# Round Table Discussion and Session Summary

## Winter 2025 Advisory Meeting

Together... Shaping the Future of Energy®

Feb 24-26, 2025
Charlotte, NC

# Overview/Contents

Summary of key points brought up during roundtable, as well as EPRI research already addressing or to be started

Summary slides for each session

# Roundtable Summary

# Roundtable Questions Asked at the Meeting

- **Use of AI in operations and planning**
  - How is your company looking to use AI in the planning/operations space?
  - What capabilities are you using for Generative AI, e.g., which LLM(s) are you using, what use cases are you exploring?
  - Impact of AI on grid: How are you studying large loads – sequence, one at a time, or clusters?
- **EPRI value delivery and technology transfer**
  - What recent examples do you have for EPRI delivering value for your organization?
  - What types of deliverables are most useful to you? Videos, webcasts, reports, quick insights, etc.?
- **Implications of regulations**
  - What recent regulatory topics have been causing most concern for you/your department?
  - Are there particular technical areas where EPRI can support for regulatory discussions and how is that best done (papers, direct engagement, participation in standards, etc.)?

**Following slides summarize the feedback at the meeting**
**Please get in touch to find out more information**

# Roundtable Summary: Use Cases of AI

| Topic | EPRI Activity |
|---|---|
| Use of AI for search for technical material/information | EPRI working on benchmarking across TOP and EPRI-wide (results later this year); Prompt engineering guides as part of deliverables (several TOP efforts). Get in touch for more details! |
| Use of AI for interconnection | $AI^2$ DOE proposal → Vikas; use case repository |
| Use of AI in forecasting | New TI project on AI Forecasting (Justin Sharp) |
| Identifying potential AI use cases in operations and planning.<br>Other use cases identified without specific EPRI work:<br>• Congestion curtailment studies and benchmarking<br>• Transmission congestion and improving dispatch accuracy<br>• IBR performance and high-speed load switching<br>• IBR compliance verification of IBR plants<br>• AI for routine report completion and voice command reviews | AI use case repository (AI.GRID→ Adrian Kelly); EPRI will update based on input from advisory and sector meetings, and send out revamped version later in 2025 |

Text Color Key – Ongoing/recent work; new or recently started work; no plans

Please get in touch to find out more information

# Roundtable Summary: Large Load and IBR Interconnections

| Topic | EPRI Activity |
|---|---|
| Need for general guidance on large load interconnection | P40A (modeling), 40D (PQ/Stability), DCFlex (interconnection). Key contact – Parag Mitra |
| Subsynchronous Oscillation Studies | P40D modeling/screening, P39E PMU applications (Sudipta) |
| Operational experience on large loads | DCFlex operations/demos for flexibility, P39B experiences and guidelines (David) |
| Need fast screening techniques for interconnection requests | Hosting capacity tool (Swaroop), insights from O2023 |
| Verification of IBR plant | P173A model verification and analysis (Deepak); compliance verification work in supplemental project |
| Power quality issues with large loads | P40D work on PQ and large loads (Bob A.) |
| Flexibility needs in operations | P173B (Andreas) |
| IEEE 1547 and 2800 standards | Standards Engagement (Jens); new standards interest group and user group on compliance verification |
| Hybrid plants with battery charging | Efforts across markets (246 - Nikita); balancing/reserves (Miguel) and modeling (Deepak) |

Text Color Key – Ongoing/recent work; new or recently started work; no plans

Please get in touch to find out more information

# Roundtable Summary: Technical Support for Regulatory and Compliance

| Topic | EPRI Activity |
|---|---|
| Integrated planning and application for O1920 | P40C, R&D application projects, and new O1920 supplemental project (Eric) |
| Communication of RA metrics and associated outputs to senior management and regulatory agencies | 173C efforts with members (Genevieve) |
| Compliance requirements and fast screening for interconnections | Interconnection efforts; i2x; use of AI? (Jens) |
| FERC 901 and relevant NERC activities | Support for implementation of standards (173A; 173D); NERC/FERC engagement (Manish) |

Text Color Key – Ongoing/recent work; new or recently started work; no plans

Please get in touch to find out more information

# Roundtable Summary: Other Misc. Technical Topics

| Topic | EPRI Activity |
|---|---|
| Node-breaker modeling | P40E – Building node-breaker models in planning cases from EMS data and mapping operation and planning models. (Tamer) |
| NERC TPL-001-05 contingency generation | P40E – Generating contingency (P1-P7) definitions for NERC reliability studies. (Tamer) |
| New 765 kV overlay planned on top of 345 kV | Potential for new effort in this area? Coordinating with Transmission Assets group in 2025 |
| Linking AAR/DLR with EMS (SRP) | GET SET efforts on DLR integration into operations; 39B operations guide w/GETS, 246 (Alberto) |

Text Color Key – Ongoing/recent work; new or recently started work; no plans

Please get in touch to find out more information

# Roundtable Summary: Tech Transfer of EPRI Research

| Topic | EPRI Activity |
|---|---|
| **Recent examples of tech transfer of EPRI research –**<br>1. P173C + RA Initiative to communicate with the senior management (Duke)<br>2. Black start planning (TVA,Xcel)<br>3. HVDC supplemental on grid code (SPP)<br>4. IBR penetration and inertia study (SRP) | |
| **Potential training topics identified –**<br>1. EMT modeling<br>2. Grid forming controls | Contact Blaine Burton on training needs |
| **Pain points –**<br>1. Installing EPRI tools<br>2. Easy access to EPRI products, ease of use of the website | TOP software strategy (Jay)<br>Use of AI (upcoming epri/AI collaboration) |
| Develop topical white papers (Grid India) | Share some of the recent papers on TOP.EPRI.COM website |

