EPRI End Use Energy Efficiency and Demand Response Program

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Utility Energy Forum

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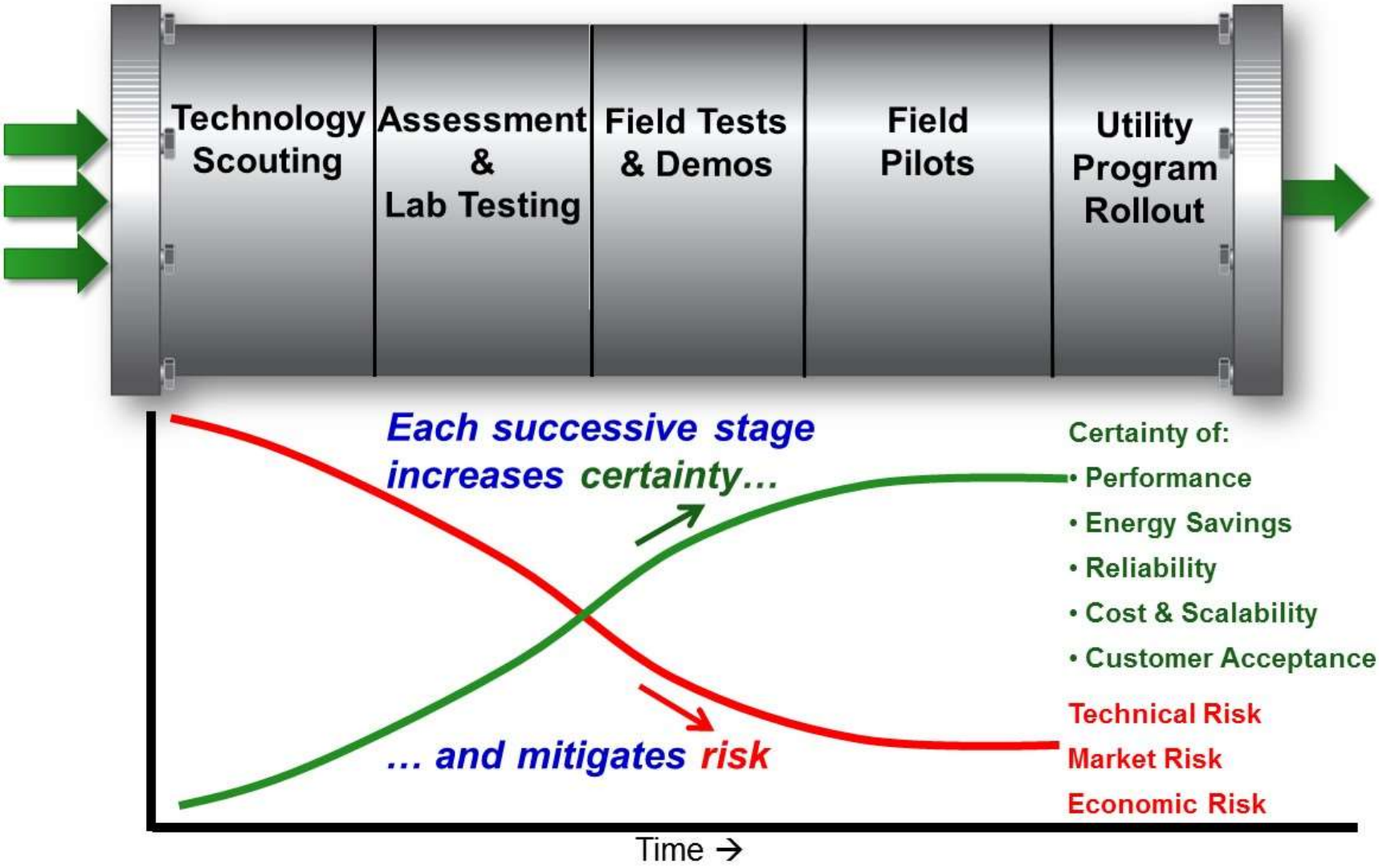
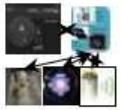
Program 170: Advancing EE & DR Technology through the Development Pipeline



Program 170: Sampling of End Use Technologies Under EPRI Evaluation

Technology Scouting

- DC Architecture for ZNE Homes 
- Phase-Change Materials 
- Wireless Sensors 
- Advanced Energy Management 
- Multi Protocol Routers 
- Next generation Heat Pumps 
- Next generation HPWHs 

