

EPRI Smart Grid Demonstration Overview

Smart Grid Advisory Meeting

6/23/2009

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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 - 8:30 pm | Bus Returns to Molly Pitcher Inn & Dinner (Molly Pitcher Inn) |

Wednesday
6/24

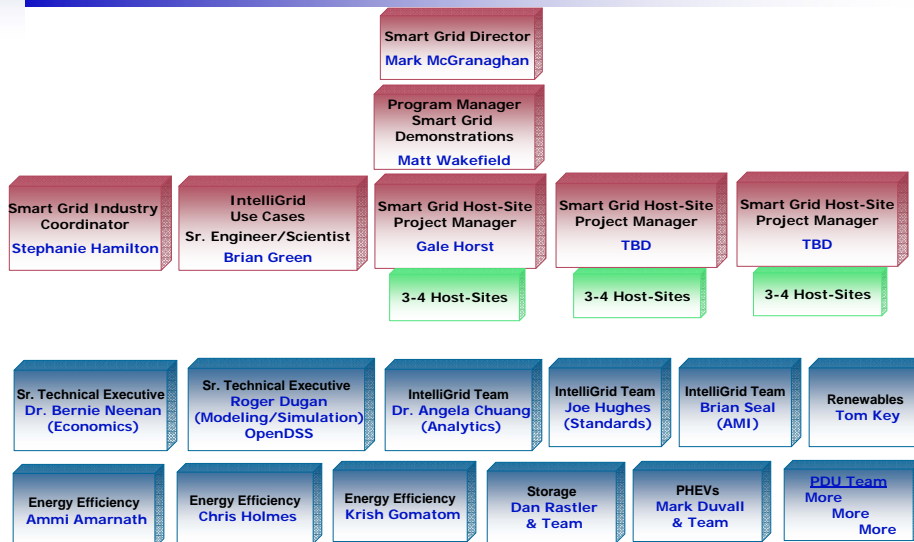
| | |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7:40 am | Bus Pickup from Molly Pitcher Inn to JCP&L Facility (Meet in Hotel Lobby at 7:30) |
| 8:00 am - 8:30 am | Registration / Continental Breakfast. Location: JCP&L Office |
| 8:30 am - 8:45 am | Welcome & Introductions |
| 8:45 am - 9:30 am | Benefits of Smart Grid Interoperability & Collaboration with Smart Grid Partners (Stephanie Hamilton, EPRI) |
| 9:30 am - 10:00 am | PSERC Update on DER Integration White Paper (Mladen Kezunovic, Texas A&M) |
| 10:00 am - 10:15 am | Morning Break |
| 10:15 am - 10:40 am | FE Project Update (Eva Gardow, FE) |
| 10:40 am - 11:05 am | PNM Project Update (Carla Barlow, PNM) |
| 11:05 am - 11:30 am | Con Edison Project Update (Frank Doherty, Con Edison) |
| 11:30 - 12:00 pm | AEP Project Overview (Tom Walker, AEP) |
| 12:00 pm - 12:10 pm | Don 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/Bristol Water Heater Analytics Update (Anna Morgan, TVA) |
| 1:30 pm - 2:30 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) Task 1.6 Deliverable: Scoping & Mapping of Smart Grid Projects (Matt Wakefield, EPRI) |
| 4:15 pm - 5:20 | Round Table: Member Smart Grid Activities & Member collaboration opportunities |
| 5:15 pm - 5:30 pm | Wrap-up / Adjourn, Bus Returns to Molly Pitcher by 6pm |

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EPRI's Smart Grid Demonstration Team



