

Load Management and Dynamic Pricing

Presented at:
2011 Annual Regulatory Studies Program
Institute of Public Utilities, Michigan State University

August 4, 2011

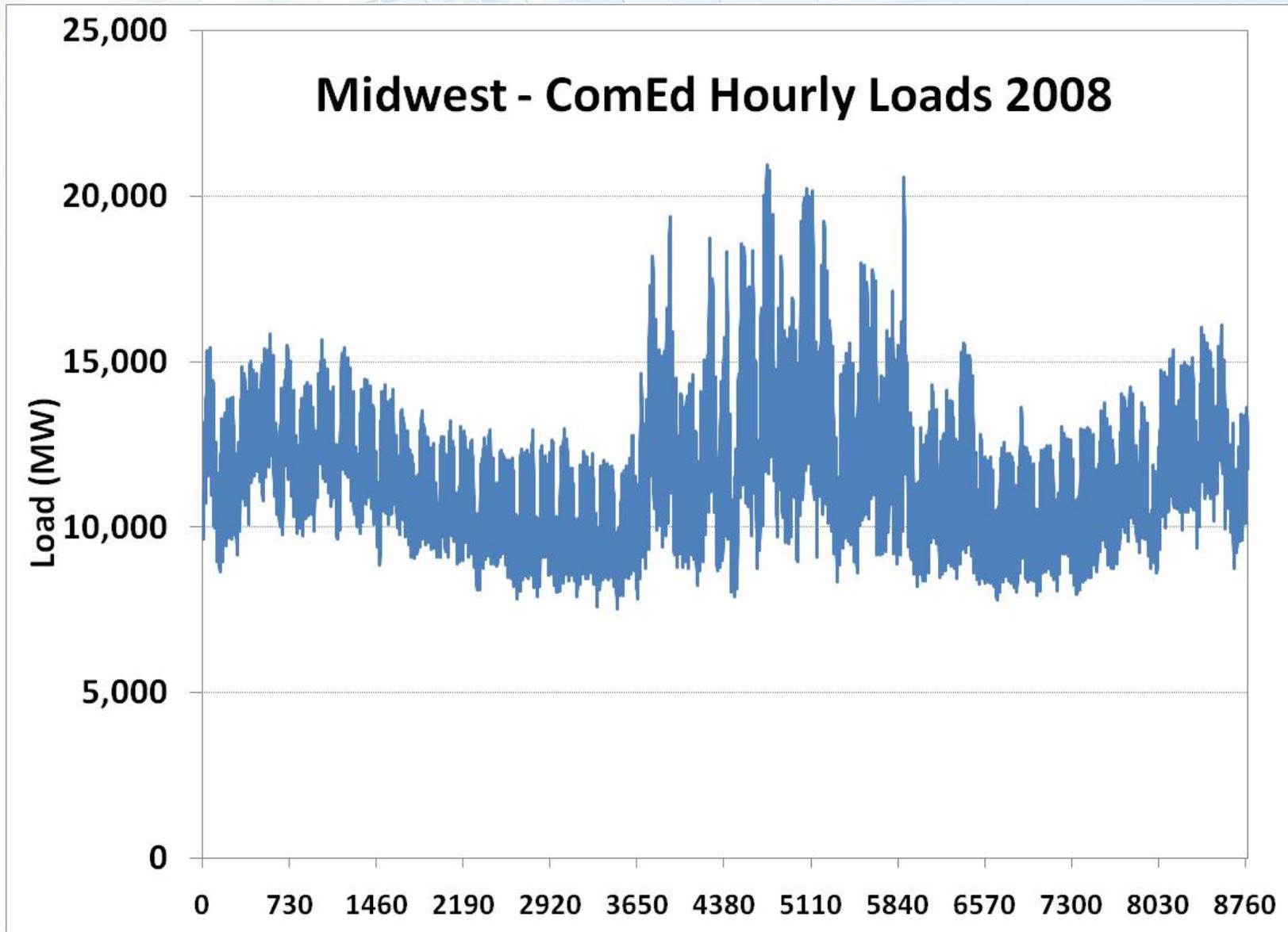
Guenter Conzelmann
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9700 South Cass Avenue
Argonne, IL 60439

Overview

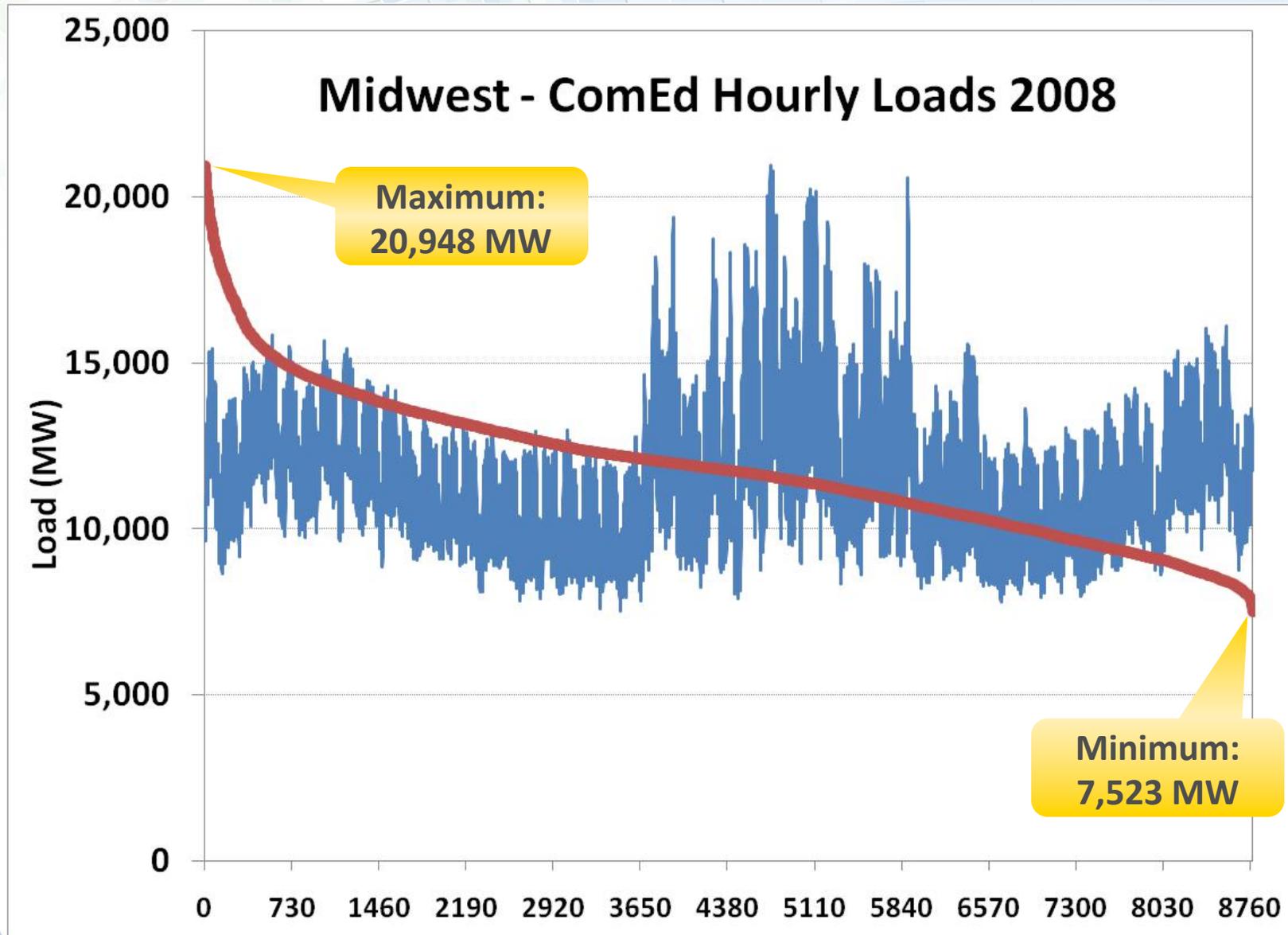
- Drivers for load management and dynamic prices
- Typical load profiles
- Close look at the residential consumer
- Load management approaches
- Residential example
- Select results from pilots
- Summary



Drivers for Load Management and Dynamic Pricing – Variation in Demand

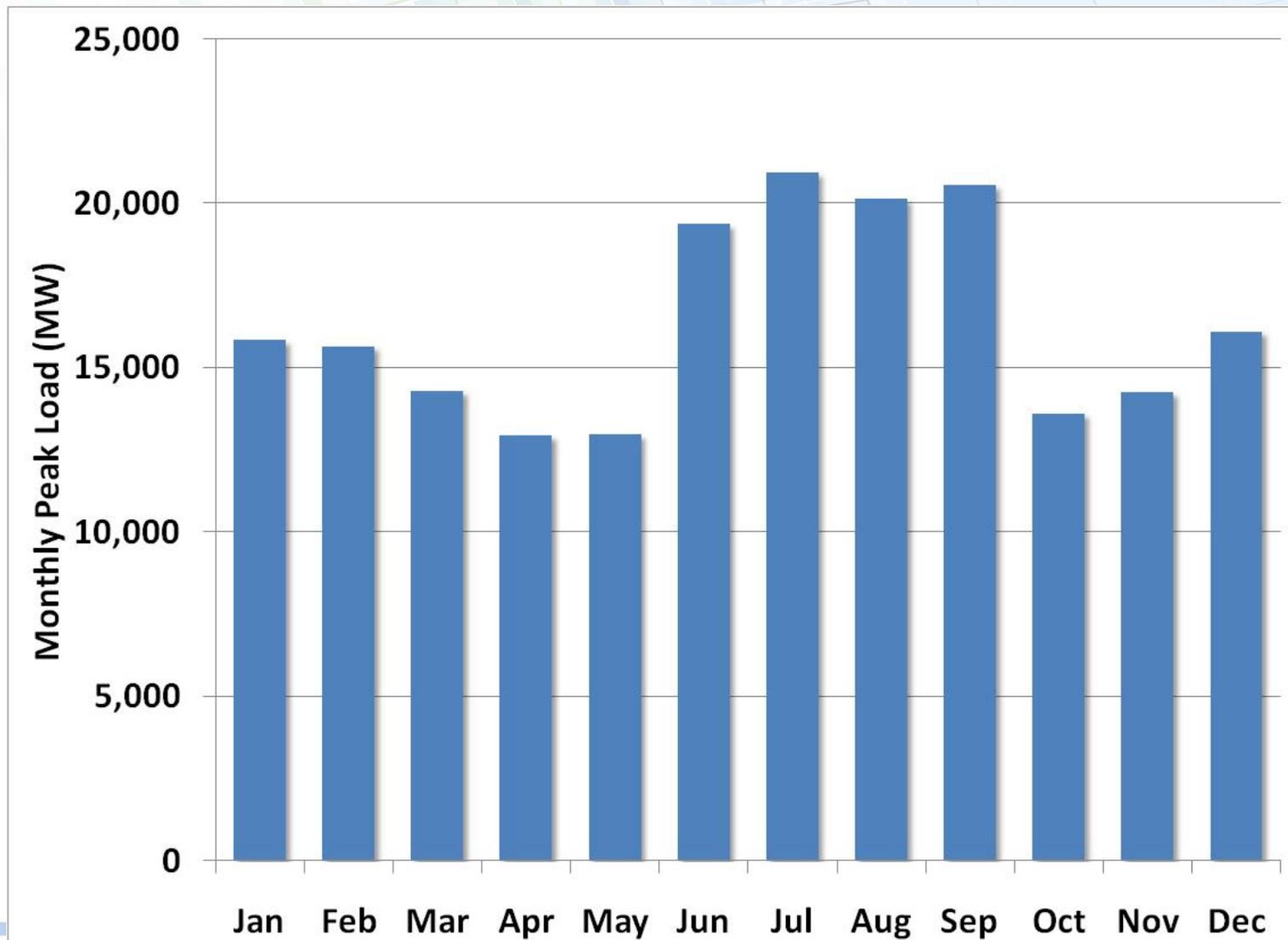


Drivers for Load Management and Dynamic Pricing – Variation in Demand (2)