Assessment & Lab Testing

- Variable Speed Circulation Pumps 
- Advanced Refrigeration 
- Efficient , DR-Ready Products 
- Advanced Lighting Systems 
- Desiccant Dehumidification 
- Non-intrusive load monitoring 

R&D Field Tests/Demos

- DR for Commercial HVAC 
- Heat Pump Water Heaters (Gen. 2) 
- Lighting Controls for EE/DR 
- Data Centers EE Technologies 
- Advanced Rooftop Air Conditioners 
- Automated DR and Energy Management 

Field Pilots

- Variable Capacity Space Conditioning 
- Smart Thermostats 
- Data Center Airflow Management 
- EE/DR in Low Income Housing 
- Integrated Whole Buildings 

Program Rollout

- LED Street and Area Lighting 
- High Efficiency Refrigerators 
- Heat Pump Water Heaters (Gen. 1) 
- VRF Heat Pumps 

Program 170:
280+ Published RD&D Deliverables: 2007 – 2015

A proven track record of delivering valuable research to members and the public

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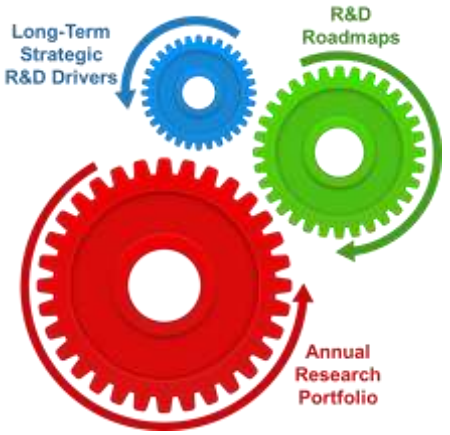
Industry Issues Related to EE and DR

- End-user productivity and comfort, and satisfaction with electric service (and service provider)
- Developing new programs for EE and DR, given saturation of successful programs like lighting for EE and increasing need for local flexibility for DR
- Utilizing demand-side as resource to improve utility economics
  - Capacity resource to defer capital investments in Gen/T&D
  - Operating resource for grid stability (e.g. balance intermittent supply)
- Environmental stewardship by utilities
  - Emissions reduction (greenhouse gases, e.g. CO_2)
  - Conservation of finite energy supplies

Why Utilities participate in EE & DR Research

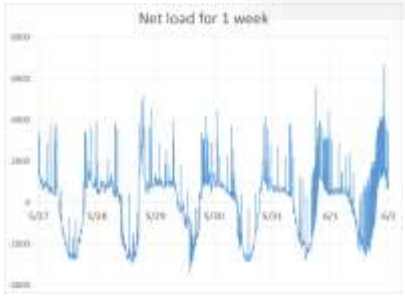
- Accelerate availability of vetted EE & DR technologies and methods into programs and markets to help members achieve EE and DR goals
  - Validate performance
  - Verify deemed savings estimates
- Mitigate risk and reduce uncertainty of EE & DR pilots and programs
- Understand potential for flexible customer resources to support the Integrated Grid activities
- Gain tools and techniques to integrate EE & DR into the integrated demand side management (IDSM) planning process



Strong alignment with long-term strategic R&D drivers and roadmaps

EPRI EE&DR Research areas of Emphasis in 2017

- Test novel configurations for higher-efficiency heat pumps
- Evaluate and test technologies for both EE and DR benefits
- Integrated whole-building approach to efficiency and demand response
- Load research & customer data analytics
- End-use technologies to provide grid services
- Enable integration of dynamic customer resources into the integrated power system