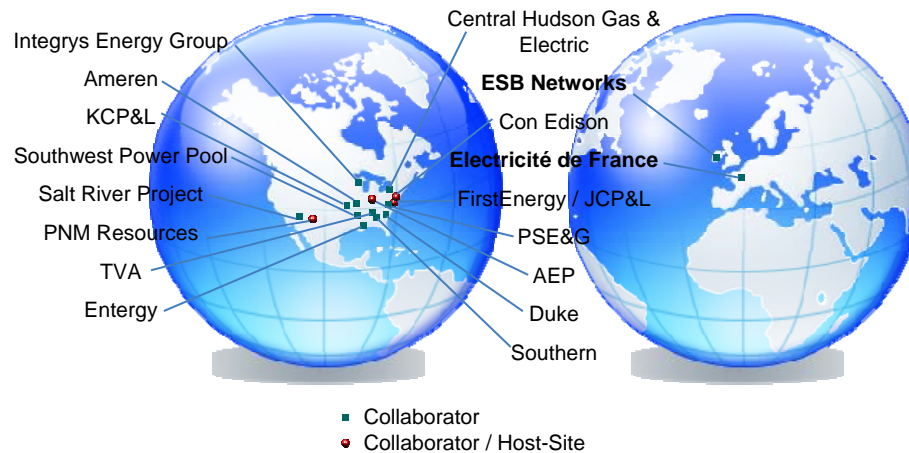
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Smart Grid Demonstration Participants

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

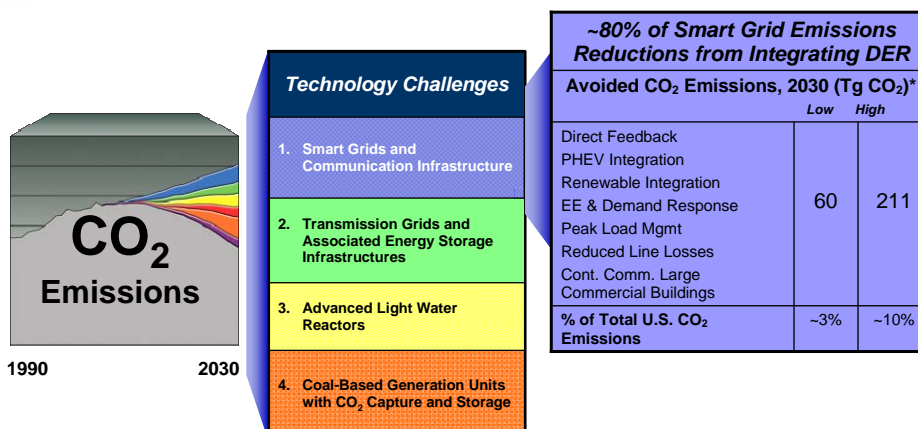


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Smart Grid – One of the Four Technology Challenges



* 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



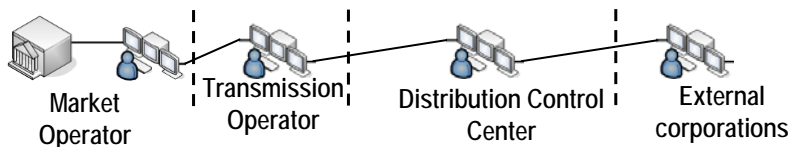
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Smart Grid Demonstration Approach

• Integration of DER with Utility Operations



• 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 Lead to Expandability, Scalability, and Repeatability

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Collaboration with DOE Distribution Integration Awards



- Allegheny Power, WVU, NC State, Research & Development Solutions, Augusta Systems, Tollgrade – **West Virginia Super Circuit**
- ATK Launch Systems, Rocky Mountain Power, P&E Automation – **integration of renewables, DG, and storage (compressed air).**
- Chevron Energy Solutions, Alameda County, PG&E, VRN Power Systems, SatCon, Univ of Wisc., NREL, LBNL, E3 – **Solar, fuel cell and storage microgrid.**
- City of Fort Collins, Colorado State Univ, InteGrid Lab, Comm Found of Northern Col, Governor's Energy Office, Advanced Energy, Woodward Spirae, Eaton – **3.5 MW mixed distributed resources for peak load reduction.**
- 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, Sentech, 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.**

