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Cost and Value Analysis of Distribution System Modernization

35th PLMA Conference Nashville TN

Michael Brown – NV Energy
Wayne Callender – CPS Energy
Allison Hamilton - NRECA
Heather Manypenny – NHEC

Joseph E. Childs – Eaton (Moderator)

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Future Uncertainty Principal

(With apologies to Werner Heisenberg)

What & When are mathematical complementary values.

The future is uncertain, knowledge & experience enhance prediction, but don't guarantee adoption. The more detailed a vision, the fuzzier the adoption timeline.

Joseph E. Childs – April 2017

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DER Value Chains

External Value

ISO/ RTO Markets
Capacity
Energy
Reserves
Regulation
Frequency

Non-Market Participants
Capacity
Energy

Internal Value

Infrastructure Upgrade Deferral
Dist. Transformer
Cable Upgrade

Operations
Voltage Management
Reverse Power Flow
Local Situations
Power Quality

Energy Efficiency

Customer Value

Utility Bill
Incentives
Energy
Demand
TOU/CPP

Power Quality
Voltage/ Frequency
Reliability
Quality of Service

Other
Special Requirements
Independence

Value State:
Known & Quantified
R&D
Largely TBD or Local

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Panelists

Wayne Callender
CPS Energy San Antonio
Zero Emissions Resource Manager

Heather Mannypenny
New Hampshire Electric Cooperative
Power Resources Executive

- **Utility View Points**
  - Investor Owned
  - Municipal Utility
  - Cooperative
- **ISO/RTO**
  - NE-ISO
  - WECC / CA-ISO Imbalance
  - Balancing Authority
  - ERCOT
- **Perspective**
  - Rates
  - Market
  - Distribution System
- **Background**
  - NY-REV
  - Distribution Deferral

Allison Hamilton
NRECA
Senior Principal, Markets & Rates

Michael Brown
NV Energy
Manager, Demand Response & Distributed Energy Resources

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DERs at CPS Energy and ERCOT

PRESENTED BY: Wayne Callender

PLMA April 4, 2017

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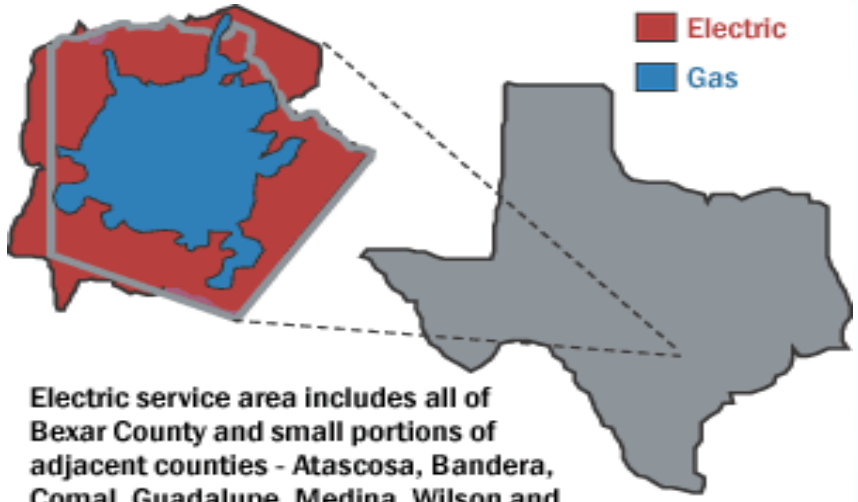
CPS ENERGY OVERVIEW

- Largest municipally owned, vertically integrated electric & gas utility in the nation - 770K Electric & 340K gas customers
- Lowest energy rates among the top 10 largest U.S. cities
- Designated by Bank of America Merrill Lynch with "Premier Credit Rating"
- $11B in asset base, $2.5B in annual revenue
- 14% of customers are on a Demand Response program
- San Antonio Ranks 7th in Nation for Solar Energy



Electric service area includes all of Bexar County and small portions of adjacent counties - Atascosa, Bandera, Comal, Guadalupe, Medina, Wilson and Kendall.

Vision 2020 transitions CPS Energy from a company that is highly dependent on power from traditional generation sources to a company that provides **competitively priced power based on a diverse generation portfolio.**

Definition

For CPS Energy we define a Distributed Energy Resource as the following:

Power generation, load reduction configuration, and/or storage technologies situated behind a customer's retail meter for the purpose of supplying all or part of that customer's electric load, selling energy, ancillary services, and/or load response.

CPS Energy's Initial Goals

- Save for Tomorrow Energy Plan (STEP)
  - Save for Tomorrow Energy Plan (STEP)
  - Reduce energy demand growth by 771 megawatts by 2020.
- Demand Response (DR)
  - 180 MW for 2016
- Solar Distributed Energy Resources (DERs) (67 MWs)
- SimplySolar
  - SolarHostSA
  - Roofless Solar

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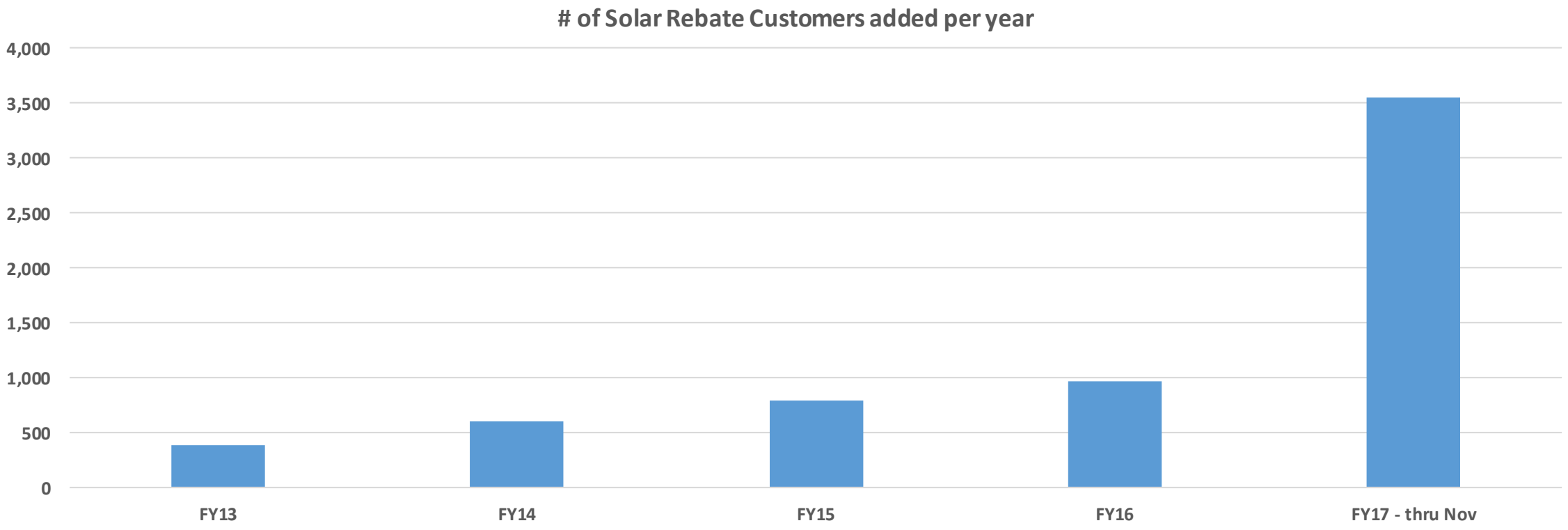
Solar is growing



