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Governor

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Secretary
Energy and Environment Cabinet

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David L. Armstrong
Chairman

James W. Gardner
Vice Chairman

Linda Breathitt
Commissioner

October 9, 2013

PARTIES OF RECORD

RE: Case No. 2012-00428
CONSIDERATION OF THE IMPLEMENTATION OF SMART GRID AND SMART METER TECHNOLOGIES

Enclosed please find a memorandum that has been filed in the record of the above referenced case for the Informal Conference to be held on October 10, 2013. Any comments regarding this memorandum's content should be submitted to the Commission within five days of the receipt of this letter. Questions regarding this memorandum should be directed to Aaron Greenwell at 502-782-2563.

Sincerely,

Jeff Derouen
Executive Director

Attachments

INTRA-AGENCY MEMORANDUM

KENTUCKY PUBLIC SERVICE COMMISSION

TO: Main Case File - Case No. 2012-00428
CONSIDERATION OF THE IMPLEMENTATION OF SMART GRID AND SMART METER TECHNOLOGIES

FROM: Aaron Greenwell, Team Leader

DATE: October 9, 2013

SUBJECT: Electric Power Research Institute PowerPoint Presentation for Informal Conference, October 10, 2013

Pursuant to Staff Notice of September 26, 2013, an informal conference ("IC") will be held on Thursday, October 10, 2013 at the Commission's offices at 211 Sower Boulevard, Frankfort, Kentucky. Presentations will be provided by representatives of the Electric Power Research Institute ("EPRI") and the Cooperative Research Network ("CRN").

In order to allow those participating in the IC by phone to more closely follow the proceedings, copies of the presentations will be placed in the case file. A copy of the EPRI presentation is attached to this memo.

Attachment: EPRI PowerPoint

ELECTRIC POWER RESEARCH INSTITUTE

EPRI Smart Grid Demonstration

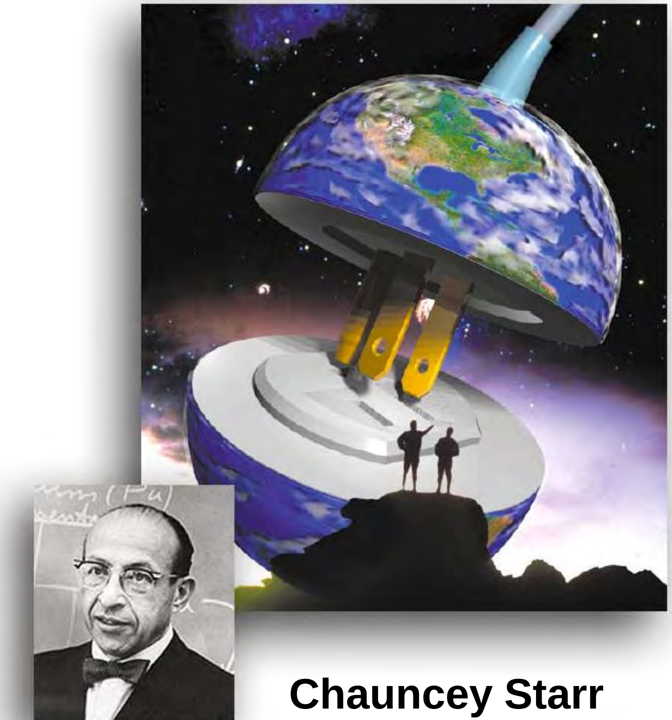
Project Overview and Results & Lessons Learned

Matt Wakefield
Director, Information & Communication Technology

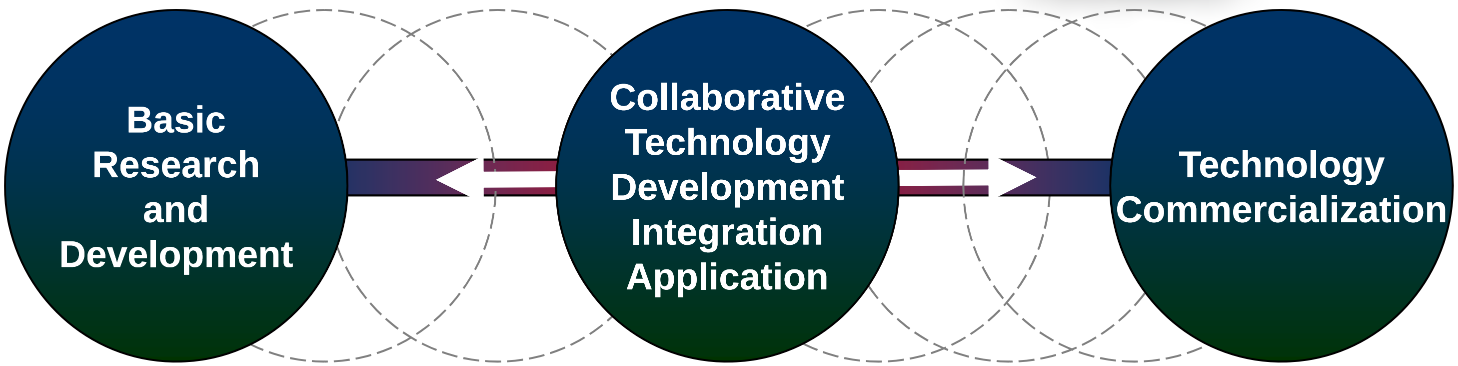
October 10, 2013

EPRI and our Role…

- Founded by and for the electricity industry in 1973
- Independent, nonprofit center for public interest energy and environmental research
- **Collaborative** resource for the electricity sector



Chauncey Starr
EPRI Founder



National Laboratories

Universities

EPRI

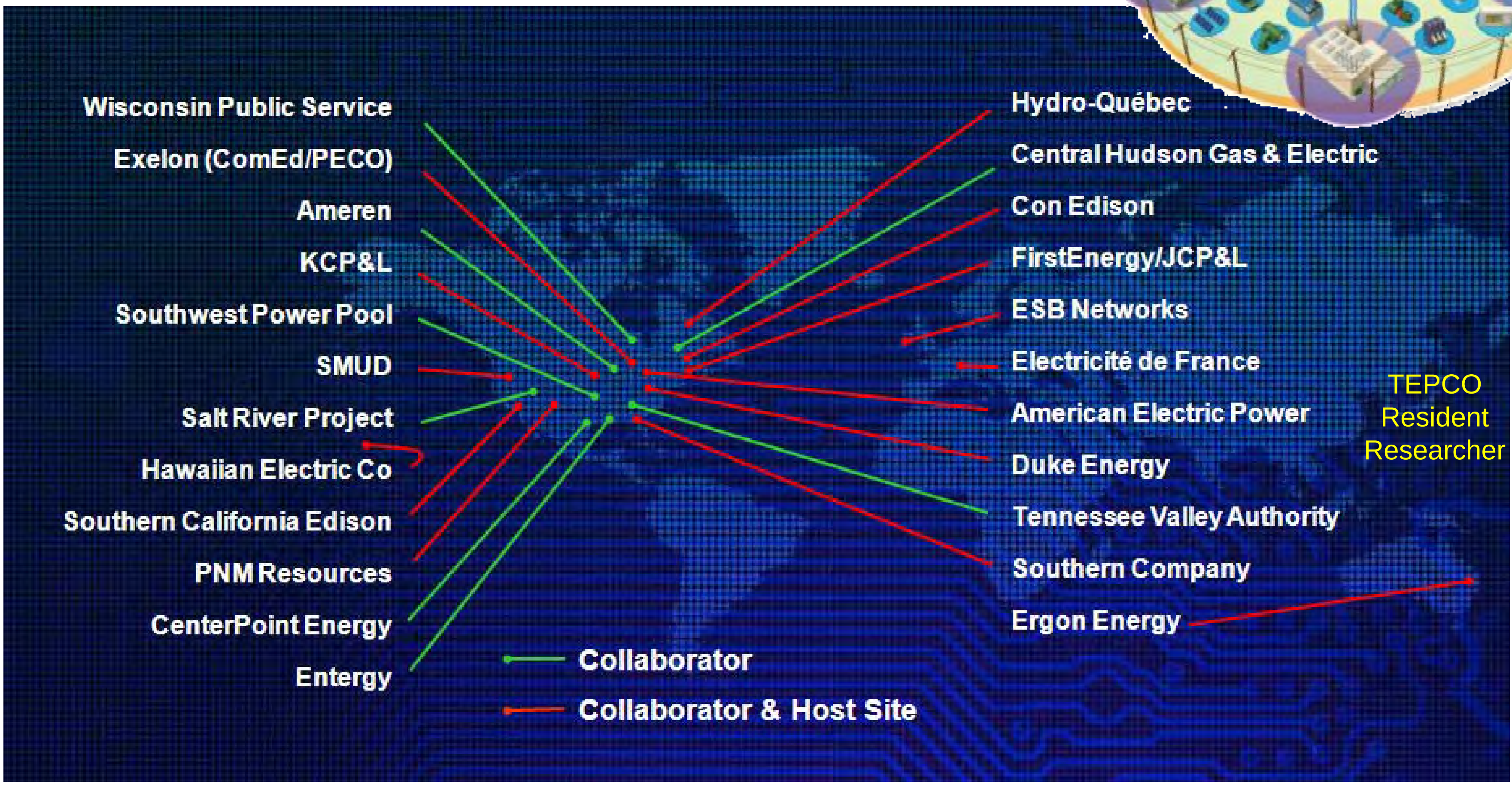
Technology Accelerator!

