Welcome to the third (but first “real”) Smart Grid Advisory meeting

- Welcome
  - Logistics
  - Purpose & “Style” of meeting
  - Attendees (Collaborators, Peer Review, Stakeholders)
  - Feedback (Survey) & Next Meeting(s)

- 1 ½ Day Agenda

- Smart Grid Demo Overview & Update
  - Brief Overview of Smart Grid Demonstration Initiative
  - Membership Update
  - Project Plan Update (Status of Tasks)
  - Host-Sites
The 3rd Smart Grid Advisory Meeting Agenda

Tuesday
6/23
2:00 pm – 2:10 pm Welcome & Introductions
2:10 pm – 3:00 pm Smart Grid Demo Project Status & Update (Matt Wakefield, EPRI)
3:00 pm – 4:45 pm First Energy Demo of IDER system (Eva Gardow, EPRI)
5:00 pm – 6:30 pm Bus Returns to Molly Pitcher Inn & Dinner (Molly Pitcher Inn)

Wednesday
6/24
7:40 am Bus Pickup from Molly Pitcher Inn to JCP&L Facility (Meet in Hotel Lobby at 7:30)
8:00 am – 8:30 am Welcome & Introductions
8:45 am – 9:15 am Benefits of Smart Grid Interoperability & Collaboration with Smart Grid Partners (Stephanie Hamilton, EPRI)
9:30 am – 10:00 am PNSC Update on DER Integration White Paper (Wade Goodric, Texas A&M)
10:00 am – 10:15 am Morning Break
10:15 am – 10:40 am FE Project Update (Eva Gardow, FE)
10:45 am – 11:15 am PHE Project Update (Carla Barlow, PHE)
11:15 am – 12:00 pm Con Edison Project Update (Frank Delokey, Con Edison)
12:00 pm – 12:10 pm Dan Lynch, President JCP&L. Welcome & Lunch
12:30 pm – 1:00 pm Working Lunch Topic: NIST Roadmap Update (Mark McGranaghan, EPRI)
1:00 pm – 1:30 pm Task 2.6 TVA/Bradenton Water Heater Analytics Update (Anna Morgan, TVA)
1:30 pm – 2:10 pm Task 1.1 & 2.4 Regional Profiles & Aggregation Methods & Tools (Angela Chuang, EPRI)
2:30 pm – 2:45 pm Afternoon Break
2:45 pm – 3:15 pm Task 1.5 Economic Framework Assessment Update (Steve Bossart, NETL & Bernie Neenan, EPRI)
3:15 pm – 3:45 pm Task 2.5 DER Controller Update (Gale Horst, EPRI)
3:45 pm – 4:15 pm Task 1.3 Identify & Evaluate Analytical Tools for Planning & Operations (Heidi Mitchell, Dynamic Energy Group)

Round Table: Member Smart Grid Activities & Member collaboration opportunities
4:15 pm – 5:20 pm
5:15 pm – 5:30 pm Wrap-up / Adjourn, Bus Returns to Molly Pitcher by 6pm

EPRI's Smart Grid Demonstration Team

Smart Grid Director
Mark McGranaghan

Program Manager
Smart Grid Demonstrations
Matt Wakefield

Smart Grid Industry Coordinator
Stephanie Hamilton

IntelliGrid Use Cases
Sr. Engineer/Scientist
Brian Green

Smart Grid Host-Site Project Manager
Gale Horst

Smart Grid Project Manager
TBD

Smart Grid Project Manager
TBD

Sr. Technical Executive
Dr. Bernie Neenan (Economics)

Sr. Technical Executive
Roger Dugan (Modeling/ Simulator, OpenDSS)

IntelliGrid Team
Dr. Angela Chuang (Analytics)

IntelliGrid Team
Joe Hughes (Standards)

IntelliGrid Team
Brian Seal (AMI)

Renewables
Tom Key

Energy Efficiency
Ammi Amarnath

Energy Efficiency
Chris Holmes

Energy Efficiency
Krish Gomatom

Storage
Dam Ranzierz & Team

PHEVs
Mark Duvall & Team

POC Team
More
More
More

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Smart Grid Demonstration Participants
(Utilities that have given us permission to use their name. 6/06/2009)

Integrys Energy Group
Ameren
KCP&L
Southwest Power Pool
Salt River Project
PNM Resources
TVA
Entergy
Central Hudson Gas & Electric
ESB Networks
Con Edison
Electricité de France
FirstEnergy / JCP&L
PSE&G
AEP
Duke
Southern