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Project Plan. Task 1 & Task 2

✓ = Presentation during meeting ✓ = Update Now

| ID | Task 1: Analytics on integrations approaches and impact of Distributed Resources | 2008 | 2009 | | | | 2010 | | | | 2011 | | | | 2012 | | | | 2013 | |
|----|----------------------------------------------------------------------------------|------|------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|----|
| | | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 |
| 1 | 1.1 Develop Regional Profiles | | | | | | | | | | | | | | | | | | | |
| 2 | 1.2 Develop Integration Framework | | | | | | | | | | | | | | | | | | | |
| 3 | 1.3 Identify & Evaluate Analytical Tools | | | | | | | | | | | | | | | | | | | |
| 4 | 1.4 Develop and Evaluate Approaches for CO2 impact | | | | | | | | | | | | | | | | | | | |
| 5 | 1.5 Develop Framework for Economic Assessments | | | | | | | | | | | | | | | | | | | |
| 6 | 1.6 Develop Scope and Mapping of SG Projects | | | | | | | | | | | | | | | | | | | |

| ID | Task 2: Critical Integration Technologies & Systems | 2008 | 2009 | | | | 2010 | | | | 2011 | | | | 2012 | | | | 2013 | |
|----|------------------------------------------------------------------------|------|------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|----|
| | | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 |
| 1 | 2.1 Architecture Reference Design for distributed Resource Integration | | | | | | | | | | | | | | | | | | | |
| 2 | 2.2 Develop Information Exchange Model to support System Operations | | | | | | | | | | | | | | | | | | | |
| 3 | 2.3 Develop Comm Interfaces & Control Algorithms for DER | | | | | | | | | | | | | | | | | | | |
| 4 | 2.4 Develop Aggregation Methods & Tools | | | | | | | | | | | | | | | | | | | |
| 5 | 2.5 Develop DER Controller Requirements | | | | | | | | | | | | | | | | | | | |
| 6 | 2.6 Lab Trials of Critical Integration Technologies | | | | | | | | | | | | | | | | | | | |

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Project Plan. Task 3 & Task 4

✓ = Presentation during meeting ✓ = Update Now

| ID | Task 3: Demonstrate Technologies & Systems in Actual Applications | 2008 | 2009 | | | | 2010 | | | | 2011 | | | | 2012 | | | | 2013 | |
|----|-------------------------------------------------------------------|------|------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|----|
| | | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 |
| 1 | 3.1 Project Definitions and Objectives | | | | | | | | | | | | | | | | | | | |
| 2 | 3.2 Application of IntelliGrid Metodology – Use case dev | | | | | | | | | | | | | | | | | | | |
| 3 | 3.3 Economic Analysis | | | | | | | | | | | | | | | | | | | |
| 4 | 3.4 Candidate Technology Selection | | | | | | | | | | | | | | | | | | | |
| 5 | 3.5 Laboratory Assessment of Technologies | | | | | | | | | | | | | | | | | | | |
| 6 | 3.6 Detailed Application Plan for Field Demonstrations | | | | | | | | | | | | | | | | | | | |
| 7 | 3.7 Field Data Collection & Assessment | | | | | | | | | | | | | | | | | | | |

| ID | Task 4: Technology Transfer | 2008 | 2009 | | | | 2010 | | | | 2011 | | | | 2012 | | | | 2013 | |
|----|--------------------------------------------------|------|------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|----|
| | | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 |
| 1 | 4.1 Quarterly Workshops | | | | | | | | | | | | | | | | | | | |
| 2 | 4.2 Coordination w/DOE, EPA, etc | | | | | | | | | | | | | | | | | | | |
| 3 | 4.3 Industry Standards Development Participation | | | | | | | | | | | | | | | | | | | |
| 4 | 4.4 Use Case and Requirements Repository | | | | | | | | | | | | | | | | | | | |
| 5 | 4.5 Technology Library | | | | | | | | | | | | | | | | | | | |
| 6 | 4.6 Publications | | | | | | | | | | | | | | | | | | | |