9,000 customers and 67 MWs by the end of the rebate program

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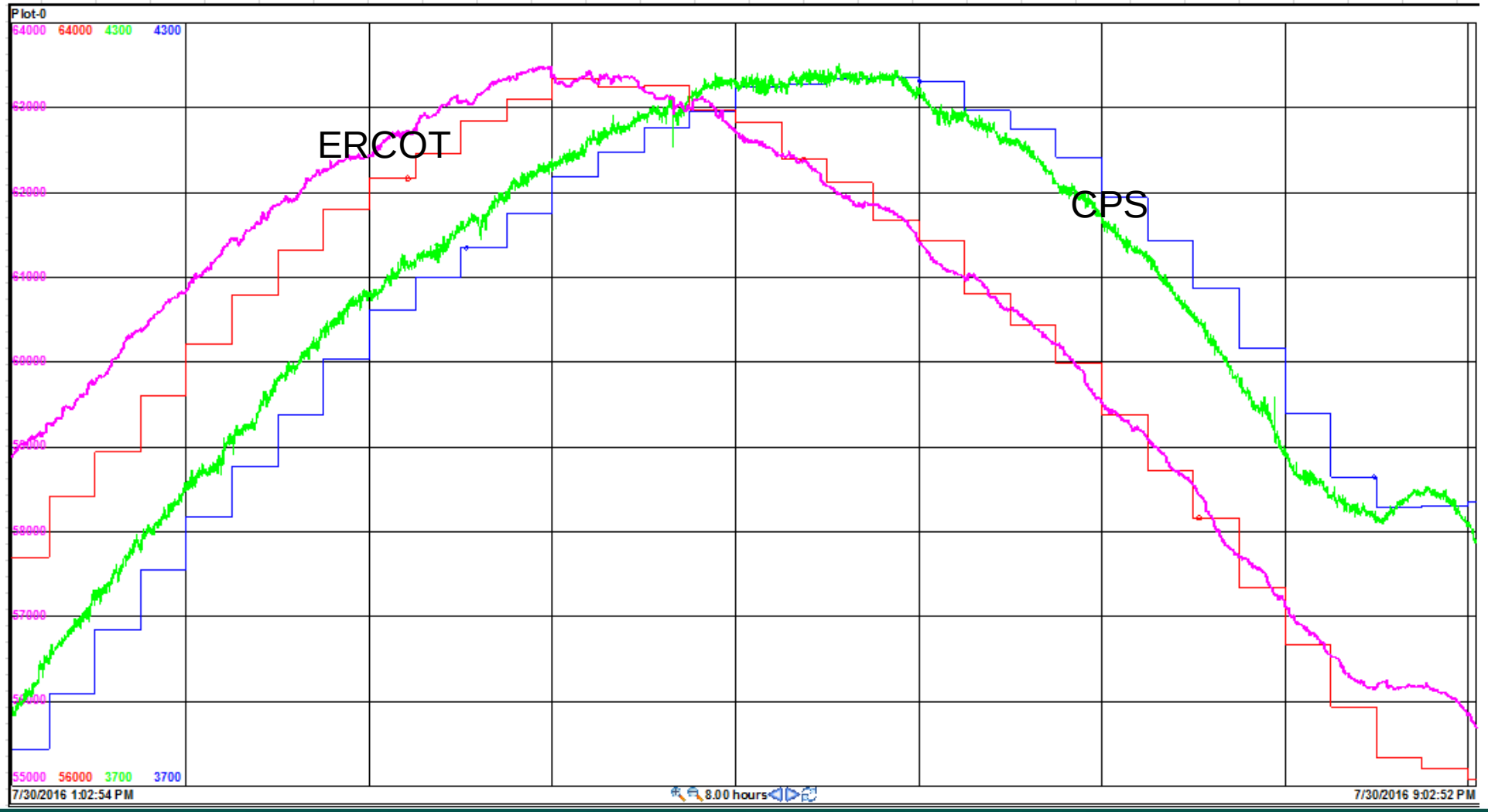
Programs

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Coincident Peak Demand Savings (kW)	Net Non-Coincident Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)
				Demand Response Programs	
Commercial Demand Response	100%	2,168,927	105,550	106,639	67,089
Auto Demand Response	100%	81,251	4,576	5,172	3,540
Emergency Demand Response	100%	19,833	19,833	19,833	4,958
Smart Thermostat	100%	1,002,740	43,103	47,266	37,512
Home Manager	100%	728,387	45,593	49,158	41,689
Bring Your Own Thermostat	100%	28,187	3,268	3,845	2,566
ThinkEco Air Conditioner	100%	1,152	204	256	188
Demand Response Subtotal		**4,030,475**	**222,127**	**232,169**	**157,543**

