

Customer and Societal Benefits Of AMI:

From Smart Meters To A More Efficient Power System

Hon. Paul A. Centolella, Commissioner
Public Utilities Commission of Ohio

NARUC Winter Meetings
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What is AMI?

- Advanced metering is a system that records and collects consumption information (and possibly other parameters) hourly or more frequently and that provides for daily or more frequent transmittal of measurements over a communication network to a central collection point.
- AMI includes the communication hardware and software and associated system and data management software that creates a network between advanced meters and utility business systems and which allows collection and distribution of information to consumers and other parties, such as competitive retail suppliers, in addition to providing it to the utility itself.

(Source: FERC Staff Report)

What is AMI?

- AMI is the communication hardware and software and associated system and data management software that creates a network between advanced meters and utility business systems and which allows collection and distribution of information to consumers and other parties, such as competitive retail suppliers, in addition to providing it to the utility itself.
- An integration of technologies rather than a single technology
 - Smart Meters
 - Home & Facility Networks
 - Data Collection and Backhaul
 - Meter Data Management Systems
 - Interface with existing software applications
- Interoperability: Open technology standards
- Plug and Play: Enables other software applications to “snap in”
- Future Proof: Creates new opportunities for the consumer and the supplier

(Source: DOE/NETL)

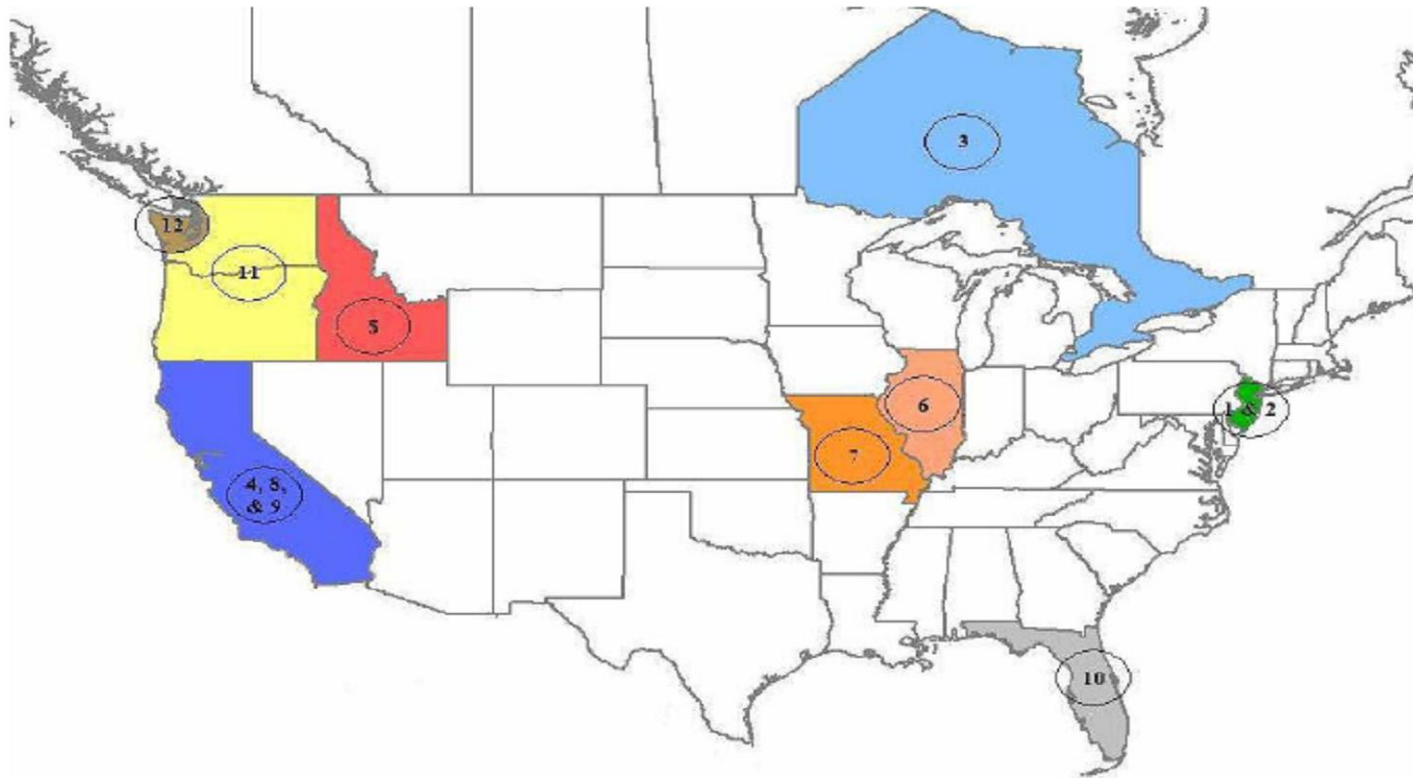
NEW EXPERIMENTAL EVIDENCE ON DYNAMIC PRICING

Ahmad Faruqui, Ph.D.

The Brattle Group

Cambridge, MA

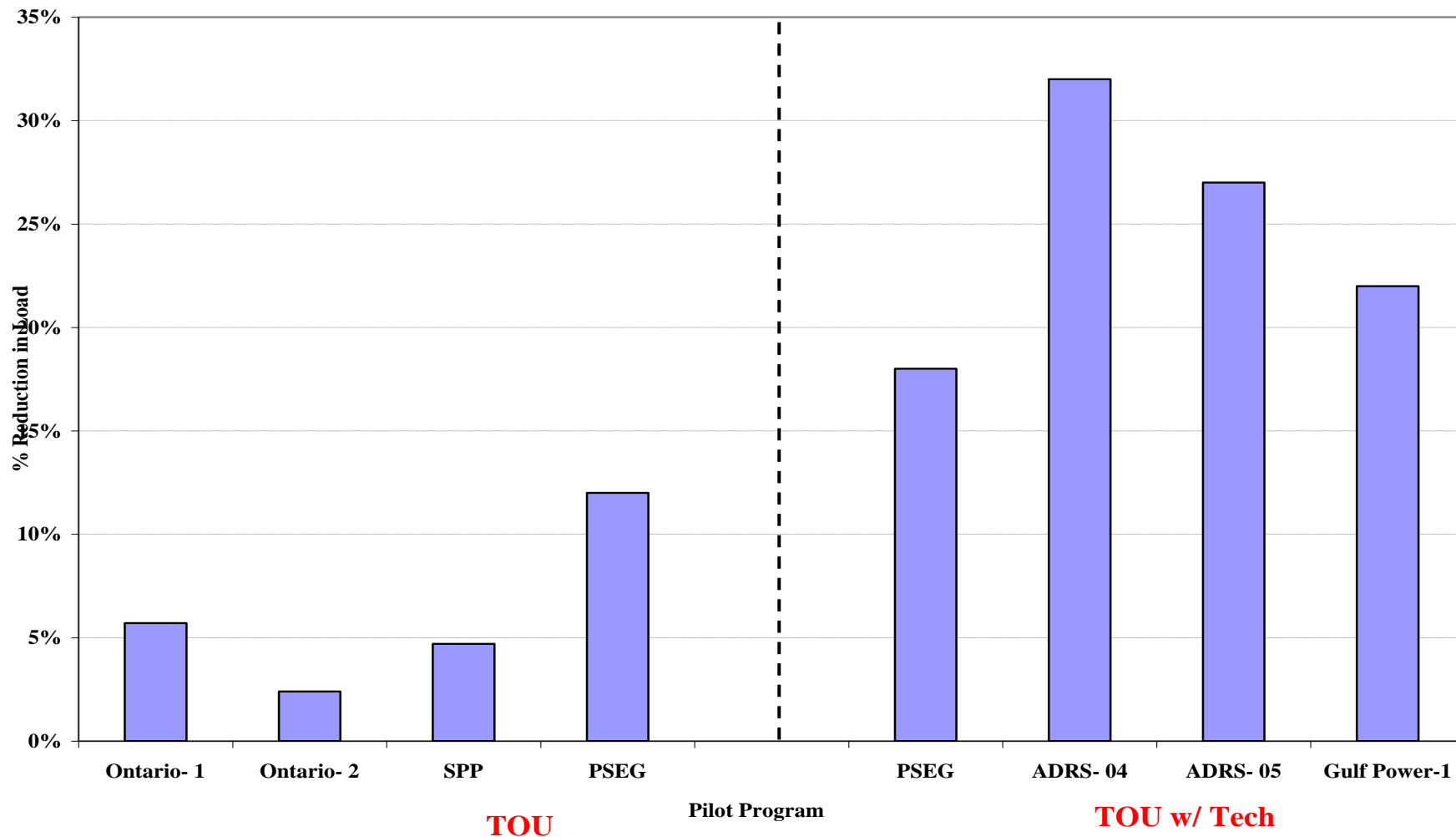
The experiments are spread out across the continent