Strong Alignment with Integrated Demand Side Management Approach

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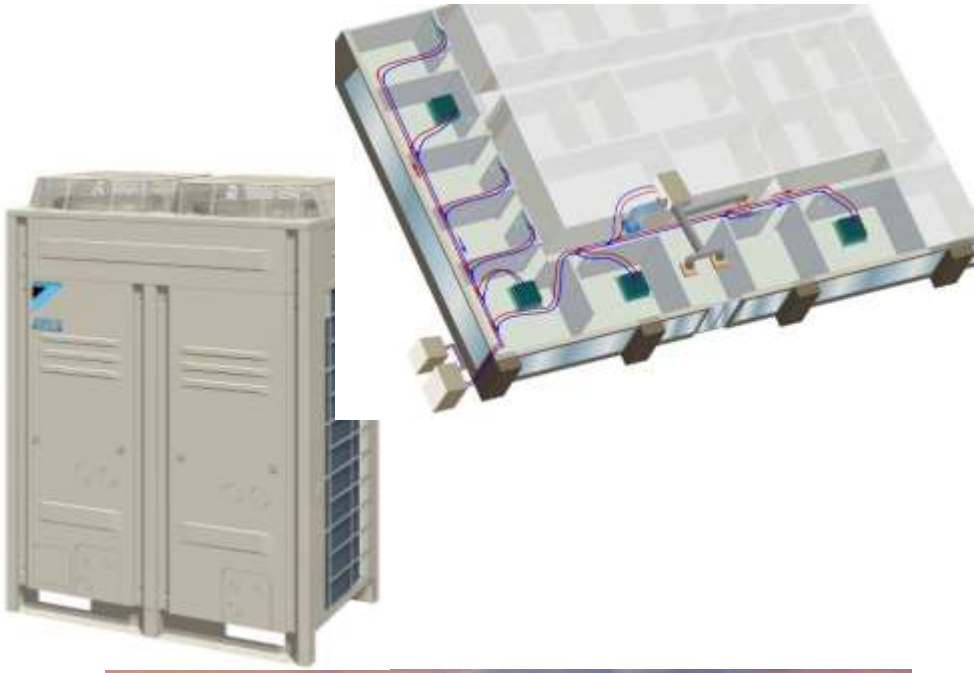
Energy Efficiency Technology Transfer Examples

- EPRI research on Variable capacity and VRF heat pumps have led to new EE programs around the country
  - SCE, PG&E and other utilities already have VRFs in their EE Programs
- Industry Leading R&D into Zero Net Energy
  - SCE is using EPRI results as part of strategy development for a customer centric grid
- Research into EE in low income communities
  - Understanding financial scalability of EE for low income customer



Demand Response Technology Transfer Examples

- EPRI research on DR-ready functional specifications are being adopted by EPA in Energy Star standards
  - EPA has adopted input from EPRI with respect to refrigerator specifications
  - Expected same with pool pumps, and other equipment
- Members are using EPRI results on smart thermostat pilots to put them in appropriate EE/DR programs
  - Glasgow (under TVA) adopting thermostats to help customers manage their demand rates
  - BGE and KCPL starting new smart thermostat programs using EPRI results through PUC approval
  - EPA adopted EPRI Smart Thermostat Data specifications and pilot results in EnergyStar specs

EPIC Funded Energy Efficiency Initiatives – ZNE

Objective

- Demonstrate affordability, scalability, customer adoption and grid integration of Zero Net Energy (ZNE) communities
- Develop scalable residential retrofits through packages of technology, financing, and business models

Approach

- Work with developers, mechanical designers, & architects to enable an optimized ZNE community.

Big Picture

- Meet California 2020 ZNE goals and drive decarbonization
- Meet California SB 350 goals for doubling energy efficiency and 50% renewables portfolio standard

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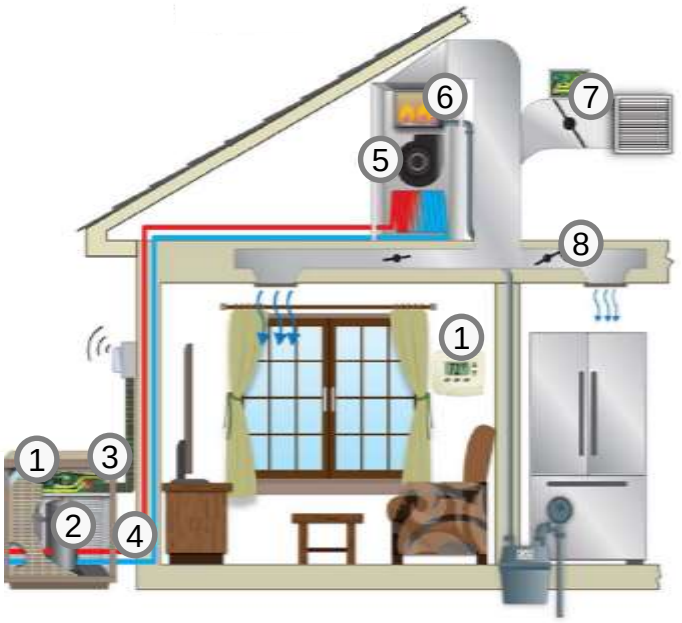
EPIC Funded Energy Efficiency on devices and systems