Text Color Key – Ongoing/recent work; new or recently started work; no plans

Please get in touch to find out more information

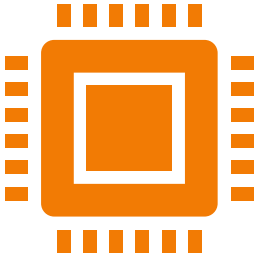
# Session Summaries

# High Level Overview – P39, P40 & P173

| | Monday 24 | Tuesday 25 | Wednesday 26 |
|---|---|---|---|
| Morning | Opening Keynote Review of 2024 | Planning Software Tools Carousel | Recent and New Cross EPRI Initiatives |
| | | Next-Gen Trans. Ops Modeling & Digital Twins | |
| | EPRI Highlights Roundtables | System Protection Updates | Special Studies for Trans. Planning |
| | | Ops Carousel | Managing IBRs in Operations |
| Afternoon | Integration of Power Electronics Based Resources and Loads | EPRI Lab Tour | IBR Integration Industry Landscape |
| | | | Enhancing Resilience in Operations |
| | Leveraging AI in Operations and Planning | Training and Educating for Evolving Grid | Long Term Trans. Planning Uncertainty & Risk |
| | | Advancing Integrated Planning | Future-ready Outage Planning |
| | Group Dinner | Joint Reception with ESCA | |

| Session Type | Location |
|---|---|
| TO&P Program | 741DEF |
| Session 1 Planning TF | 741DEF |
| Session 2 Operations TF | 741ABC |
| Joint Session | 741ABC |
| Lab Tour | EPRI Building 1 |
| Group Dinner | Culinary Dropout |
| Reception | EPRI Cafeteria |

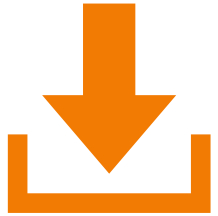
# Download Meeting Materials



## SFTP website

Materials were **posted in live time** throughout the Advisory meetings as they become available.

- https://eprisftp.epri.com
  Username: Trans.Ops.Guest
  Password: 2025TOPAdvisory!



## Member Center

Meeting Materials are available for download in the Member Center.

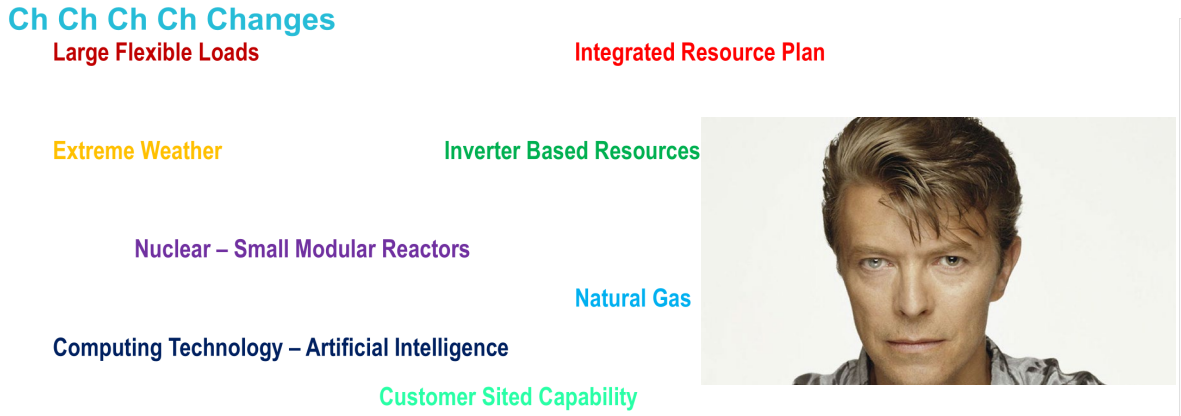
- P39: Transmission Operations
- P40: Transmission Planning
- P173: Bulk System Integration of Renewable/DER
- P246: Electricity Market Design and Operation

# Monday 24

# Keynotes – Collaborate to Manage the Pace of Change!!

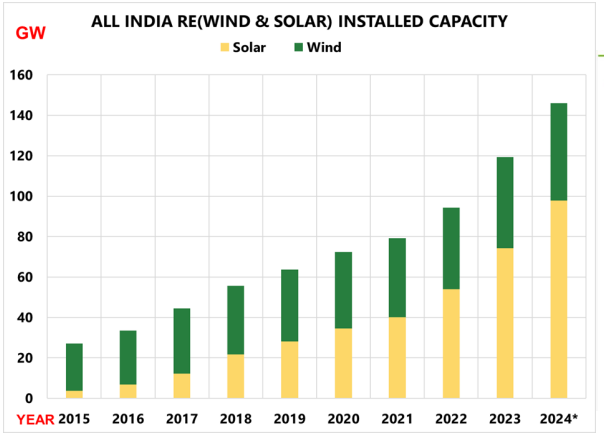
## Sam Holeman – Duke Energy

- Key changes happening in the industry – loads, generation, delivery, extreme events, customers, etc.
- David Bowie links it together!!
- Motivation for us to be here and collaborate




## Rajiv Porwal – Grid-India

- Increasing penetration of RES in India to meet energy transition challenges
- Reviewed key activities to meet renewable integration needs
- Identified areas for collaboration and knowledge sharing