Suppliers

Vendors

EPRI Smart Grid Demonstration Projects
Integration of Distributed Energy Resources

23 Utilities, 15 Large Scale Demonstrations
6 Countries



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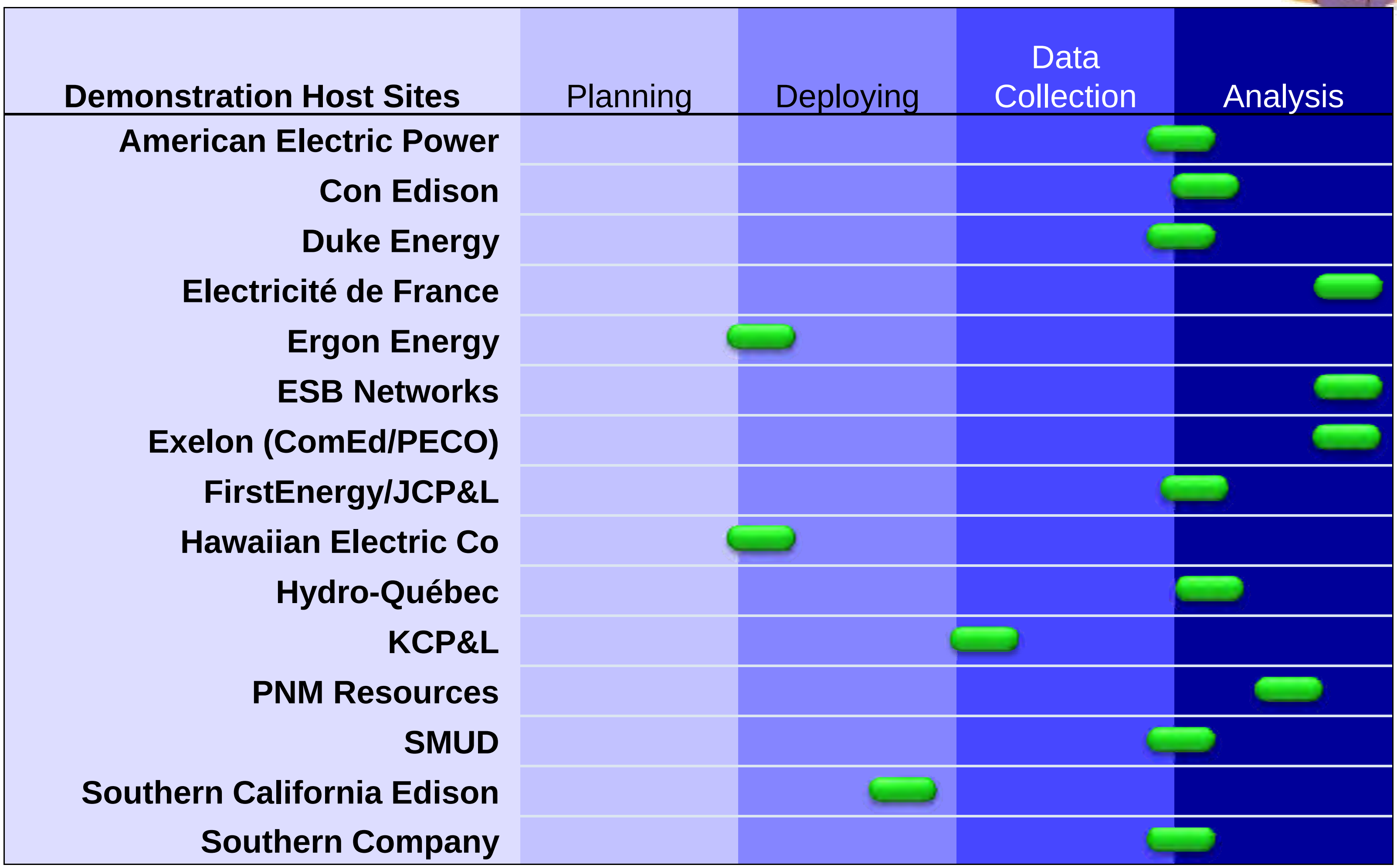
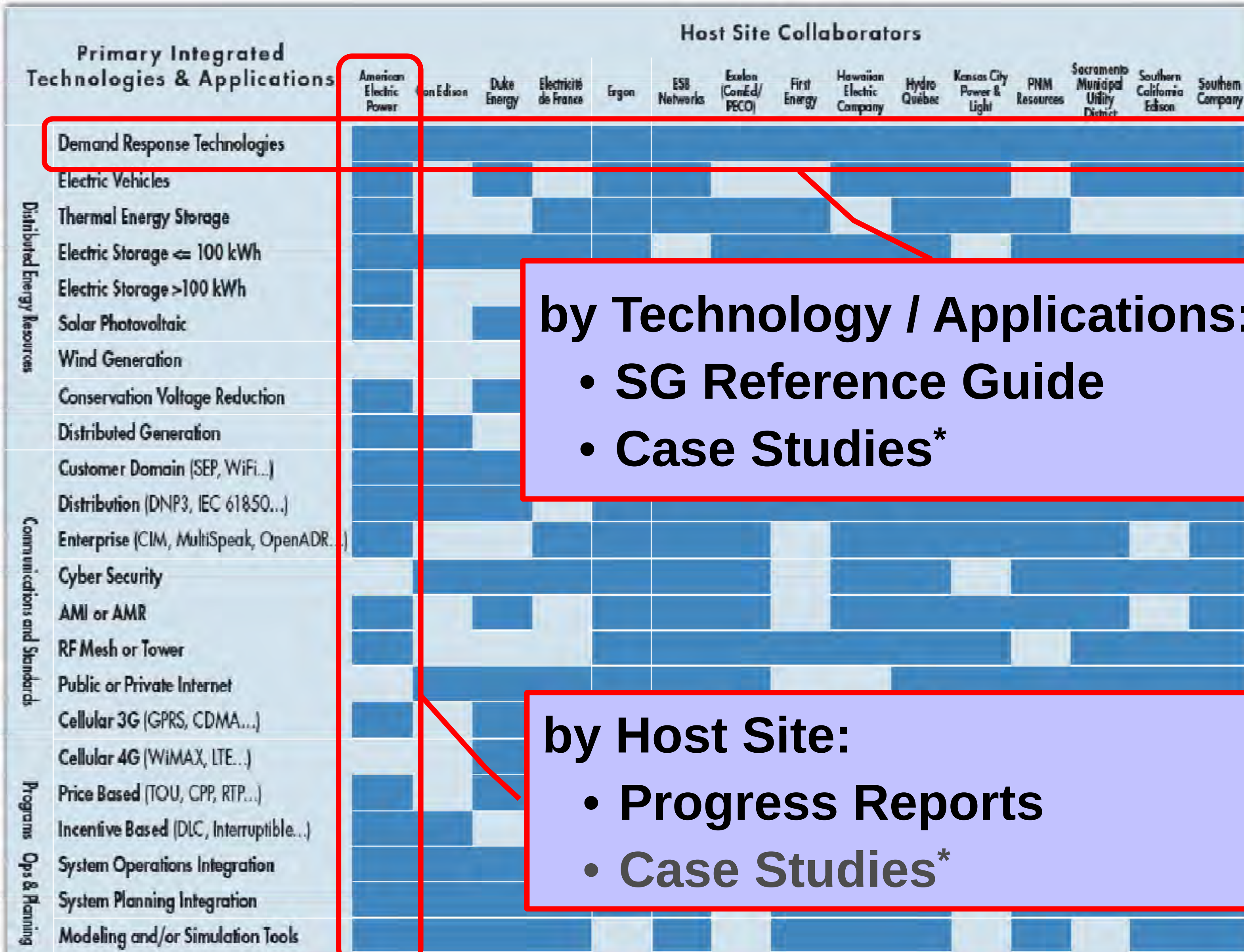
Status of Host-Site Demonstrations
(as of Mid 2013)



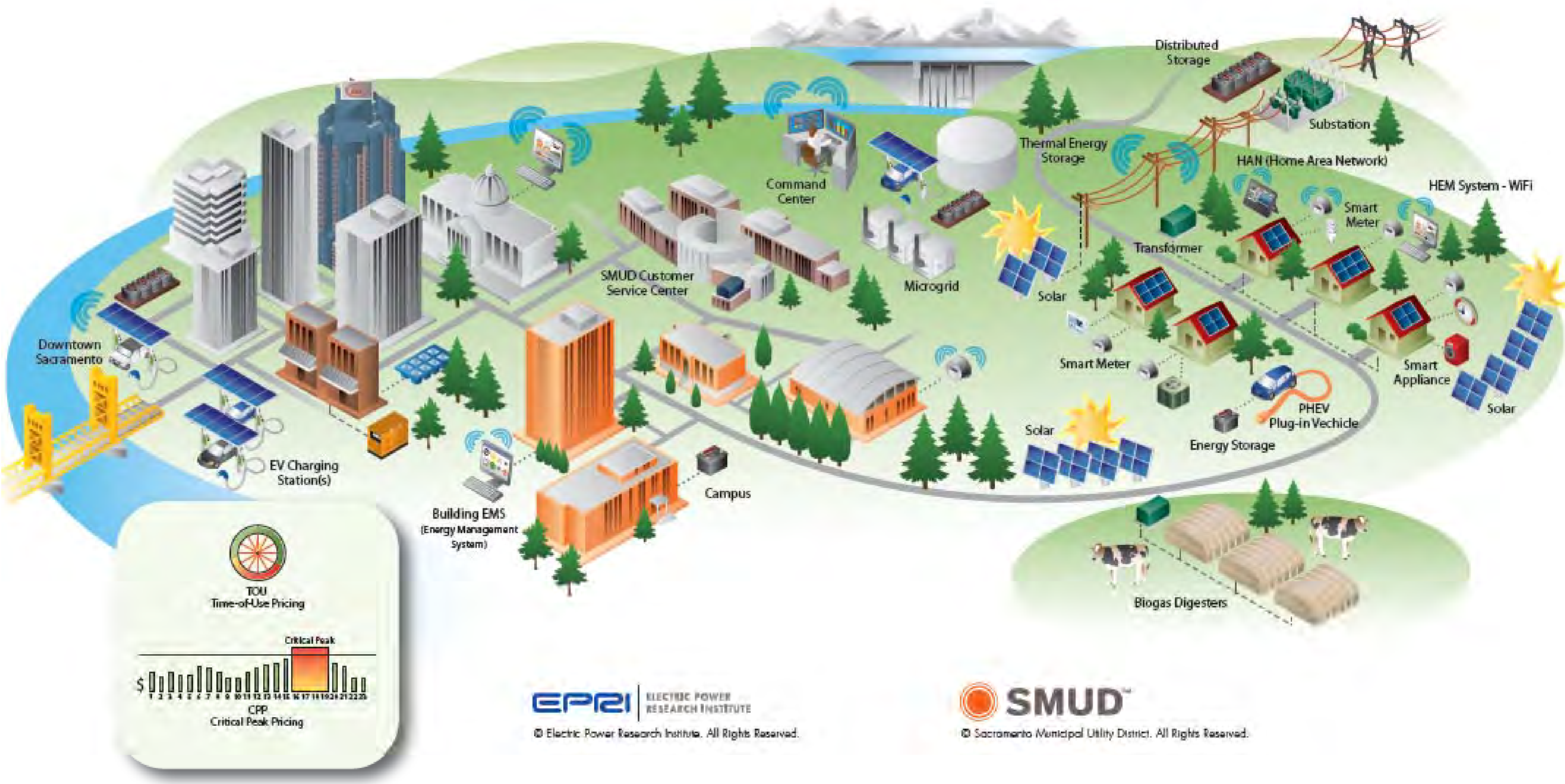


by Technology / Applications:
- **SG Reference Guide**
- **Case Studies***

by Host Site:
- **Progress Reports**
- **Case Studies***

Consumer Behavior Trials & Results

Sacramento Municipal Utility District (SMUD)



A Case Study on

Residential Summer Solutions Program

SMUD

- How do Different <u>Information</u> and <u>Load</u> Treatments affect Energy Savings and Peak Demand Reduction?
- **<u>Information Provided to Customers</u>**
  - Online Portal,
  - Home level data: (RT Usage and Cost)
  - Appliance Data: HVAC, Water Heater, Clothes Dryer (RT Usage & Cost)
- **<u>Summer Solutions Rate (SS Rate): Time of Use (TOU) & Critical Peak Price (CPP)</u>**
  - Tier 1: 7.21 cents/kWh (Tier 2: 14.11 cents/kWh (>700 kWh for the month))
  - On Peak (4-7pm): 27 cents/kWh (only weekdays)
  - During CPP Event: 75 cents/kWh (1600-1900, up to 12 events/year)
- **<u>Load Control - Customer programmed Temperature Settings in Air Conditioning (AC) Thermostat</u>**
  - During CPP Event, AC turns off, allows 4 degree (F) rise in Temperature
  - Customer could override at any time
  - No financial Incentive
- **<u>Utility Controlled Temperature Setting (Automatic Temperature Control – ATC)</u>**
  - During CPP Event, AC turns off, allows 4 degree (F) rise in Temperature
  - One override allowed per season
  - $4.00 incentive paid to customer per event