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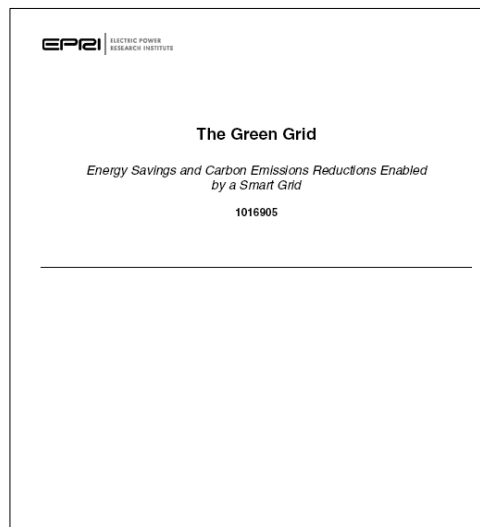
Task 1.4 Develop and Evaluate Approaches for CO₂ Impact

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



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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:

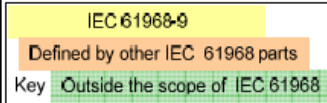
- Part 9 of IEC 61968 specifies information content of a set of message types to support business functions of meter reading and control.
- Purpose –Information exchange between metering systems and utility enterprise.
- [Link to Final Draft](#)

| | | | |
|---------------------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------|--|
|  | | 57/1009/FDIS | |
| | | FINAL DRAFT INTERNATIONAL STANDARD PROJET FINAL DE NORME INTERNATIONALE | |
| Project number Numéro de projet | | IEC 61968-9 Ed.1 | |
| IEC/TC or SC / CENELEC ou SC | | Secretariat / Secrétaire | |
| 57 | | Germany | |
| <input checked="" type="checkbox"/> Submitted for parallel voting in CENELEC Soumis au vote parallèle au CENELEC | | Distributed on / Diffusé le | |
| | | 2009-06-12 | |
| | | Voting terminates on / Vote clos le | |
| | | 2009-08-14 | |

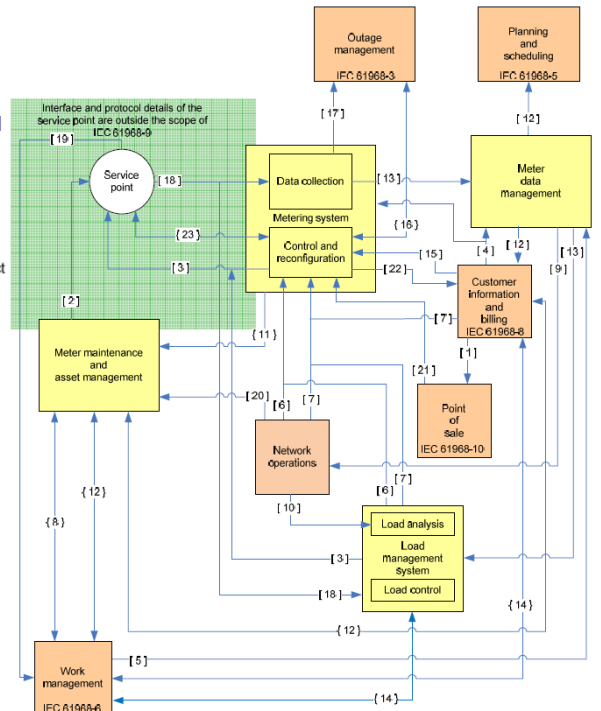
IEC 61968-9

(as example)