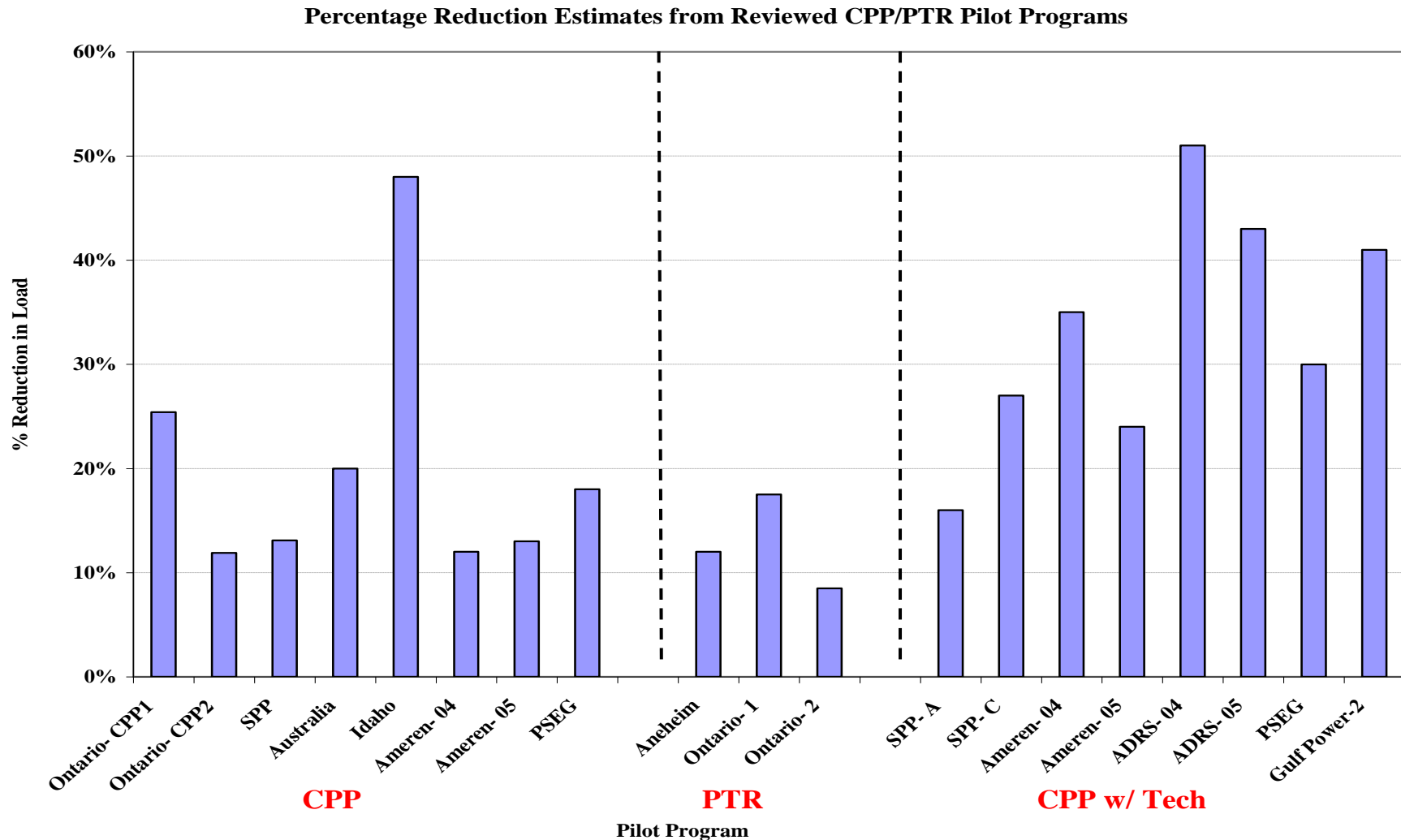
- | | |
|---|-----------------------------------|
| 1- PSE&G Pilot Program | 7- AmerenUE Residential TOU Pilot |
| 2- GPU Pilot Program | 8- ADRS Pilot |
| 3- Ontario Energy Board Smart Price Pilot | 9- Statewide Pricing Pilot |
| 4- Anaheim Critical Peak Pricing Experiment | 10- The Gulf Power Select Program |
| 5- Idaho Residential Pilot Program | 11- Olympic Peninsula Project |
| 6- Energy-Smart Pricing Plan | 12- PSE TOU Program |

Across these pilots, there is compelling evidence of demand response

Percentage Reduction Estimates from Reviewed TOU Pilot Programs

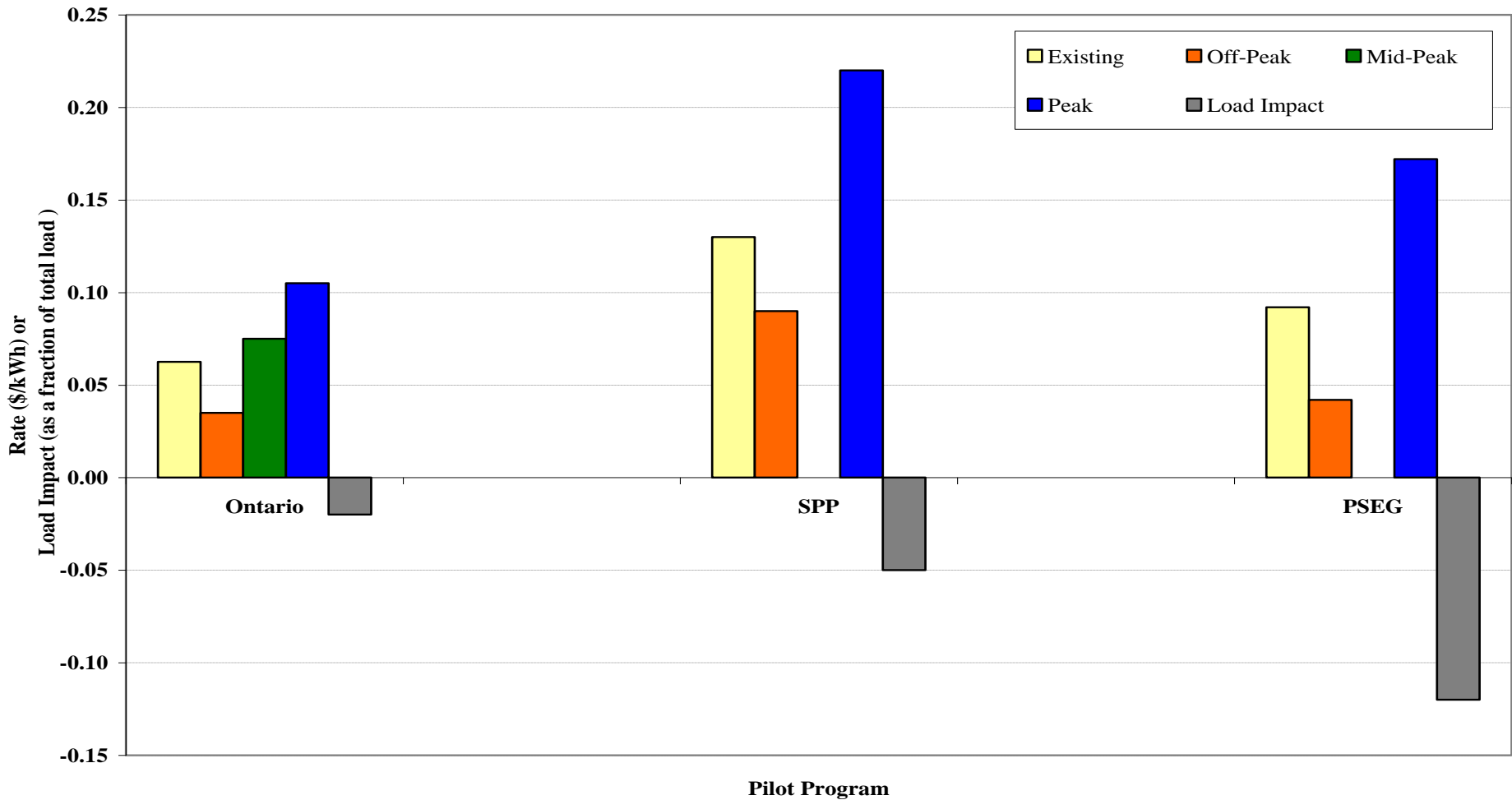


Higher impacts are observed for dynamic pricing rates than for time-of-use (TOU) rates