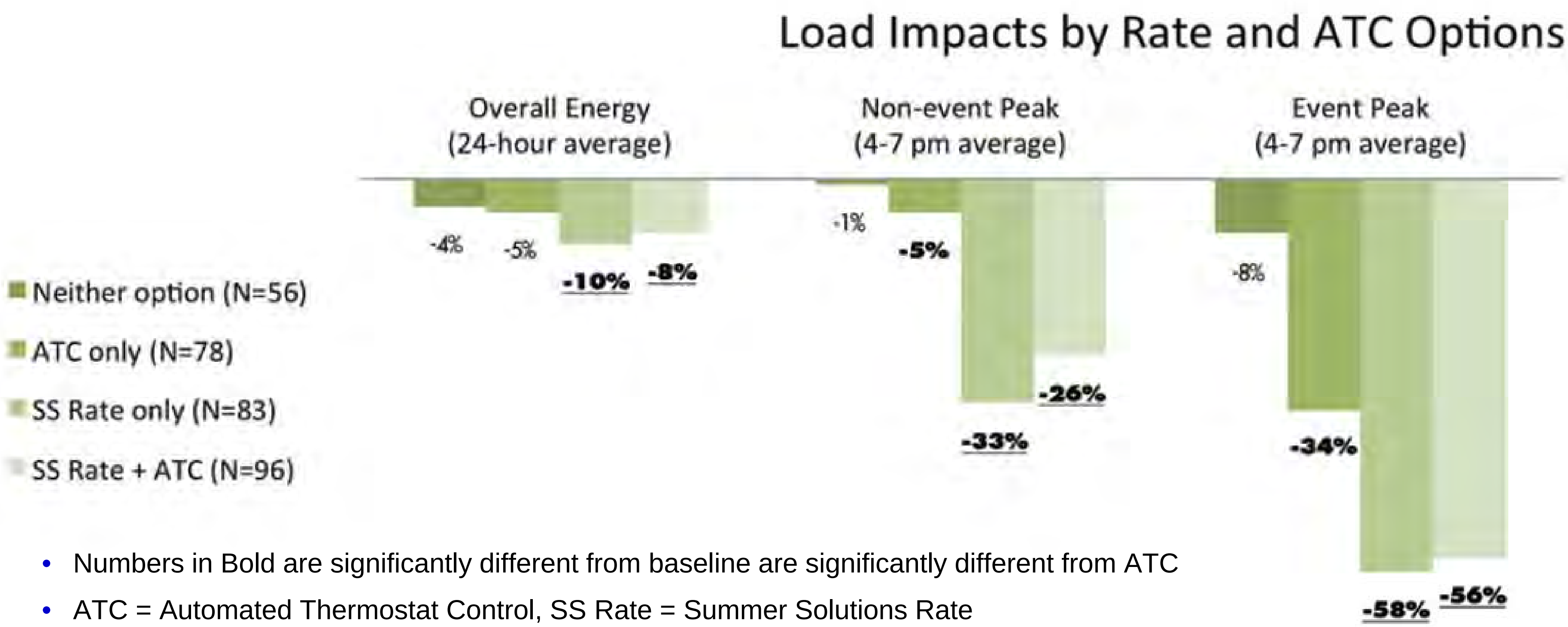
A Case Study on

Residential Summer Solutions Program

SMUD

Results & Lessons Learned

- Automated Thermostat Control (ATC) with financial incentive had minimal affect
- No need to offer financial incentive for direct load control, it didn't have big impact on usage



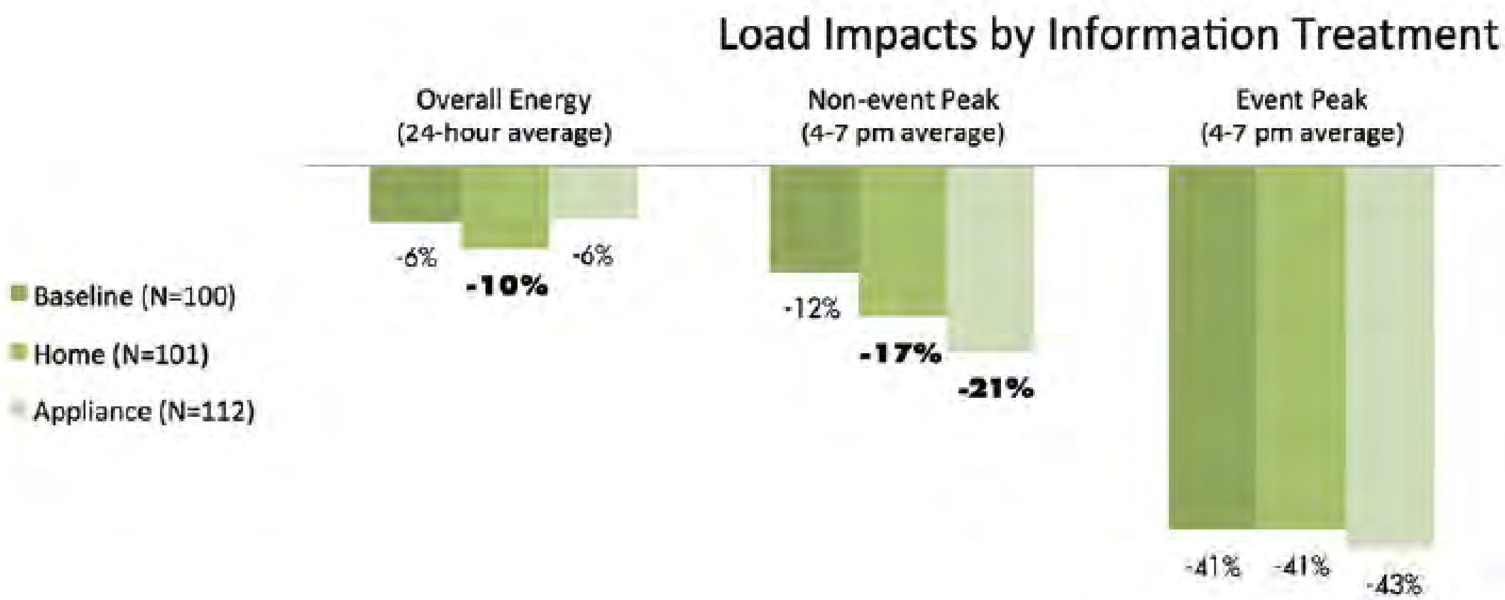
- Numbers in Bold are significantly different from baseline are significantly different from ATC
- ATC = Automated Thermostat Control, SS Rate = Summer Solutions Rate

A Case Study on SMUD™

Residential Summer Solutions Program

Results & Lessons Learned from **Home and Appliance Level Monitoring**

- Little additional effect during events compared to baseline
- Do not offer appliance level information. HIGH COST and limited energy savings



Participants who opted for a TOU/CPP rate dropped 70% more load during peak events than did those on direct load control.

Participants saved 7.5%, Opt-in Rate was 5.7%

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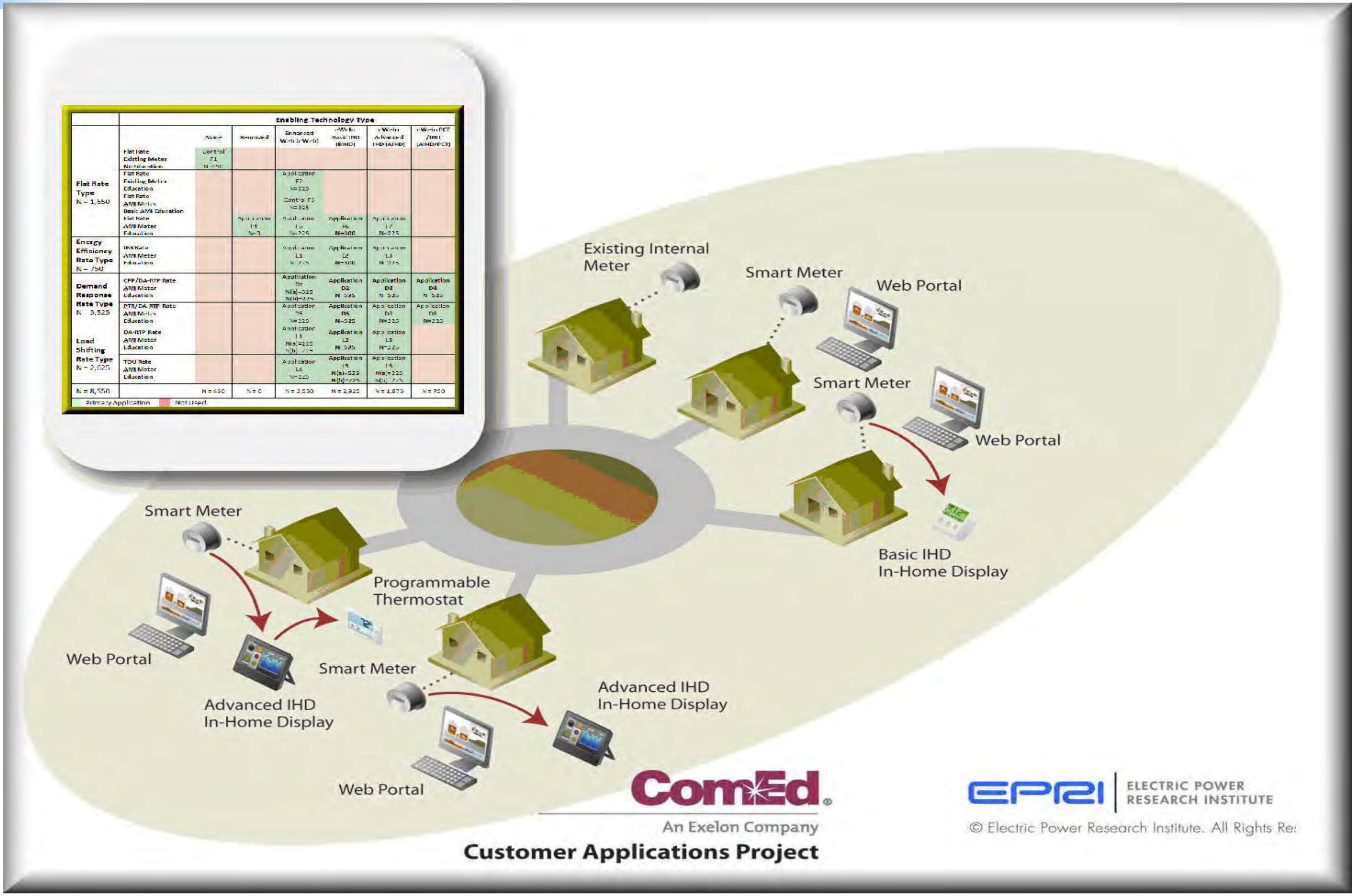
ComEd AMI Assessment
Customer Applications Plan (CAP)