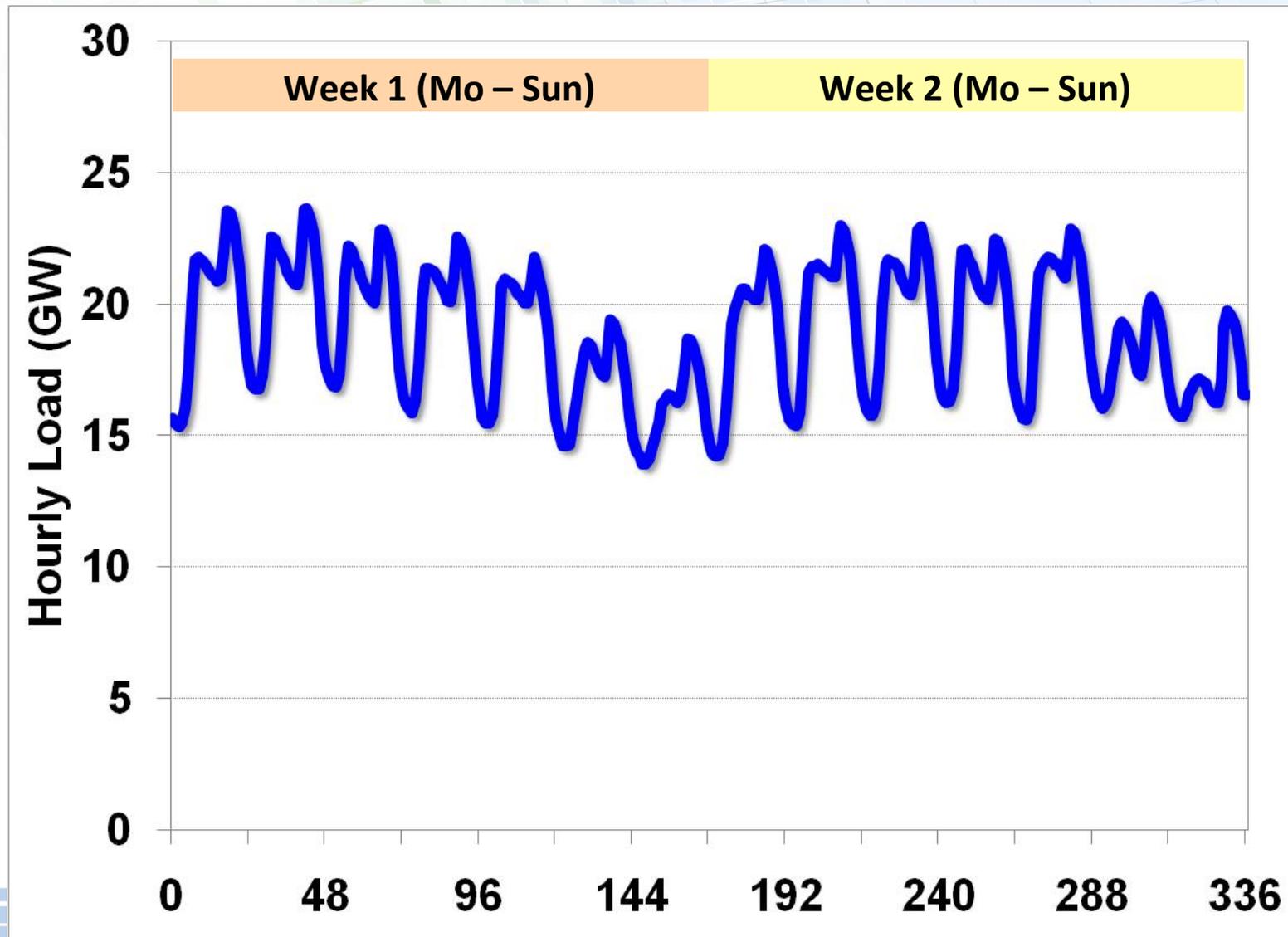
Drivers for Load Management and Dynamic Pricing – Variation in Demand (3)

- We usually observe an annual or seasonal variation in loads which may vary by region

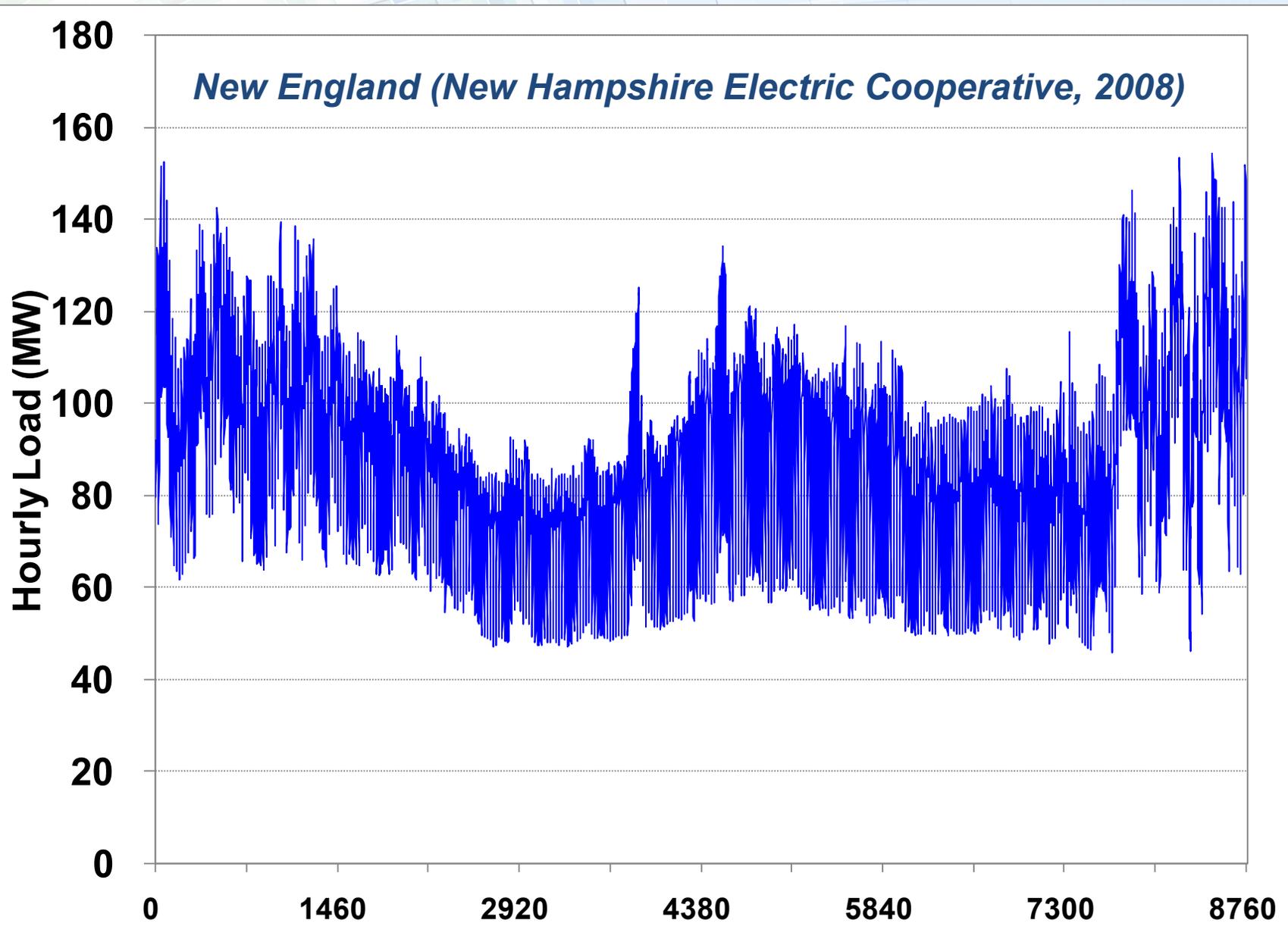


Drivers for Load Management and Dynamic Pricing – Variation in Demand (4)

- Typically, we see a distinct daily profile of consumption that often varies by season