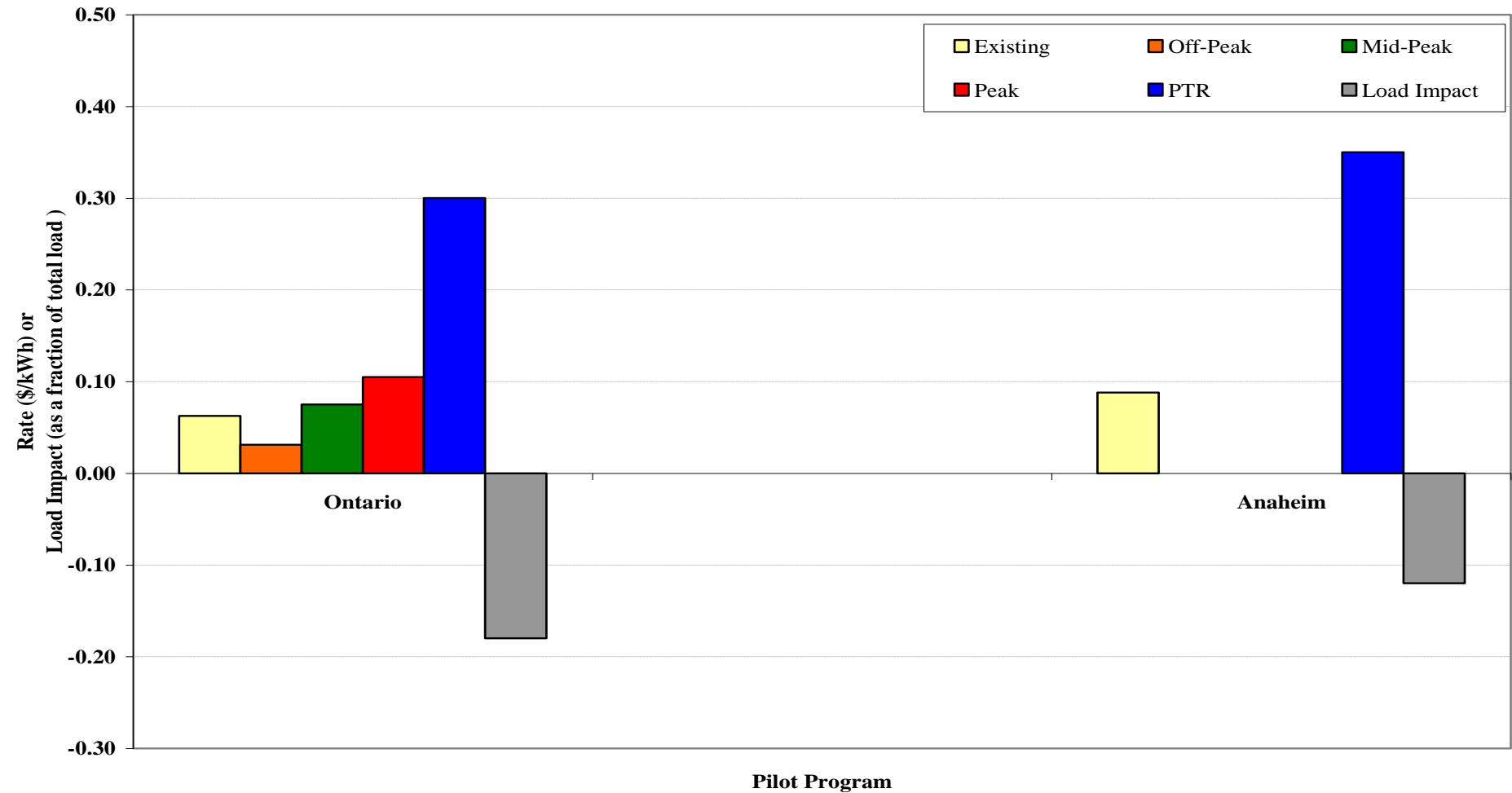
Time-of-use (TOU) pricing programs provide a modest amount of demand response

Comparison of Time of Use (TOU) Tariffs and Resulting Impacts



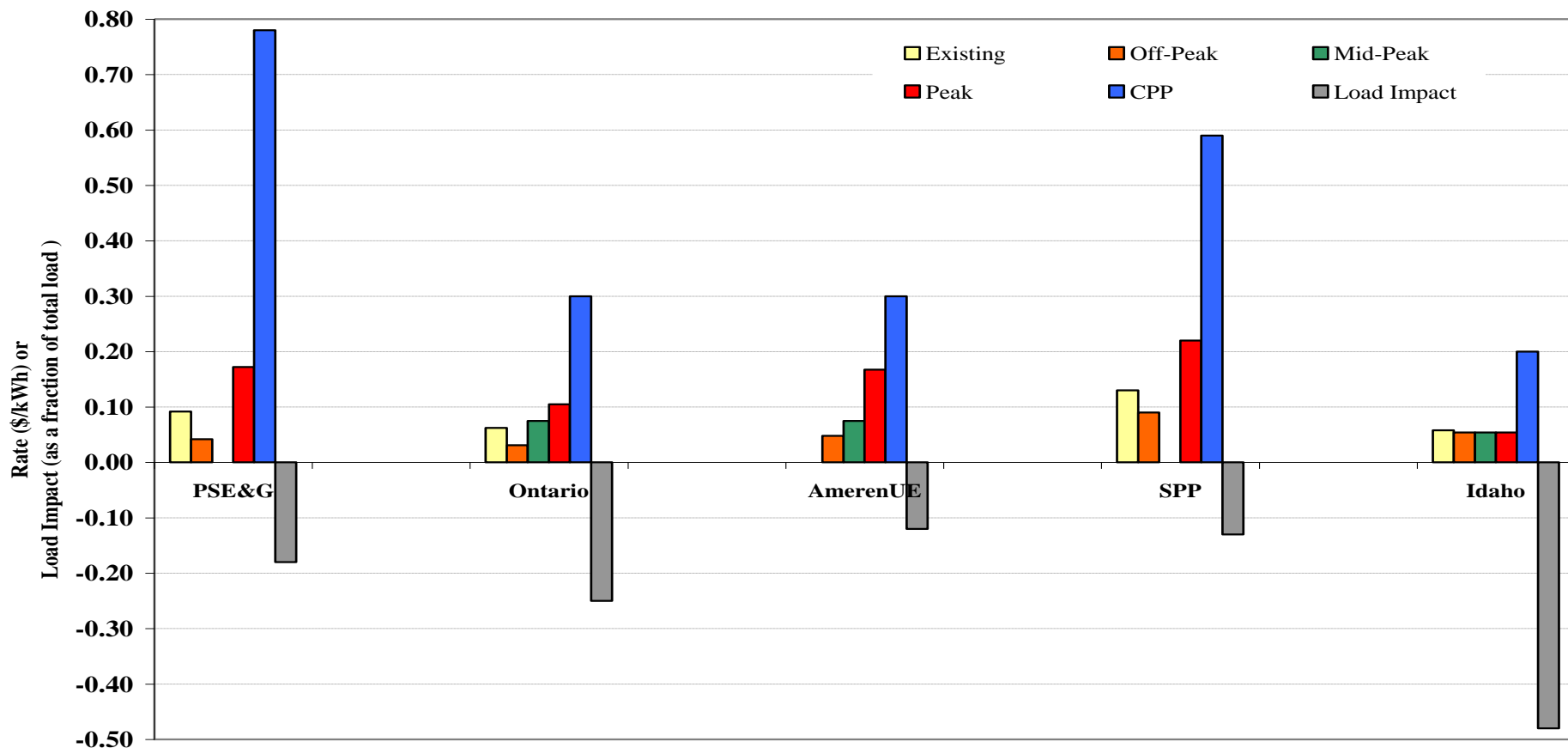
The peak-time rebate (PTR) rate has achieved demand response but the evidence is limited to two pilots