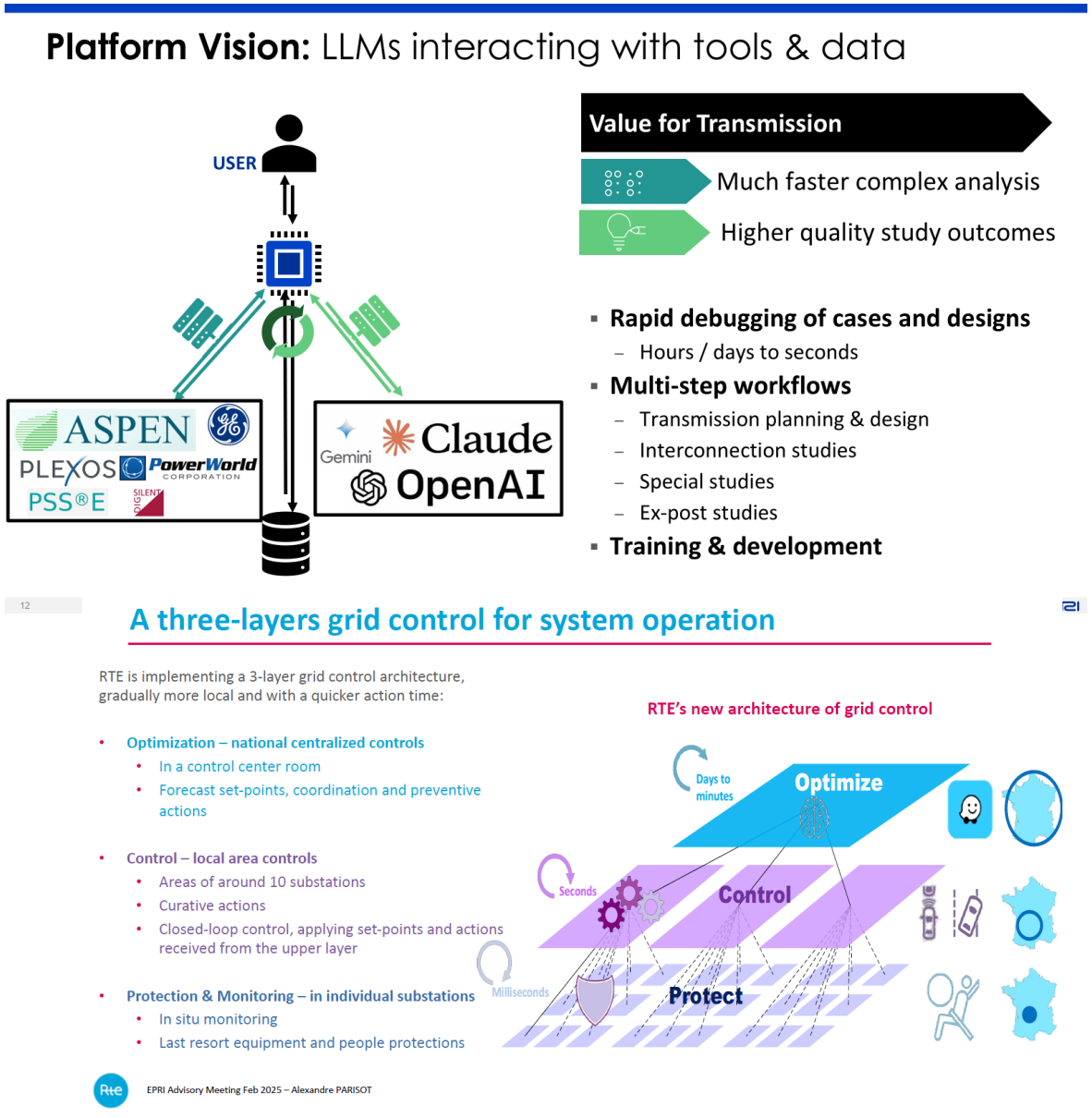

# Integration of Power Electronics-Based Resources and Loads: The Journey Continues

- Grid Controller of India – Challenges with IBR in India
  - Increased number of IBR related events resulting in loss of 1000 MW or more. Fault ride through failure one of the primary reasons
  - Development of robust compliance verification and sustainable periodic testing and model validation frameworks are high priority
- EPRI – Grid Forming around the world
  - The hierarchy of control objectives within an IBR plant can determine its nature and performance, spanning a continuum from non-GFM to GFM
  - Development of performance requirements, adequate modeling and parameterization, and testing/verification are important avenues
- NERC – Large Loads Task Force
  - Data center electricity use is expected to grow to a maximum of 12% of Total U.S. electricity use by 2028
  - The task force is developing a white paper that would aim to characterize the risks and identify gaps in existing practices
- EPRI – Load Modeling
  - Research work continues with focus on large loads including data centers and beyond such as Crypto Mining, EV Charging, Hydrogen Electrolyzers
  - The performance of the EV charger in addition to the EV itself, is important to evaluate and get an understanding.

Deepak Ramasubramanian dramasubramanian@epri.com , Parag Mitra pmitra@epri.com

# Leveraging AI In Operations and Planning

- EPRI's latest efforts in AI for ops/planning
  - Sean McGuinness: Use to support system protection – how can you use AI to support studies? What are the key abilities and limitations, and what can EPRI to do advance state of the art?
  - Adrian Kelly: AI for Alarms and Operations: Reviewed aLLarMA tool for integrating alarm and operational data with an LLM
  - Razvan Pabat-Stroe: Use of AI as an optimization assistant for real time ops
- RTE discussion on use of AI for system operations across system optimization, control and protection
- Group breakouts on AI use cases
  - Compiled and will be added to EPRI AI use case
  - Contact Adrian Kelly for more information



# Tuesday 25

# IBR ID/CA Tool – *I*nverter *B*ased *R*esource Performance *Id*entification and *C*onformity *A*ssessment Tool

Carousel Topic

**EPRI Member Need**

Ability to identify performance characteristics of an IBR simulation model and validate its performance across various simulation domains. Also to verify conformance against any standards/grid codes that may be present