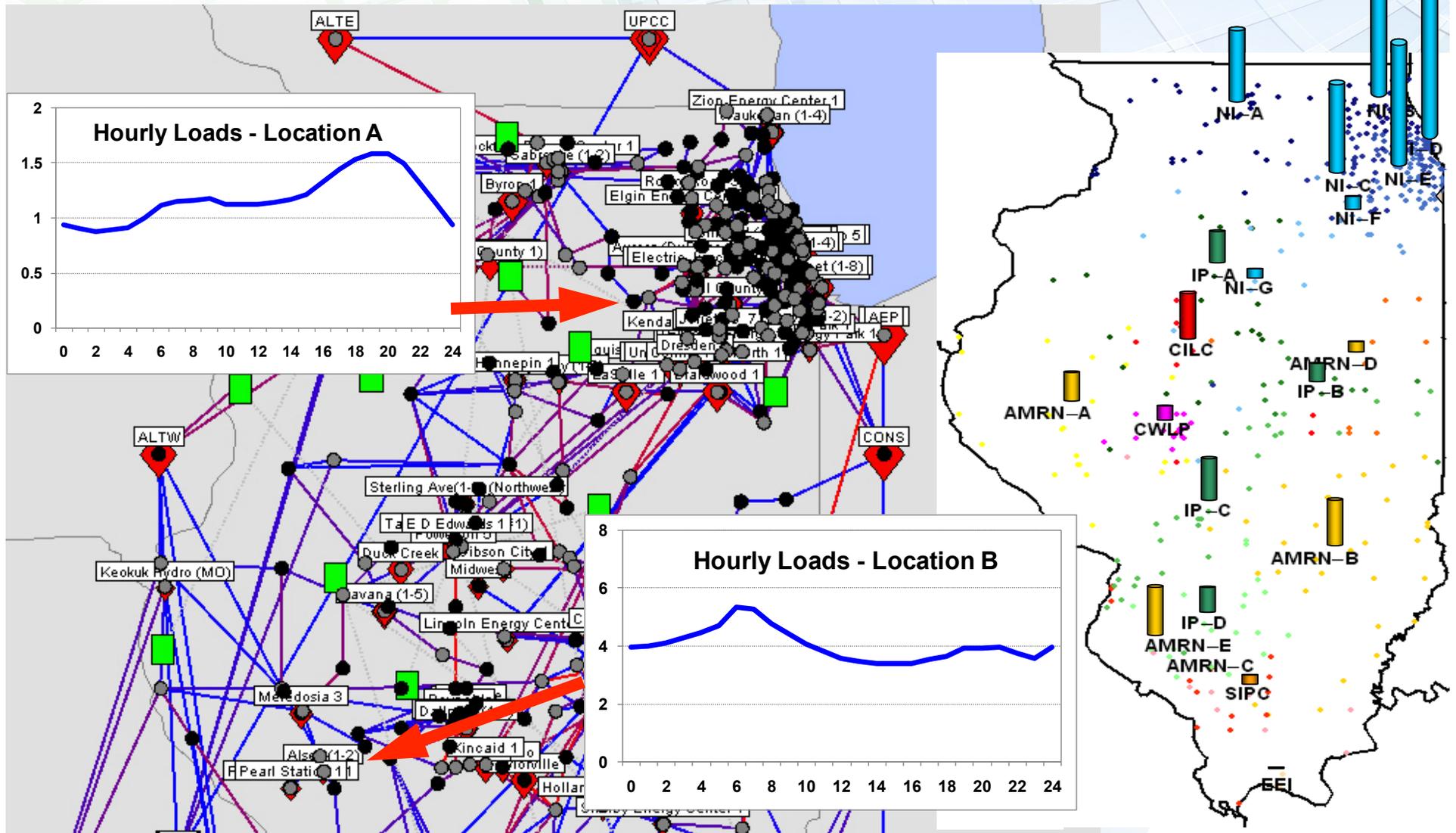


Drivers for Load Management and Dynamic Pricing – Variation in Demand (5) Winter-Peaking System

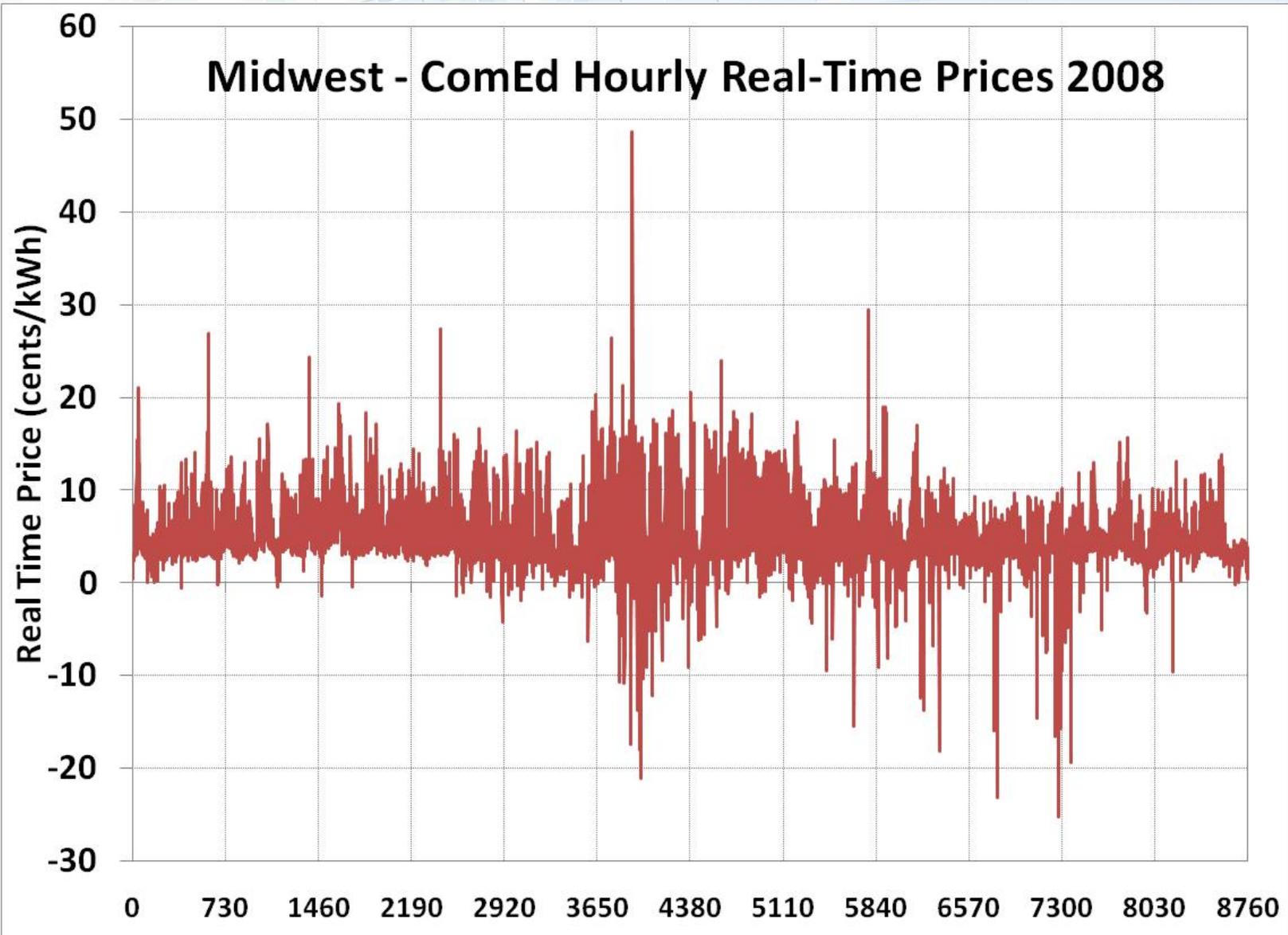


Drivers for Load Management and Dynamic Pricing – Variation in Demand (6)

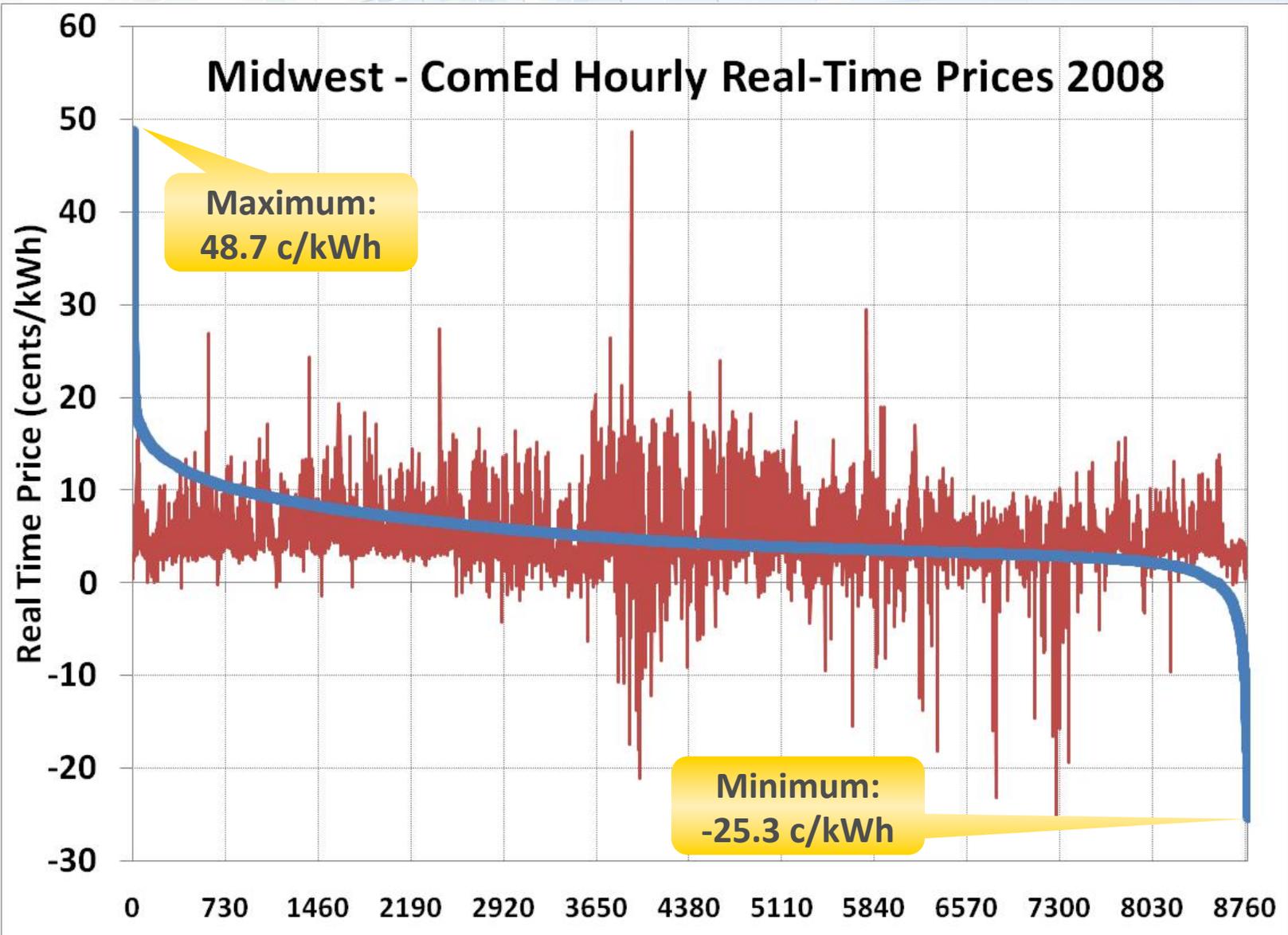
- Location of the load matters, particularly if transmission is congested; will impact benefits of dynamic pricing/DR implementation