Comparison of Peak Time Rebate (PTR) Program Tariffs and Resulting Impacts



Different critical-peak pricing (CPP) tariffs induce different load impacts during critical peak hours

Comparison of Critical Peak Pricing (CPP) Program Tariffs and Resulting Impacts

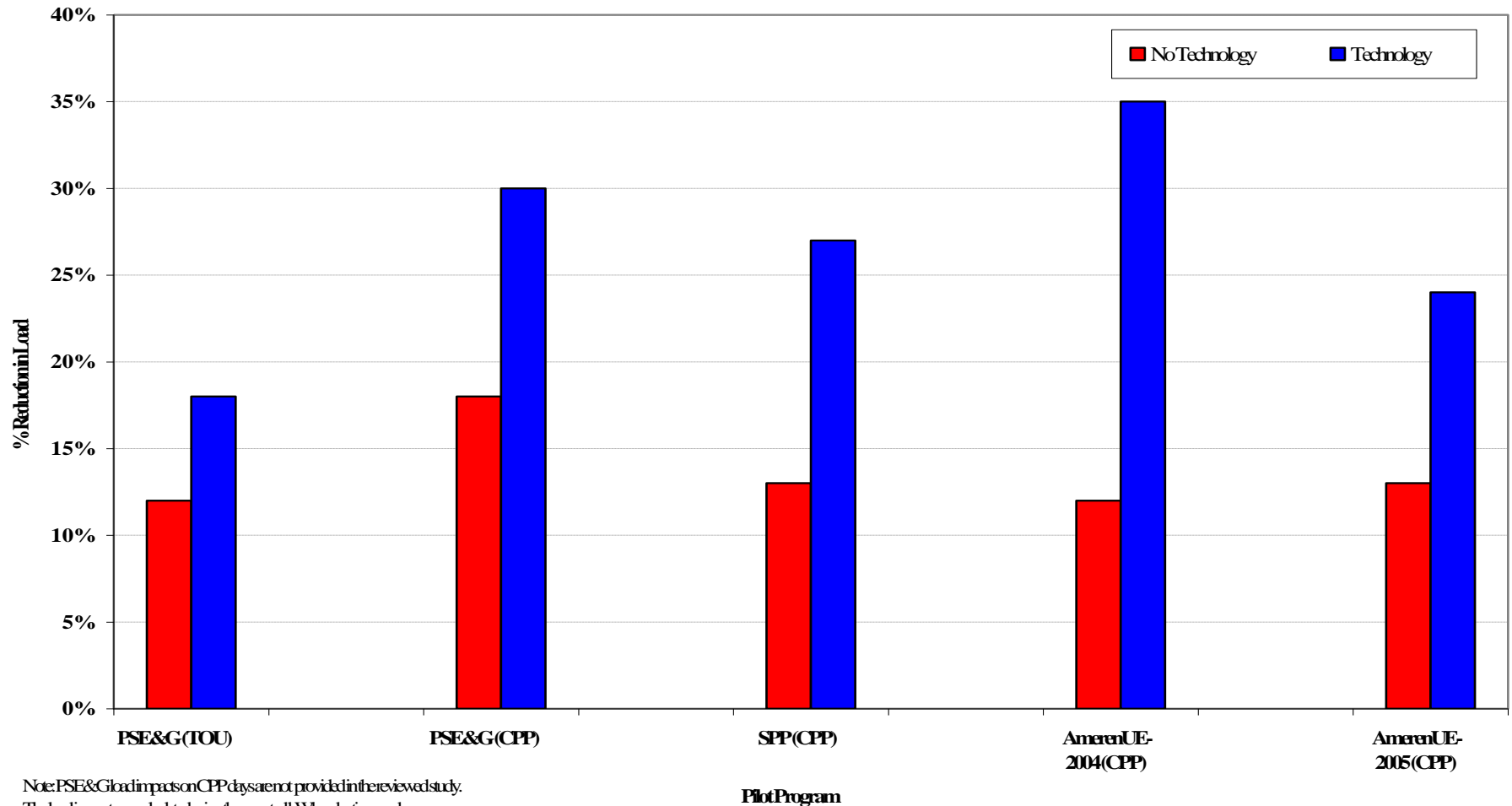


Pilot Program

Note: PSE&G load impact on CPP days is not provided in the reviewed study. The load impact is calculated using the reported kWh reductions and an estimate of consumption during peak on CPP days.

Enabling technologies magnify demand response

Role of Technology on Pilot Program Impacts



Note: PSE&G load impacts on CPP days are not provided in the reviewed study. The load impacts are calculated using the reported kWh reductions and an estimate of consumption during peak on CPP days.

Pilot Program

Footnotes

- Percentage reduction in load is defined relative to the different bases in different pilots. Following notes are intended to clarify these different definitions. TOU impacts are defined relative to the usage during peak hours unless otherwise noted. CPP impacts are defined relative to the usage during peak hours on CPP days unless otherwise noted.
- Ontario- 1 refers to the percentage impacts during the critical hours that represent only 3-4 hours of the entire peak period on a CPP day. Ontario- 2 refers to the percentage impacts of the programs during the entire peak period on a CPP day
- TOU impact from the SPP study uses the CPP-F treatment effect for normal weekdays
- PSEG program impacts represented in the TOU section are the % impacts during peak period on non-CPP days.
- PSEG program impacts represented in the CPP section are derived using the reported kWh reductions and the estimated consumption during the peak period on CPP days
- ADRS- 04 and ADRS- 05 refer to the 2004 and 2005 impacts. ADRS impacts on non-event days are represented in the TOU with Tech section
- CPP impact for Idaho is derived from the information provided in the study. Average of kW consumption per hour during the CPP hours (for all 10 event days) is approximately 2.5 kW for a control group customer. This value is 1.3 kW for a treatment group customer. Percentage impact from the CPP treatment is calculated as 48%.
- Gulf Power-1 refers to the impact during peak hours on non-CPP days while Gulf Power-2 refers to the impact during CPP hours on CPP days.
- Ameren-04 and Ameren-05 refer to the impacts respectively from the summers of 2004 and 2005.
- SPP- A refers to the impacts from the CPP-V program on Track A customers. Two-thirds of Track A customers had some form of enabling technologies.
- SPP-C refers to the impacts from the CPP-V program on Track C customers. All Track C customers had smart thermostats.

Questions?