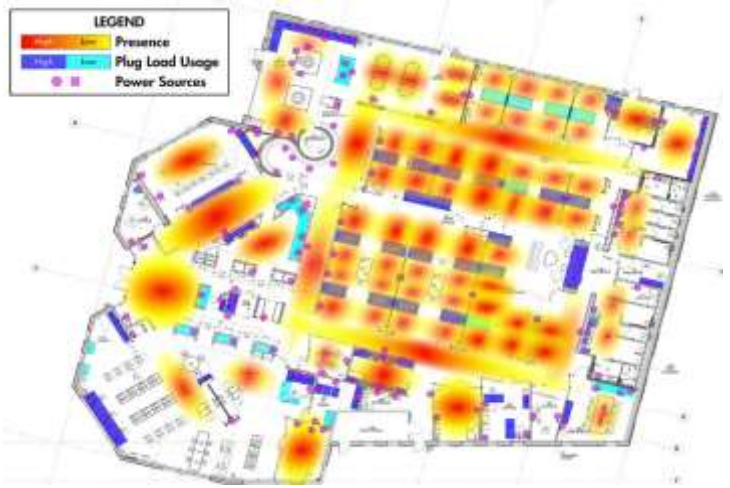
Initiatives

- Development of Next Gen Residential HVAC systems
- Advancing integrated VRF + IEC concepts for commercial buildings
- Flexible Control Strategies for Plug Loads
- Industrial Energy Efficiency with advanced vortex cooling and CO2 Heat Pumps

Big Picture

- Advancing variable capacity heat pumps
- Reducing HVAC energy use by 30% in commercial buildings
- Developing low GWP refrigerant solutions
- Reduce plug load and vampire load energy use in commercial buildings





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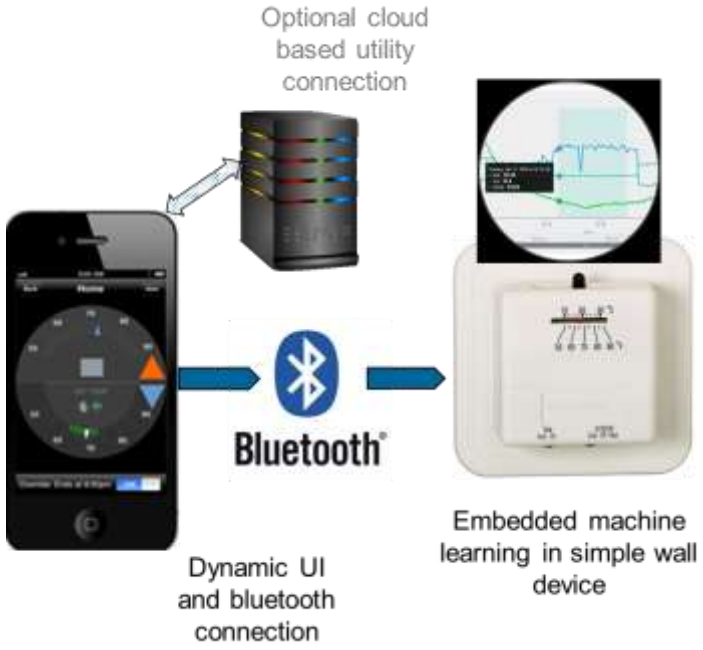
EPIC Funded Grid Integration initiatives

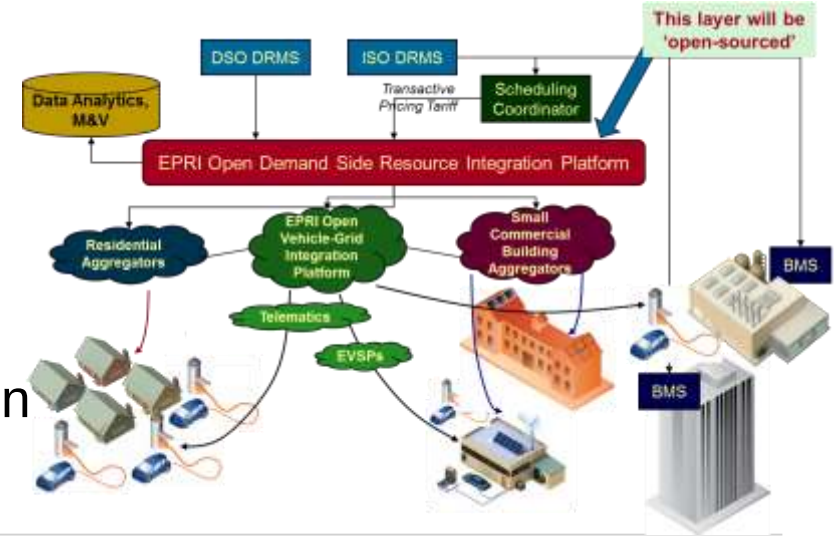
Initiatives

- Developing smart thermostats for low income customers
- Develop Aggregation Platform for integrated demand response from multiple customer owned resources
- V2G – Distribution system aware Vehicle to Grid Capability