		Enabling Technology Type					
		None	Required	Enhanced Web (eWeb)	eWeb Basic IHD (BIHD)	eWeb Advanced IHD (AIHD)	eWeb PCT /IHD (AIHD/PCT)
Flat Rate Type N = 1,550	Flat Rate Existing Meter No Education	Control F1 N=[illegible]					
	Flat Rate Existing Meter Education			Application F2 N=225			
	Flat Rate AMI Meter Basic AMI Education			Control F3 N=225			
	Flat Rate AMI Meter Education		Application F4 N=0	Application F5 N=225	Application F6 N=800	Application F7 N=225	
Energy Efficiency Rate Type N = 750	IBR Rate AMI Meter Education			Application E1 N=225	Application E2 N=300	Application E3 N=225	
Demand Response Rate Type N = 3,525	CPP/DA-RTP Rate AMI Meter Education			Application D1 N(a)=525 N(b)=225	Application D2 N=525	Application D3 N=525	Application D4 N=525
	PTR/DA-RTP Rate AMI Meter Education			Application D5 N=225	Application D6 N=525	Application D7 N=225	Application D8 N=225
Load Shifting Rate Type N = 2,025	DA-RTP Rate AMI Meter Education			Application L1 N(a)=225 N(b)=225	Application L2 N=525	Application L3 N=225	
	TOU Rate AMI Meter Education			Application L4 N=225	Application L5 N(a)=525 N(b)=225	Application L6 N(a)=225 N(b)=225	
N = 8,550		N = 450	N = 0	N = 2,550	N = 2,925	N = 1,875	N = 750

Primary Application / Not Used

Opt-Out Results

Hypothesis – Opt-Out Program will result in more participation

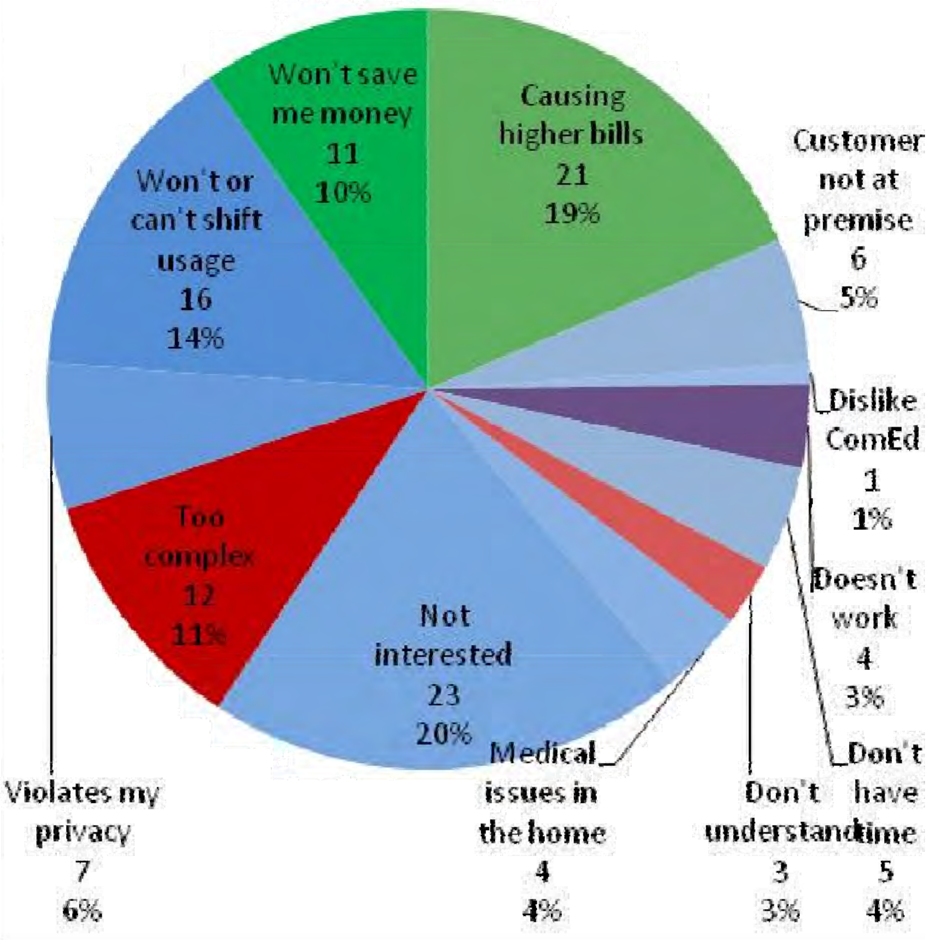
About 8500 Customers

- Assigned a new electric rate
- Provided enabling technologies
- Given option to "Opt-Out"

Percentage of Customers Opting Out

1. 2%
2. 17%
3. 41%

Opt Out Reasons



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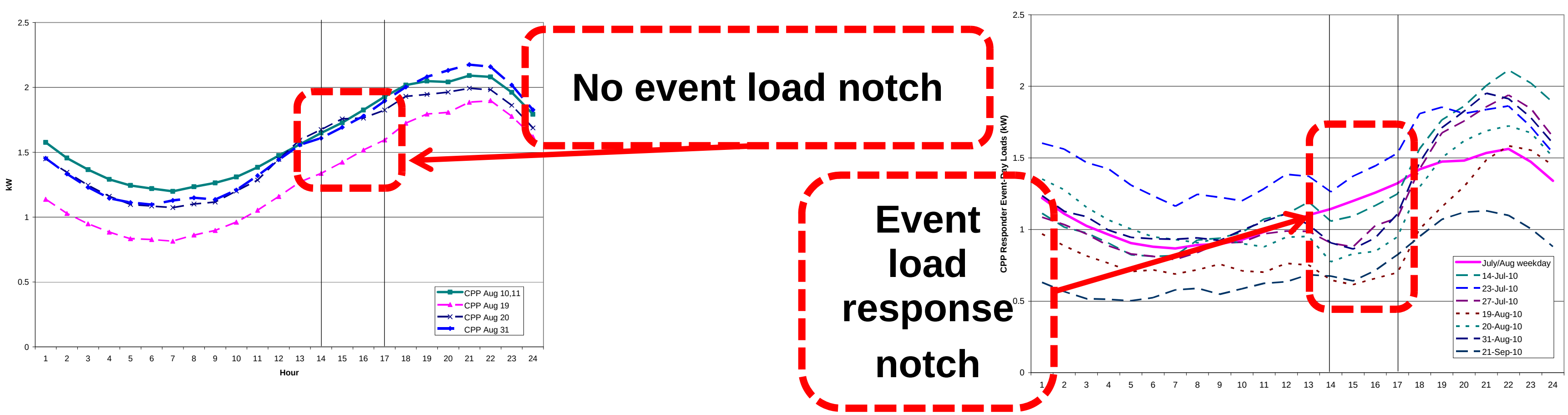
Results

ComEd
An Exelon Company

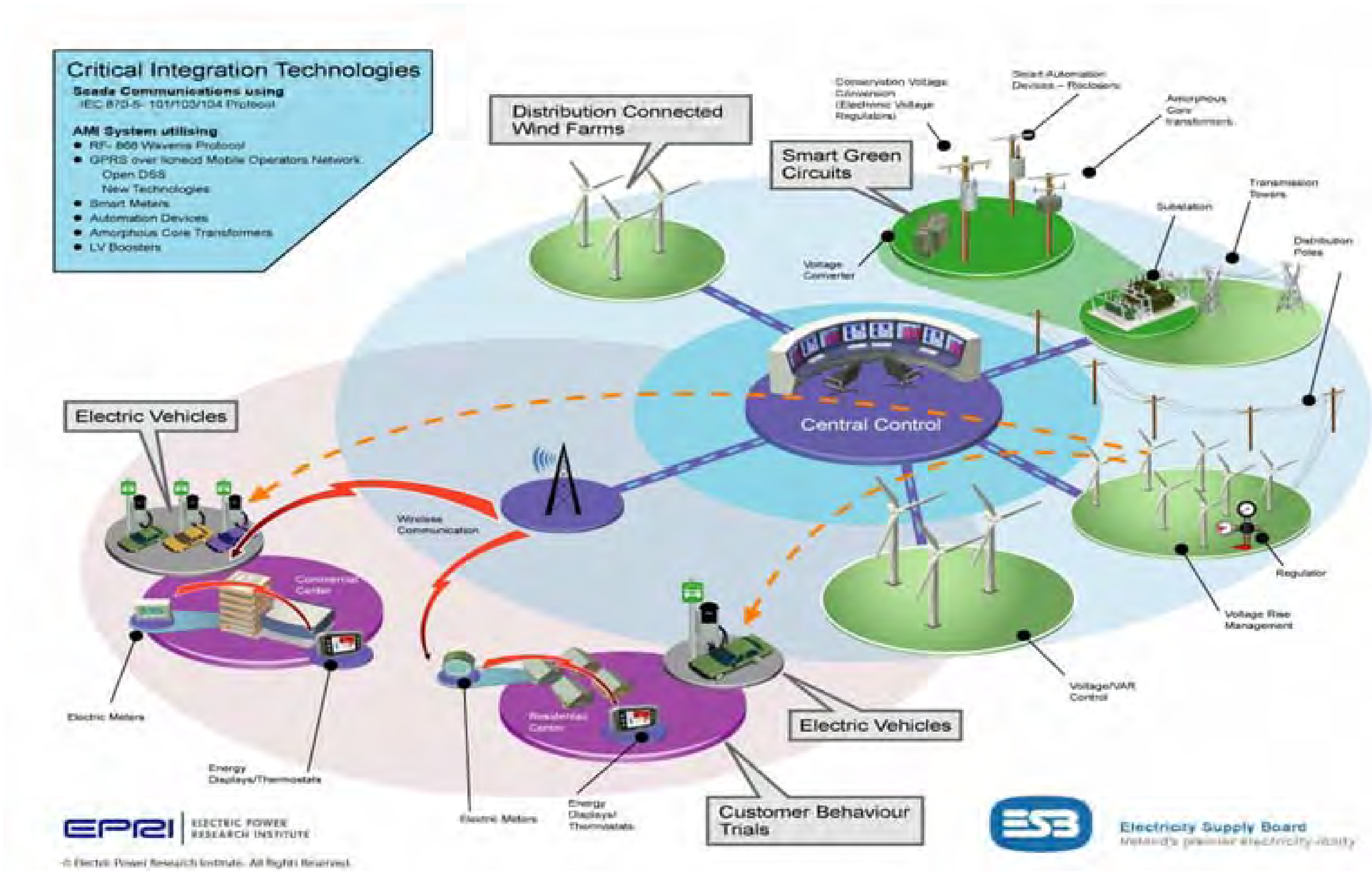
- Up to 20% DR from subset of Critical Peak Price and Peak Time Rebate customers
- Technology treatments added no measurable improvement