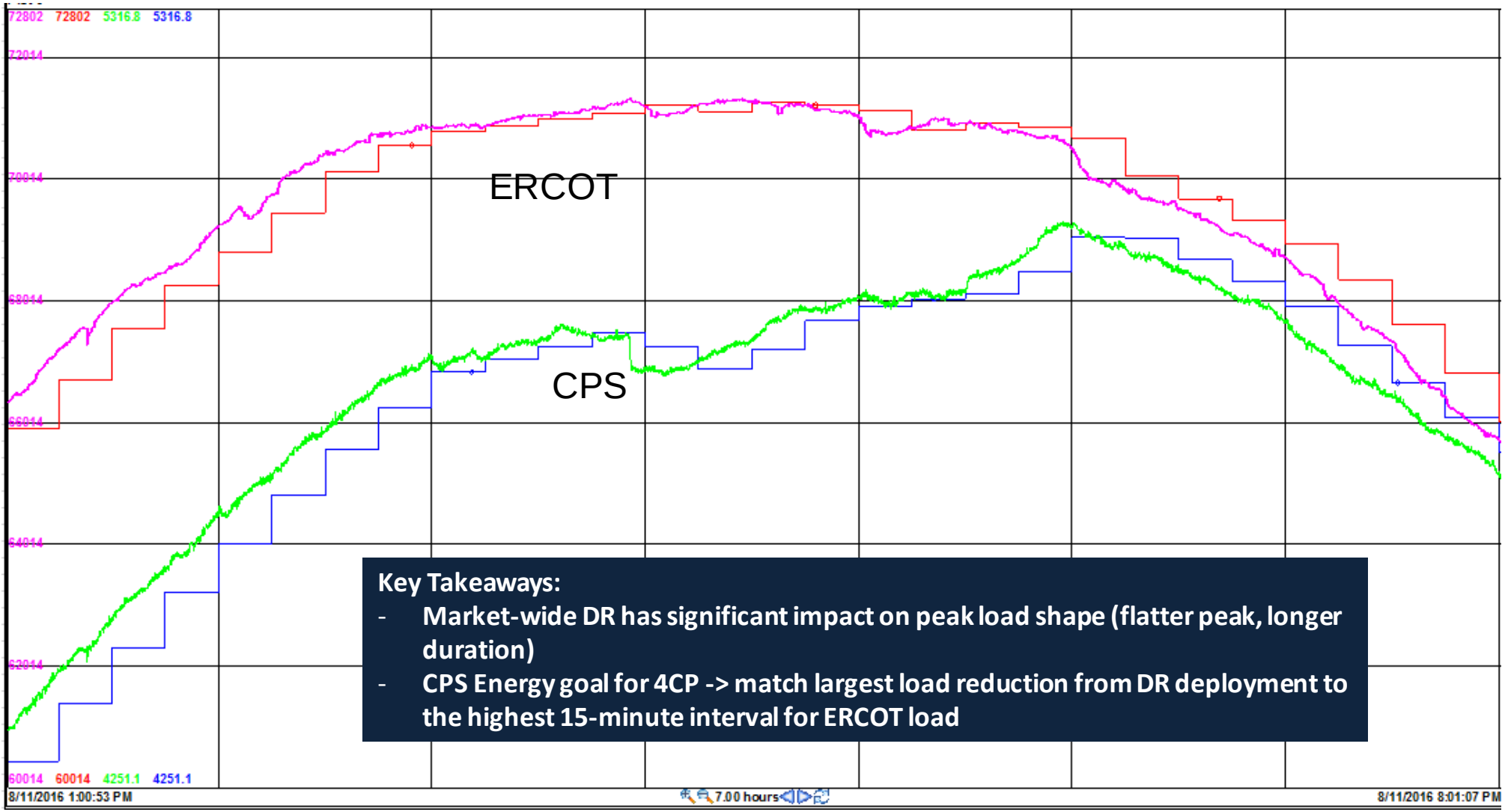
Meanwhile in ERCOT

- DR growing in response to 4CP transmission pricing
- Texas PUC gives customers the right to have DERs
- ERCOT DER Participation in Wholesale Markets
  - implemented a task force
  - developed white papers
- Objective: get ahead of the curve related to high DER penetration.

ERCOT/CPS load shapes (summer non-DR day")



ERCOT/CPS load shapes (coincident peak day)



Key Takeaways:

- **Market-wide DR has significant impact on peak load shape (flatter peak, longer duration)**
- **CPS Energy goal for 4CP -> match largest load reduction from DR deployment to the highest 15-minute interval for ERCOT load**

Path forward

- CPS Energy expanding DR portfolio
  - More BYOT
  - Behavioral DR
  - Conservation Voltage Reduction
- Behind the meter generation
  - Several pilots
  - Solar/Storage RFP
  - Continued solar rebates
  - Comprehensive review of rates and regulations
- Aggregation system
  - Adding more DR programs to DRMS
  - Adding smart inverters to the system → DERMS

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The Value of Data

Cost and Value Analysis of Distribution System Modernization

PLMA Spring Conference 2017

Allison Hamilton
Senior Principal, Markets and Rates
Business and Technology Strategies

NRECA®
A Touchstone Energy® Cooperative

National Rural Electric Cooperative Association

- Not-for-profit, national service organization representing over 900 not-for-profit, member-owned, rural electric cooperative systems.
- Serve 42 million customers in 47 states. NRECA estimates that cooperatives own and maintain 2.5 million miles or 42 percent of the nation's electric distribution lines covering three-quarters of the nation's landmass.
- Cooperatives serve approximately 18 million businesses, homes, farms, schools and other establishments in 2,500 of the nation's 3,141 counties.

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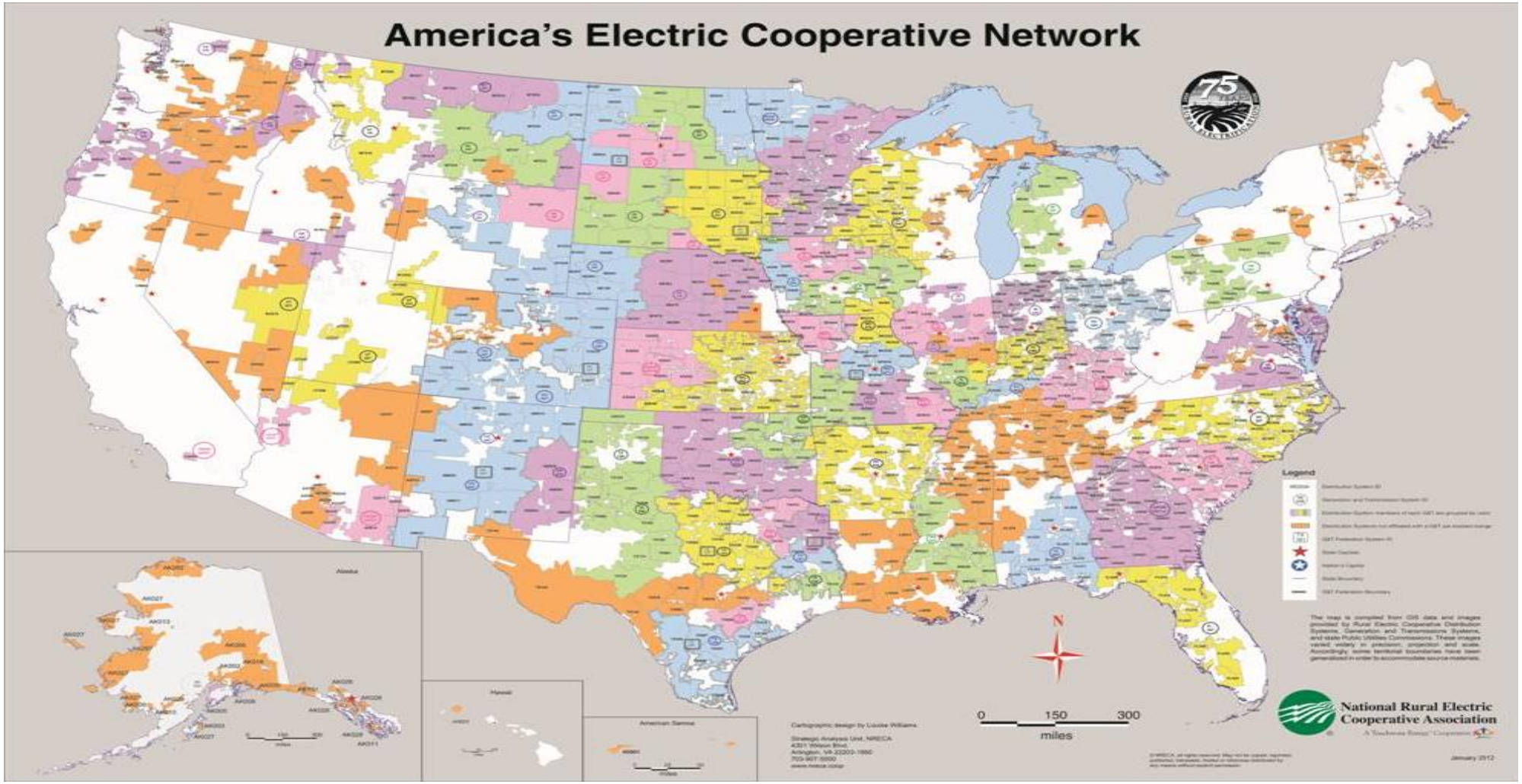
Cooperative Service Territory



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Business and Technology Strategies

Inputs

Member Resolutions

Member Advisory Groups

Industry Bodies

Labs & Universities

Feedback

Partnerships and more …

How We Are Different….