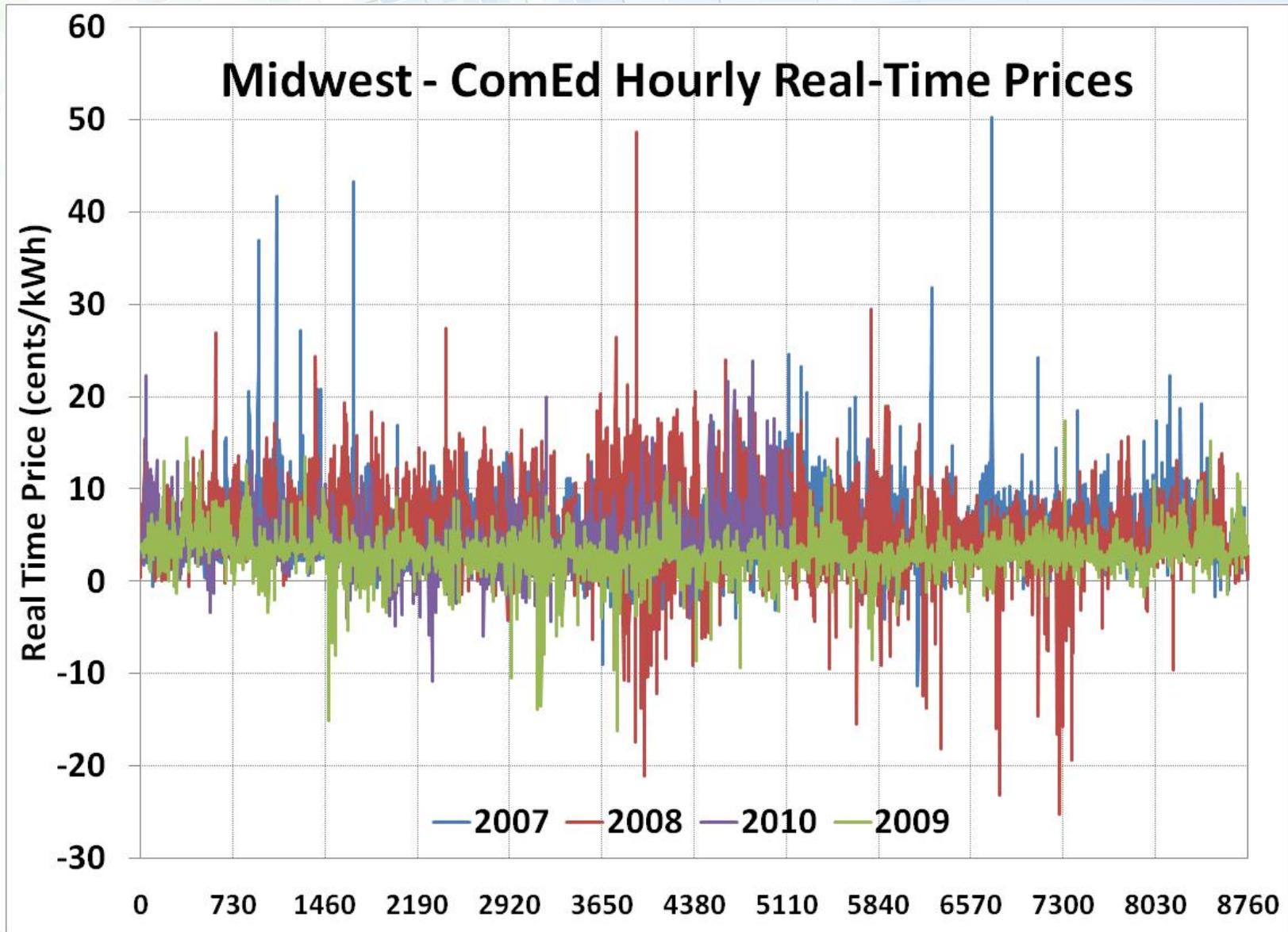
Drivers for Advanced Metering, Dynamic Pricing, and Demand Response - Highly Variable Wholesale Prices (1)



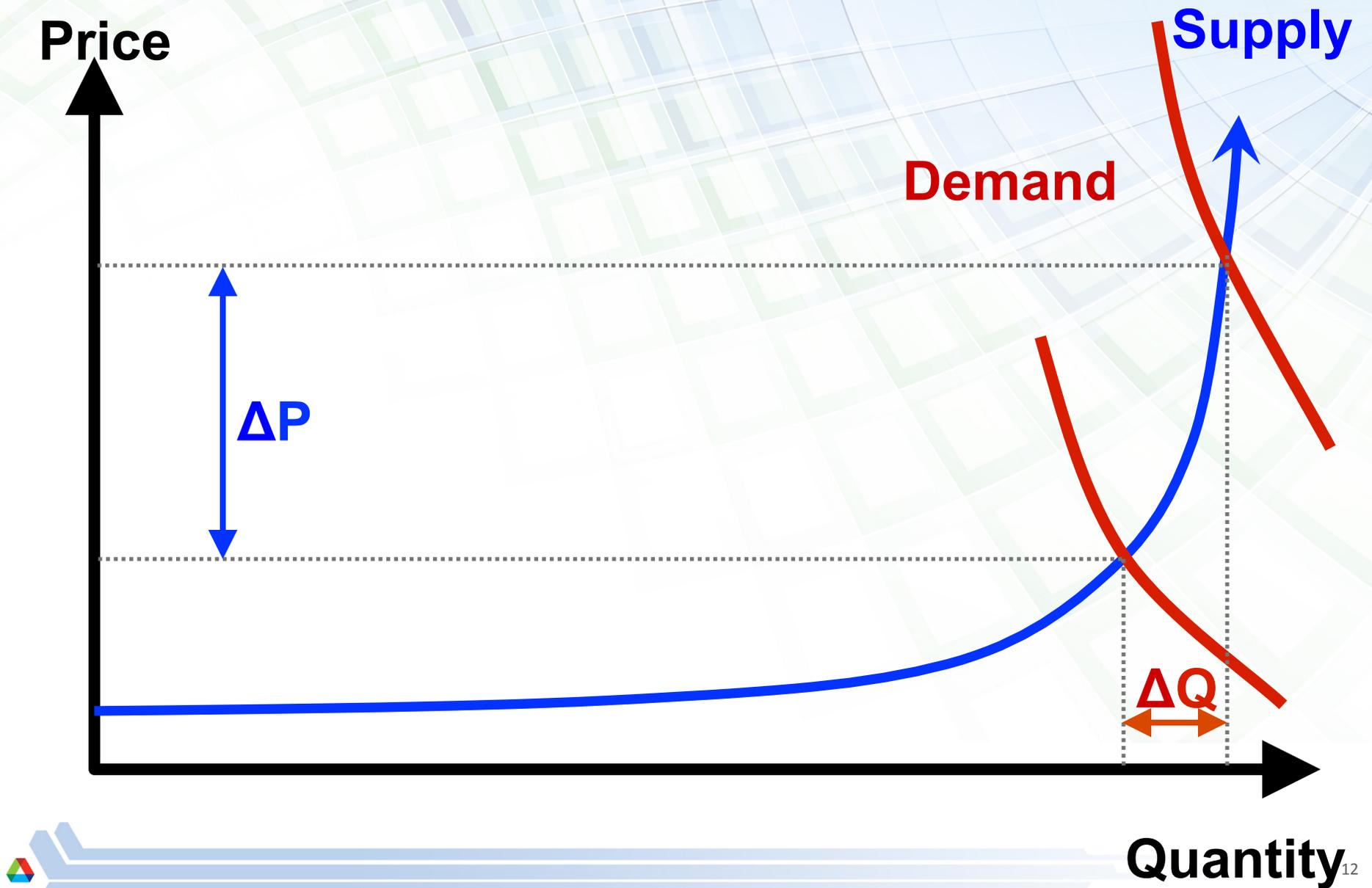
Drivers for Advanced Metering, Dynamic Pricing, and Demand Response - Highly Variable Wholesale Prices (2)



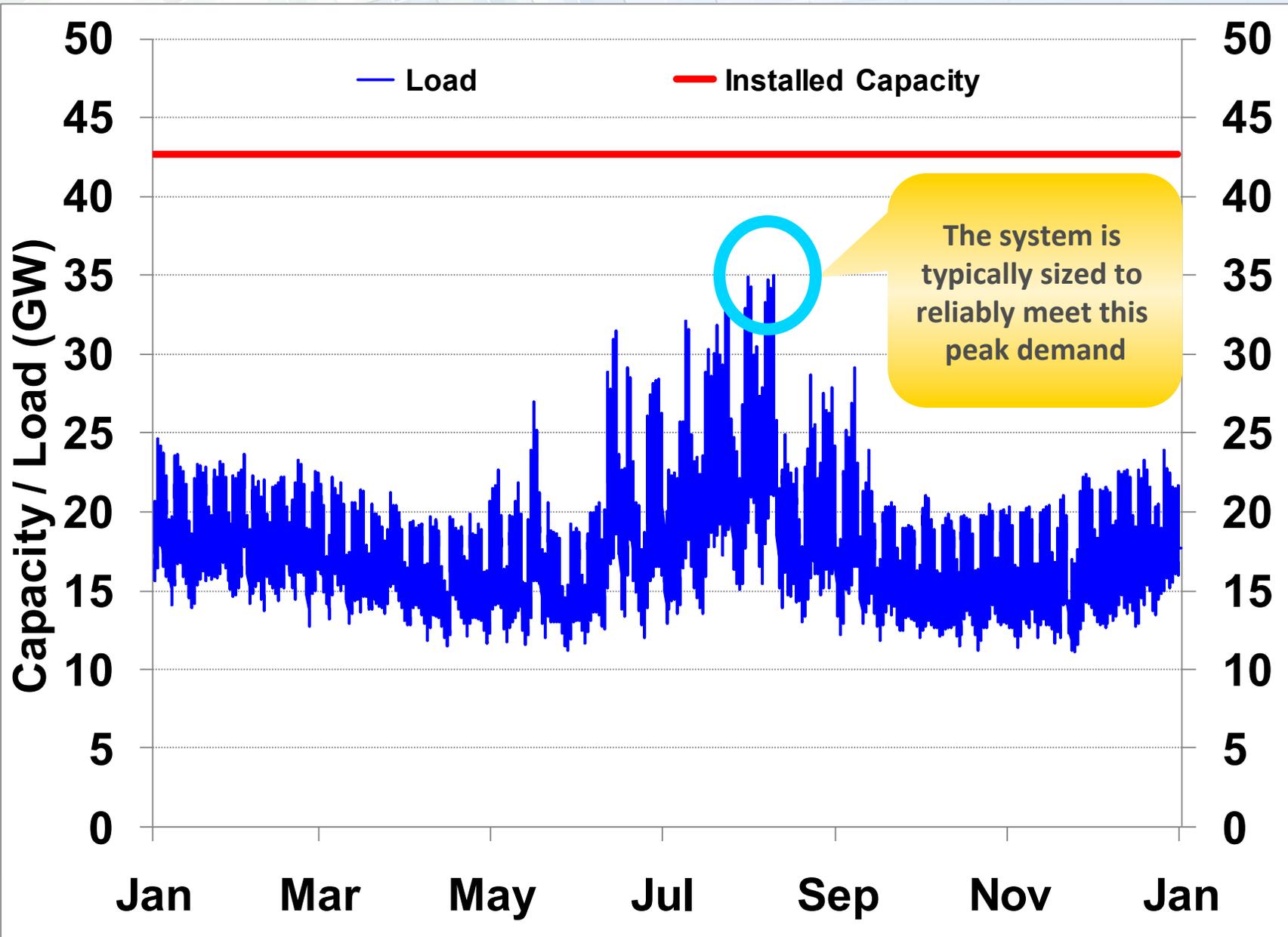
Drivers for Advanced Metering, Dynamic Pricing, and Demand Response - Highly Variable Wholesale Prices (3)