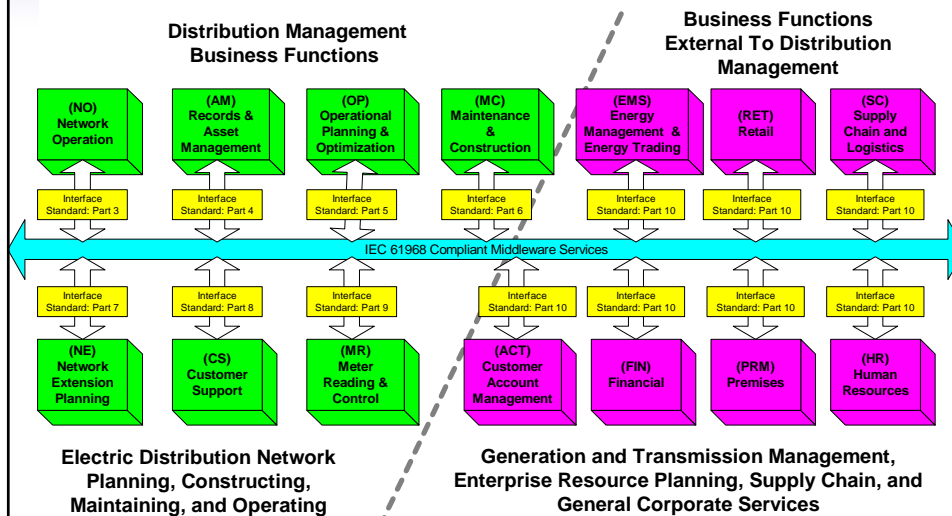
- [1] Account information
- [2] Configuration, installation etc.
- [3] Controls and signals
- [4] Customer data set
- [5] Data obtained by special read
- [6] Demand response signals
- [7] Disconnect/reconnect, demand reset
- [8] Install, remove, repair, disconnect, reconnect
- [9] Load curves, Measurement history, etc.
- [10] Load scenarios
- [11] Meter health and tamper detection
- [12] Meter history
- [13] Meter readings
- [14] Meter service request
- [15] On request read
- [16] Outage and restoration verification
- [17] Power reliability and quality events
- [18] Readings, events and status
- [19] Special read
- [20] Tariffs, parameters
- [21] Transaction information
- [22] Transaction records
- [23] Tokens



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IEC TC57 WG14. IEC 61968 Part X



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NIST Smart Grid Roadmap Coordination

| Standard | Application |
|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| AMI-SEC System Security Requirements | Advanced metering infrastructure (AMI) and Smart Grid end-to-end security |
| ANSI C12.19/MC1219 | Revenue metering information model |
| BACnet ANSI ASHRAE 135-2008/ISO 16484-5 | Building automation |
| DNP3 | Substation and feeder device automation |
| IEC 60870-6 / TASE.2 | Inter-control center communications |
| IEC 61850 | Substation automation and protection |
| IEC 61968/61970 | Application level energy management system interfaces |
| IEC 62351 Parts 1-8 | Information security for power system control operations |
| IEEE C37.118 | Phasor measurement unit (PMU) communications |
| IEEE 1547 | Physical and electrical interconnections between utility and distributed generation (DG) |
| IEEE 1686-2007 | Security for intelligent electronic devices (IEDs) |
| NERC CIP 002-009 | Cyber security standards for the bulk power system |
| ..NIST Special Publication (SP) 800-53, NIST SP 800-82 | Cyber security standards and guidelines for federal information systems, including those for the bulk power system |
| Open Automated Demand Response-OpenADR | Price responsive and direct load control |
| OpenHAN | Home Area Network device communication, measurement, and control |
| ZigBee/HomePlug Smart Energy Profile | Home Area Network (HAN) Device Communications and Information Model |

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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

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2.6 Lab/Field Trials of Critical Technologies

Active “Mini Projects”