Impact of AMI on Demand Response

Rate Application	Responder Load as % Application Load	Average % Responder Load Change	Total Responder Load Impact % Application Load
CPP	10.2	-21.8 %	-2.2 %
DA-RTP	8.1	-14.4 %	-1.2 %
PTR	8.1	-14.7 %	-1.2 %
TOU	8.0	-11.3 %	-0.9 %
IBR	5.0	- 5.6 %	-0.3 %
FLR	4.8	- 7.2 %	-0.3 %



ESB Networks, Ireland



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Customer Behaviour Trial Scope

Objective is to '**Assess impact of SM on peak demand & overall energy use**"

- 6,400 customers
  - Installation complete June 2009
  - 4800 Domestic
  - 1600 Business

	Residential Tariffs- Charges		
Tariff	Night	Day	Peak
Tariff A	12.0	14.0	20.0
Tariff B	11.0	13.5	26.0
Tariff C	10.0	13.0	22.0
Tariff D	9.0	12.5	38.0
Weekend	10.0	14.0	

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ESB Networks Results

Overall reduction	$2^1/_2$%
Shift of Peak Load	8.8%
Behaviour	Sustained
In-house display customers achieved peak shift	11%

- Minimal benefit doesn't justify cost of IHD
- No TOU "Tipping Point"

16

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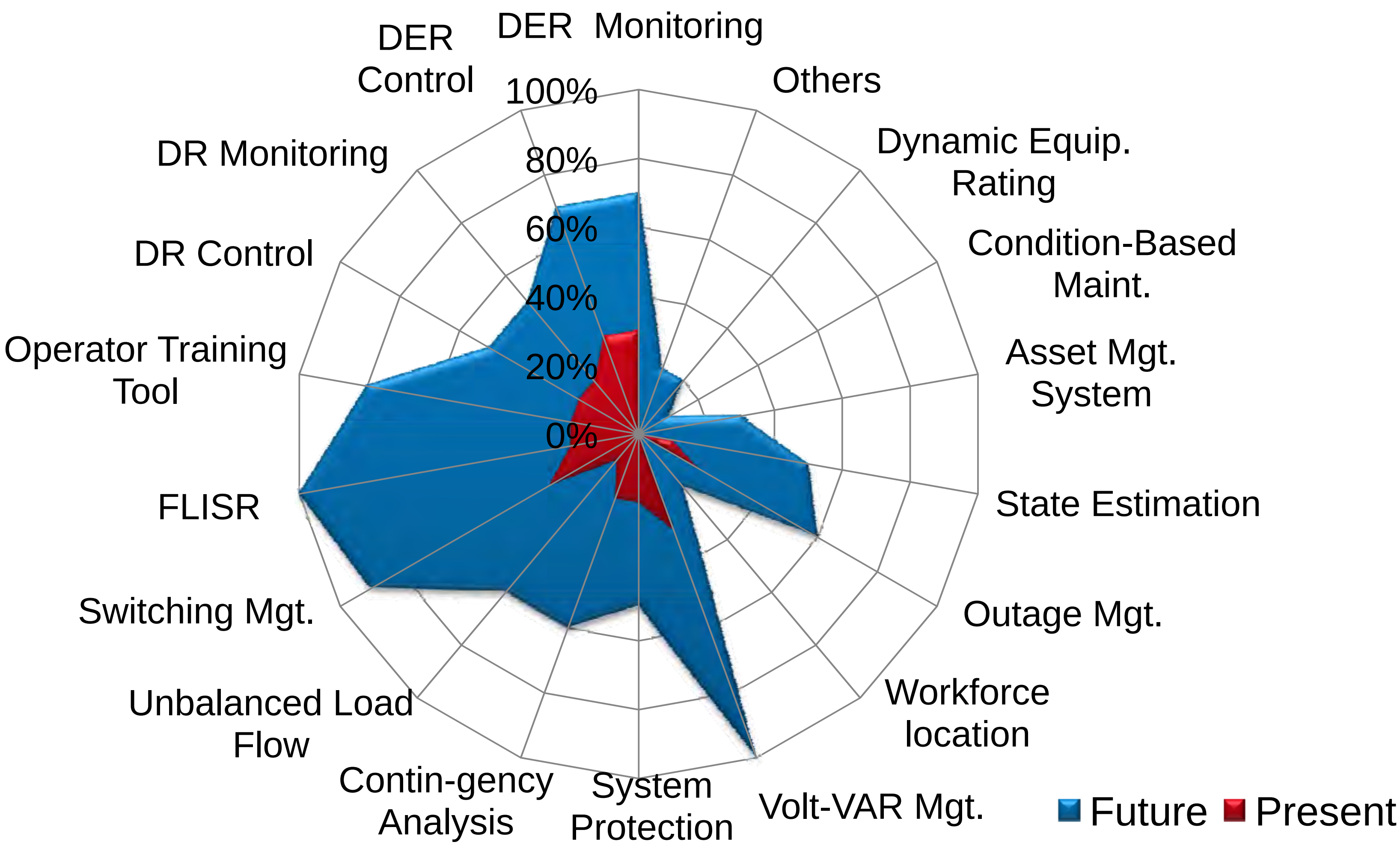
Conservation Voltage Reduction (CVR) and Volt/VAR Optimization (VVO)

DMS Advanced Applications (present versus future)



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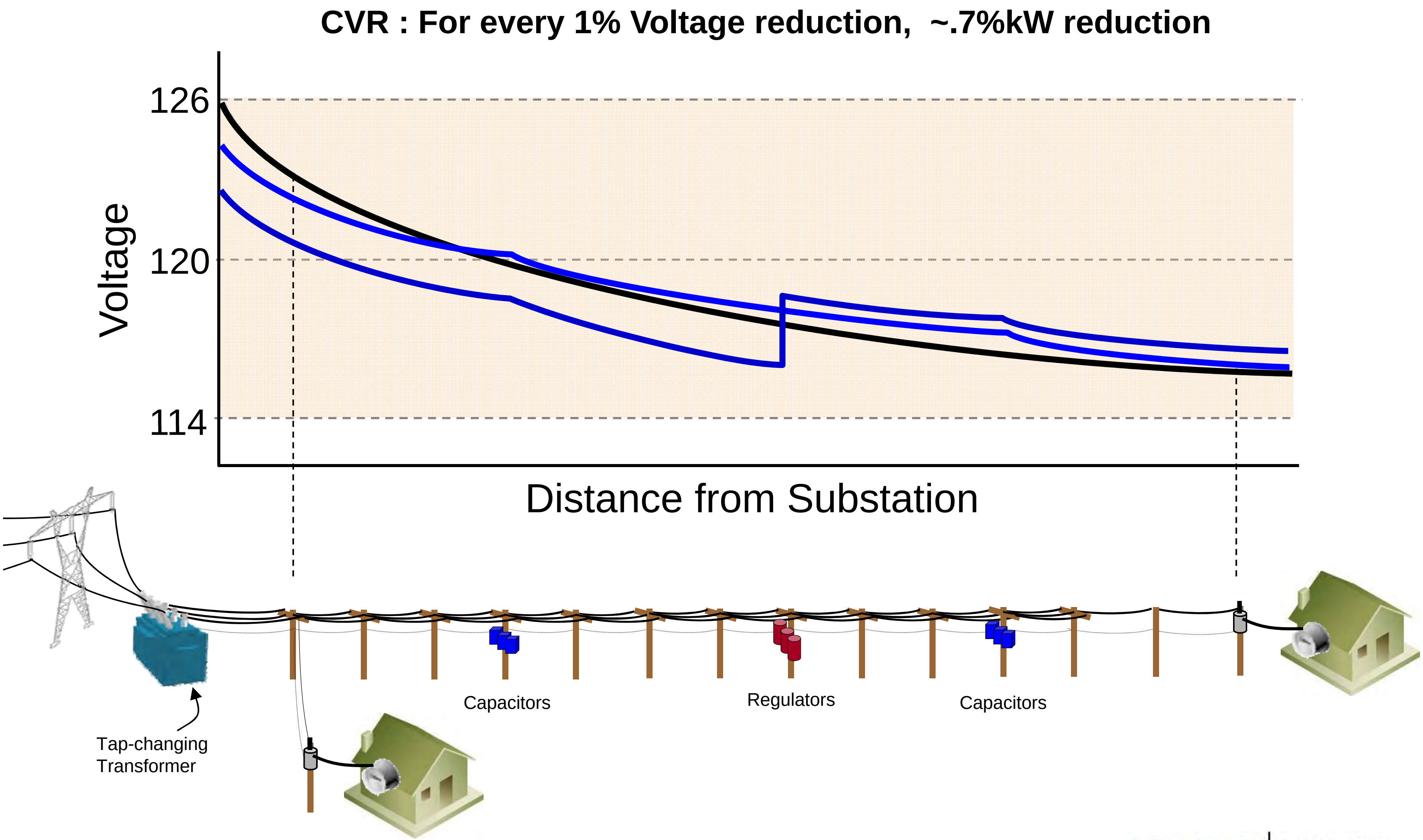
Conservation Voltage Reduction for Efficiency and Demand Response (Matt's Cartoon)

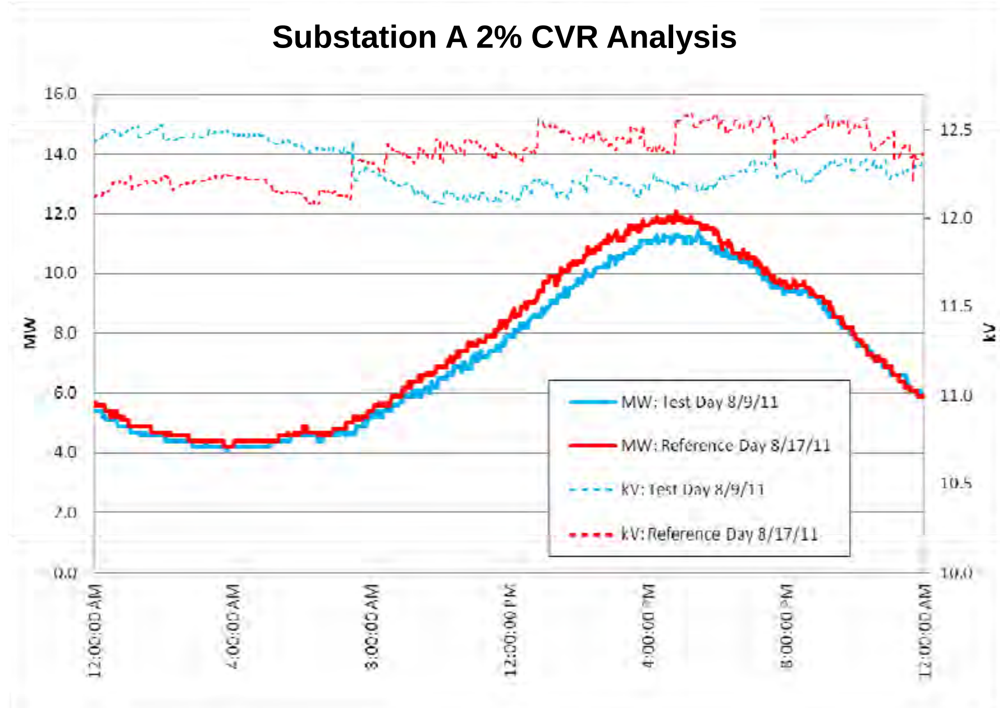


A Case Study on - SMUD

Conservation Voltage Reduction and Volt-VAR Optimization

Substation	Approximate Avg. Percentage Demand Reduction (2% V reduction)
Substation A	2.5%
Substation B	1.0%