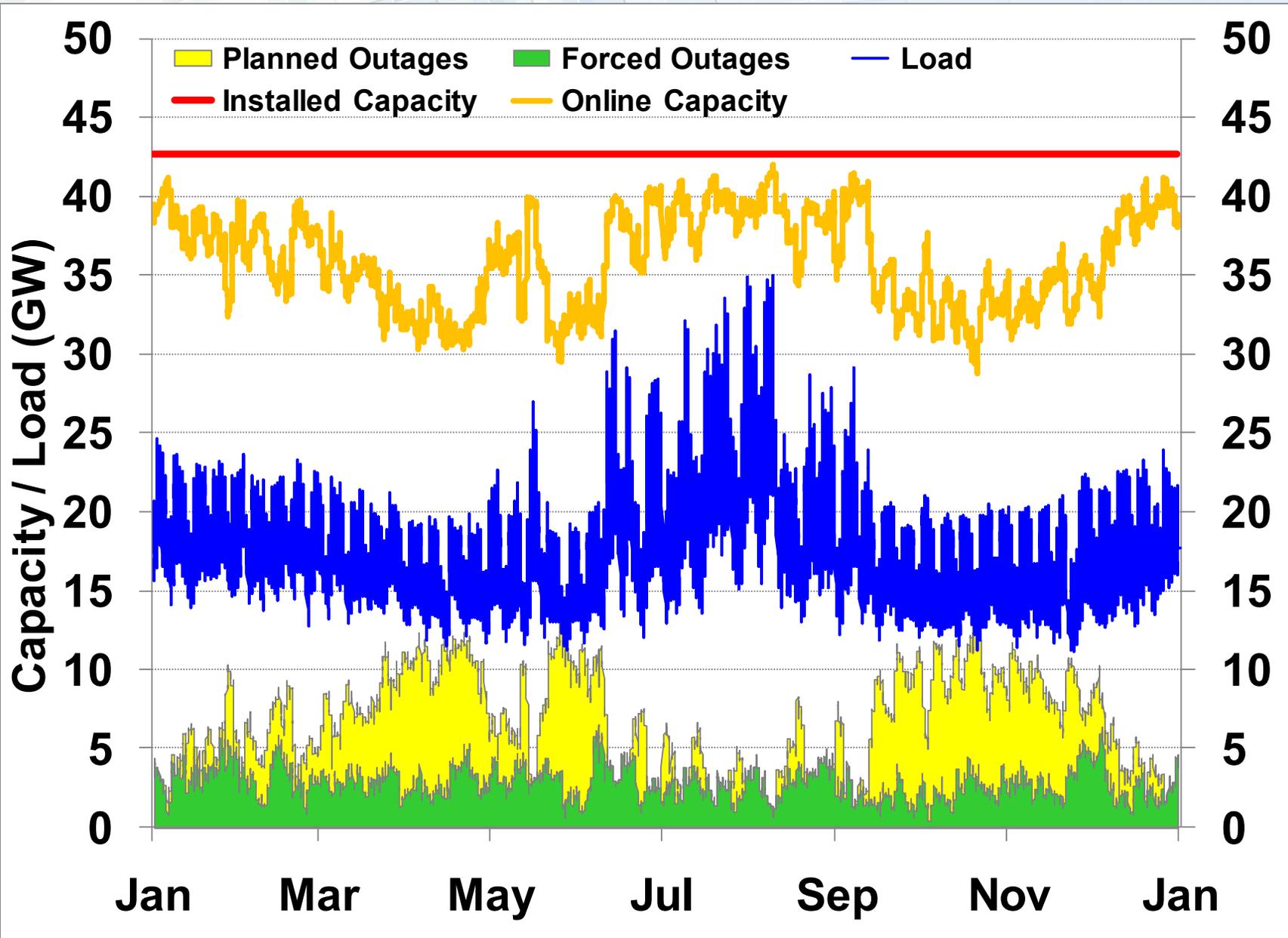
*Load Management Can Improve Market/System Efficiency
(Small Changes in Quantity Produce Large Changes in Price)*



Load Profile Drives Need for Generation Resources (1)

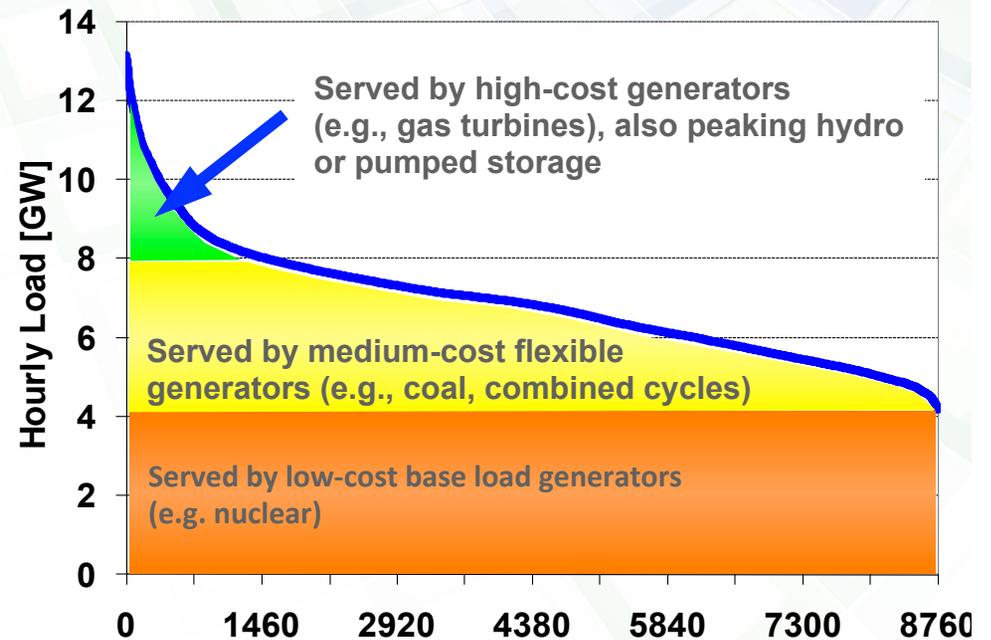
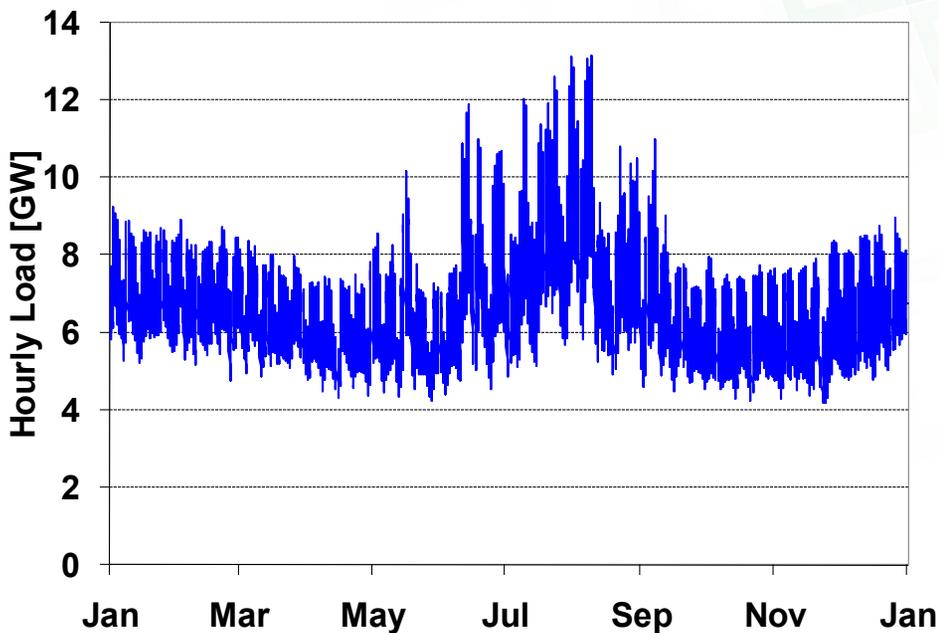


Load Profile Drives Need for Generation Resources (2)



Load Profile Drives Need for Generation Resources (3)

- The pattern/shape of the demand has a significant impact on the resource mix and how we meet the demand
- Different technologies have different technical and economic characteristics and operational capabilities and limitations



Drivers for Load Management and Dynamic Pricing – Grid Reliability

- Cost of power disturbances in U.S. is about \$80 billion/year (up to possibly \$185 billion/year)

Historical Analysis of U.S. outages (1991-2005)

66 Occurrences over 100 MW
41 Occurrences over 50,000 Consumers

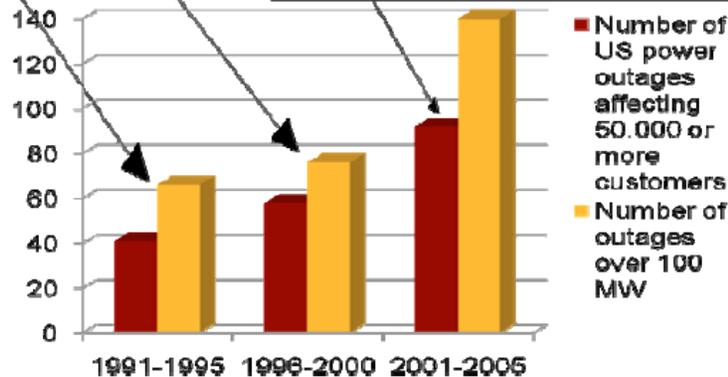
76 Occurrences over 100 MW
58 Occurrences over 50,000 Consumers

140 Occurrences over 100 MW
92 Occurrences over 50,000 Consumers

Result: Large blackouts are growing in number and severity

*Analyzing outages in 2006 we had:
24 Occurrences over 100 MW
34 Occurrences over 50,000 or more Consumers