Dr. Ahmad Faruqui

The Brattle Group

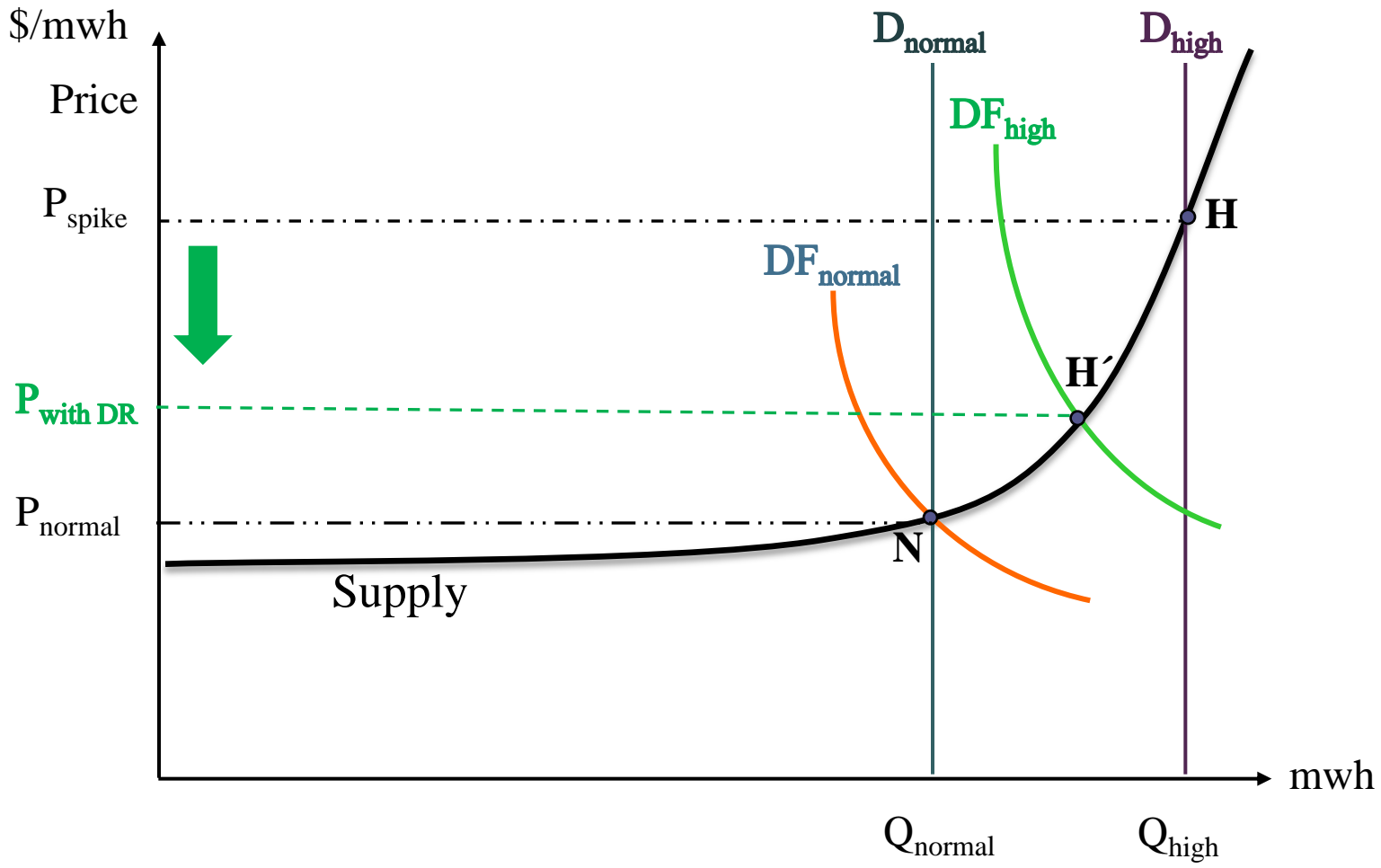
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Demand response dampens price spikes



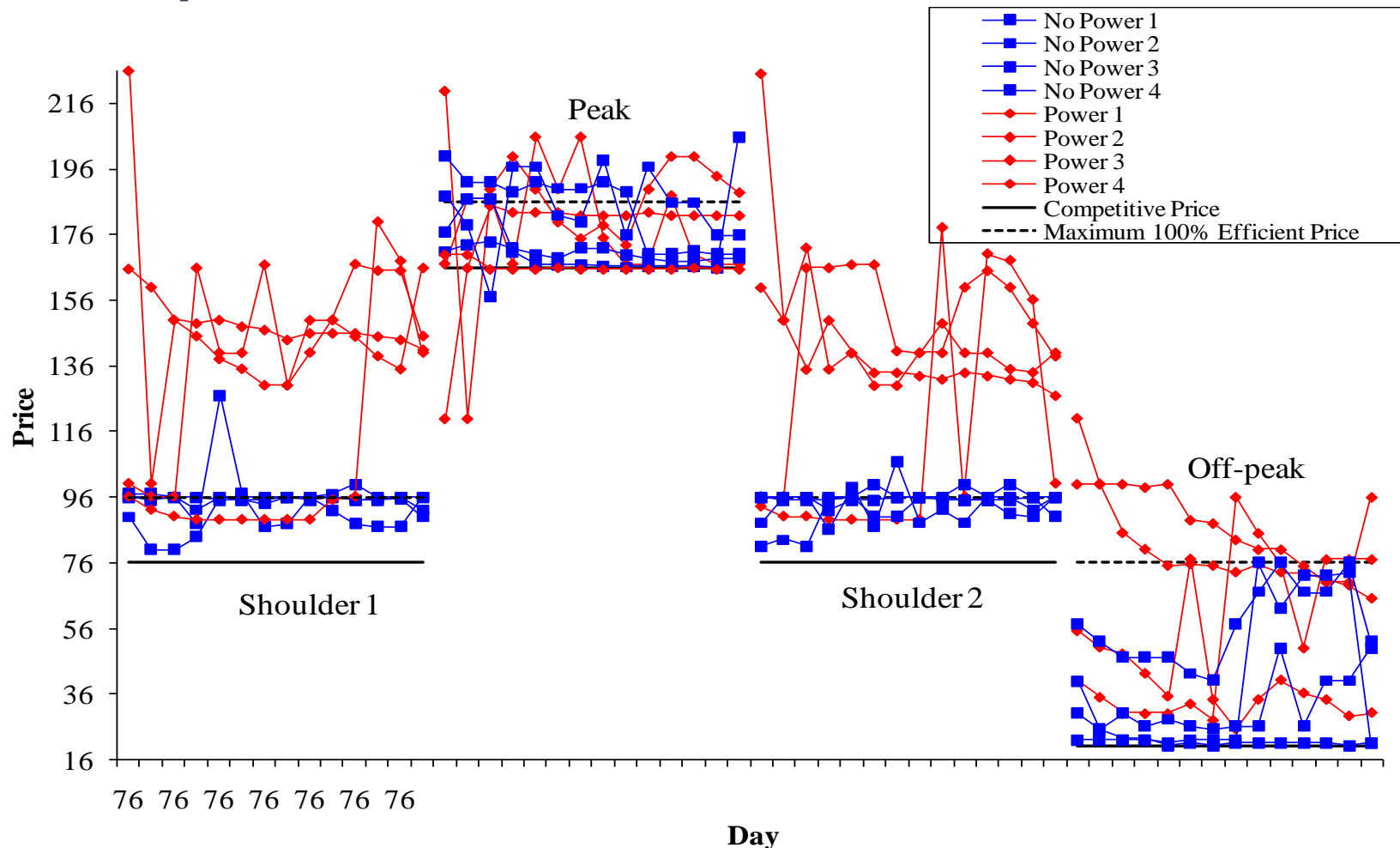
Benefits of performing economic experiments

- Test-bedding of workable decentralized incentive systems
 - Exploit the reality of decentralized knowledge and distributed intelligence
 - Give policymakers confidence in implementing policy changes
- Humans are creative in ways that computer simulations cannot capture
- We can study and learn from *what is not*
- Both research and education outcomes

Demand Response's Erosion of Market Power: Evidence From Economic Experiments

- S. Rassenti, V. Smith, B. Wilson, *Proceedings of the National Academy of Sciences* (2003)
- Electricity experiments in a controlled environment with profit-motivated human participants
- Subject were generators bidding into a wholesale market
- Real-time market, uniform price single auction vs. uniform price double auction
- Active demand response of **only 16%** of load was enough to control supplier market power and dampen price spikes
- *Extension*: Demand response reduces price volatility and facilitates integrated spot/forward energy markets instead of artificial capacity constructs