Outputs

BTS Resources

- Cooperative Research Network
- Energy & Power
- Strategic & Economic Analysis

Engineering | Research
Economic Analysis | Policy & Standards Development | Tech Trends | Tools | Business Models

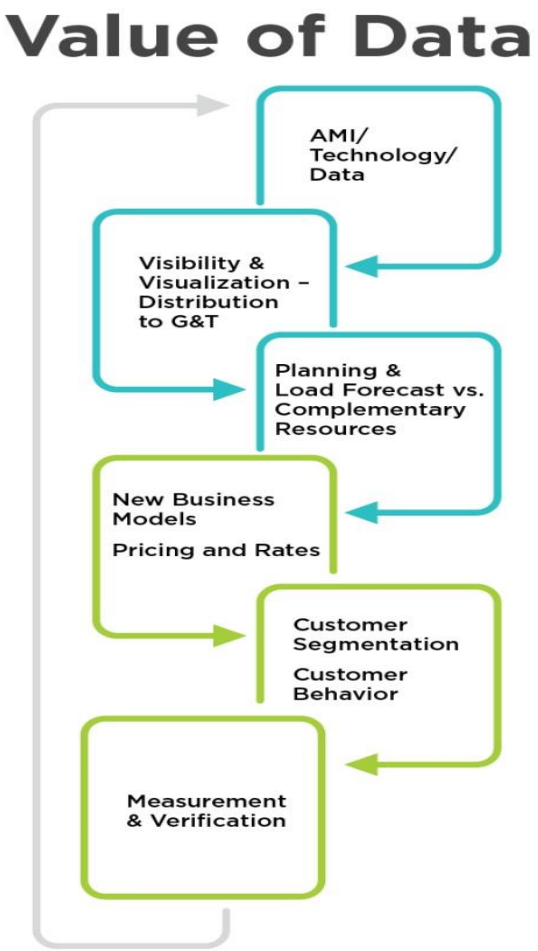
Emerging Landscape

Power System that is Highly Flexible, Resilient, Comms Connected and Optimizes Energy Resources

Value of Data

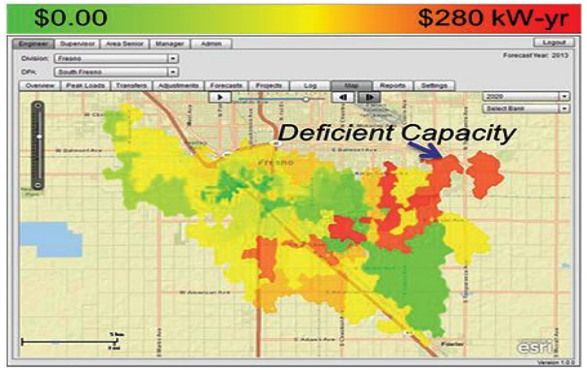
- Connected networks provide better, more timely data, so we can make more accurate decisions
- Better understand our system and our customers to enable future business models
- Incentivize behaviors that benefit the customer and optimizes the system

Value of Data Feedback Loop



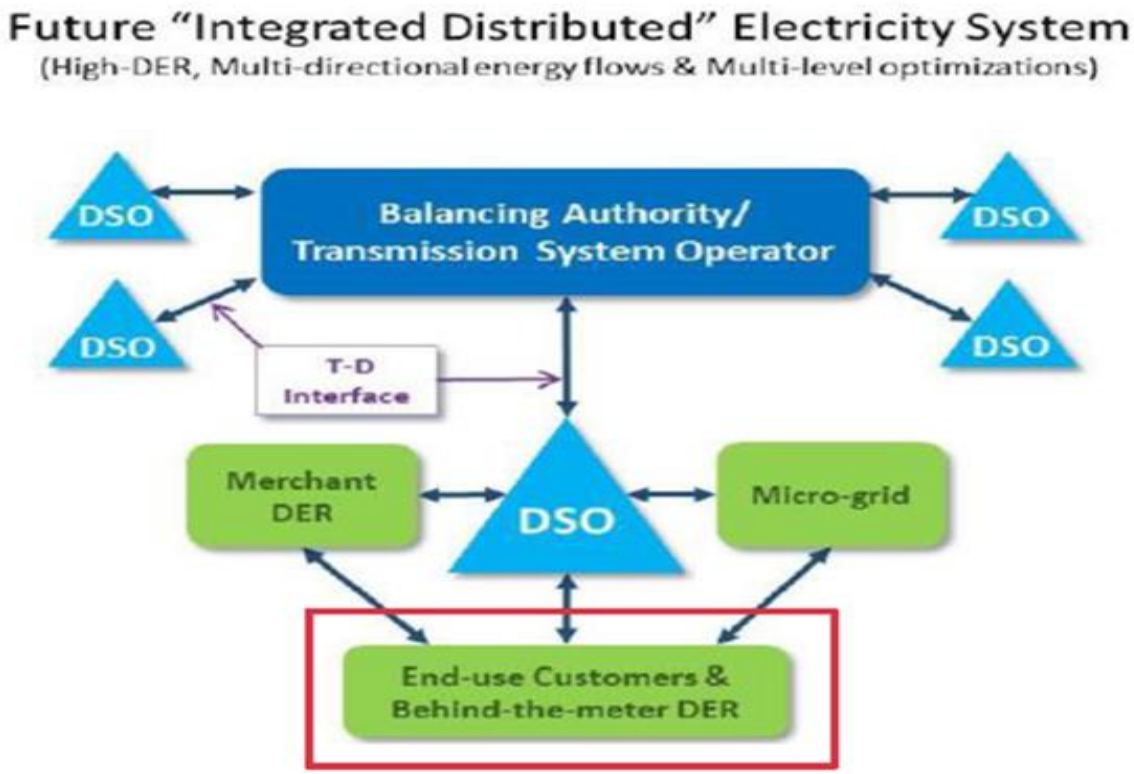
System Optimization

- Data aggregation for better planning
- Accuracy and immediacy
- Locational and temporal
- Power quality
- Electricity withdrawals and injections
- Visualization and forecasting
- Identify and project impacts