- Collaborator
- Collaborator / Host-Site

Smart Grid – One of the Four Technology Challenges

CO₂ Emissions

1990
2030

-80% of Smart Grid Emissions
Reductions from Integrating DER

Avoided CO₂ Emissions, 2030 (Tg CO₂)*

<table>
<thead>
<tr>
<th>Direct Feedback</th>
<th>Low</th>
<th>High</th>
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<td>PHEV Integration</td>
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<td>Renewable Integration</td>
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<td>EE &amp; Demand Response</td>
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<td>Peak Load Mgmt</td>
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<td>Reduced Line Losses</td>
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<td>Cont. Comm. Large Commercial Buildings</td>
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% of Total U.S. CO₂ Emissions

-3% ~10%

* Source: EPRI Publication 1016905, The Green Grid Savings and GHG reduction Enabled by a Smart Grid

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EPRI Smart Grid Demonstrations

• Deploying the Virtual Power Plant

• Demonstrate Integration and Interoperability

• Several regional demonstrations
  – Multiple Levels of Integration
  – Multiple Types of Distributed Energy Resources & Storage

• Leverage information & Communication Technologies

Smart Grid Demonstration Approach

• Integration of DER with Utility Operations

  Market Operator

  Transmission Operator

  Distribution Control Center

  External corporations

• Ensure Interoperability of DER
  – Demonstrating use of common language to exchange information with distributed resources from various manufacturers
  – Multiple use of communication and metering infrastructure for control, measurement & verification of the dispatchable resource

  Shared Learning from Multiple Demonstrations and Use of EPRI’s IntelliGrid Architecture will Lend to Expandability, Scalability, and Repeatability
Collaboration with DOE Distribution Integration Awards

- IIT, Exelon/ComEd, Galvin Electricity, S&C – “perfect Power” demonstration
- Con Edison, Verizon, Innovative power, Infotility, Enernex – Interoperability between utility and end use customers for DG aggregation.
- SDG&E, Horizon Energy Group, Advanced Control Systems, PNNL, Univ of San Diego, Motorola, Lockheed Martin – Integrating multiple distributed resources with advanced controls.
- Univ of Hawaii, GE, HECO, MECO, Columbus Electric Coop, NM Inst of Mining and Tech, Senteck, UPC Wind – Mgt of distributed resources for improved quality and reliability, grid support, and transmission relief.
- Univ of Nevada, Pulte Homes, Nevada Power, GE Ecomagination – Integrated PV, battery storage, and consumer products with advanced metering.

Project Plan. Task 1 & Task 2

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<th>ID</th>
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<th>2009</th>
<th>2010</th>
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<th>2012</th>
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<td>Develop Regional Profiles</td>
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<td>Develop Integration Framework</td>
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<td>Identify &amp; Evaluate Analytical Tools</td>
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<td>4</td>
<td>Develop and Evaluate Approaches for CIG Impact</td>
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<td>5</td>
<td>Develop Framework for Economic Assessments</td>
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<td>Develop Scope and Mapping of IG Projects</td>
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<td>2.2 Develop Information Exchange Model to support System Operations</td>
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<td>2.3 Develop Comm Interfaces &amp; Control Algorithm for DER</td>
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<td>2.4 Develop Aggregation Methods &amp; Tools</td>
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<td>2.5 Develop DER Controller Requirements</td>
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<td>2.6 Lab Trials of Critical Integration Technologies</td>
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Project Plan. Task 3 & Task 4

### Task 3: Demonstrate Technologies & Systems in Actual Applications

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<td>3.2 Application of IntelliGrid Methodology – Use case development</td>
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<td>6</td>
<td>3.6 Detailed Application Plan for Field Demonstrations</td>
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<td>7</td>
<td>3.7 Field Data Collection &amp; Assessment</td>
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### Task 4: Technology Transfer

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<td>4.2 Coordination w/DOE, EPA, etc</td>
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<td>4.4 Use Case and Requirements Repository</td>
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<td>4.5 Technology Library</td>
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<td>4.6 Publications</td>
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### Task 1.4 Develop and Evaluate Approaches for CO₂ Impact

Leveraging Existing Work

- The Green Grid
- Prism Analysis (Update)

Smart Grid is Primarily an enabler for reduce CO₂

Next Phase will be Applying these learnings in the Demonstrations
2.1 Architecture Reference Design for DER

- Partnering with IBM on this Deliverable
- Case Studies where requirements exceed capabilities of deployed infrastructure
- Use Cases of DER
- Emerging Requirements of DER Communication & Controls – minimize risk of technology obsolescence
- Architectural considerations in the face of changing market requirements and opportunities
- Common Information Model (CIM) of Architecture
- Expect to complete Draft in Nov. Have Final in Dec.