Active demand smooths prices and controls market power



Source: Rassenti, Smith, and Wilson, PNAS 2003

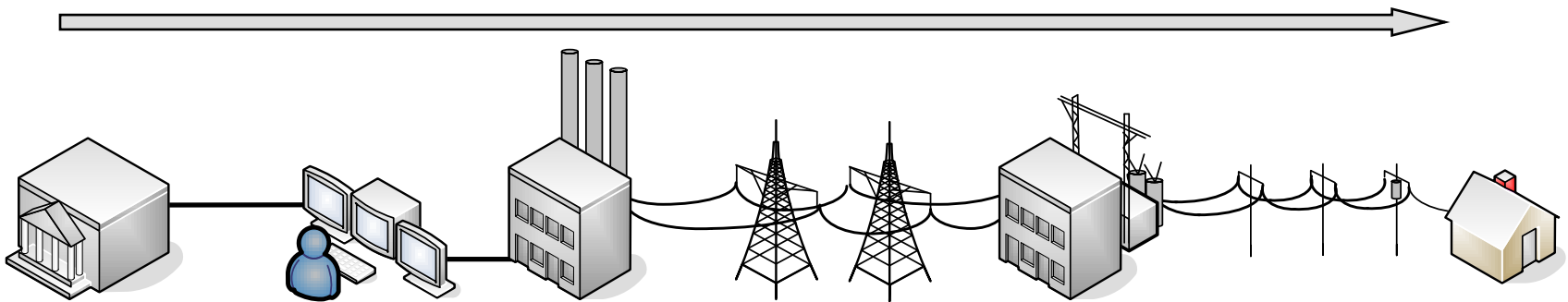
Smart Grid and AMI

Mike Howard, Ph.D.

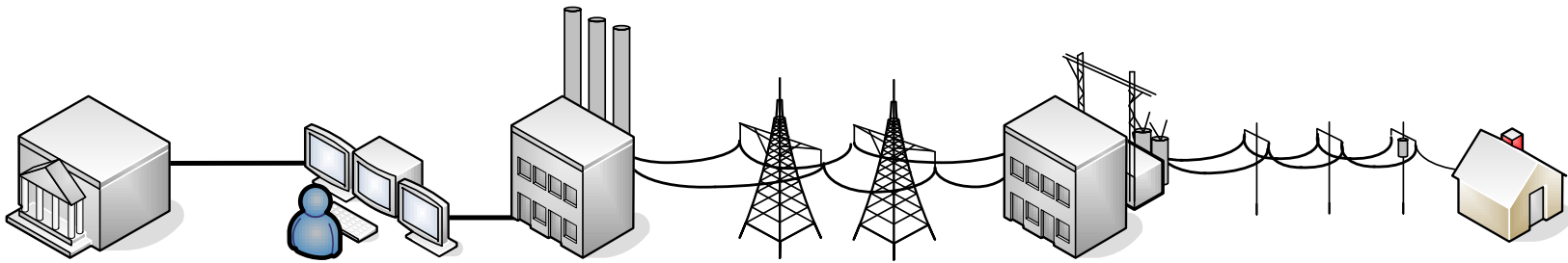
Electric Power Research Institute

Charlotte, NC

Today . . .

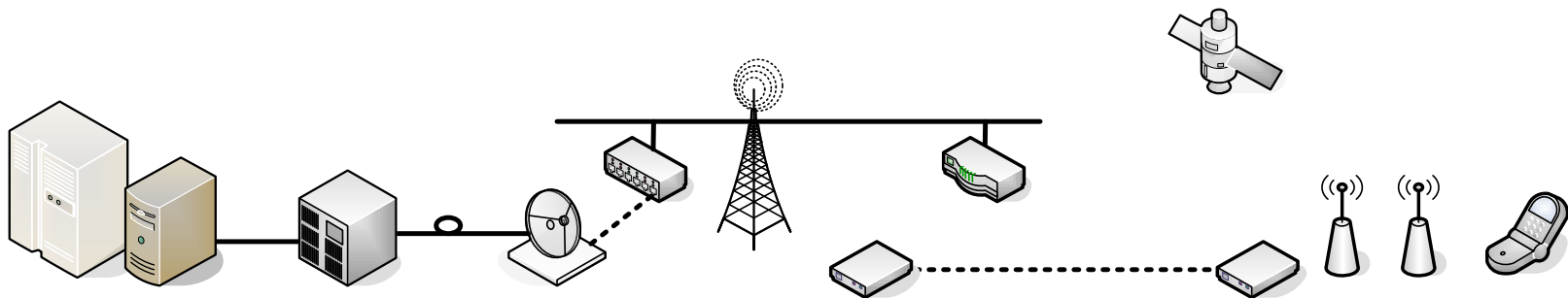


Tomorrow . . . A Smart Grid



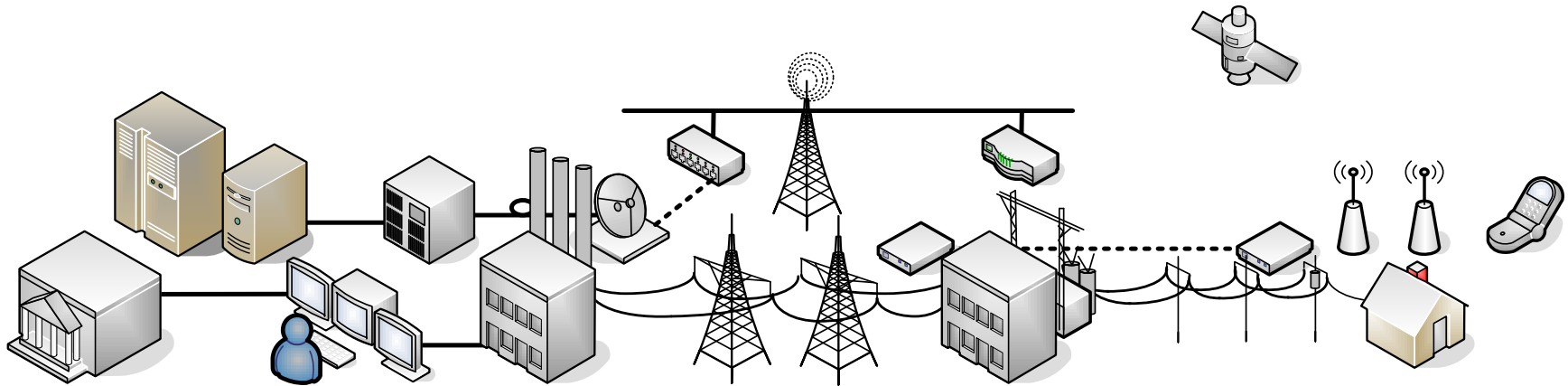
Electrical Infrastructure

Merging Two Infrastructures



"Intelligence" Infrastructure

The Benefits . . .