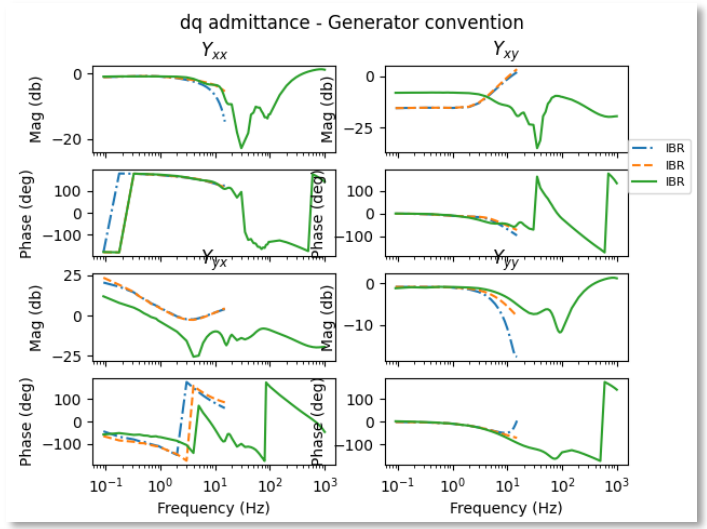
**2025 Research Objective**

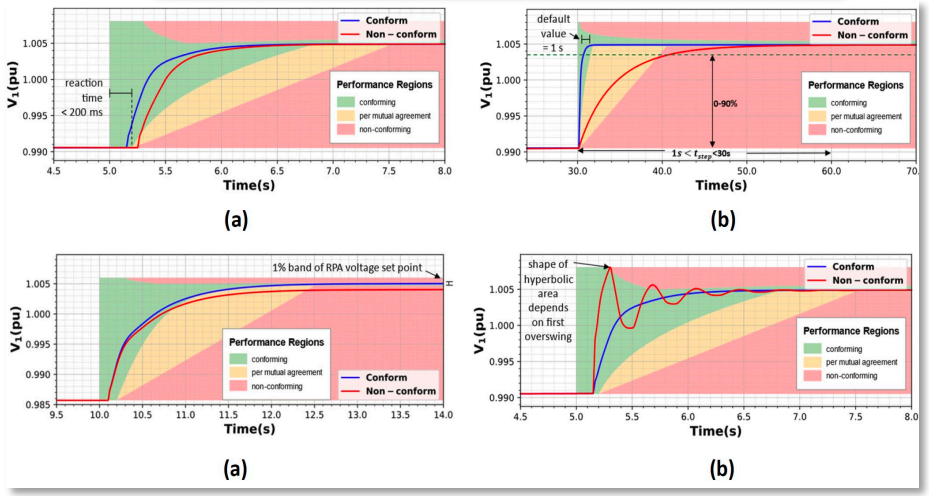
Develop and deliver a performance identification and conformance verification tool that can be used to test IBR models across various simulation domains.

**Scope**

1. Define list of tests, both time domain and frequency domain to be used to identify performance and verify conformance.
2. Develop software modules that can apply and carry out the tests across EMT and positive sequence domain
3. Verify performance and conformance of both generic and user defined models.
4. Deliver software

SCAN ME




**Deliverable Type(s): Software**

**Deliverable Date(s): Q2 2025**

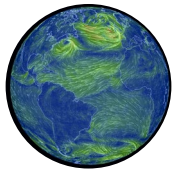
# The Risk Screening Tool (climate RiSc) and the climate RiSc Users' Group

Carousel Topic

1

## Identify & Characterize Stress Test Events

Screen for extreme events over large climate data set, group and select events

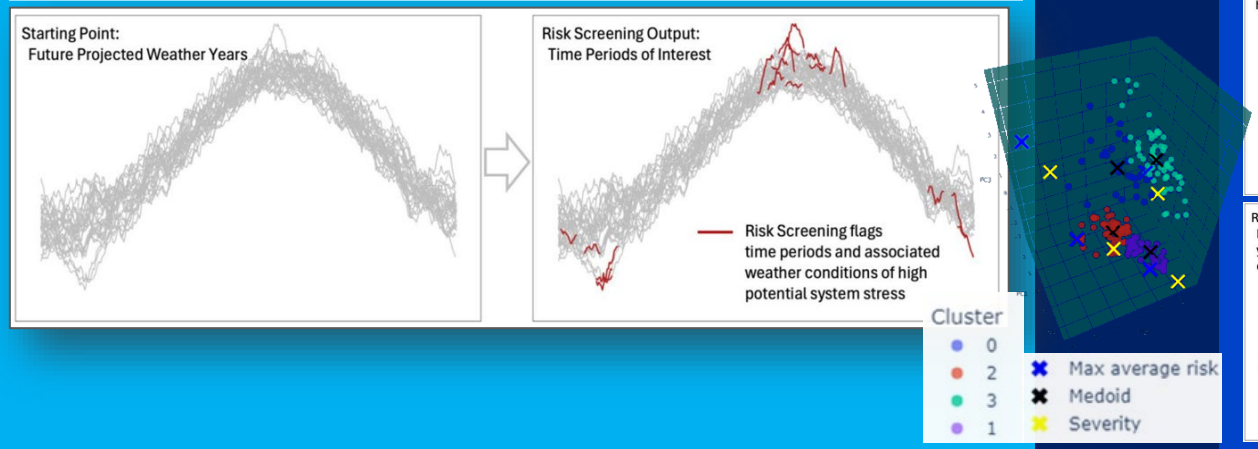


Decades of weather from millions of locations that…

- Can be trend adjusted and/or mapped to…
- Multiple climate model representations of…
- Multiple emissions scenarios

⇒ Hundreds of weather years at millions of points globally, representing past variability and future estimates

**RiSc identifies, and clusters the set of extreme events (1) used to plan the system and (2) additional events required to test the effectiveness of the plans**



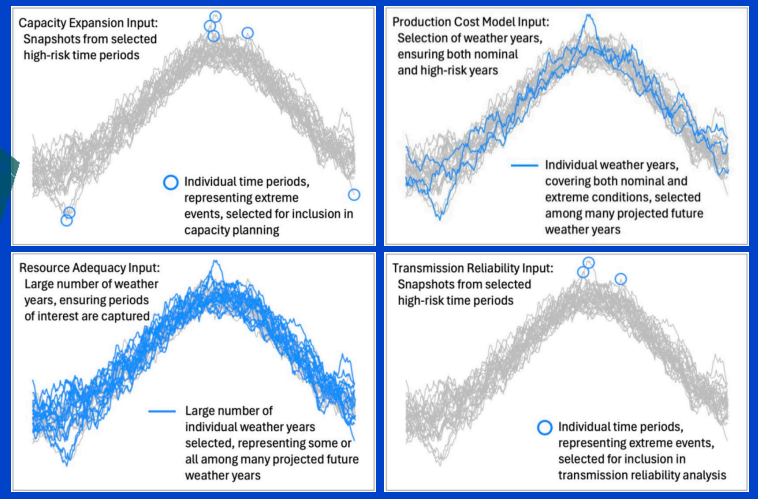

RiSc is step 1 in EPRI's 3-step stress testing approach. It is an open-source, transparent framework providing an efficient, replicable and standardized process to screen for scarcity events across large datasets portraying past and/or projected climate, and cluster similar events.