Big Picture

- Address digital divide barriers for energy efficiency with low income customers
- Enable customer owned resources to participate in DR programs and markets for flexibility without new hardware
- Enable EV penetration through distribution integration of EV loads



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Program 170: Project Sets Structure in 2017

Analytical Frameworks (170A)	Demand Response Systems (170B)	Energy-Efficient Technologies (170C)	Technology Transfer (170D)
170.005 End Use Load Research	170.006 Enabling DR-Ready Devices and Programs	170.013 Space Conditioning	170.026 Technology Briefs
170.024 Customer Data Analytics	170.007 Peak Load Management of Thermal Loads	170.019 Motors and Drives	170.027 Knowledge Transfer
	170.009 Intelligent Buildings	170.020 High Performance Homes and Buildings	
	170.018 Demand Response Program Assessment	170.021 Plug Loads & Electronics	
		170.025 Data Centers	
		170.028 Water Heating	
		170.030 Lighting	
		170.031 Refrigeration	

Technology Innovation Projects

Supplemental Projects – Utility & Government

Project Set 170A: Analytical Frameworks 2017 Overview & Projects

- **Project Set Overview**
  - Emphasis is on utility strategy regarding planning, analysis and the regulatory incentives as it relates to EE&DR
- **Expected Deliverables**
  - Update to U.S. Potential Study with increased geographical resolution, emphasis on environmental impacts of EE&DR, and update to codes and standards
  - Focus on methods for whole premise and end-use data collection including Non Intrusive Load Monitoring, Conditional Demand Analysis, and direct measurement methods.
  - Continued monitoring of data mining and customer analytics best practices.

Project Set 170B: Demand Response Systems 2017 Overview

DR-Ready Devices | Building Energy Storage | Integrated Buildings | DR for Systems and Markets

Devices → Integrated systems → Facilities → Programs & Markets





170.006 DR Ready Devices

170.007 Peak Load Shift Technologies

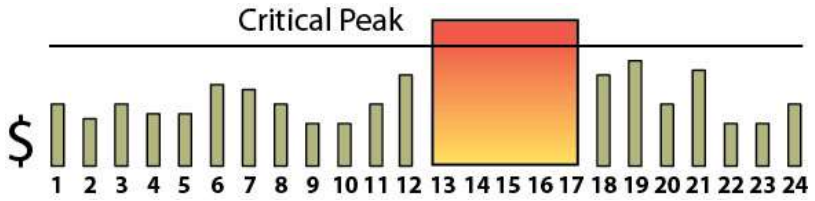
170.009 Intelligent Buildings

170.018 DR Program Assessment Tools

DR across Devices, Systems, Buildings and Markets

Project Set 170B: Demand Response Systems
2017 Projects

- **DR Ready Devices**
  - Lab testing and standards engagement to advance specifications for demand response from mass market devices
- **Peak Load Shift Technologies**
  - Test capability of aggregated thermal storage for grid needs
- **Intelligent Buildings**
  - Lab evaluation of integrated customer side resources (DR, Storage) for renewable balancing
- **DR Program Assessment Tools**
  - Evaluate market drivers and case studies for enhancing flexibility of customer demand usage



Project Set 170C: Energy Efficient Technologies 2017 Overview

- **Project Set Overview**
  - Identify emerging technologies with energy efficiency potential
  - Evaluate functional capabilities
  - Identify appropriate applications
  - Identify barriers to adoption
  - Provide data for furtherance of technologies to program implementation

- **Expected Deliverables**
  - Technical updates across 6-7 topic areas
  - May include state-of-the-art assessment, lab & field test results and tech transfer

Quantifying Energy Saving Potential of Emerging Technologies

Project Set 170C: Energy Efficient Technologies
2017 Projects

- **Space Conditioning & Water Heating**
  - Test advanced space conditioning and heat pump water heating technologies
- **Motors and Drive Systems**
  - Evaluate and test new motor/drive systems for fan control
- **High Performance Buildings**
  - Evaluate energy use and electric grid impacts of market available zero net energy homes
- **Plug Loads and Electronics**
  - Assess advanced plug load control technologies
- **Efficient Data Centers**
  - Assess and test new technologies for small and medium data centers
- **Lighting**
  - Assess and test new ‘smart city’ lighting technologies
- **Refrigeration**
  - Assess and test alternate refrigerants for commercial refrigeration