- PV Integration
- Two-Way Control of Electric Water Heaters

Under Consideration or Development

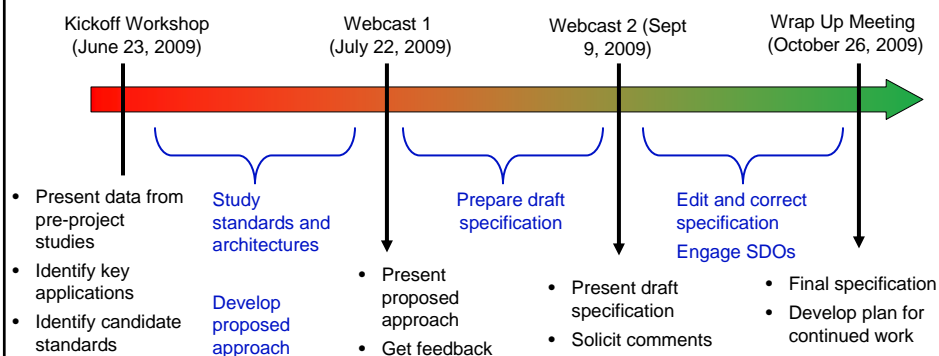
- Community Energy Storage
- Underground Network Monitoring
- “Smart Home” Evaluation
- Customer Behavior with AMI Enabled Technologies

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



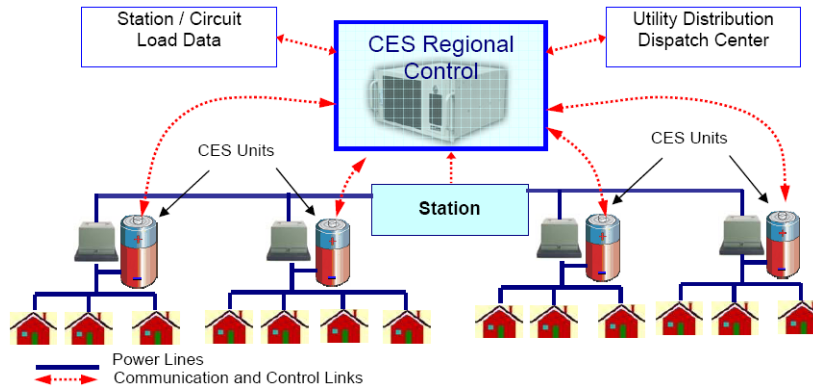
2.6 Community/Neighborhood Energy Storage

Grid Functions

- Load Leveling / Peak Shaving
- Power Factor Correction (VAR Support)
- Ancillary Services

Load Functions

- Backup power for locally connected houses
- Local Voltage Control



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4.4 Use Case and Requirements Repository

The screenshot shows the EPRI Smart Grid Resource Center Use Case Repository website. The page features a navigation bar with links to Home, Use Case Repository, Event Calendar, Smart Grid Demo, and Related Links. The main content area is titled 'Use Case Repository' and includes a description of the repository, a list of Use Case Categories, and a table of Use Cases.

Use Case Categories

- Customer Services (79)
- Distributed Energy Resources (18)
- Distribution Operations (19)
- Federated System Management Functions (7)
- Market Operations (52)
- Transmission Operations (34)