Reduced Carbon Emissions Through Optimized Use of Assets

Improved Reliability and Power Quality

Integrated Distributed and Renewable Energy

Enables Demand Response and Energy Efficiency

Greater Consumer Value at Lower Cost

Enhanced System Security

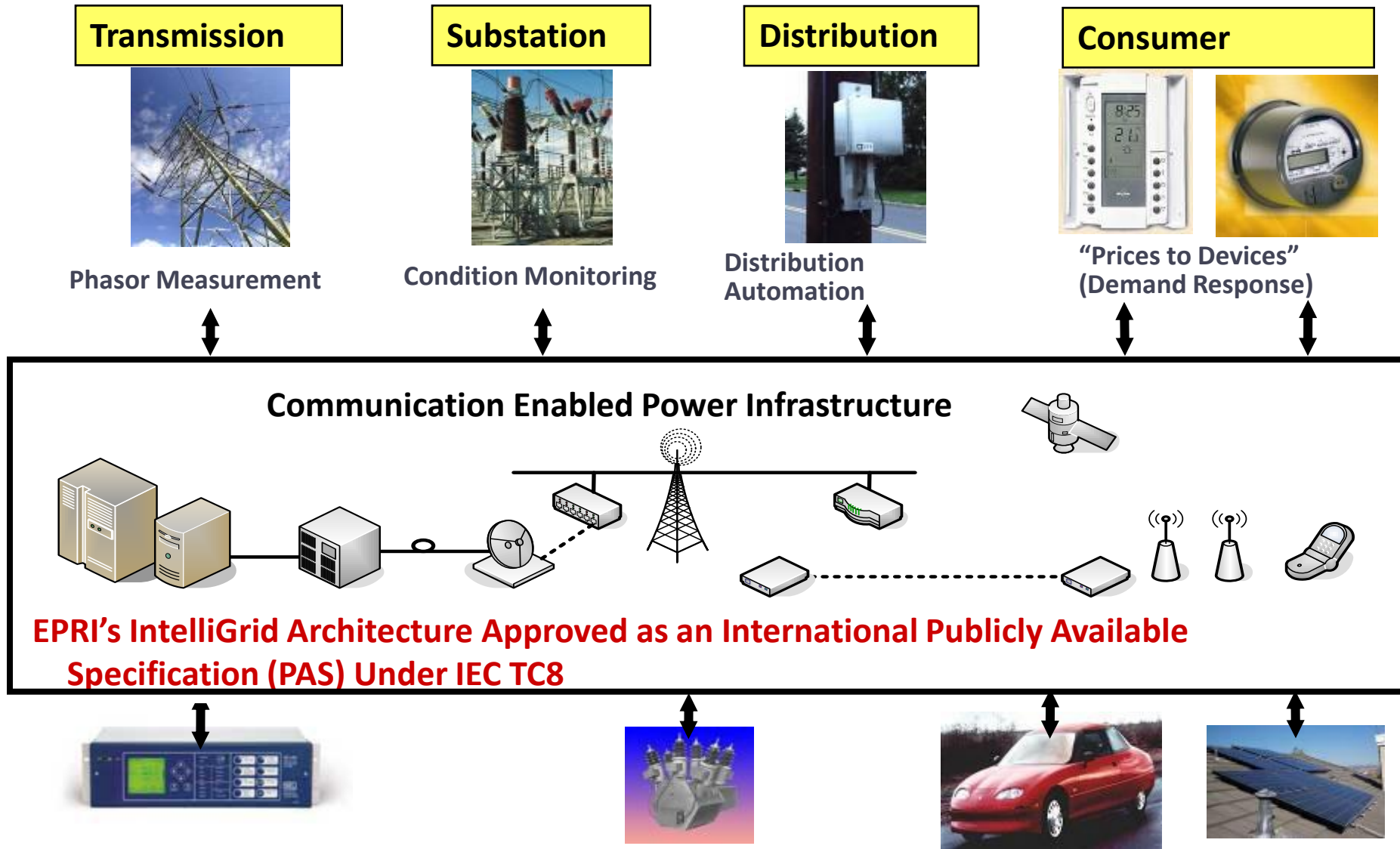
Improved Operational Efficiency

Participation in Energy Markets

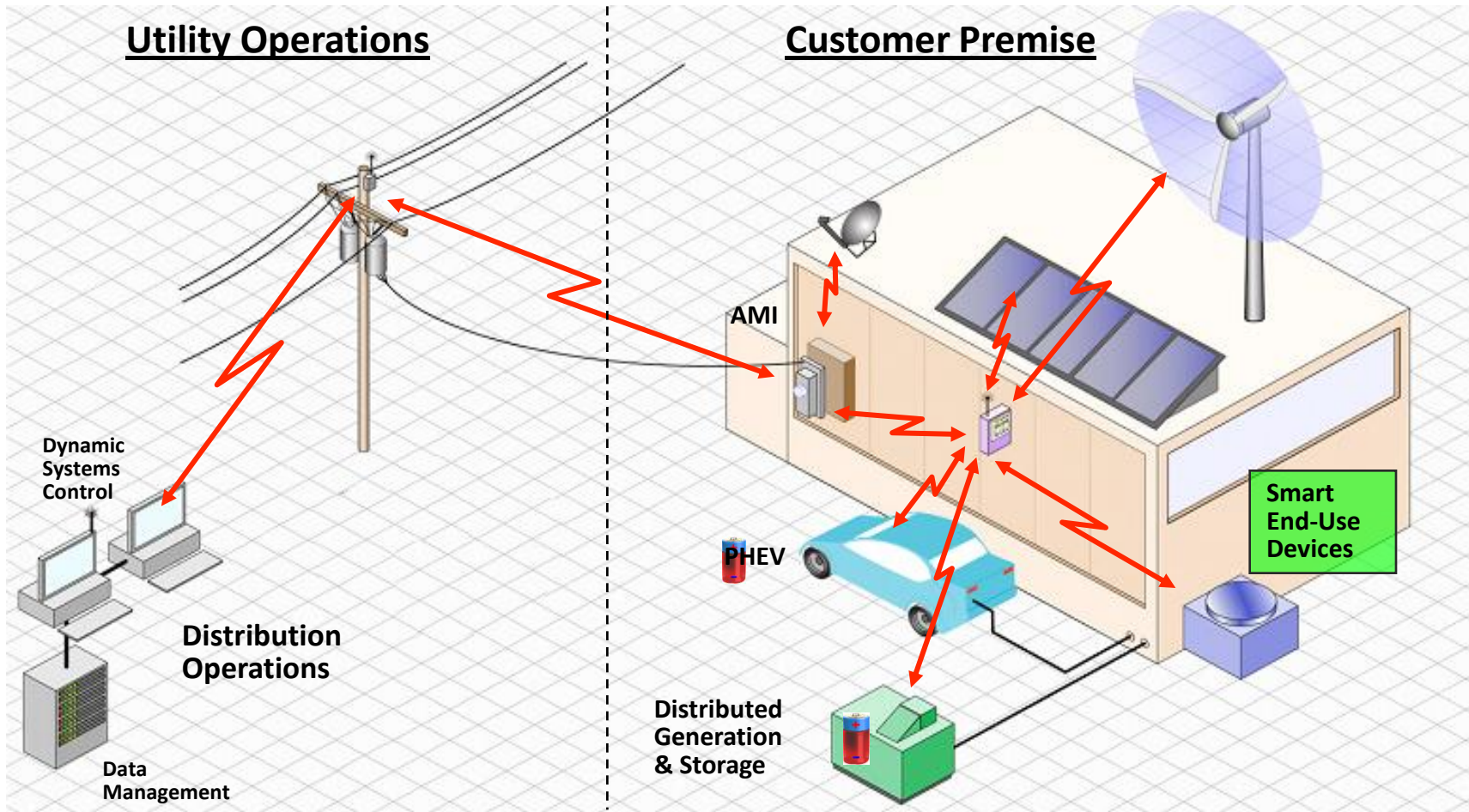
Interoperability . . . Critical for a Smart Grid



Interoperability. . .Critical for a Smart Grid



Advanced Metering Infrastructure . . .



Smart Grid will evolve with time . . . AMI is *today's* building block?

Smart End-Use Devices . . .

Input Signals

Electric System Characteristics

Price Signals

Temperature

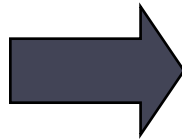
Time-of-Day

Individual Preferences

Weather Forecast

Thermal Storage

Device Condition



Creating a Smart Grid and AMI . . .

- ***Evolves*** over many years
- Incremental deployment and integration of ***intelligent systems***
- Deployed to meet specific business, regulatory or legislative ***drivers***
- Positive ***business case***



Summary . . .

- Smart Grid
 - Merger of two infrastructures
- Interoperability
 - Critical for a Smart Grid
- Advanced Metering Infrastructure
 - Smart Grid will evolve . . . AMI is *today's* building block
- Smart End-use Devices



Questions?

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AMI, Demand Response and the Environment

Dan Delurey, Executive
Director

DRAM Coalition
Washington, DC

Demand Response and Advanced Metering Coalition (DRAM):

Founded in 2001 as the trade association for the demand response industry. Focused on providing information on demand response and its enabling technologies and services to policy makers and stakeholders.

- Aclara
- Cellnet
- Comverge
- Echelon
- Eka Systems
- Elster Electricity
- eMeter
- EnergySolve
- EnerNOC
- Ice Energy
- Itron
- Landis + Gyr
- Orion Energy Systems
- Sensus Metering
- Silver Spring Networks
- SmartSynch
- Trilliant Networks

Questions?

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Operational & Customer Experience Benefits of a Smartgrid...