2.2 Information Exchange Model to Support System Operations

- State of Industry
- Best Practices (Are ISO / RTO Models adequate for Utility Applications?)
- Security
- Leveraging Existing Efforts
- International Electrotechnical Commission (IEC) Technical Committee 57, Working Group 14 (IEC TC57 WG14)
- Expect 1st Deliverable in Jan. 2010

Recent Release:
- Part 9 of IEC 61968 specifies information content of a set of message types to support business functions of meter reading and control.
- Purpose – Information exchange between metering systems and utility enterprise.
- Link to Final Draft
NIST Smart Grid Roadmap Coordination

<table>
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<th>Standard</th>
<th>Application</th>
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<tr>
<td>AMI-SEC System Security Requirements</td>
<td>Advanced metering infrastructure (AMI) and Smart Grid end-to-end security</td>
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<td>ANSI C12.19/MC1219</td>
<td>Revenue metering information model</td>
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<td>BACnet ANSI ASHRAE 135-2008/ISO 16484-5</td>
<td>Building automation</td>
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<td>DIN3</td>
<td>Substation and feeder device automation</td>
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<td>IEC 60870-6 / TASE.2</td>
<td>Inter-control center communications</td>
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<tr>
<td>IEC 61850</td>
<td>Substation automation and protection</td>
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<tr>
<td>IEC 61966/61970</td>
<td>Application level energy management system interfaces</td>
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<tr>
<td>IEC 62351 Parts 1-8</td>
<td>Information security for power system control operations</td>
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<td>IEEE C37.118</td>
<td>Phasor measurement unit (PMU)communications</td>
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<td>IEEE 1547</td>
<td>Physical and electrical interconnections between utility and distributed generation (DG)</td>
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<td>IEEE 1686-2007</td>
<td>Security for intelligent electronic devices (IEDs)</td>
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<td>NERC CIP 002-009</td>
<td>Cyber security standards for the bulk power system</td>
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<tr>
<td>...NIST Special Publication (SP) 800-53, NIST SP 800-62</td>
<td>Cyber security standards and guidelines for federal information systems, including those for the bulk power system</td>
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<td>Open Automated Demand Response-OpenADR</td>
<td>Price responsive and direct load control</td>
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<td>OpenHAN</td>
<td>Home Area Network device communication, measurement, and control</td>
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<tr>
<td>ZigBee/HomePlug Smart Energy Profile</td>
<td>Home Area Network (HAN) Device Communications and Information Model</td>
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</tbody>
</table>

2.3 Develop Comm Interfaces & Control Algorithms for DER

- Task 2.1 & Task 2.2 are Prerequisites
- State of the art in Communication Interfaces for DER
- Gaps in Communication Interfaces
- Align Research Activities with Gaps in Demonstrations to “Fill-the-Gap”
- Expect 1st Deliverable in early to mid 2010
2.6 Lab/Field Trials of Critical Technologies

Active "Mini Projects"
- PV Integration
- Two-Way Control of Electric Water Heaters

Under Consideration or Development
- Community Energy Storage
- Underground Network Monitoring
- “Smart Home” Evaluation
- Customer Behavior with AMI Enabled Technologies

Task 2.6 - Opportunity for All Collaborators, especially non host-sites.
I want to ensure every member has the opportunity to participate in an active project that can benefit the member and the collaborative.

2.6 PV Integration

- To produce a communication specification for integrating PV inverters in utility programs
- Residential focused, larger systems noted
- Gaps identified, coordinated with SDOs
- Limited to a core set of functions... TBD
- Allowing flexibility for the phy/mac

Kickoff Workshop (June 23, 2009)

Webcast 1 (July 22, 2009)

Webcast 2 (Sept 9, 2009)

Wrap Up Meeting (October 26, 2009)

- Present data from pre-project studies
- Identify key applications
- Identify candidate standards

Study standards and architectures

Develop proposed approach

Prepare draft specification

Edit and correct specification

Engage SDOs

- Present proposed approach
- Get feedback

- Present draft specification
- Solicit comments

- Final specification
- Develop plan for continued work
2.6 Community/Neighborhood Energy Storage

Grid Functions
– Load Leveling / Peak Shaving
– Power Factor Correction (VAR Support)
– Ancillary Services

Load Functions
– Backup power for locally connected houses
– Local Voltage Control

Load Functions
– Backup power for locally connected houses
– Local Voltage Control

4.4 Use Case and Requirements Repository
4.5 Smart Grid Web-Site & Technology Library

Smart Grid Resource Center
This directory is an online database of EPRI Smart Grid research, wind and solar projects, and the Smart Grid Use Case Repository.
- A Smart Grid is a more efficient electric system with improved communication and control of electricity generation, delivery, and consumption in order to
  - enhance economic growth,
  - reduce pollution,
  - improve reliability and security,
  - reduce costs, and
  - improve energy efficiency.