RiSc output feeds across all bulk-system planning models, establishing a consistent basis for assessment

2

## Build Range of Hi-Fidelity Scenarios for Each Event

Initialize stress test events multiple ways and add high resolution demand, renewables, failure and fuels data




3

## Simulate System Performance Under Stress

Simulate each event-scenario with operational simulator to understand operational performance

RiSc is Open Source

Become a RiSc Power User by Joining the RiSc Users Group Collaborative Supplemental

For details contact:
Justin Sharp
jsharp@epri.com

# RiSc has been Delivered as Open Source and EPRI is Supporting the Industry to Use it to Implement Stress Testing in Power System Assessments.

Carousel Topic

| Education and Support | Engagement | Collaboration |
|---|---|---|
| • Learn about use cases where RiSc can help your organization<br>• Get help installing, configuring and running the software<br>• Early access to bug fixes and enhancements<br>• Access to SME knowledge | • Work with experts to understand how different data and configurations impact results<br>• Get a seat at the table to advocate for additions and improvements to the tool and data<br>• Help set priorities | • Share experiences with peer organizations and learn from others<br>• Collectively drive and contribute to tool improvements<br>• Drive future development and potentially find partners to share effort and cost (UG supplementals) |

## Become a RiSc Power User by Joining the RiSc Users Group Collaborative Supplemental


### User Group

An EPRI user community to support RiSc users and secure the long- term development and sustainability of the RiSc tool

### Open Source RiSc v1.0

EPRI has delivered an open-source version of RiSc to accelerate adoption. EPRI will continue to support the development of RiSc through Climate READi in the mid term

### Custom Implementations

EPRI can help with custom implementations of RiSc in support or planning and operational planning processes, and is already supporting several entities in this process

# RSIF- Summary

Carousel Topic

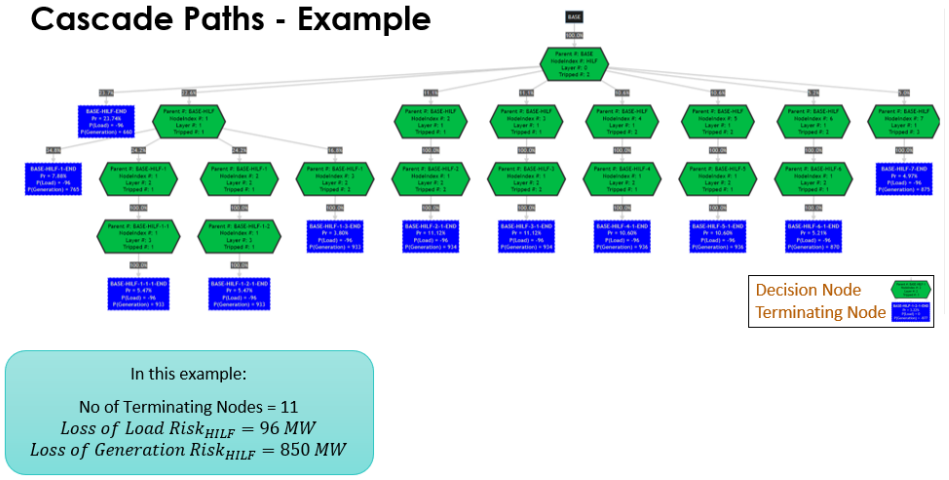
Wrapper around PSS/E that automates the cascade analysis of contingencies and provides additional insights for planners

Originally designed for power system resilience analysis, this tool offers a wide range of applications for cascade analysis

TPL-008-1 **Requires** cascade analysis for P1 and P7 contingencies

Existing commercial tools lack this capability

RSIF can efficiently conduct such analysis

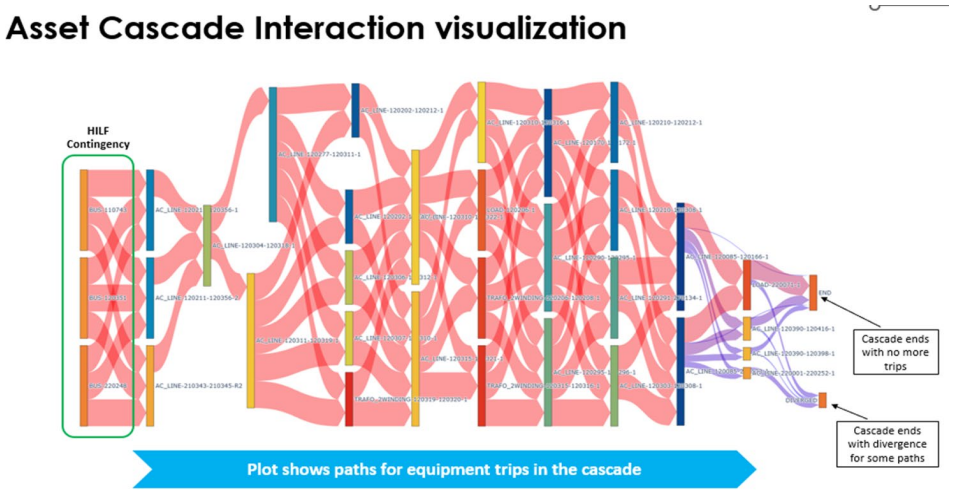



In this example:

No of Terminating Nodes = 11

$Loss\ of\ Load\ Risk_{HILF} = 96\ MW$

$Loss\ of\ Generation\ Risk_{HILF} = 850\ MW$




Contact: Dinesh Dhungana (ddhungana@epri.com)

# Training and Educating for an Evolving Grid

## Michael McAmis (TVA): Training Needs

- New types of generation
- Grid supporting technologies
- Standards!