Data courtesy of NERC's Disturbance Analysis Working Group database

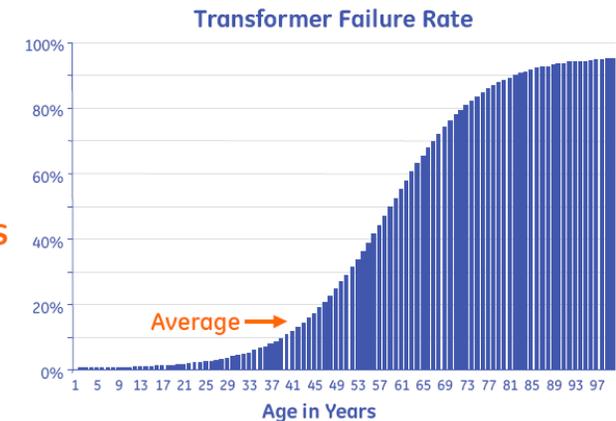


Source: Amin, 2010

The average US transformer age is just under 40 years old

50% of US utility workers are within 7 years of retirement

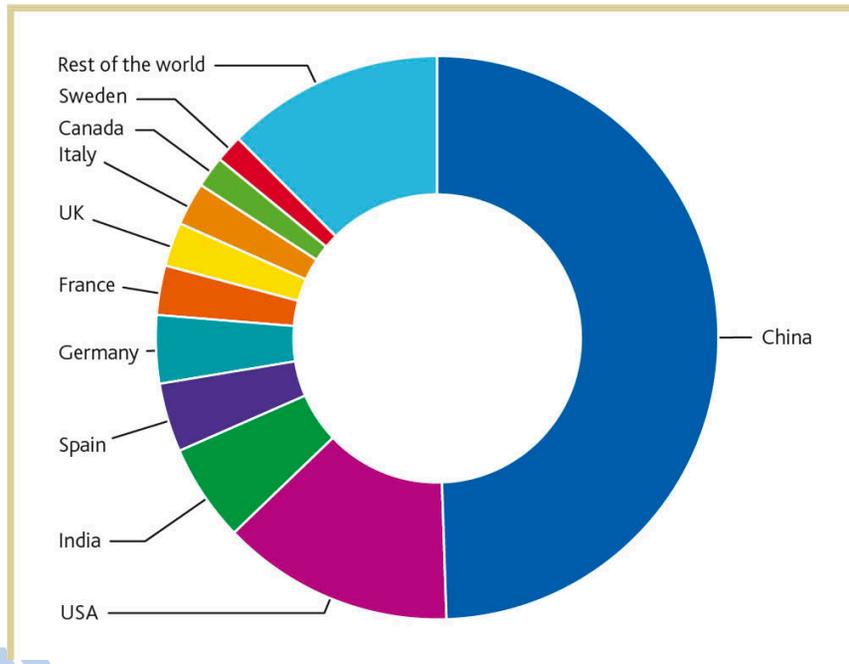
Source: GE, 2010



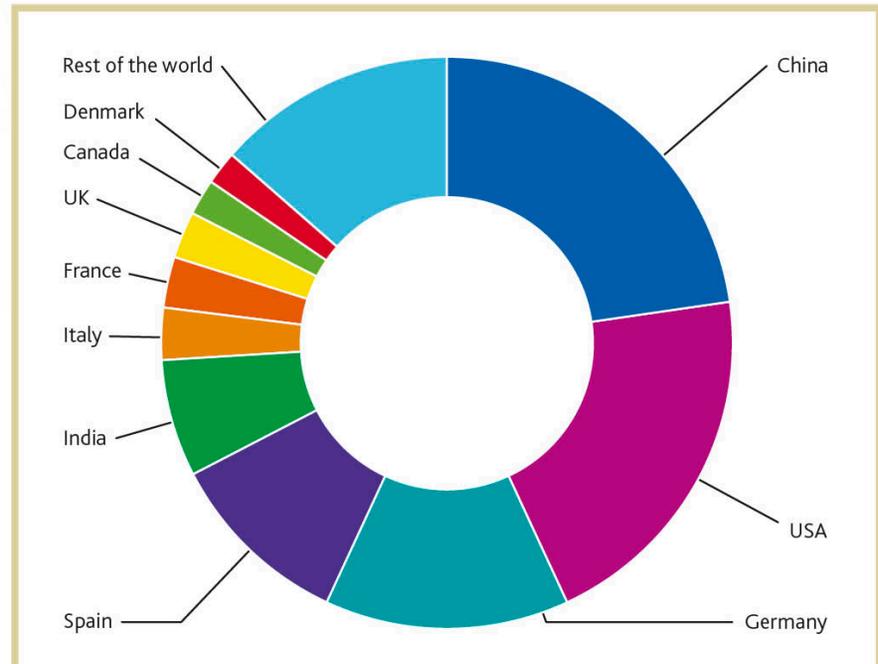
Drivers for Load Management and Dynamic Pricing – Growth in Renewables

- Wind – Global: 2010 NEW Installed Capacity of over 38 GW
 - Highly concentrated in 10 countries (close to 90%)
 - China lead 2010 with almost 19 GW or 50% of total new wind installed globally
 - U.S. second with 5.1 GW newly installed wind
- Total cumulative capacity approached 200 GW
 - China leads with 45 GW, U.S. second with over 40 GW

TOP 10 NEW INSTALLED CAPACITY JAN-DEC 2010



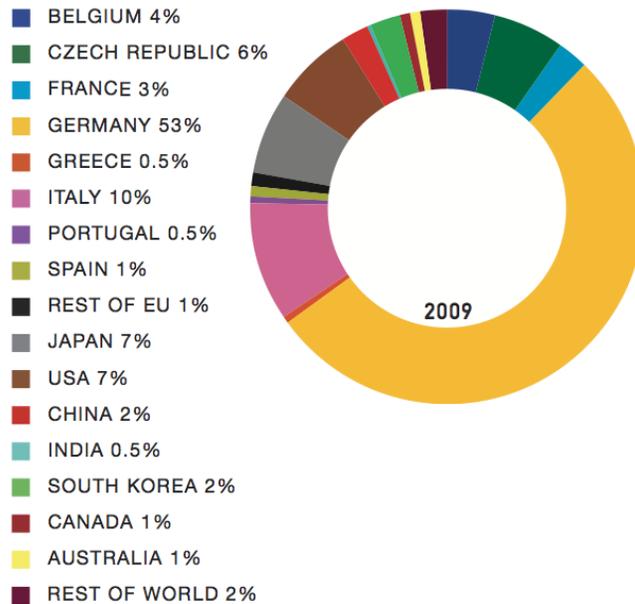
TOP 10 CUMULATIVE CAPACITY DEC 2010



Drivers for Load Management and Dynamic Pricing – Growth in Renewables (2)

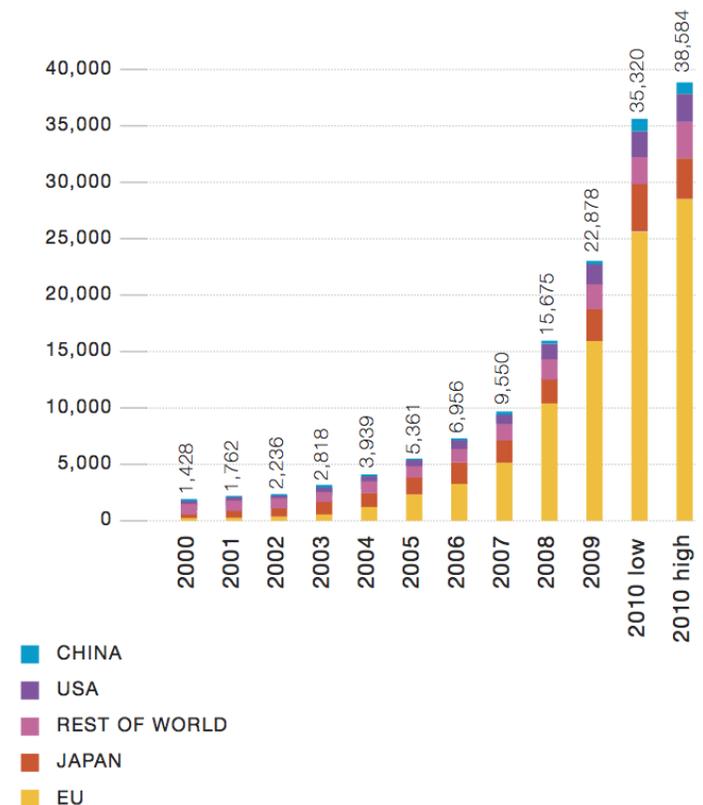
- Solar Global PV: Installations in 2010 were 17.5 GW (7.5 GW in Germany), for total of 37 GW
- U.S. total PV: 0.9 GW

FIGURE 30
THE WORLD PV MARKET IN 2009



source: EPIA.