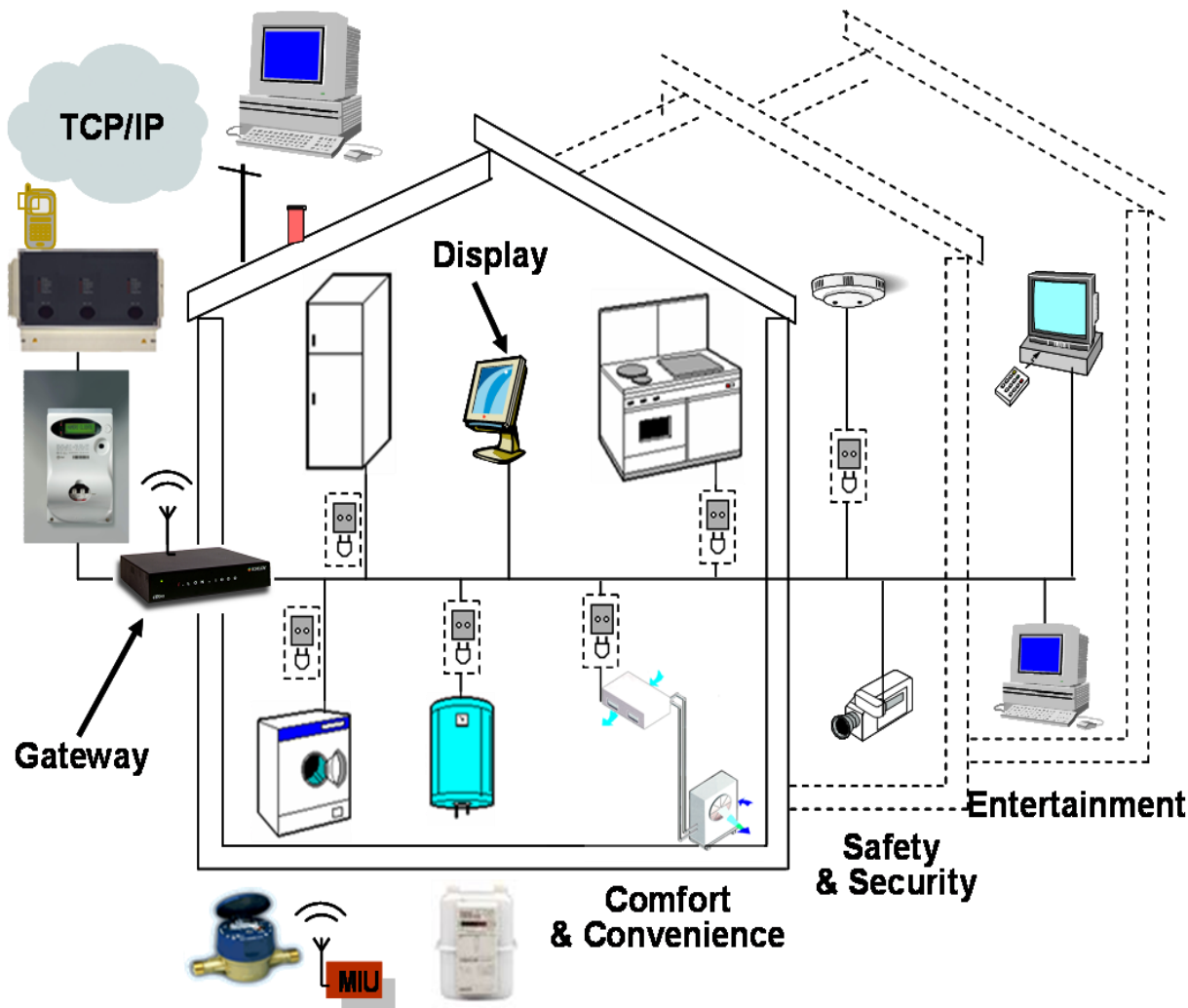
Matt Smith, Director

Utility of the Future—Duke Energy

Charlotte, NC

Category	Description
Metering	AMI, move in/out, connect/disconnect, billing exceptions, reduction in billing cycle, improved meter accuracy, revenue protection, load research
Energy Efficiency Related	DSM program proliferation, operational efficiencies, value of load to operations, value of energy in the market
Distribution	Var. management, asset management, voltage control, PQ driven O&M
Outage Management	Detection and verification, revenue impacts
Call Center	Reduction in overall call volume related to meters, trouble calls, change in service and billing
Substation	Asset management
Environmental	Reduction in CO2 from reduced truck rolls
Societal	Customer service enhancements and improved experience

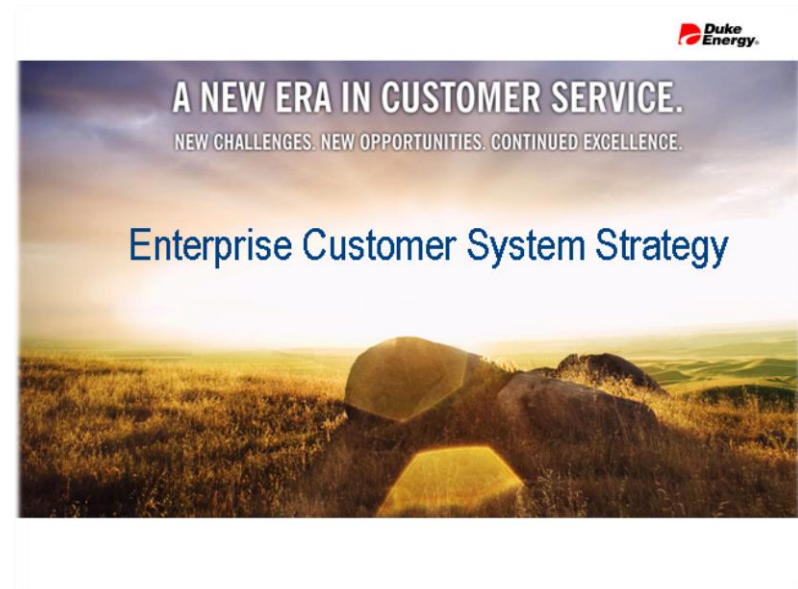
...Achieved through Smarter Intercation with our Customers



- Technology investment will enable Energy Efficiency to be delivered to all of our energy consumers
- Universal access to Energy Efficiency will require different programs and tariffs for different classes of customers
- Energy Efficiency needs to serve our customers – not the other way around

While Maintaining the Required Duke Energy Customer Experience

- Treat energy efficiency and demand response as a fifth fuel
- Provide universal access to electricity, and now Energy Efficiency Services
- Promote standard service offers that includes efficient use of energy
- Empower customers to choose efficient solutions that work for them
- Enable appliances and equipment to be “smart” in how they use electricity



“A lasting and sustainable shift in the way we use electricity will require a ‘back of mind’ approach – where customers can take energy efficiency for granted, the same way they take for granted that the lights will come on when they flip a switch.”

- Jim Rogers

Questions?

Mr. Matt Smith

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Closing Remarks

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Customer & Societal Benefits of AMI

- Greater Consumer Control over Bills
- Avoided Generation
 - Avoiding a Capacity Shortfall
 - Peak Energy Costs
 - Planning Reserves
- Avoided T&D Capacity
- Conservation Impacts
 - Enables Sustainable ESCO Services
- T&D Operations
 - Reduced T&D Losses
 - Reduced Congestion
 - Lower Cost Dispatch / Power Purchases
 - More Predictable Power Flows
- Provision of Ancillary Services
 - Non-Spinning & Spinning Reserves
 - Frequency Control
- Environmental Benefits of Conservation, Reduced Losses, & Less Reliance on Generation for Ancillary Services
- Market Price Reductions
- Reduced Price Volatility
 - Lower Supplier & Consumer Long-term Contract & Investment Risk
- Mitigation of Supplier Market Power
- Improved Energy Market Price Signals
 - Allows DR to Set Scarcity Price
 - Enhanced Incentive for Unit Availability
- Reduced Capacity Market Reliance
 - Flatter Load Improves Asset Utilization
 - Facilitates “Energy Only” Option
- Improved Outage Management
- Building Block for Smart Grid
 - Premium Reliability & Power Quality for High Value Uses & Digital Economy
 - Facilitates Integration of Distributed & Renewable Resources
- New Consumer Services
 - Integrates to Building & Home Network