Smart Grid Use Case Repository
This repository contains use cases for the electric power industry's diverse Smart Grid research and development efforts as well as provide a forum for the industry to collaboratively examine and expand their own efforts.
- Use Case Repository

Smart Grid Demonstrations
EPRI is conducting a series of industry demonstrations to validate the use and potential of Smart Grid technologies and concepts. The industry demonstrations provide an opportunity for all stakeholders to work together and report progress toward development and implementation objectives.
- SmartGridDemonstrations

Smart Grid Functions & Use Case Newsletter
- EPRI Smart Grid Functions & Use Cases Newsletter
- Dec 2009
- Feb 2009
- Oct 2008
- Dec 2008
- Oct 2008
- Dec 2008

4.6 Publications

Deliverables
1018945
Smart Grid Distributed Energy Resources (DER) Project Assessment

1018926
EPRI Pre-Conference Workshop: Active Distribution System Management for Integration of Distributed Resources Research, Development and Demonstration Needs
Workshop Proceedings, Nice, France, December 9, 2008
Smart Grid Host Sites Overview

<table>
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<tr>
<th>Resources</th>
<th>Consolidated Edison</th>
<th>FirstEnergy</th>
<th>PNM Resources</th>
<th>AEP</th>
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<td>-Distributed Generation</td>
<td>-Distributed Generation</td>
<td>-HVCe (Res., C&amp;I) DR</td>
<td>-Solar PV (residential &amp; System)</td>
<td>-Battery Storage</td>
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<td>-Electric Storage</td>
<td>-Storage &amp; DR</td>
<td>-Panel &amp; Conc. Solar</td>
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<td>-Wind Plant</td>
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<td>-Permanent Peak Shifting (electro-thermal storage)</td>
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<td>-Small Wind Systems</td>
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<td>-Nat Gas fired DG</td>
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<td>-T-Stat Control</td>
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<td>-PHEV Charging</td>
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<td>-Ice Bear (Thermal)</td>
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<td>-Volt/Var Mgmt</td>
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<td>Integration</td>
<td>End-to-end (Customer owned DG, DR provider, Con Edison, NYSO)</td>
<td>Real Time T&amp;D Ops &amp; Planning PJM</td>
<td>HAN, SCADA, System Ops &amp; Planning</td>
<td>System Ops &amp; Planning Simulation Software</td>
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<td>Diversity</td>
<td>Dense Urban Environment Customer Owned Resources</td>
<td>Smart Grid w/Out use of AMI system Master Controller Concept</td>
<td>Large deployment of Residential PV, Optimization Incl. Volt &amp; Freq control</td>
<td>Power Flow Communications</td>
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<td>Business Case</td>
<td>Increase Reliability</td>
<td>Grid efficiency and reliability at local level</td>
<td>15% peak load reduction at feeder</td>
<td>Reduce Risk of Smart Grid Deployment with Simulation Tools</td>
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<td>Furthers Industry</td>
<td>Interoperability of Distributed Energy Resources (DER)</td>
<td>Local delivery system Integration of DER</td>
<td>Technologies &amp; Standards for Renewable Integration</td>
<td>Risk Evaluation of DER Implementation Advances Simulation Tools</td>
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Smart Grid Demonstration Critical Elements

1. Integration of Multiple Distributed Resource Types
2. Connect retail customers to wholesale conditions
3. Integration with System Planning & Operations
4. Critical Integration Technologies and Standards
5. Compatibility with EPRI’s Initiative and Approach
6. Funding requirements and leverage of other funding resources
Host Site Selections (1-2 Selections Per Cycle)  
(Expect 8-12 in total. 4 Selected, 1 Under Review)

Host Site Selection Timeline

<table>
<thead>
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<th>Start Proposal Review Process No Later Than</th>
<th>Host Site Selection Timeline</th>
<th>Present Qualified Proposal at EPRI BOD Meeting</th>
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<td>End of May</td>
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Host-Site Selection Cycle. Requires AT LEAST 3 months

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<td>Utility Draft Proposal</td>
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<td>Peer Review</td>
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<td>Present to BOD</td>
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EDF Host-Site Peer Review Webcast

- Monday, July 6th 10-11am EDT (4-5pm Paris)
- EDF PREMIO Smart Grid Project
Summary

• Maximize the benefits of existing and planned investments
  – Communications and advanced metering infrastructures
  – Identify and further the foundation for demand side resource integration.

• Integration of distributed resources with utility system operations and planning

• Integration of distributed power generation, storage, demand response technology, and renewables into a virtual power plant.

• Demonstrations should further the industry in regards to integration of DER

• Expect 8-12 EPRI Demonstrations

Questions?