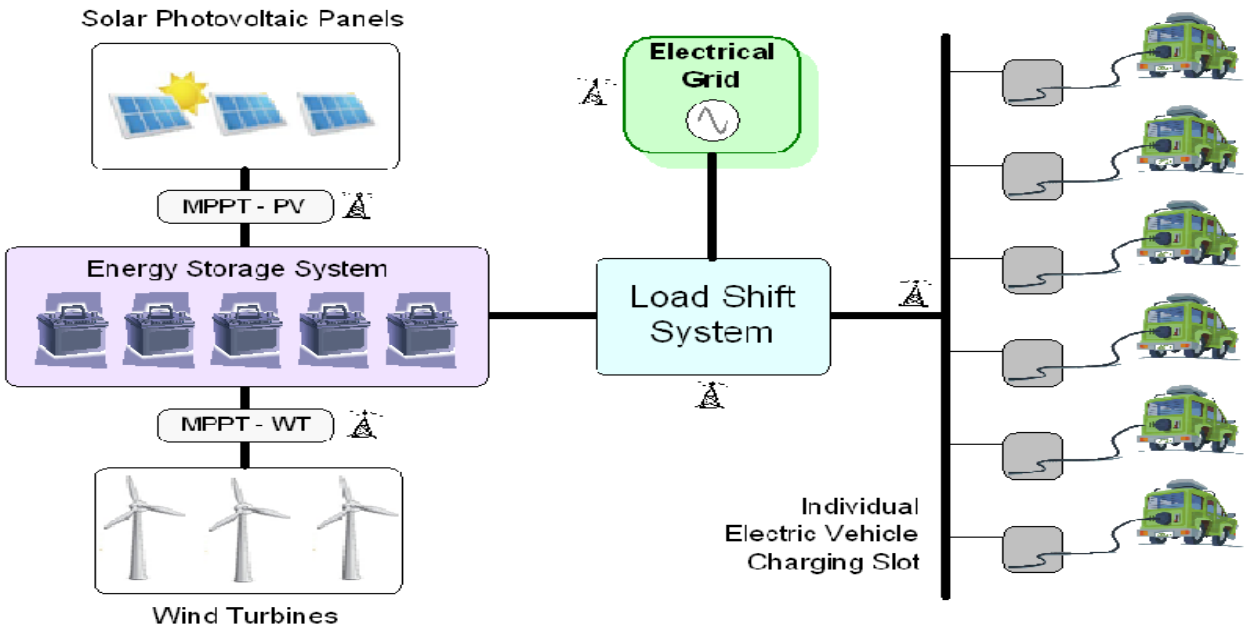
New Business Models

- Regressive net pricing models
- Innovative rate design
- Service level oriented pricing
- Innovative product offerings
- Distributed System Operator (DSO)



Customer Engagement

- Customer choice
- Demand response
- Smart appliances
- EV Charging
- Behind the meter
- Energy Storage Arbitrage
- Microgrids

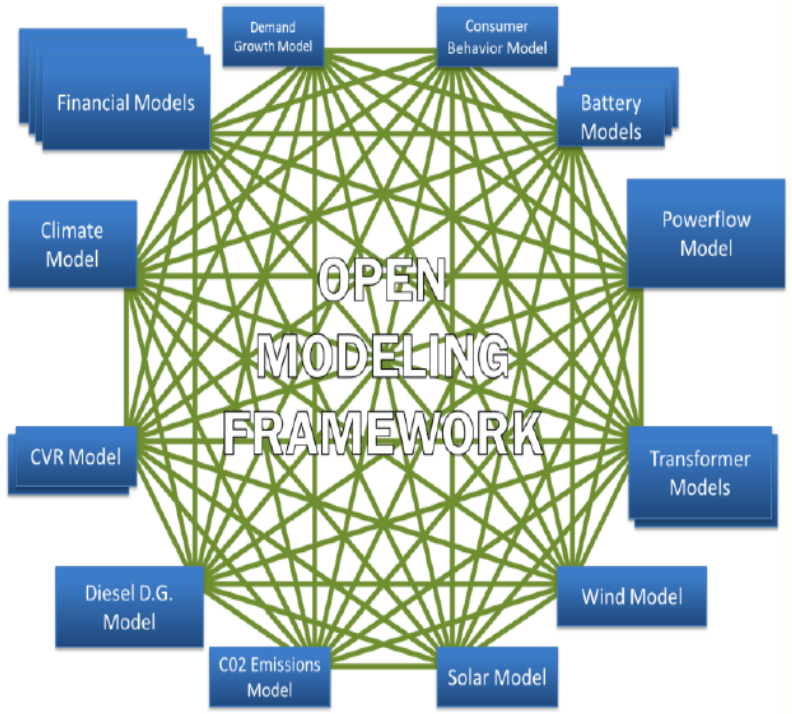


Utility of the Future

"The 'smart' grid uses computers to alleviate the abiding problem of peak load. It also has the benefit of producing new things that customers might find appealing to buy: autonomous vacuum cleaners, programmable clothes driers, and learning thermostats. Following the model of the telecommunications industry ***the utilities would like to remake themselves into providers of services and gadgets***. If they can manage this double task they will likely stay alive." Gretchen Bakke, *The Grid*

NRECA Resources to Help

- Solar Utility Network Deployment Acceleration (SUNDA) Project
- Distributed Generation (DG) Toolkit
- Open Modeling Framework - provides a framework to evaluate DG options on the distribution system



Other BTS Projects

- Advanced control architecture (on own and with DOE)
- GridBallast (with Eaton and Sparkmeter)
- DOE Communications planning model (based on OMF)
- ABC4PV (with Carnegie Mellon)
- DSOSS (with Georgia Tech)
- Microgrid Integration Tool
- Engagement with DERMS vendors

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New Hampshire Electric Cooperative Distribution Generation Costs & Value: Myth or Reality?

Heather Manypenny

April 4, 2017

your New Hampshire Electric Co-op

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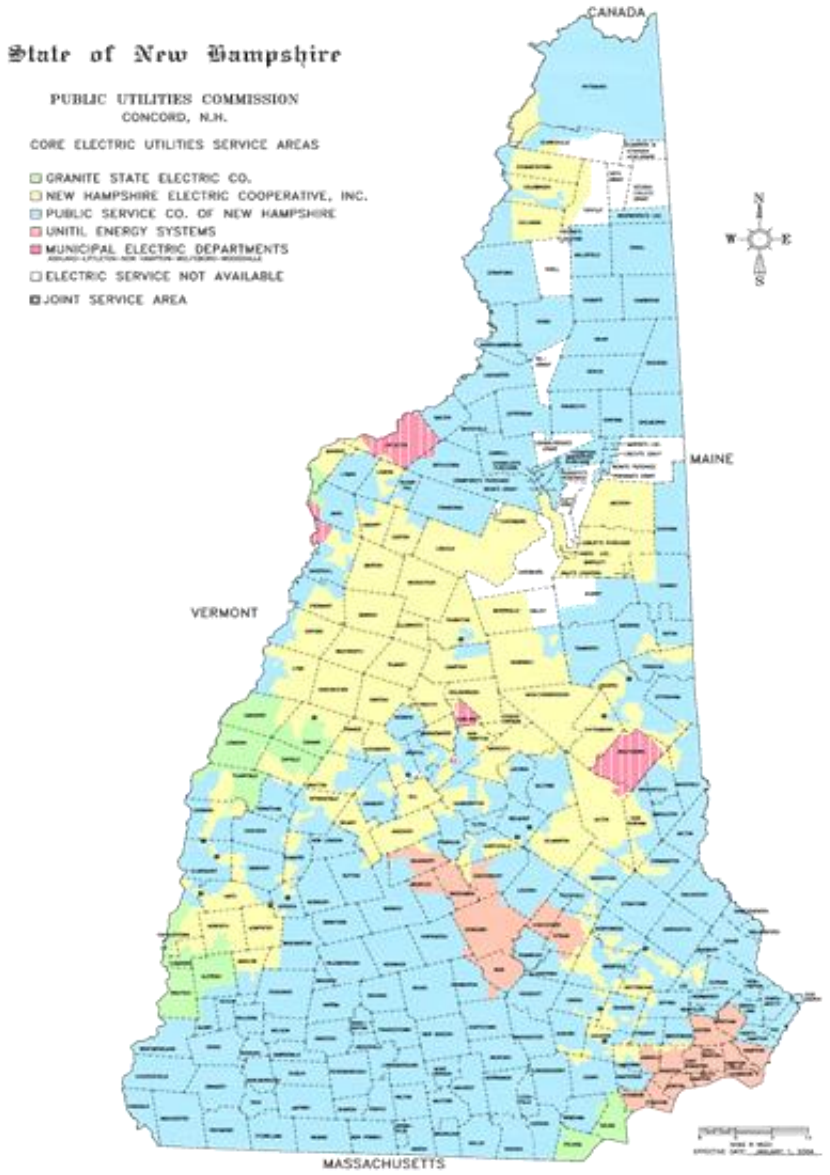
Background on NHEC