Use Cases Table

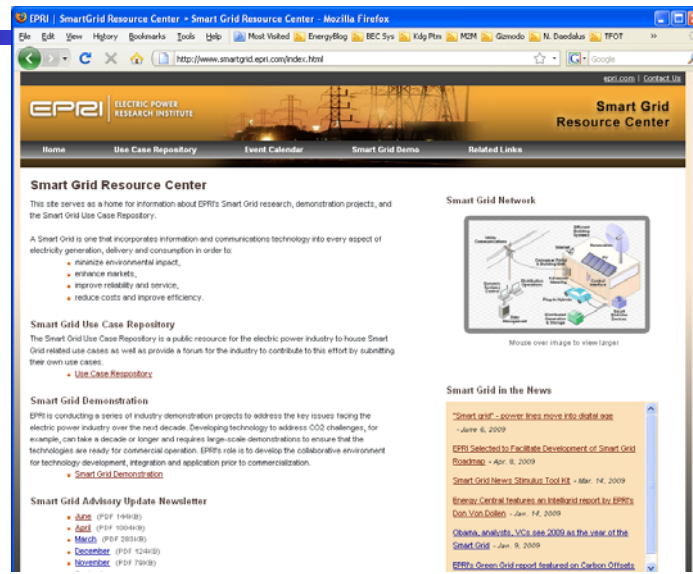
| Name | Size | Published |
|---------------------------------------------------------------------------|------|-----------|
| Customer Services | | |
| Consumer Portal P1 Customer Needs Meter Device | 69k | 1/6/09 |
| Consumer Portal Scenario P4 Customer Account Move | 75k | 1/6/09 |
| Consumer Portal Scenario P5 Customer Sign-Up for Demand Reduction Program | 78k | 1/6/09 |
| Consumer Portal Scenario P7 | 113k | 1/6/09 |
| Consumer Portal Scenario P8 | 103k | 1/6/09 |
| Consumer Portal Scenario P9 | 69k | 1/6/09 |
| Create ORR Contingency Files V04 | 37k | 1/23/09 |

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4.5 Smart Grid Web-Site & Technology Library



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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

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Smart Grid Host Sites Overview

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

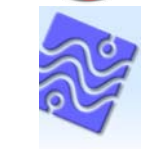
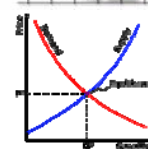
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Smart Grid Demonstration Critical Elements

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







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Host Site Selections (1-2 Selections Per Cycle)

(Expect 8-12 in total. 4 Selected, 1 Under Review)

| Start Proposal Review Process No Later Than | Host Site Selection Timeline | | | | | Present Qualified Proposal at EPRI BOD Meeting |
|---------------------------------------------|-----------------------------------------------------------------------------------|----|------|----|----|------------------------------------------------|
| | 2009 | | 2010 | | | |
| | Q3 | Q4 | Q1 | Q2 | Q3 | |
| End of May |  | | | | | August 4, 2009 |
| August 21, 2009 |  | | | | | November 18, 2009 |
| January 8, 2010 |  | | | | | April 6, 2010 |
| April 29, 2010 |  | | | | | August 3, 2010 |

| Host-Site Selection Cycle. Requires <u>AT LEAST</u> 3 months | | | |
|--------------------------------------------------------------|------------------------------------------|---------|---------|
| | Month 1 (1+ month strongly preferred) | Month 2 | Month 3 |
| Utility Draft Proposal | | | |
| EPRI Technical Review | | | |
| Peer Review | | | |
| Present to BOD | | | |

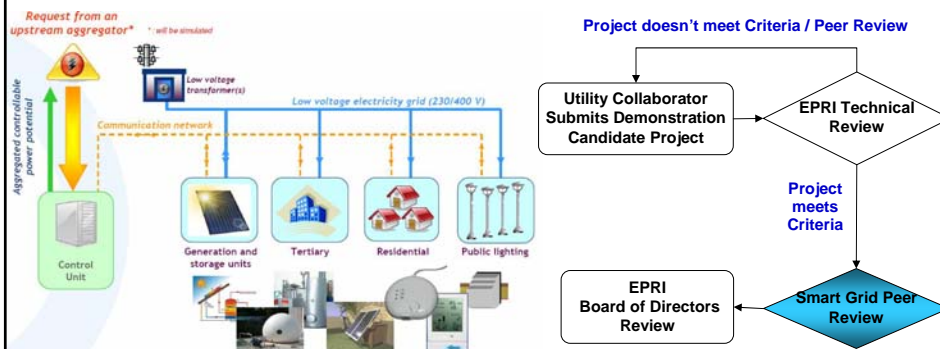
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EDF Host-Site Peer Review Webcast

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



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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?