Additional testing of a larger pool of substations to be done to determine predictability of the CVR control strategy



Volt-VAR optimization enabled efficient operation of the distribution system while conservation voltage reduction reduced peak demand by an average of 1.7% (CVR Factor ~1.1)

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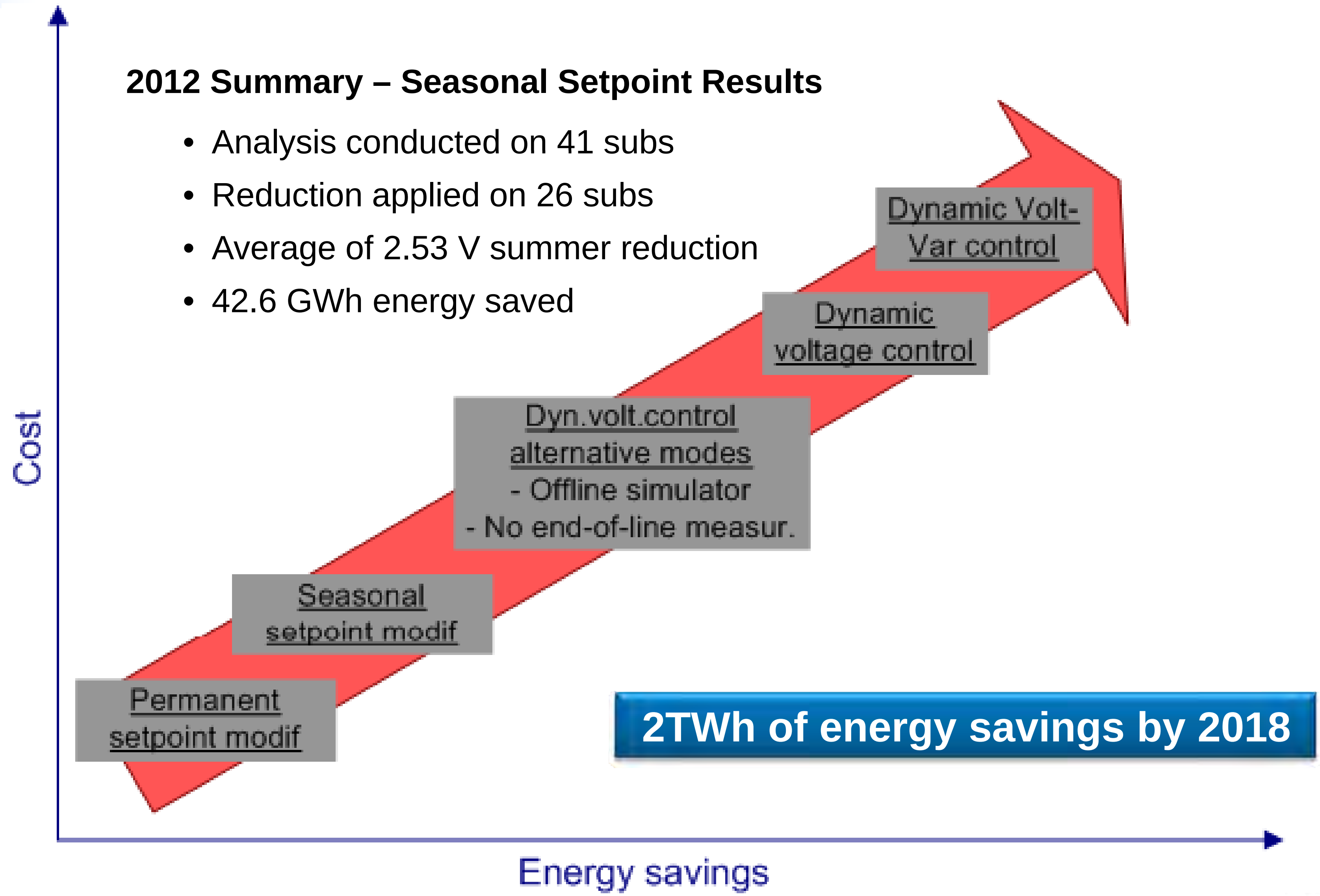
Voltage reduction techniques
Summary of cost-effectiveness

2012 Summary – Seasonal Setpoint Results

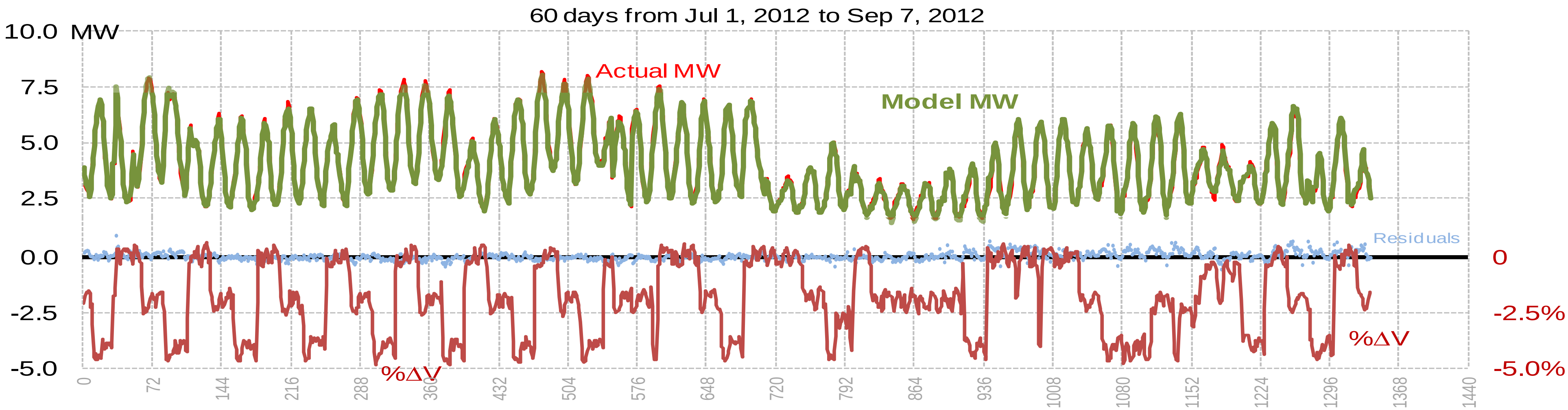
- Analysis conducted on 41 subs
- Reduction applied on 26 subs
- Average of 2.53 V summer reduction
- 42.6 GWh energy saved



2TWh of energy savings by 2018

A Case Study on

Conservation Voltage Reduction



Estimated CVRf

Feeder	Summer	Fall
Urban	.78	1.24
Rural/Urban	.97	.44

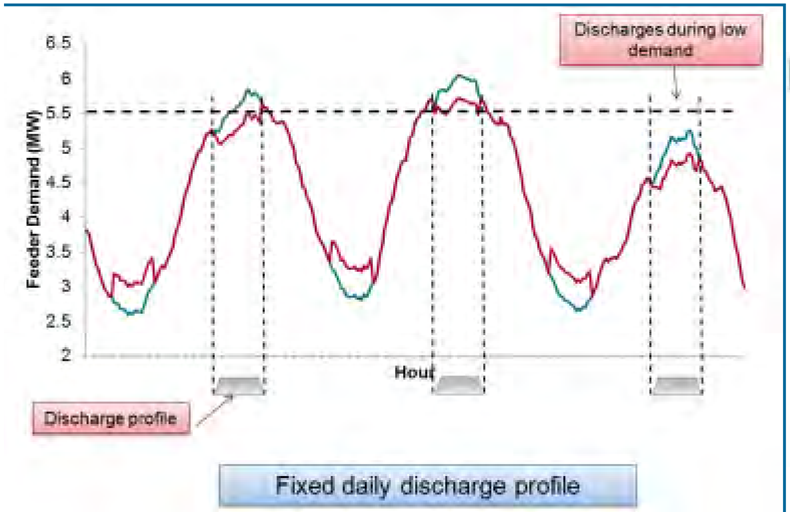
Different CVR capabilities are attainable during different periods of time
Factors: Seasonal Changes (Summer, Fall) & Feeder Load Characteristics

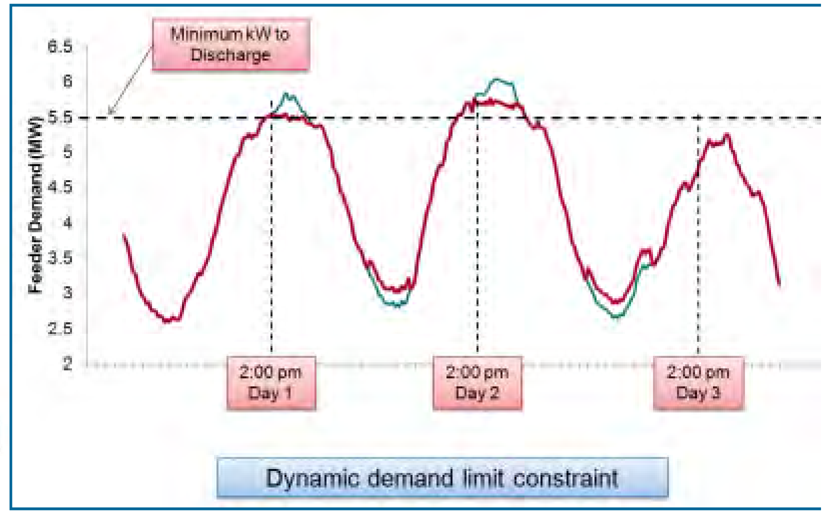
Additional Results

A Case Study on

Simulation of Community Energy Storage

AEP AMERICAN ELECTRIC POWER





Modes	Pros	Cons
Peak Shaving	Directly targets peak demand periods	Required kWh may exceed Stored kWh
Load Following	Directly targets peak demand periods	Dependant on load characteristics
Scheduled	Control settings require minimal updates	Fully discharges battery each day

Dispatch of storage based on "monitored kW" reduces number of charge/discharge cycles needed to shift the peak demand.