- Service territory: approximately 1/3 of New Hampshire (shown in yellow on map to the right)
- Second largest electric utility in New Hampshire
- Member accounts: 80,000+
  - **86%** residential (**61%** of total energy usage)
  - **14%** commercial and industrial (**39%** of total energy usage)
- "Self-regulated" by member-elected board of directors
  - Except:
    - Service territory open to Retail Competition for energy supply
    - Qualifying Facilities including net metering up to a "cap"
    - "Systems benefits" including energy efficiency and low income programs



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Background Information

- *"NHEC values and supports the development of renewable generation by and to serve its members."*
- NHEC's share of NH state law "net metering cap" = 3.16MW
  - Full retail net metering
  - Reached that cap in early 2015 (due in part to incentives)
- Self-regulation = flexibility
  - Other NH utilities approaching or surpassing caps
  - PUC docket DE 16-576 – about 200 documents filed

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"Above the Cap" Rate Development

- 4 Options Considered:
  - X Feed-in Tariff
    - Long-term set prices require long-term cost estimates creating risk for NHEC's other members
    - Potentially duplicates RPS compensation
  - X TOU rate
    - Not able to implement a Critical Peak element
    - Without CP, the math didn't work
  - X Fixed monthly net metering charge per kW generation
    - Not transparent relationship between costs (avoided or otherwise)
  - ✓ Modified Net Metering
    - Full retail for energy delivered from the utility
    - Less than full retail for energy exported to the utility
    - Full retail for any energy consumed instantaneous with generation

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"Above the Cap" Rate Development

- **No quantifiable distribution system costs which NHEC actually avoids due to member-sited generation**
  - **Continuing incentive for the value NHEC has long placed on member-sited renewables.**
  - **Exported rate includes distribution-related under-recovery**
- **Exported rate includes NHEC's avoided costs of power supply capacity and transmission**

	Monthly	Per kWh
Standard Residential Rate	$28.93	$0.14761
Net metered <=20kW Generator		
Delivered to Residence	$28.93	$0.14761
Exported to Distribution System		($0.10960)

Hypothesis #1: "PV Generates at Peak Times"

- Well, sometimes…. Not all the peaks…. Not full capacity
- Analysis of more than 250 PV systems
- Coincidence with ISO-NE Forward Capacity Market peak
  - 19% July 28, 2015 hour-ending 6:00 pm
  - 51% August 12, 2016 hour-ending 3:00 pm
- Coincidence with monthly regional network transmission peaks
  - 7 months per year --- after dark --- 0%
  - 21% to 48% the other 5 months

Hypothesis #2: BTM Generation = Lost Revenues

- Well, maybe not as much as you think
- An interesting and unexpected discovery:
  - NHEC members who install net metered systems increase their total home electric usage by an average of 50%
  - Replace fossil fuel heating systems with mini-split heat pumps
- Rate development recognized this as well as a continued distribution-related incentive

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NV Energy DER Initiatives

Cost and Value of Distribution System Modernization

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Company Overview

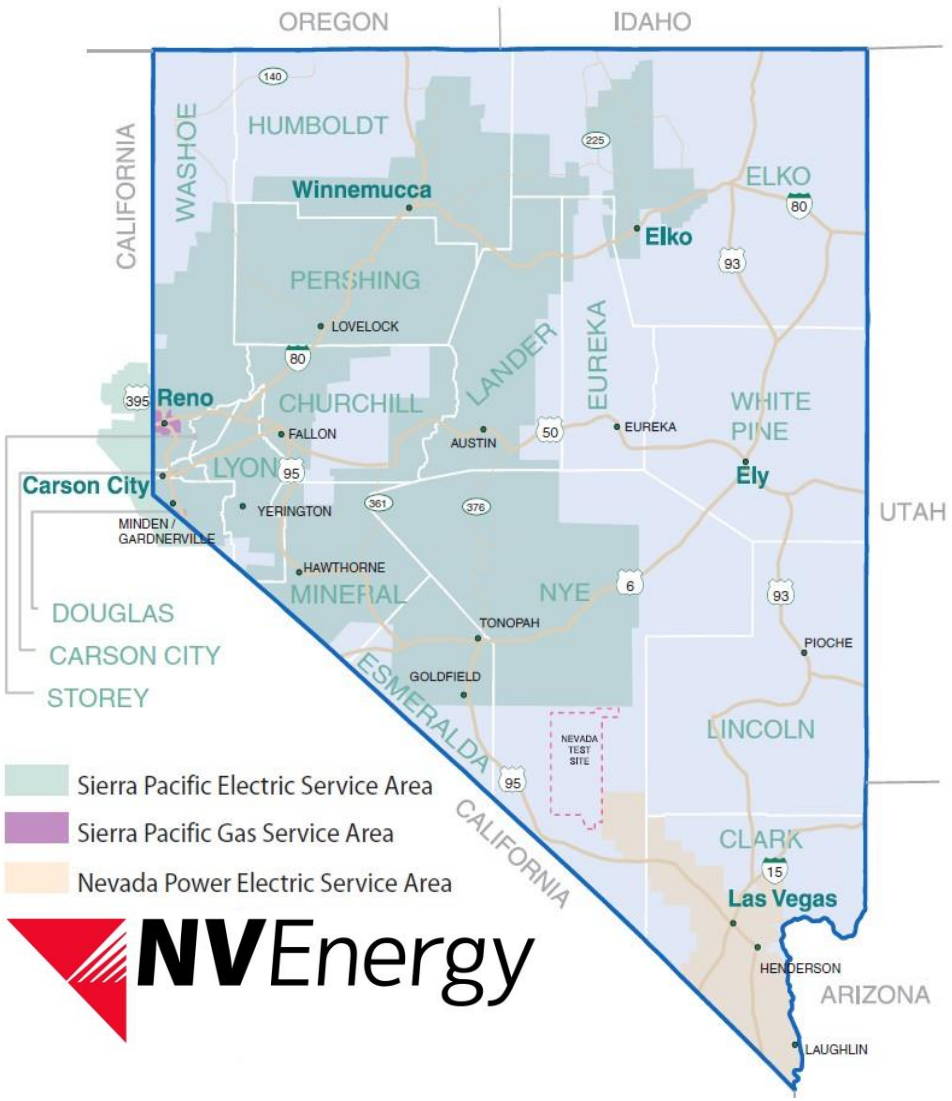
- Vertically Integrated *(for now)* Electric and Gas Utility
- State Commission Regulated
- 1.2 M Electric Customers
- 156 k Gas Customers
- 93% of Nevadans Served
- 7,961 MW Peak *(July 28, 2016 @ 5pm)*
- 230 MW statewide of Demand Response