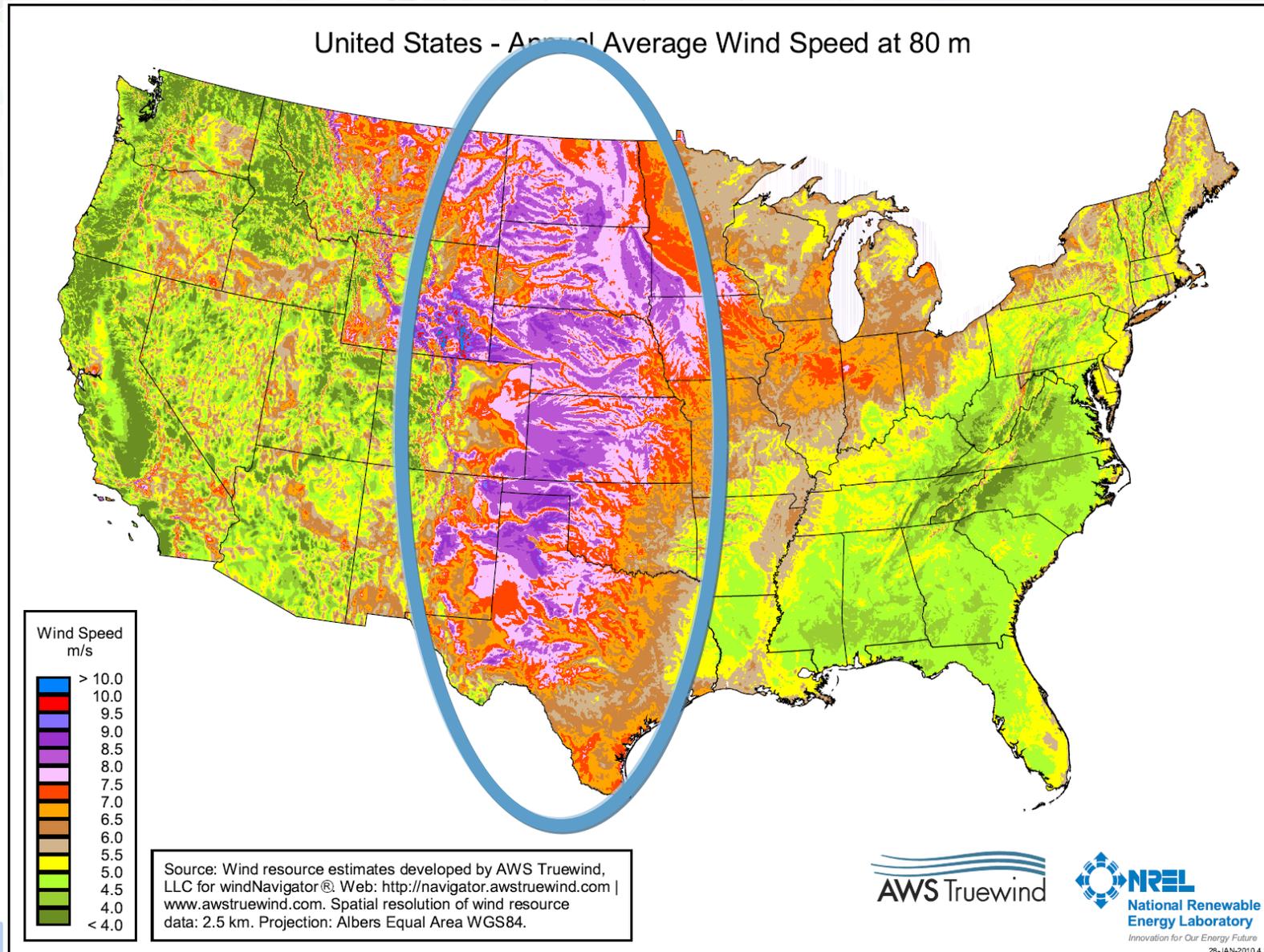
FIGURE 31
GLOBAL EVOLUTION OF PV INSTALLED CAPACITY MW



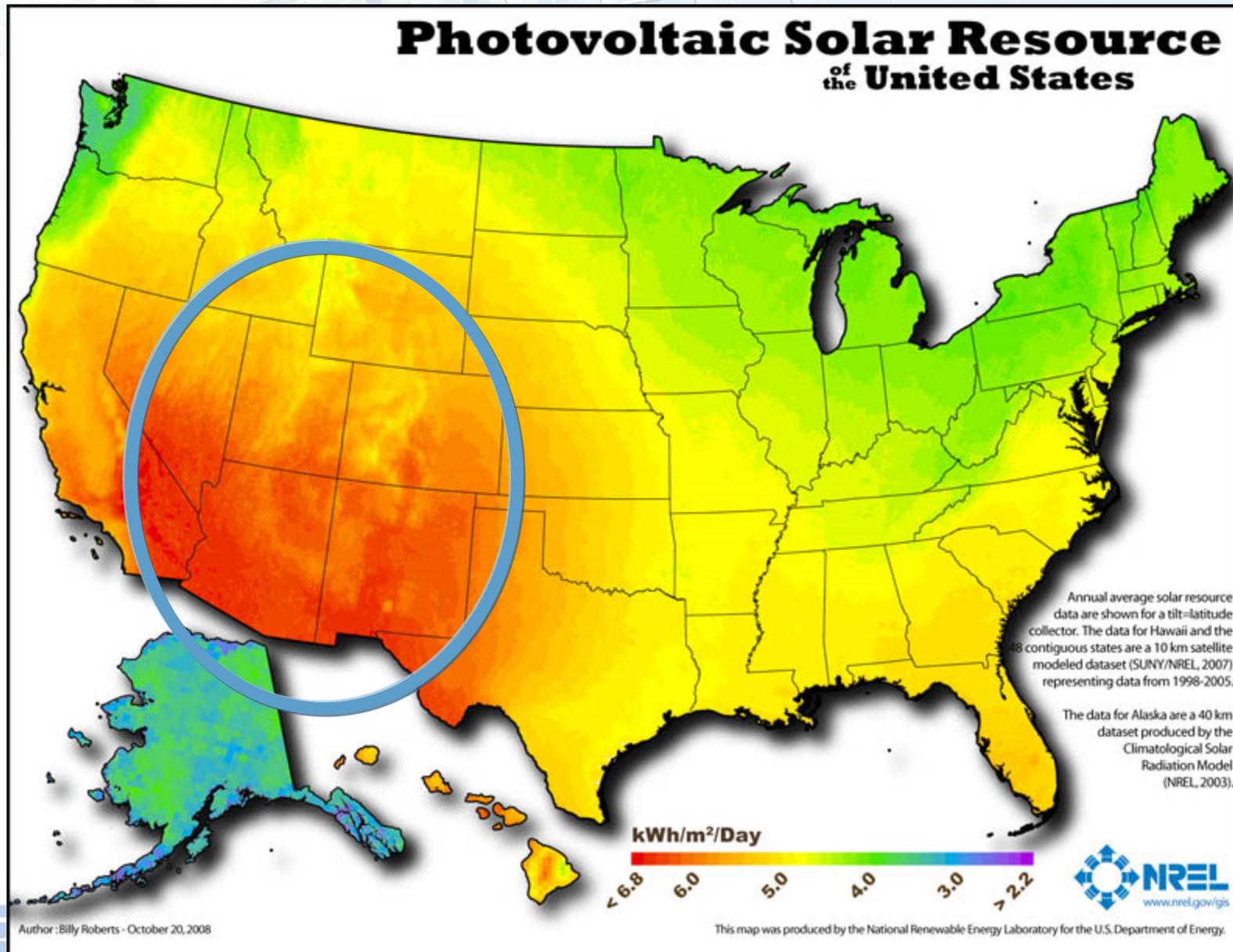
source: Global Market Outlook for Photovoltaics until 2014, EPIA, May 2010.



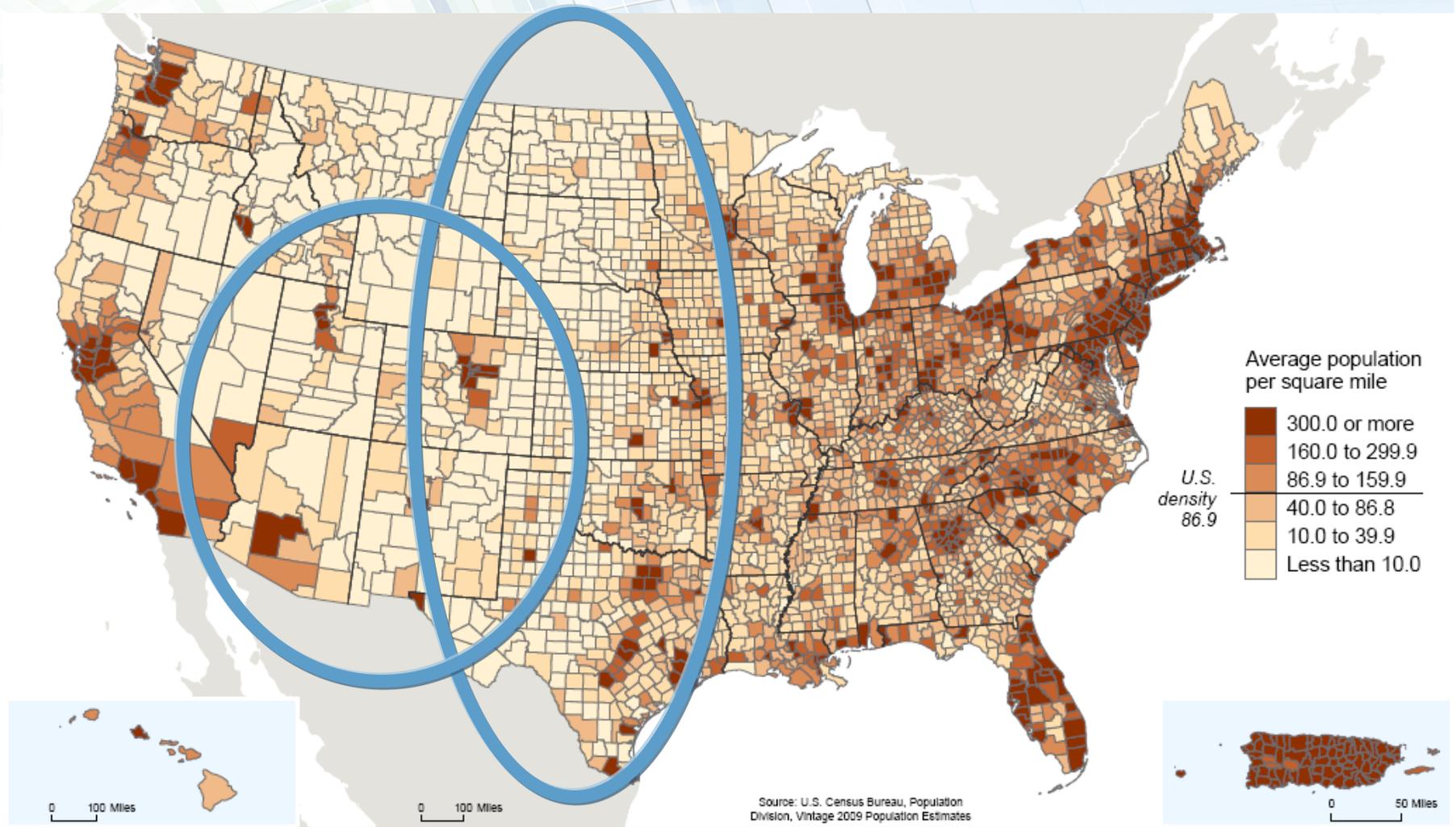
Drivers: Our Best Land-Based Wind Resources Are in the Great Plains and Upper Midwest



Drivers: Our Best Solar Resources Are in the Southwest



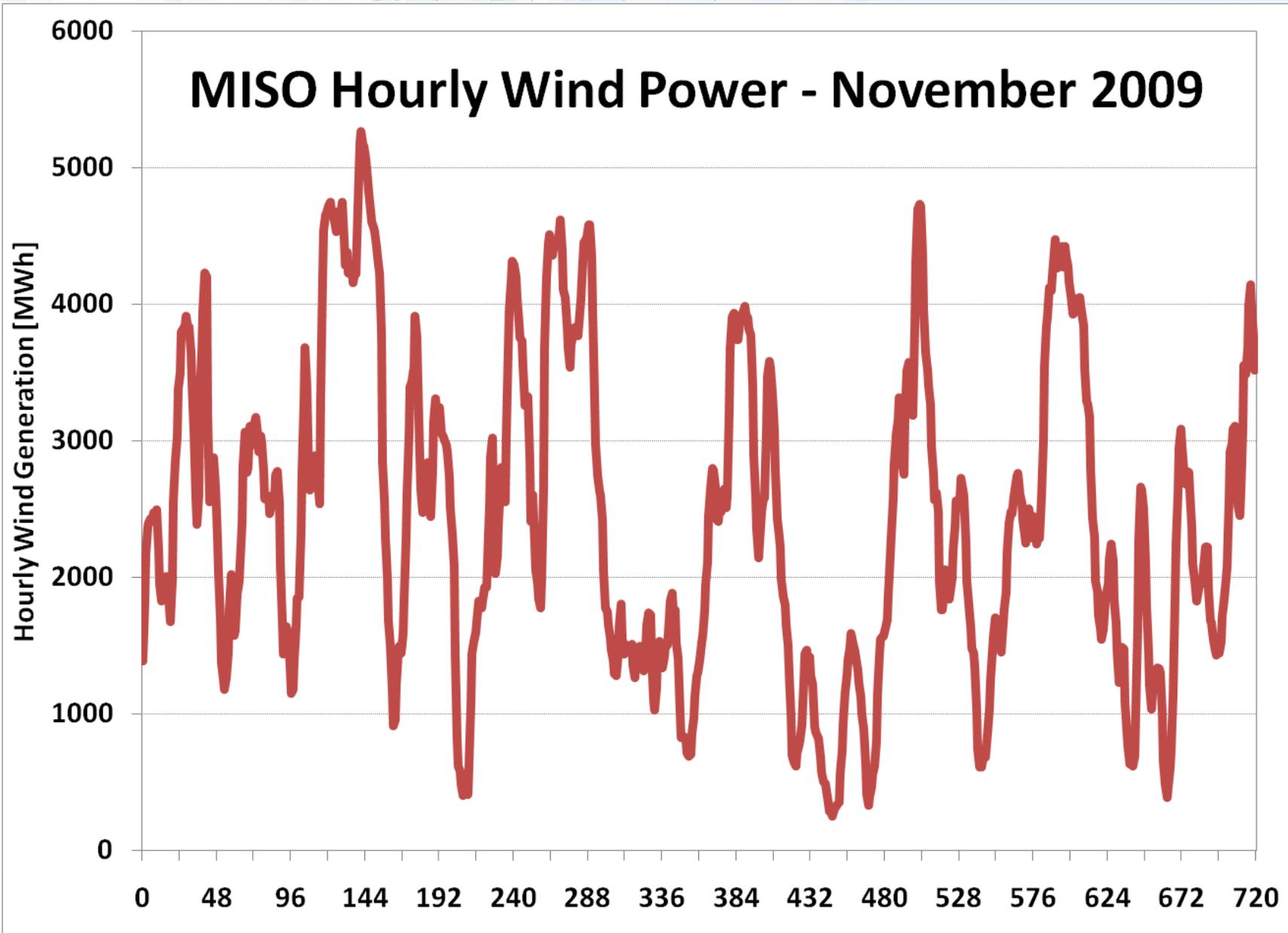
Drivers: Problem is Not a Lot of People Live Where the Best Resources Are