## Michelle Wood (Xcel): Training Needs

- Changing system dynamics
- Simulator training for operators
- Coordination amongst neighbors and DSPs

## Robert Haromszeki (EPRI): EPRI University for Transmission (EU4T)

- EU4T Offerings
- Recap on 2024 Stats
- Poll for new topics

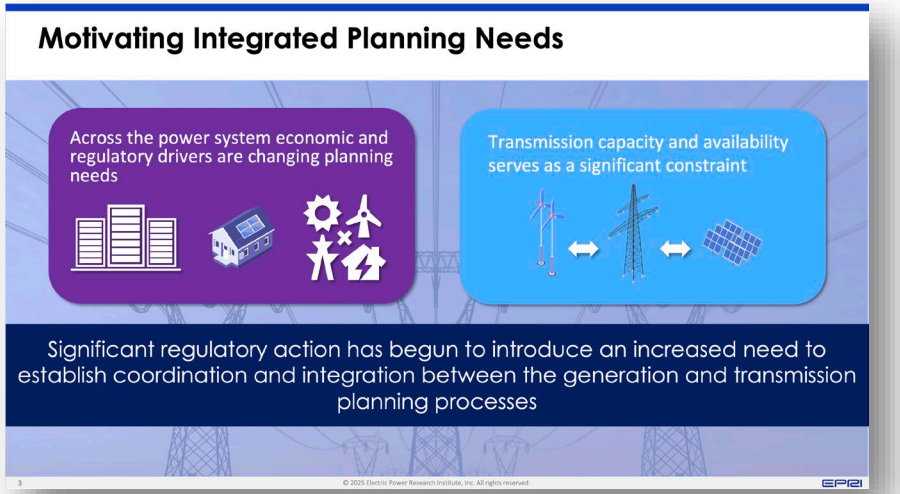
## Blaine Burton (EPRI): TOP Training Delivery

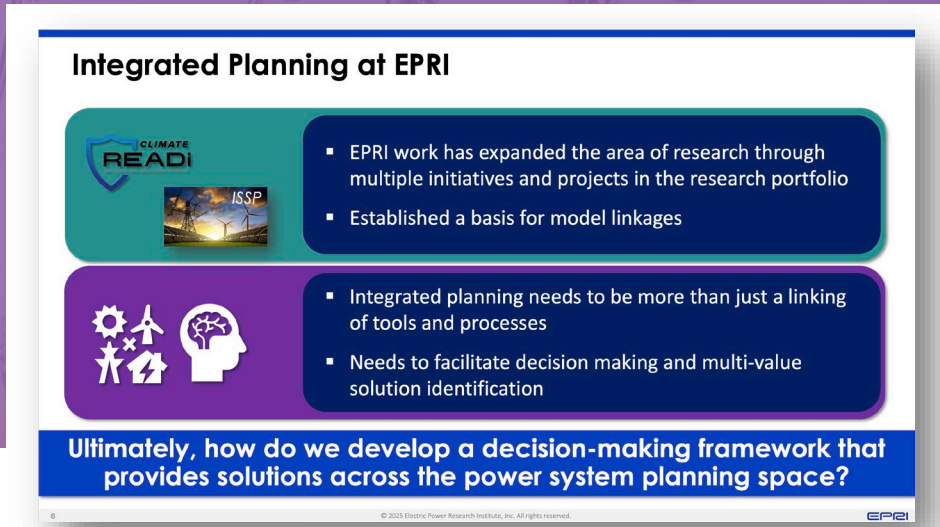
- Background on Training Needs
- TOP Training Offering Types
- Benefits of EPRI Training

**Contact: Blaine Burton, bburton@epri.com**

# Joint Session: Advancing Integrated Planning

- Joint session between TOP and ESCA
  - EPRI team discussed ongoing efforts to leverage initiative learning on integrated planning into the ARP
- Group breakout discussions focused on four key research questions:
  1. Data Needs and Structures to integrate between generation and transmission planning. What data are common and available? Where do data needs diverge?
  2. How can AI be used to accelerate and facilitate integrated planning?
  3. How are scenarios generated for individual components of integrated planning? What scenarios are common and what scenarios diverge? (e.g. min load forecasts vs peak forecasts).
  4. What tools are you using or plan to use to facilitate integrated planning



# Wednesday 26

# Initiatives: Carousel Session

GET SET
Grid-Enhancing Technologies for a Smart Energy Transition

Alberto Del Rosso

CLIMATE READi
RESILIENCE AND ADAPTATION INITIATIVE

Eknath Vittal

GridIMPACT
Grid Infrastructure & Modernization to Propel a Clean Energy Transition

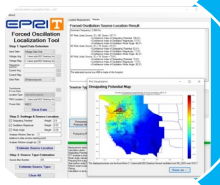
Aidan Tuohy

DCFlex
Data Center Flexible Load

Parag Mitra


**Discussed each of above initiatives and got feedback from members; to follow up on any of these, contact the person listed**

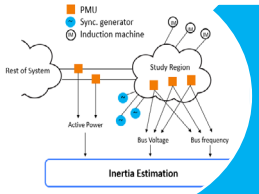
# Session: Managing IBRs in Operations




**Operations Challenge**: IBR Induced Oscillations

**Industry Presentation**: PMU-based IBR Oscillation Monitoring at SRP, Matthew Rhodes (SRP)

**EPRI Related R&D**: PS39E, Forced Oscillation Localization Tool (FOLT)




**Operations Challenge**: Declining System Inertia – Frequency Response Adequacy

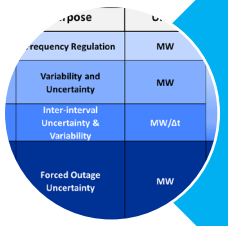
**Industry Presentation**: Inertia Estimation & Monitoring at KEPCO, Jiyoung Song (KEPCO)

**EPRI Related R&D**: PS39E & PS173B, Inertia Estimation Toolbox (IET), IBR Fast Frequency Response


**Operations Challenge**: IBR Volt/VAR Management and Control

**Industry Presentation**: Volt/Var Control Experience at Duke, Adam Guinn (Duke Energy)

**EPRI Related R&D**: PS39B: Voltage Control Optimization in Operations, VCA Studio




**Operations Challenge**: Operation under Variability and Uncertainty – Flexibility Adequacy

**Industry Presentation**: Research on Flexible Solar as a System Resource, Will Hobbs (Southern Company)

**EPRI Related R&D**: PS173B, Uncertainty Management in Operations, Flexibility Reserve Requirements, DynADOR, DynADCR

Contact: Evangelos Farantatos, efarantatos@epri.com

# Special Studies for Transmission Planning Session

- This session focused on special studies (PS40D) and HVDC planning (PS40E) related to GMD, power quality, SSO, HVDC). This included:
  - Challenges with large-load Integration as it pertained to planning for power quality impact on transmission.
  - The use of AI in EMT simulations.
  - Increasing operating experiences of sub-synchronous events.
  - EPRI work in planning and operating HVDC networks.

