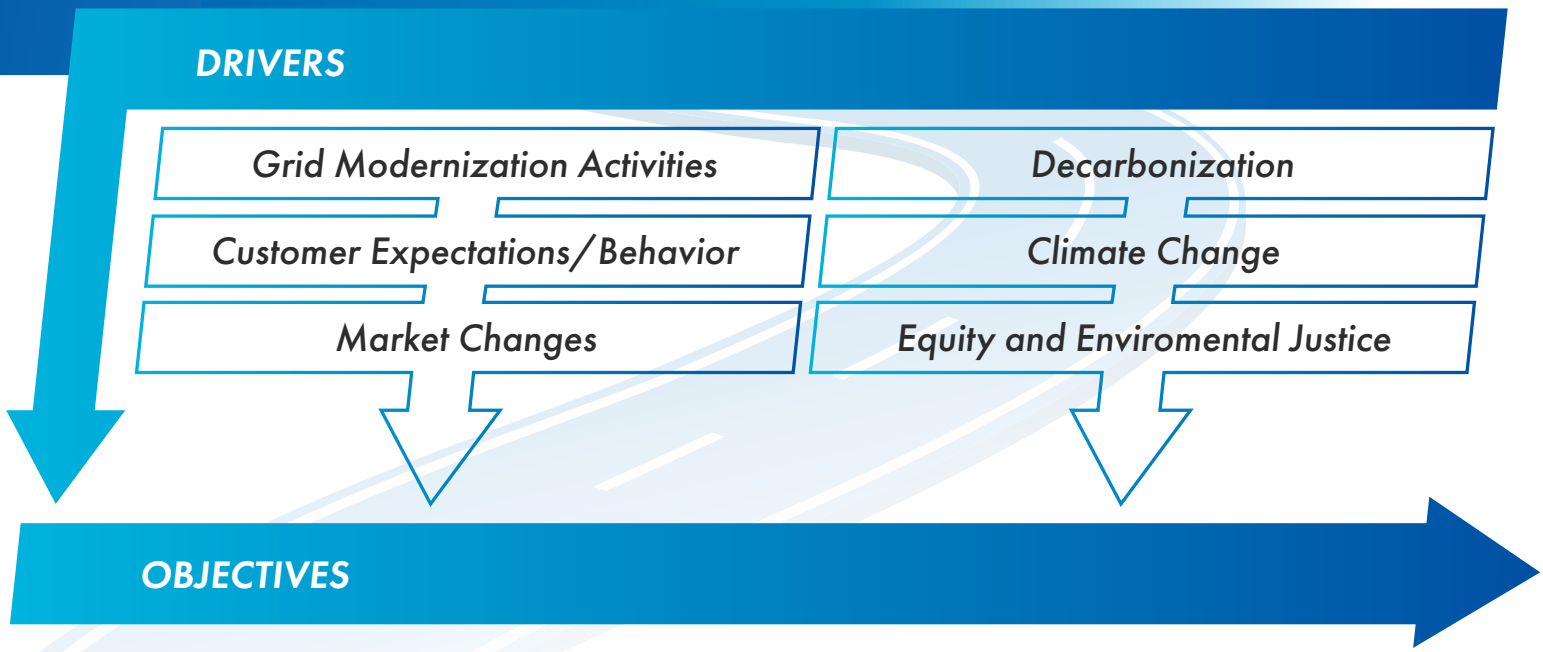
AMI in Operations and Planning

"The collaborative engagement on Fleet Electrification continues to deliver exceptional results through the hosting capacity analysis. We are excited to integrate the fleet assessments into a strategic distribution planning study."

CHRIS MERTZ | DOMINION ENERGY

RESEARCH ROADMAP

The P200 Roadmap provides directional guidance and priority to the research, development, and demonstration activities across the program. The roadmap is informed by program members and adjusted based on priorities and needs.



- *Planning Study Specification & Practices*
- *Active Distribution System Planning*
- *Strategic Planning for Electrification & Decarbonization*
- *Automating the Management of the Distribution System*
- *Operating a Decarbonized Distribution System*
- *Modernizing the Distribution Control Center*
- *Automating Distribution Protection Analysis and Settings*
- *Applying Protection Technologies*
- *Preparing Protection Systems for High Penetration DER*
- *Intelligent Data Integration*
- *Advancing Analytics to Support Planning & Operations*
- *Grid Modeling for Digital Transformation*

PRIMARY GAPS

The following are primary gaps - research required to bridge from the current to future state. The gaps are reviewed through EPRI member advisors and task force interactions.

PLANNING STUDY SPECIFICATION & PRACTICES

- Load and DER Forecasting
- Evolving Planning Criteria
- Planning Guidance & Training

ACTIVE DISTRIBUTION SYSTEM PLANNING

- System Design with DER
- NWA Design & Evaluation
- Automating Planning Analytics
- System Configuration Assessment

STRATEGIC PLANNING FOR ELECTRIFICATION & DECARBONIZATION

- Benefit & Cost Optimization Strategies
- Integrated Planning
- Resilience

AUTOMATING MANAGEMENT OF THE DISTRIBUTION SYSTEM

- Distribution Automation
- Monitoring & Control
- DMS Applications

OPERATING A DECARBONIZED DISTRIBUTION SYSTEM

- DER Visibility and Monitoring
- Distribution System State Estimation
- Operating the System with DER and Energy Storage

MODERNIZING THE DISTRIBUTION CONTROL CENTER

Operator roles, responsibilities & training

- Cyber Security
- Situational Awareness
- Emergency Procedures

AUTOMATING DISTRIBUTION PROTECTION ANALYSIS & SETTINGS

- Protection Data
- Protection Analysis Toolkit
- Event Analysis
- Protection Training

APPLYING PROTECTION TECHNOLOGIES

- New Protection Technologies & Testing
- Communication-Assisted Protection
- Protection Algorithms

PREPARING PROTECTION SYSTEMS FOR HIGH PENETRATION DER

- DER Modeling & Studies
- Microgrid Protection
- Preparing Protection for High Penetration DER

INTELLIGENT DATA INTEGRATION

- Utilizing New & Existing Data
- Integrating AMI

ADVANCED ANALYTICS TO SUPPORT PLANNING & OPERATIONS

- Hosting capacity
- Electrification
- Mitigation
- Wide Area Distribution Assessments

GRID MODELING FOR DIGITAL TRANSFORMATION

- DER & Grid Modeling Requirements
- Modeling Practices and Management
- Model Validation Framework

PROGRAM STAFF

Over 560 combined years of experience

Lindsey Rogers
Manager, Program 200

Brian Deaver
Operations Lead

Mattew Rylander
Analytics Lead

Jouni Peppanen
Planning Lead

Jared Green

Sean McGuinness

Roger Dugan

Miguel Hernandez

Alison O'Connell

Nick Heine

Andres Ovalle

Jeremiah Deboever

Paulo Radatz

Celco Rocha

Tallat Masood

Karen Montano-Martinez

Fluent in 8 languages

We are an extension ***of your team***

Aadityaa Padmanabhan
Protection Lead

Jeff Smith
Manager, T&D Ops & Planning

Mário Couto

Shammya Saha

Inalvis Alvarez Fernandez

Catie McEntee

Rob Sheridan

Van Holsomback

Don Von Dollen

Wes Sunderman

Arin Nichols

Greg Adams

Davis Montenegro

Prajjwal Gautam

Alessio Coccia

Kevin Reeser

About EPRI

Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together, we are shaping the future of energy.

3002026093

3420 Hillview Avenue, Palo Alto, California 94304-1338
PO Box 10412, Palo Alto, California 94303-0813, USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com