Project Set 170D: Technology Transfer 2017 Overview and Projects

- **Project Set Overview**
  - 170.026: Technology Briefs
  - 170.027: Knowledge Transfer

- **Expected Deliverables**
  - 2017 Technology Readiness Guide
  - 2017 Energy Efficiency and Demand Response Symposium
  - CES 2017 Conference Report
  - Integrated Grid Pilot updates (Quarterly)
  - LightFair 2017 Report
  - ASHRAE Conference and AHR Expo report

Together…Shaping the Future of Electricity

Appendix:
2017 Supplemental Projects

Non-Intrusive Load Monitoring (NILM) Cost vs. Accuracy Assessment

Objectives

- Further the development of low-cost methods for developing end-use load data
- North American device testing
- European device testing

Test Scenario #	Test Scenario Name or Activity	Begin Date & Time	End Date & Time
1	Trial/Training	Ongoing from September 8, 2015 (Tuesday) 12:00 Noon	Sept. 22, 2015 (Tuesday) 12:00 Noon
2	Single Family Home - Weekday	Sept. 22, 2015 (Tuesday) 12:15 PM	October 02, 2015 (Friday), 12:00 Noon
3	Single Family Home - Weekend	October 02, 2015 (Friday), 12:15 PM	October 12, 2015 (Monday), 12:00 Noon
4	Retired Citizen Home - Week	October 12, 2015 (Monday), 12:15 PM	October 19, 2015 (Monday), 12:00 Noon
5	College Student Dorm - Week	October 19, 2015 (Monday), 12:15 PM	October 26, 2015 (Monday), 12:00 Noon
6	Training	October 26, 2015 (Monday), 12:15 PM	November 02, 2015 (Monday), 12:00 Noon
7	Energy Efficient Home - Week	November 02, 2015 (Monday), 12:15 PM	November 12, 2015 (Thursday), 12:00 PM

Value

- Inform utilities as to the trade-off between cost and accuracy of alternative methods of end-use load disaggregation
- Allows for better matching of products capabilities with customer needs

Details and Contact

- $45k
- Qualifies for TC and SDF

Krish Gomatom

- kgomatom@epri.com
  (865) 218-8070

SPN #: 1025685

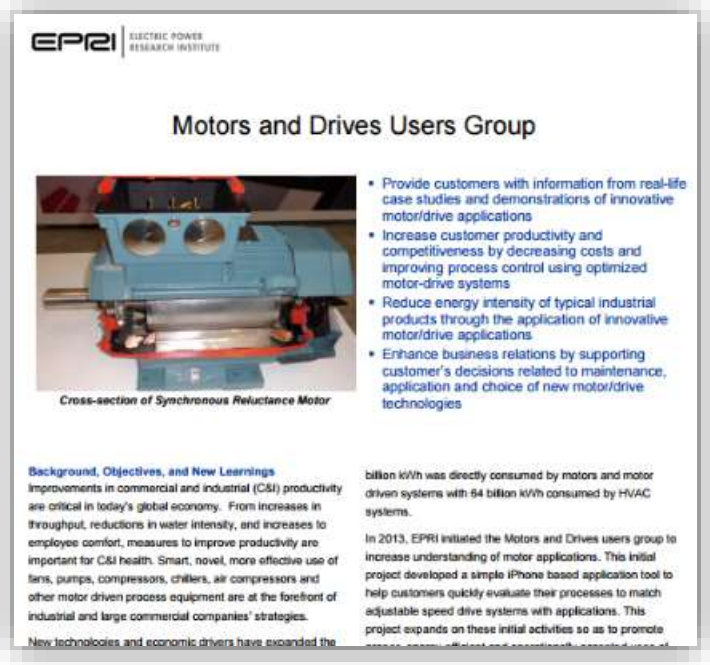
Motors and Drives Users Group

Objectives

- Test various motor frames (A, B, C, and D) and corresponding applications
- Evaluate motor 3Rs: Repair, Rewind, Replace
- Regular Webcasts and Conference calls to convey intermediate learnings

Value

- Inform utilities as to the state of new motors and drives technologies
- Allow utilities to better match products capabilities with customer needs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Motors and Drives Users Group