Foundational Infrastructure

Statewide AMI	aDMS	EMS	DRMS	SOA	BDP

Drivers of Change

3rd Party Solar	Energy Prices	Economic Development	Storage & EV	Regulatory	Energy Choice



Summary of Initiatives (DER & Modernization)

- **Organizational Changes**
  - New business unit "Renewable Energy & Smart Infrastructure"

- **DER Testing & Deployment**
  - Behind the Meter – testing smart inverters and PV plus battery storage systems
  - Distribution System/Substation – piloting Conservation Voltage Reduction ("CVR") and searching for non-wires solutions
  - Capital Projects Review – all T&D infrastructure projects already in the ten-year plan are under re-evaluation for DER alternatives

- **Technology Review** – new process to assist in evaluating investments and the capability of technologies to satisfy business case requirements

- **DER Valuation & Planning**
  - Valuation – working to determine the value of grid services
  - Planning Procedures – working to incorporate hosting capacity studies and more robust distribution system forecasting models
  - Infrastructure Gap Analyses - identifying gaps in existing systems that would be needed to realize non-wires solutions

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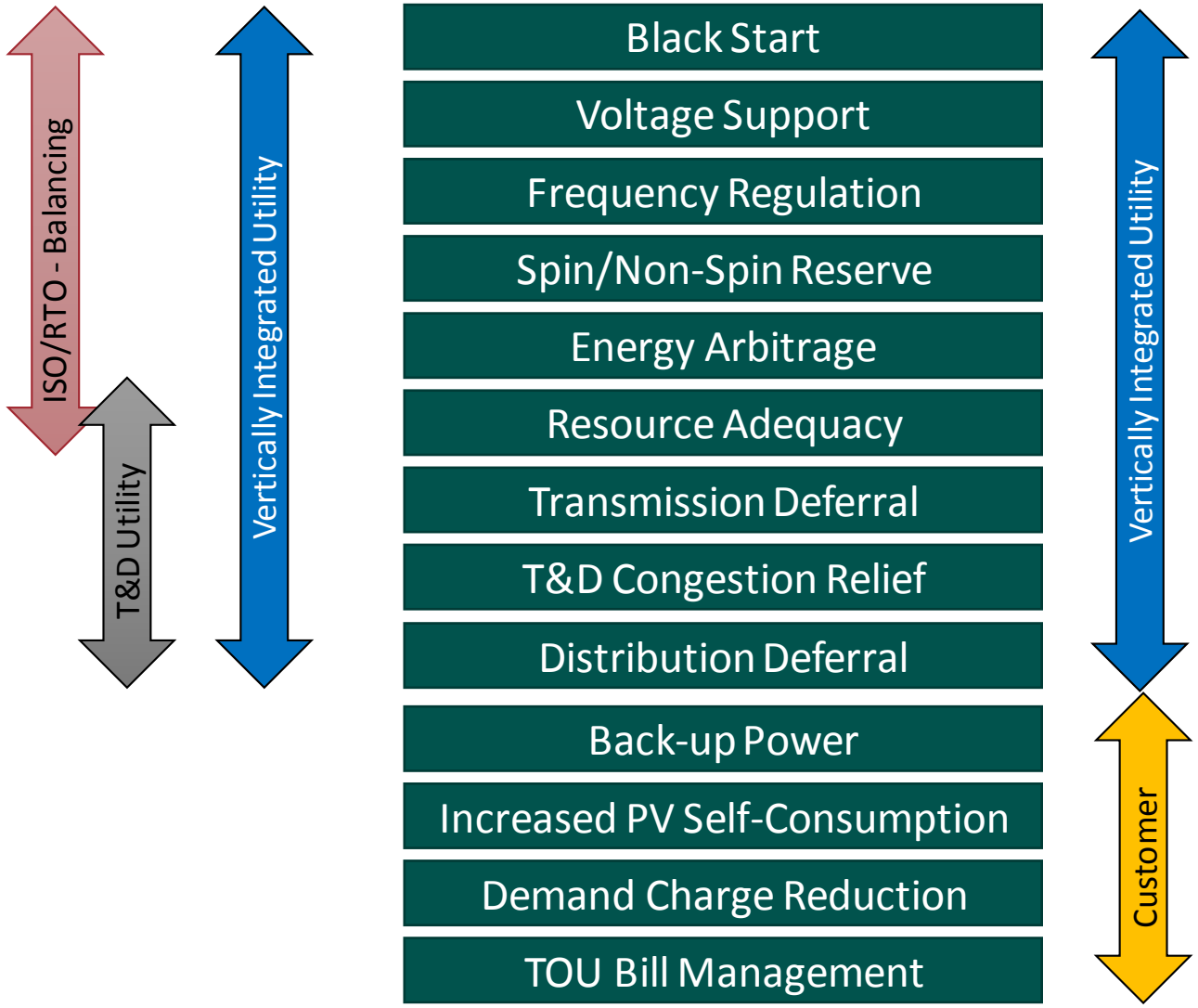
Valuation of Grid Service Benefits



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Mapping & Harmonization of Methods

	Benefits		Costs
Known: *Traditional Demand Response (DR)*	Peak Shaving / Shaping (avoided capacity & energy)	Resource Adequacy Energy Arbitrage	Customer Systems Communications Engineering Field Services Customer Engagement Back office/IT Analytics / M&V
	Operating Reserve (10-min spinning reserve)	Spin/Non-Spin Reserve	
	Avoided T&D	T&D Deferral	
Unknown: "Fast DR" , *PV + Battery Storage, Grid-Interactive Loads*	Area and Distribution Operations:	Voltage Support Frequency Regulation T&D Congestion Relief	Customer Systems Battery Systems
	Renewables Integration	Renewable Energy Time Shift Firming intermittent generation	
	Customer Benefits	Back-up Power Increased PV Self-Consumption Demand Charge Reduction TOU Bill Management	Back office/IT DRMS > DERMS