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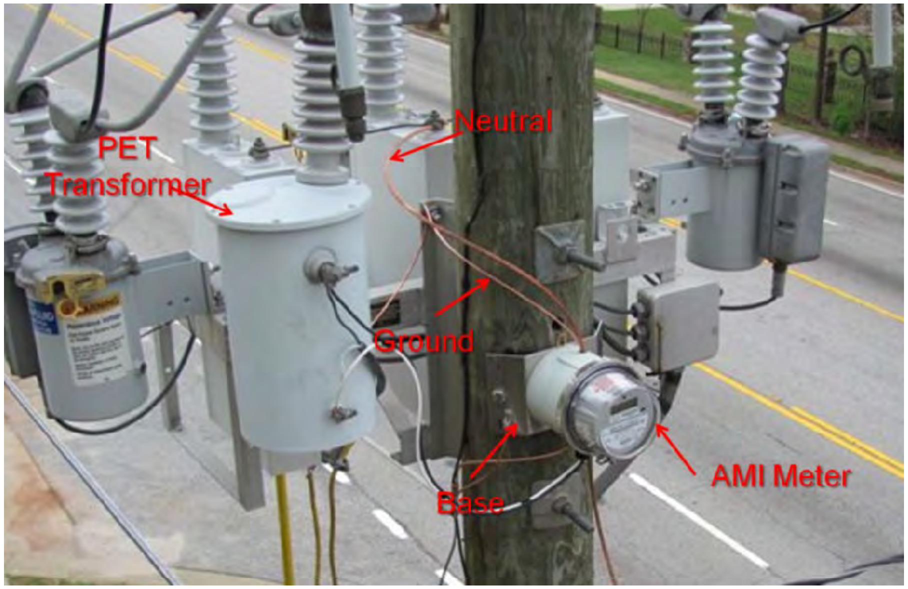
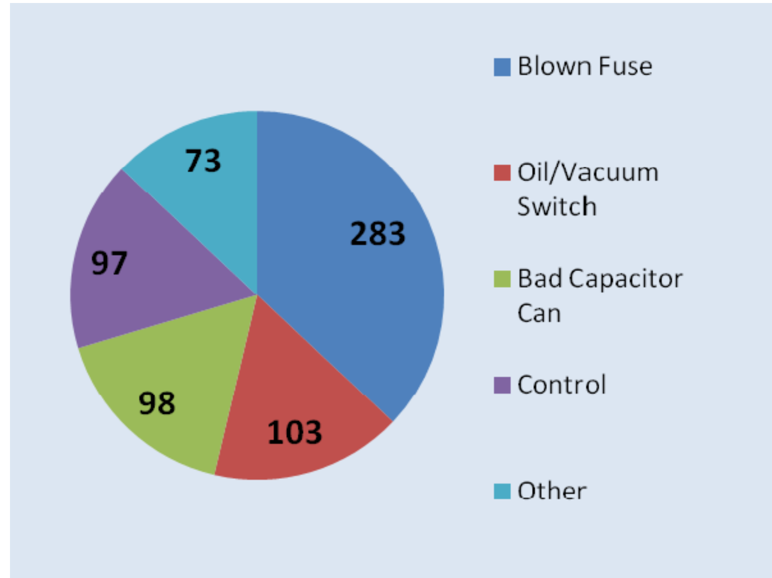
A Case Study on

A Capacitor Bank Health Monitor



Installation of Advanced Meter Capacitor Bank Health Monitor

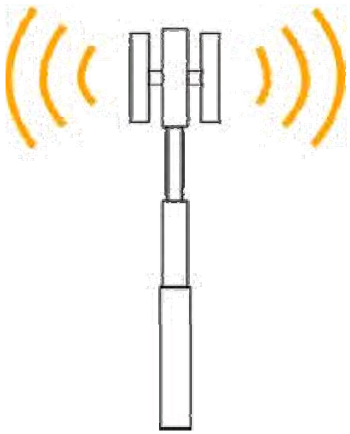


Issues Causing Failure of Capacitor Banks

AMI capacitor bank health monitors identified over 650 problems in the first 6 months and changed the inspection schedule from once a year to once a day.

Communication Technologies for Grid Management

- Cost of communications is dropping
- Capability of devices to provide data is increasing
- Innovation is enabled by access to devices



- A Unified Utility Communication Infrastructure:
  - Handles traffic for many devices
  - Can replace common communication systems
  - Provides a Platform for new applications and services
  - Enhance performance of existing applications
- Business case is challenging
  - i.e. AMI systems designed to meet core requirements
  - New Innovations are unknown….

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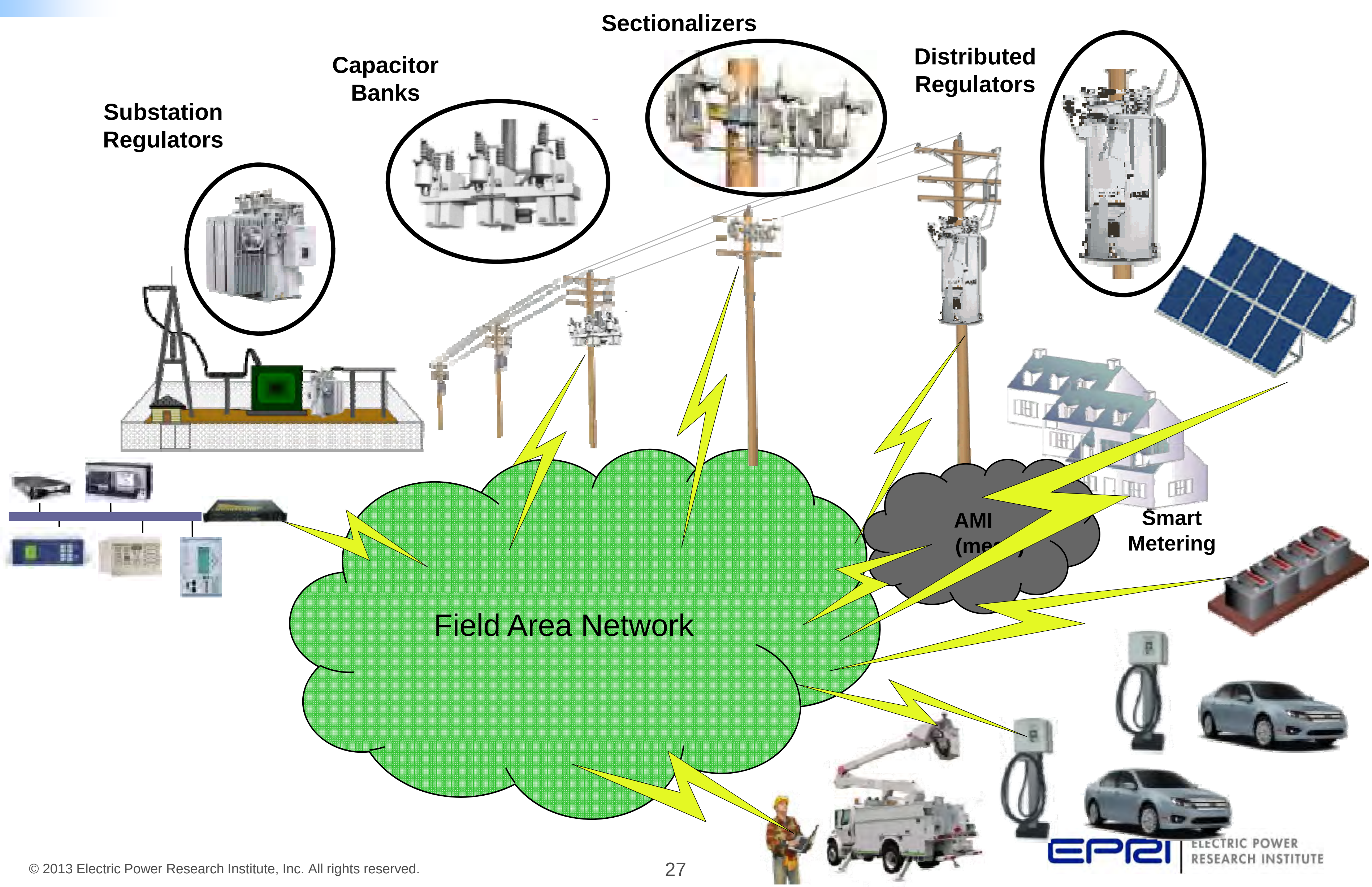
Field Area Network (FAN) to Unify Communications



A Case Study on

A Field Area (communications) Network Pilot

3.65GHz equipment being tested.

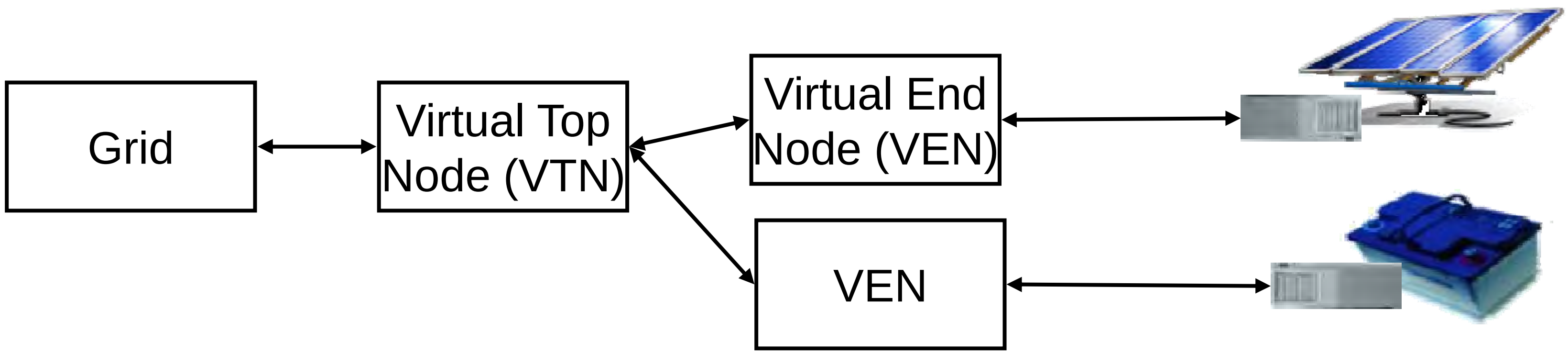
Two-way capacitor bank monitors and controllers, for volt/var control: Control, voltage, temperature

Additional Applications

Distribution Automation
Transformer Monitors
SCADA
Video
AMI

A wireless broadband network can be integrated across a utility to serve as the unifying infrastructure.