- Utility Presentations
  - Olumide Aluko, Entergy, discussed experiences with SSO on the Entergy Network
  - Dasola Ademola, Dominion, discussed experiences with the implementation of TPL—007 “GMD Vulnerability Assessments”.
  - Dave Kempf, GRE, discussed the operational advantages of HVDC.

- For more information please contact:
  - Bob Arritt, barritt@epri.com 865-218-5908

# IBR Integration – Industry Landscape

- ESIG – Collaboration between EPRI and ESIG
  - Objective is to multiply and not duplicate efforts
  - ESIG helps identify new challenges and technologies while EPRI carries out deeper research/development of models and tools/ conducts comprehensive studies
- EPRI – Roadmapping efforts
  - An overview of four roadmap efforts were discussed. The roadmaps discussed were (i) System stability and tools, (ii) Adoption of EMT simulations, (iii) Future system strength, (iv) Future system security
- SPP – IEEE 2800 Adoption
  - Adoption of ride through requirements were carried out in 2024. Now, in the second phase, IBR voltage and frequency support capabilities would be leveraged.
  - In collaboration with industry stakeholders, will also look at GFM performance requirements for BESS
- EPRI – Modeling efforts 2025 and beyond
  - In addition to large loads, modeling efforts continue for (i) HVDC and FACTs devices, and (ii) IBRs and DERs
  - The generic model development process at EPRI can result in a more detailed generic model that goes above and beyond the capabilities of a WECC generic model. This is due to EPRI's worldwide membership, but learnings from these are transferred by EPRI staff to WECC over course of time.

Deepak Ramasubramanian dramasubramanian@epri.com , Parag Mitra pmitra@epri.com

# Session : Enhancing Resiliency in Operations

- The first part of the session focused on significant system events and defense plans related to power systems to prevent widespread outages.

- Key takeaways include the importance of effective Underfrequency Load Shedding (UFLS) strategies to prevent widespread outages during system disturbances

  - Challenges posed by changing generation mix

  - Need for adaptive UFLS schemes that can respond to real-time grid conditions.

# Session : Enhancing Resiliency in Operations

- The second part of the session focused on Role of IBR in System Restoration.

- David Plumb (TVA) and Michelle Wood (Xcel Energy) presented on case studies preformed in collaboration with EPRI on integration of different IBR technologies is restoration strategies.

  - Discussion was focused on modelling needs, network assessments, potential challenges and solutions to enable these technologies

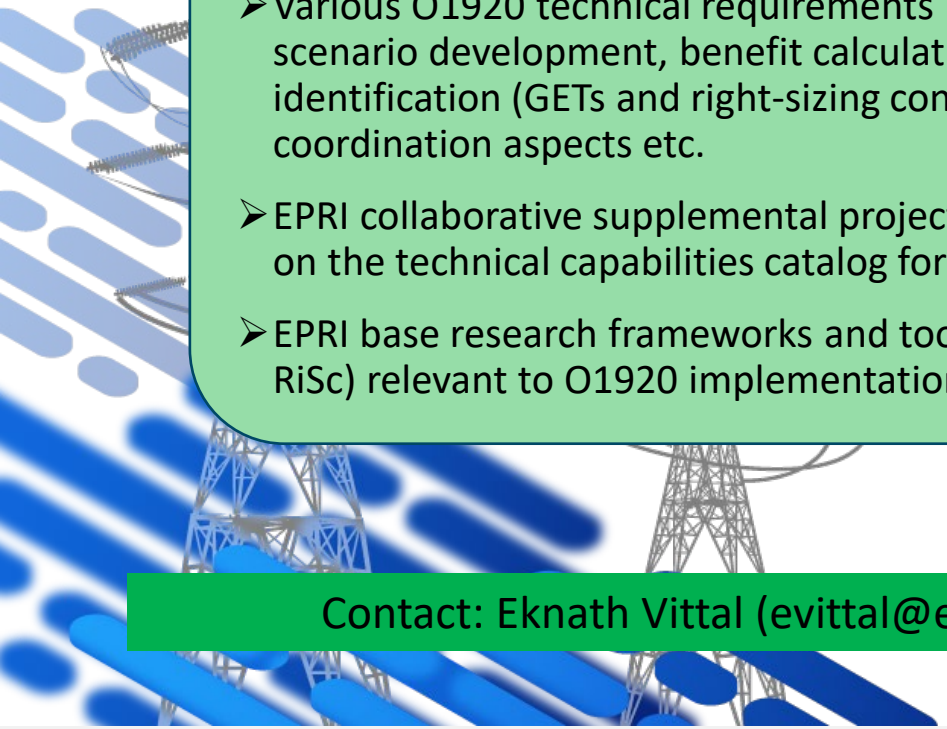
- Mel Schultz (NOWRDC) and Curtiss Fox (EPRI) shared key objectives and goals of a recently awarded project "Offshore Wind Blackstart Feasibility Framework"

# Long Term Transmission Planning – Uncertainty and Risk

## Research needs in implementing FERC Order 1920 – EPRI R&D insights

Discussions on:

- Various O1920 technical requirements including scenario development, benefit calculations, solution identification (GETs and right-sizing considerations), coordination aspects etc.
- EPRI collaborative supplemental project and update on the technical capabilities catalog for Task 1
- EPRI base research frameworks and tools (ACEP, HiLS, RiSc) relevant to O1920 implementation



Contact: Eknath Vittal (evittal@epri.com)