Cross-section of Synchronous Reluctance Motor

- Provide customers with information from real-life case studies and demonstrations of innovative motor/drive applications
- Increase customer productivity and competitiveness by decreasing costs and improving process control using optimized motor-drive systems
- Reduce energy intensity of typical industrial products through the application of innovative motor/drive applications
- Enhance business relations by supporting customer's decisions related to maintenance, application and choice of new motor/drive technologies

Background, Objectives, and New Learnings

Improvements in commercial and industrial (C&I) productivity are critical in today's global economy. From increases in throughput, reductions in water intensity, and increases to employee comfort, measures to improve productivity are important for C&I health. Smart, novel, more effective use of fans, pumps, compressors, chillers, air compressors and other motor driven process equipment are at the forefront of industrial and large commercial companies' strategies.

billion kWh was directly consumed by motors and motor driven systems with 64 billion kWh consumed by HVAC systems.

In 2013, EPRI initiated the Motors and Drives users group to increase understanding of motor applications. This initial project developed a simple iPhone based application tool to help customers quickly evaluate their processes to match adjustable speed drive systems with applications. This project expands on these initial activities so as to promote

Details and Contact

Cost: $20k

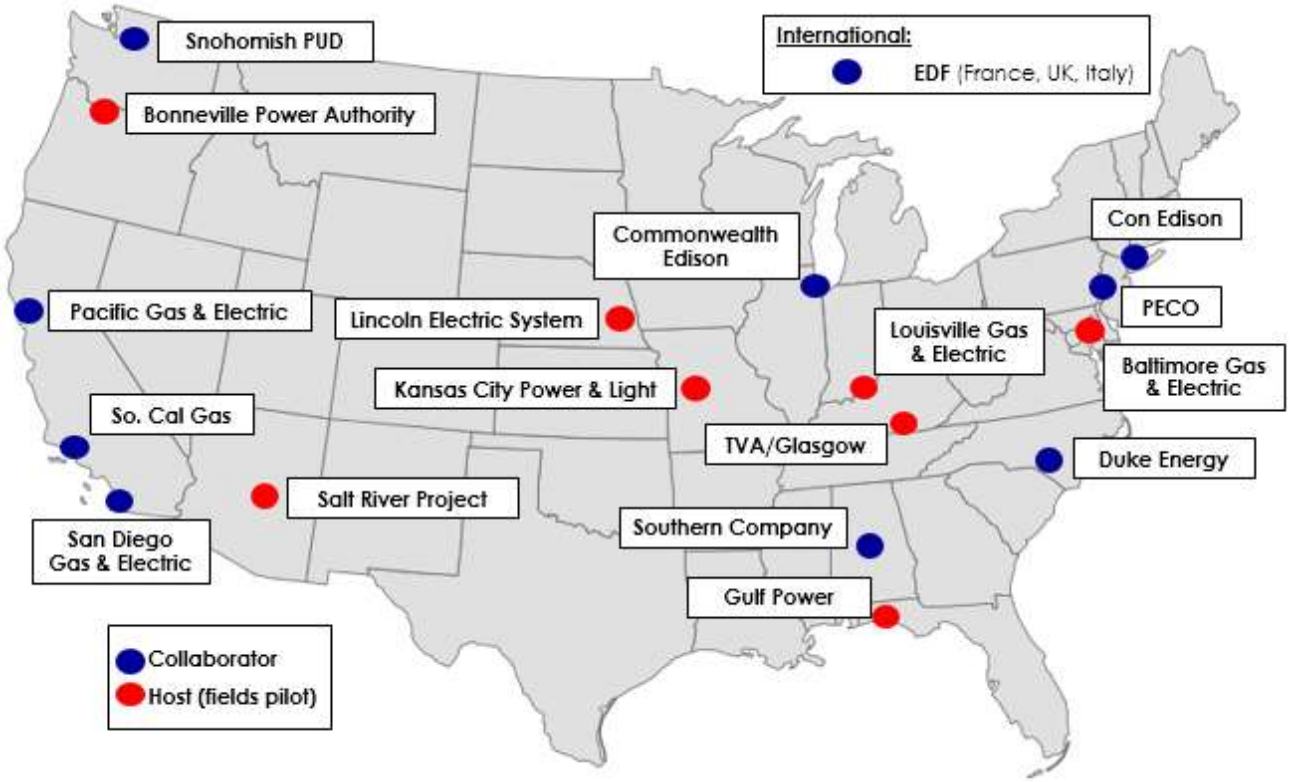
Qualifies for TC and SDF

Contact: Marek Samotyj;
msamotyj@epri.com; (650) 855-8754

SPN #: 3002008582

Smart Thermostat Collaborative

Thermostat and AMI/billing data from 5000+ homes around the country, both electric and gas