Architecture & Standards Supporting DER



EPRI Report #1020432

Architecture Leveraged for OpenADR 2.0

<u>Key Standards Enabling Innovation</u>

- **OpenADR 2.0**
- **Smart Inverter Standards (IEC 61850, DNP3, SEP 2)**
- **CEA – 2045 (Modular Communications)**

OpenADR (Automated Demand Response)

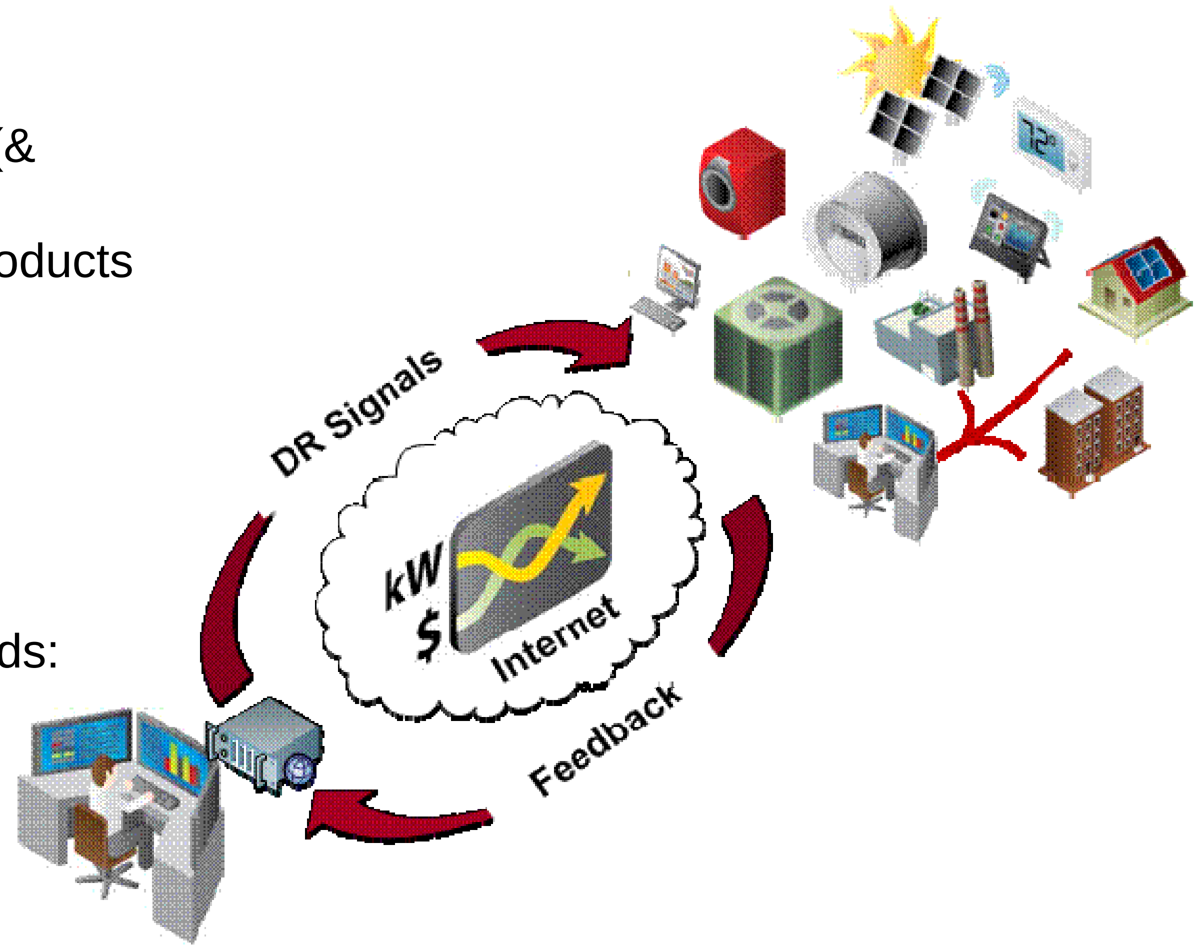
Standardized messaging for Utilities, ISO's Aggregators and Device Manufacturers

Standards provide

- Vendor Choice
- Over 100 Vendors Involved (& growing)
- Commercial Off the Shelf Products
    - 20+ products now
- Innovation
- International Collaboration

Research Questions

- Capability to meet utility needs:
    - DR Programs
    - Ancillary Services
    - Aggregation
- Cyber Security
- Migration Strategy



Emerging Challenges:
How to turn Data into Opportunity & Value

- Availability of Data is Increasing
- How can we Leverage our Assets?
- Demonstrate & Assess Value
- Prioritize New Investments & Efforts
- Educate our Staff & Industry
  - Supports formation of Data Analytics Groups

EPRI Approach – Collaborative Demonstrations

Transmission Demo & Distribution Demo on “Big Data”

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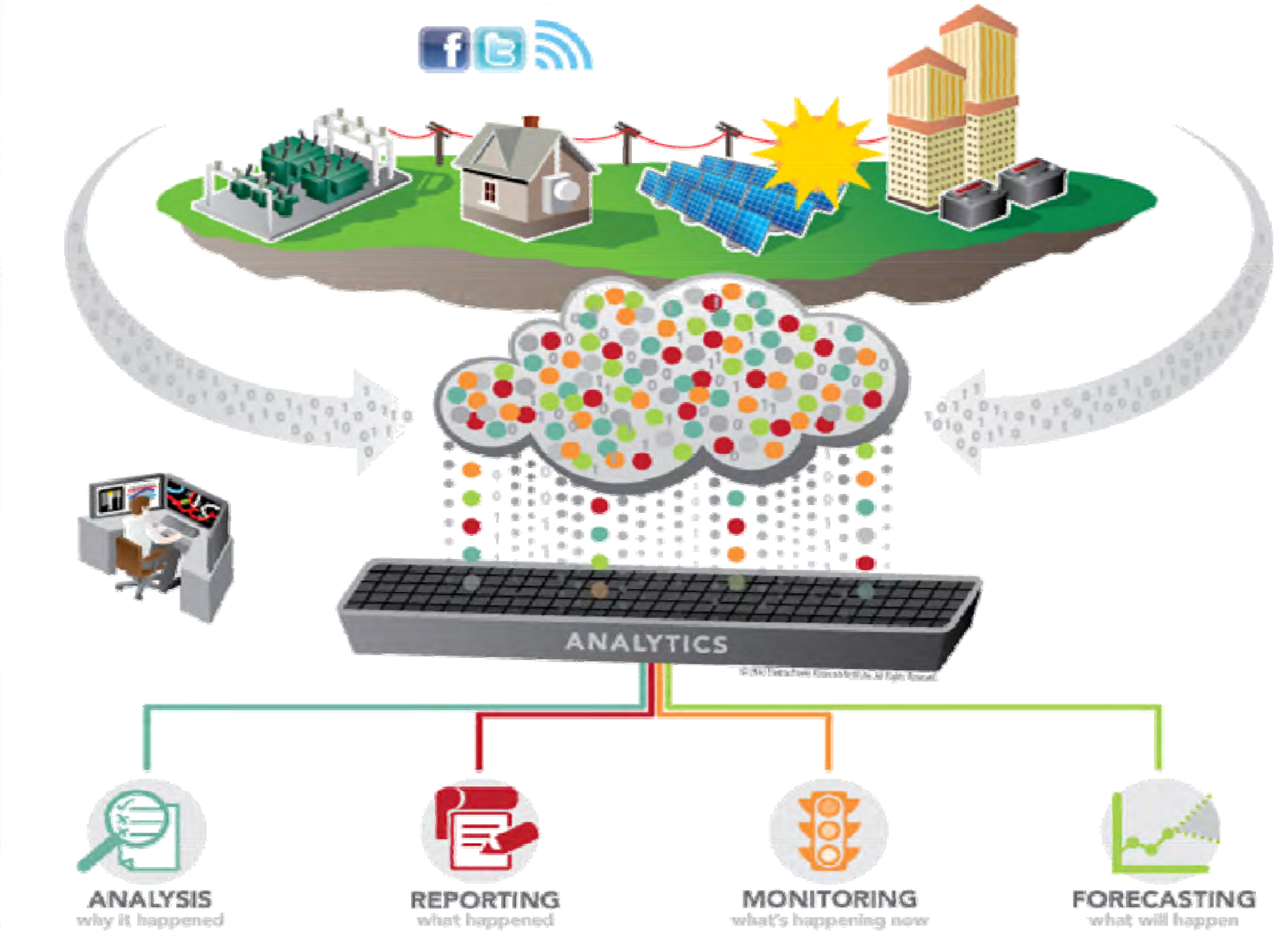
Distribution & Transmission Demonstrations on "Big Data"

Data Management & Analytics to Support Operations, Planning and Asset Management



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What are we Learning

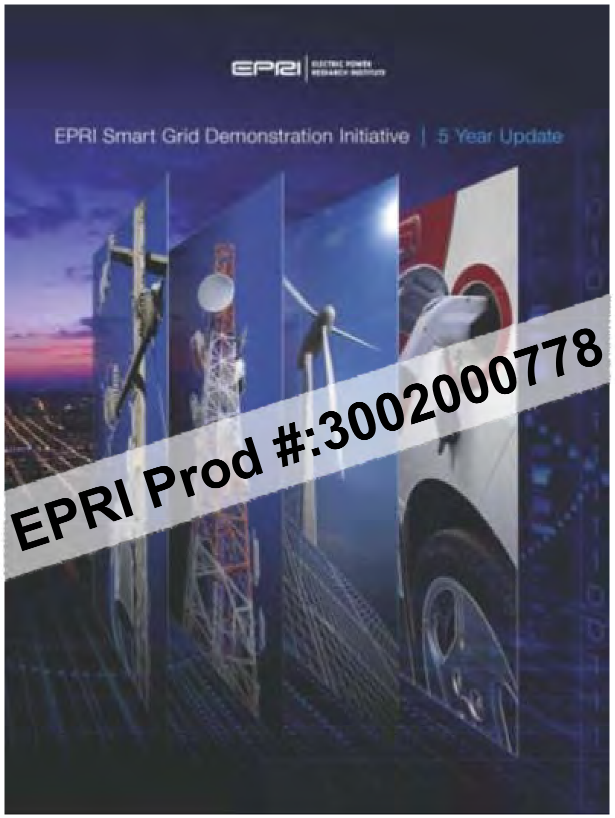
Perspective from the Demonstrations

- Successes
  - Conservation Voltage Reduction / Volt-Var Optimization
  - Confirmation of Consumer Responses to Variable Pricing & Events
  - Innovation Use of Deployed Technology (Use of AMI for Cap Banks)
  - DER can be managed on individual feeders

- Challenges
  - Consumer Adoption of Technology & Product Availability
  - Energy Storage Business Case
  - Standards Adoption Slow, but Vendors are Paying Attention
  - Lack of ubiquitous communication network
  - Virtual Power Plant
    - Not managing significant quantity or variety of resources (yet)

EPRI Smart Grid Demonstration 5-Year Update

Publication date: August 2013 EPRI Prod #:3002000778



5-Year Update: 9 Case Studies

- **Conservation Voltage Reduction**, Ameren
- **Multiple Technology Aggregate Response**, American Electric Power
- **Integrated Control Platform Visualization**, FirstEnergy
- **Anti-islanding using Autoground**, Hydro-Québec
- **Volt-Var Control Equipment Tests**, Hydro-Québec
- **Storage for Simultaneous Shifting and Smoothing**, Public Service of New Mexico
- **Field Area Network Pilot**, Salt River Project
- **Residential Summer Solutions Study**, Sacramento Municipal Utility District
- **Effects of Capacitors on Substation Bus Voltage**, Southern Company

Together…Shaping the Future of Electricity

Matt Wakefield, mwakefield@epri.com

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