## Panel Discussion: Utility Perspective in implementing FERC Order 1920

- Emmanuele Bobbio (PJM), Sammy Robers (Duke Energy) and Eknath Vittal (EPRI) participated in the panel discussion
- Discussions around the need for guidance on important aspects of the order like the use of best available data, scenario selection, benefits calculation, etc.
- Discussions around how investment decisions can be made under uncertainty and relevant best practices
- Panelists emphasized the benefits of the collaborative as there is no one size fits all approach, and participants will be able to learn from each other

# Future Ready Operations Planning

## Blaine Burton (EPRI): Future Operations Roadmap and Gaps

- Survey by John Simonelli of Flashover, LLC
- Hot topics and concerns throughout the industry w.r.t. Operations
- Identify Research Gaps and next steps

## Slava Maslennikov (ISO-NE): Moving Towards Risk-Based Dispatch

- Using tools and data to calculate risk in Operations
- Ability to incorporate weather and cascading into outage analysis

## David Duebner (MISO): Centralized Outage Processing System

- Moving towards automation of outage processing
- Ability to analyze multiple scenarios
- Improve outage study processes

## Blaine Burton (EPRI): P39D Optimal Outage Scheduling

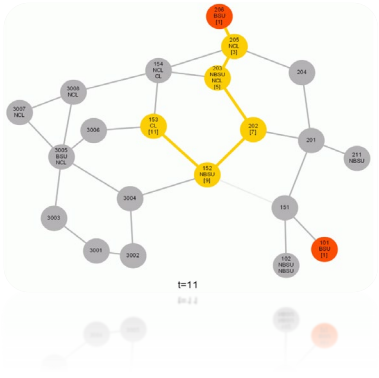
- Moving from reactive to proactive outage scheduling
- Optimize outages against scenarios and N-1 reliability criteria
- Focus on case studies and expanding methodology in 2025

**Contact: Blaine Burton, bburton@epri.com**

# EPRI PS39C : System Restoration and Emergency Operations

## *2025 Plan Overview*

### Restoration Optimization

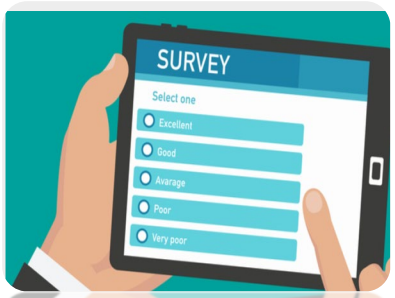


- Perform Case Studies
- Refine Probabilistic restoration framework
- Further develop OBC and SRN tools.

### Role of IBR and NPP in Restoration

- **Support members on case studies and live demonstration**
- **Update Guidelines and recommendations** for integration of IBR in restoration strategies
- Learnings from NOWRDC offshore wind farm blackstart project
- NPP: Utility case study considering specific grid topology, dynamics and reactor types

### Industry Survey

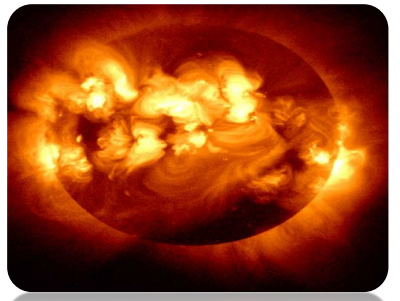



1. Identify industry trend
2. Understand what utilities are doing to address challenges
3. Provide overview of utility preparedness levels to inform strategy and investment decisions

### Emergency Operations

- **Improve situational awareness** following extreme control center contingencies – resilient state estimation framework
- **Grid modeled intrusion detection system** – analytical framework to automatically identify and remove anomalies (e.g., due to a cyber-attack) in SCADA data

### Guides, Tech Briefs, , Training



- **System defense plans** : Focus on challenges of UFLS practices and potential future solutions
- Blackstart Testing : **Large transformer energization case studies considering different grid and generation configurations**

**Develop guidelines, processes and tool to support reliable operation of power system during and following extreme events**

# Save the Date

# TOP 2025 Kick Off Webcasts

| Project Set | Date | Time | Meeting Link |
|---|---|---|---|
| **PS39A** Real-time Operations and Situational Awareness | Completed | | Materials |
| **PS39B** Volt/Var Management and Power Flow Control | March 18th | 1:00 PM – 2:00 PM | Join the Meeting |
| **PS39C** System Restoration and Emergency Operations | March 27th | 1:00 PM – 2:00 PM | Join the Meeting |
| **PS39D** Operations Planning and Engineering Support Studies | March 20th | 1:00 PM – 2:00 PM | Join the Meeting |
| **PS39E** Monitoring, Analysis, and Control Using Synchrophasors | March 17th | 1:00 PM – 2:00 PM | Join the Meeting |
| **PS40A** Model Development, Validation, and Management | Completed | | Materials |
| **PS40B** Protection Methods, Tools, and Guides | Completed | | Materials |
| **PS40C** Methods and Frameworks for Advancing Transmission Planning | March 13th | 1:00 PM – 2:00 PM | Join the Meeting |
| **PS40D** Special Assessments Supporting Transmission Planning | Completed | | Materials |
| **PS40E** Analytics for Emerging Transmission Planning Needs | March 12th | 1:00 PM – 2:00 PM | Join the Meeting |
| **PS173A** Modeling and Analytics for Emerging Technologies | March 10th | 12:00 PM – 1:00 PM | Join the Meeting |
| **PS173B** Operator Support Tools and Methods for Emerging Technologies | Completed | | Materials |
| **PS173C** Flexibility and Resource Adequacy Assessment | March 11th | 11:00 AM – 12:00 PM | Join the Meeting |
| **PS173D** Technology Transfer | March 24th | 1:00 PM – 2:00 PM | Join the Meeting |
| **P246** Electricity Market Design and Operation | Completed | | Materials |

*all times in Eastern

# September

# 8 - 11

EPRI ED&CS Advisory &
Sector Council Meeting
Fall 2025

**Marriott Marquis Houston**
1777 Walker St.,
Houston, TX 77010

# 2025 Mark your Calendars