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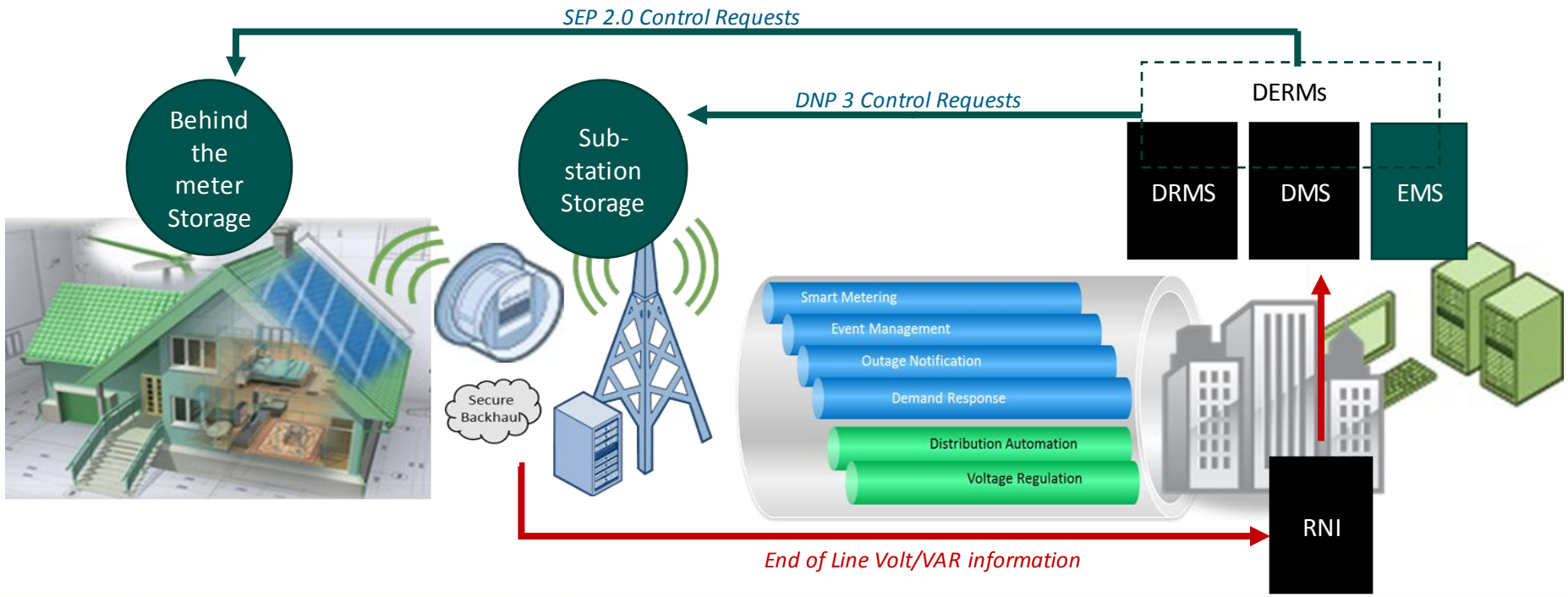
Valuation of Grid Service Costs

Key Gap Areas

- DERMS
- Co-Optimization
- IT Architecture
- Telemetry
- Standards



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CPS Energy San Antonio
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Open Discussion

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Michael Brown
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Wayne Callender
CPS Energy
Zero Emissions Resource Manager

Wayne is currently the Zero Emissions Resource Manager for CPS Energy. He works in the Energy Market and Operations area and has operational responsibility for the utility's wind, solar and demand response assets. He has been at CPS for 23 years, and worked on a variety of projects, including: wholesale deregulation; retail market design; automated meter reading deployment; advanced meter infrastructure (AMI) and meter data management (MDM) procurement and deployment; home area network (HAN) pilots; load research and analysis; and demand response. His most recent project is the implementation of a Demand Response Manage System (DRMS) for CPS Energy.

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Heather Manypenny
New Hampshire Electric Cooperative
Power Resources Executive

Heather has been employed by New Hampshire Electric Cooperative for 26 years. She is currently the Power Resources Executive, involved in all aspects of power procurement. In this role she is part of a team that is responsible for contracting for power and renewable attributes, interaction and compliance with the Independent System Operator of New England (ISO-NE), load management / demand response, rate/revenue requirements for power supply and "Regional Access" (transmission). Ms. Manypenny leads an interdepartmental team responsible for the development, design and implementation of Demand Response programs. Prior to her role as Power Resources Executive, she held a variety of positions within NHEC including Controller, Rates and Financial Analysis Manager and Accountant. Ms. Manypenny holds a bachelor's degree from Franklin Pierce College. Heather Manypenny is a member of PLMA's Executive Committee.

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Allison Hamilton is the Senior Principal, Markets and Rates for Business and Technology Strategies at the National Rural Electric Cooperative Association (NRECA). She provides technical expertise for NRECA staff and membership with respect to issues affecting price formation in centralized/organized markets, wholesale rate making issues in decentralized/bilateral markets and the integration of rates across wholesale and retail markets and business structures. Prior to NRECA, Ms. Hamilton worked for Pepco Holdings in various roles in business and finance. She has almost 15 years' experience in the regulated and deregulated energy industry. She holds an B.A. in Psychology from Valparaiso University and an M.B.A. from Johns Hopkins University.

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Michael Brown
NV Energy
Manager, Demand Response & Distributed Energy Resources

Michael has over eighteen years of experience in the energy sector focused on demand response, energy efficiency, and renewable energy in both deregulated and regulated electricity markets. He has held a variety of positions at consulting and energy service firms, including: energy systems analysis; energy efficiency project development and project management; key account management for energy and commodity (gas and electricity) services; product development; and strategy development. Since 2005, Michael has worked at NV Energy. He currently manages a business unit focused on smart grid enabled customer solutions for energy and peak demand management. Michael's efforts have included the design and implementation of: one of the largest two-way communicating programmable thermostat program in the country; a large scale Home Area Network program that integrates energy efficiency and demand response; a commercial building demand response program that utilizes automated communications and optimization software technology to obtain significant energy and peak demand savings; and, an advanced Demand Response Management System that allows demand side resources to actively participate in utility energy resource portfolio optimization and risk management processes. He is currently focused on improving utility energy resource options and customer offerings via business process and technical integration of demand response, energy efficiency, advanced consumer gateways, advanced building control techniques, distributed energy resources, and smart grid technologies. Michael has a Bachelor of Science in Chemistry and International Relations from The College of William and Mary, and a Master of Business Administration from The Cranfield School of Management.

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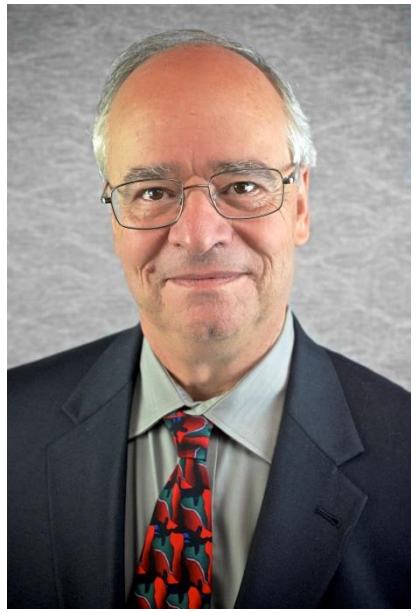

Joseph E. Childs
Eaton
Senior Program Manager, Smart Grid Network Solutions
josephechilds@eaton.com

Joe's primary responsibility at Eaton is to work with customers on value assessment and data analysis. Joe has worked in and with utilities for the last 30 years on utility control systems as a supplier and user including SCADA/EMS, Power System Restoration, Operator Training Simulators, and Demand Response. Joe holds a B.S. in Computer Science and an M.S. in Bioclimatology from Colorado State University. He currently holds the officer position of Secretary for the PLMA. Mr. Childs has been awarded two US patents for DR/EE solutions.