Participation

Two funding options:

- General collaborator
- Host site sponsor

Contact: Ram Narayanamurthy; rnarayanamurthy@epri.com; 650-855-2419

SPN #: 3002000323

Energy Efficiency and Demand Response programs are utilities' touch point with customers

Research into customer segmentation, passive storage capacity, and grid connectivity

Flexible DR Collaboration

DR-Ready Devices for Renewable Integration

1. Assess Flexibility Requirements

- Response requirements, respecting regional differences

2. Characterize DR Capability

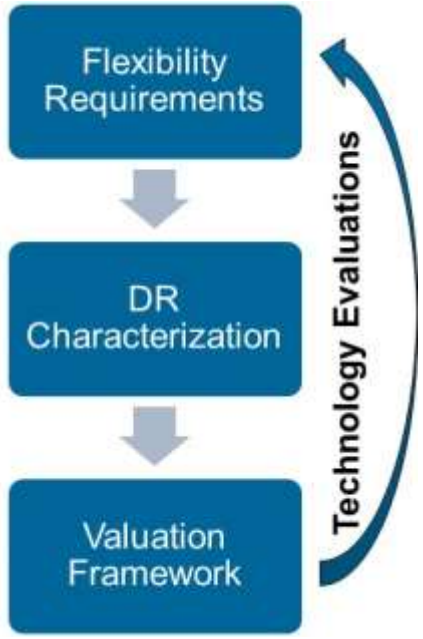
- Response, restoration, predictability and persistence

3. Develop Framework for DR Valuation

- Diverse grid services, operational strategies, types of loads

4. Lab and Field Evaluations

- Technology suitability for flexibility



Participation

Two funding options:

- Collaborator
- Host

Contact: Angela Chuang; achuang@epri.com; 650-855-2488

SPN #: 3002001028

Enable Mass Market Flexible DR

Energy Efficiency of Lighting Controls

- Objectives
  - Field demonstration of lighting control systems to verify and access energy efficiency and demand response potential in a range of applications
  - Comparison of system reported data vs utility grade data
  - Deeper understanding of the impact of applications on energy savings
- Value
  - Verification of manufacturer's claims
  - Numerous case studies from commercial applications
  - Modeling verification
  - Persistence of use data
- Scope
  - Market survey of relevant lighting controls
  - Installation of one technology per funder with various stages of monitoring
  - Installation and removal of monitoring system
  - Reporting

Details

- Total level of effort $75K per funder
- Two year project – can be $37.5K each year or $75K upfront
- Qualifies for Self Directed Funds and Tailored Collaboration

Contact

- Frank Sharp – fsharp@epri.com - 865.218.8055

- **SPN #: 3002006475**

Lighting Controls are the next step to improve lighting programs

DR with Variable Capacity Commercial HVAC Systems

Objectives and Scope

- Collaboration with manufacturers, aggregators and technology vendors to identify DR objectives
- Support development of standardized responses and technical means
- Demonstration of capability, response and benefits from VC-HVAC systems.
- Can VC-HVAC systems be incorporated into existing utility DR programs?
- **Value**
  Help utilities deploy EE technologies with the capability to provide DR; reduce program costs.

Details and Contact

- Participant $50k; Host $80k
- Qualifies for TC and SDF
- ***Contact: Harshal Upadhye***
  - –hupadhye@epri.com; (865) 218-8135

SPN #: 3002007494

DR with Existing EE Technology

Data Center Collaborative

Objectives and Scope

- Multi-year project Q2 2016
- Initial focus: embedded data centers
  - Identify potential in small and embedded DCs
  - Formulate approaches for utilities to unlock this market
  - Assess existing and emerging solutions
  - Evaluate *in-situ* performance of promising technologies

Value

- Methods to identify embedded data centers
- Energy savings potential and cost effectiveness assessment of efficient technologies/solutions
- Low-cost M&V approaches
- Best-practices guide for utilities and data center owners/operators
- *In-situ* evaluation in real-world operation
- Support member utilities with customer engagement

Participation

- Two funding options:
  - General collaborator
  - Host site sponsor
- Contact: Mukesh Khattar mkhattar@epri.com; 650-855-8797
- **SPN #: 3002007545**

Follow-up project to provide solutions to needs identified in DCIG