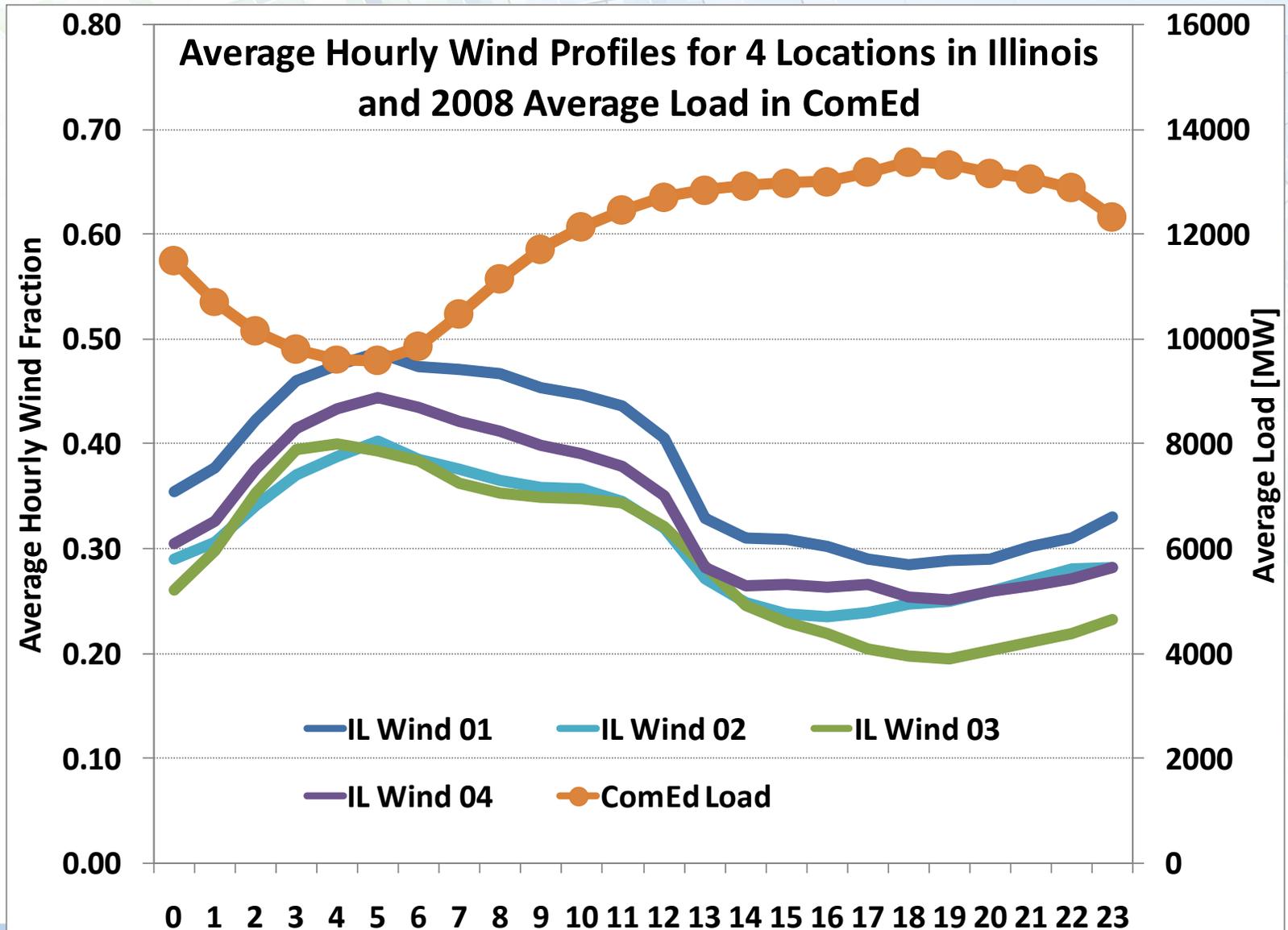
U.S. Population Density by County (July 1, 2009)



Drivers: Wind Availability Varies Significantly

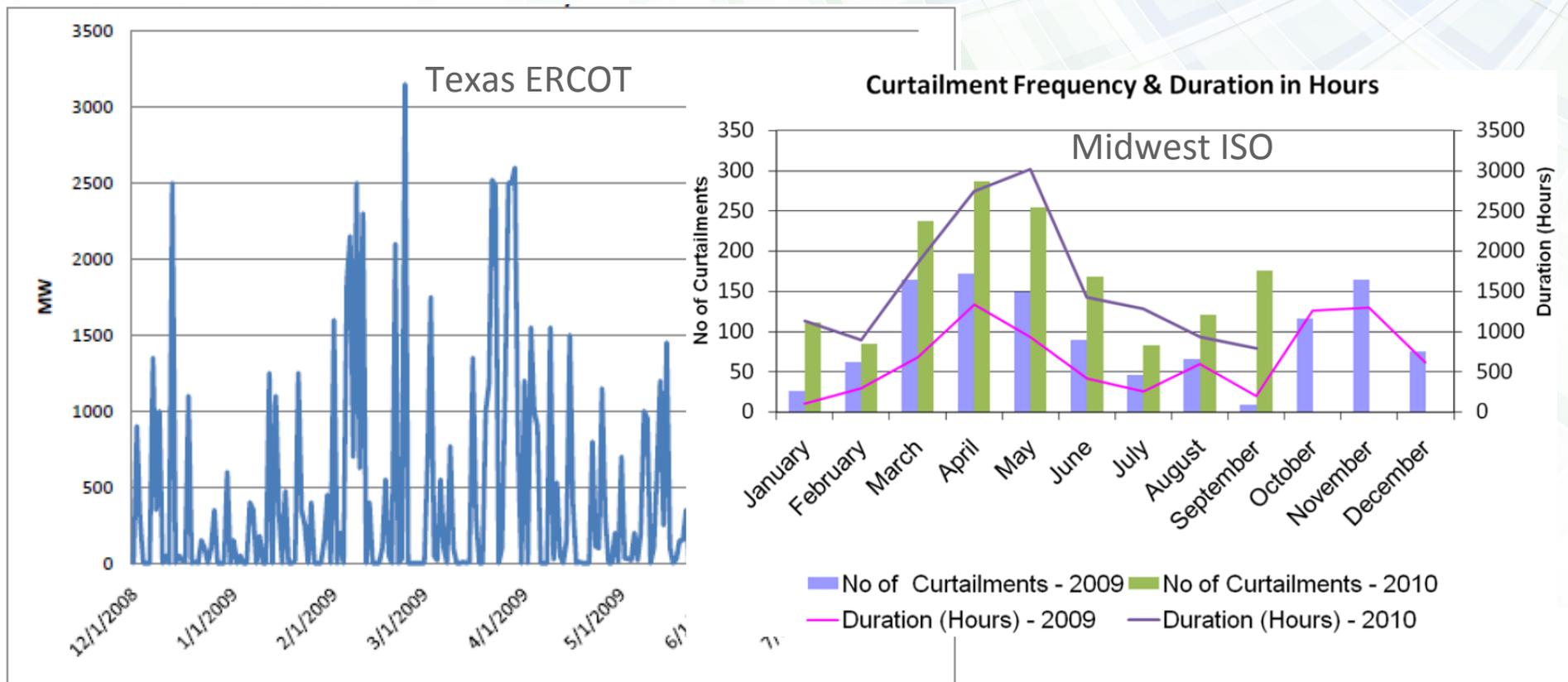


Drivers: Wind Typically is Stronger at Times of Low Demand



Drivers: Curtailments of Renewable Energy Sources

- Estimated wind capacity curtailed daily during the peak hour in ERCOT: December 2008-July 2009
- Close to 17% of wind generation was curtailed in 2010



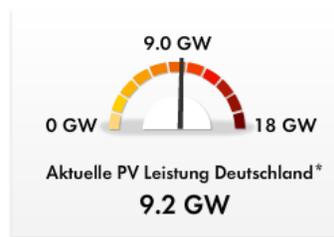
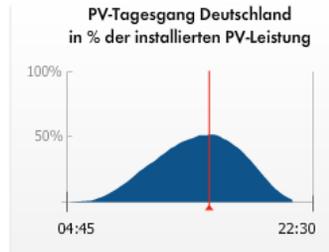
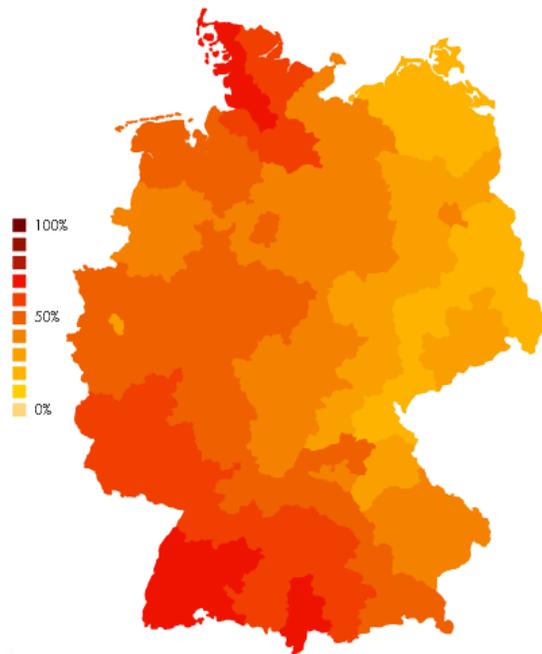
Source: NREL



Drivers: Similarly, Solar Power is Variable but with Different Profile

Das leistet Photovoltaik in Deutschland

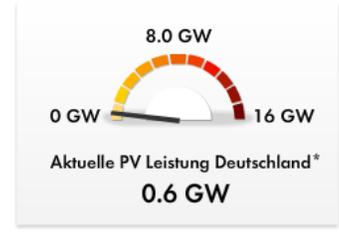
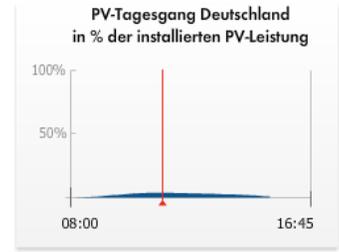
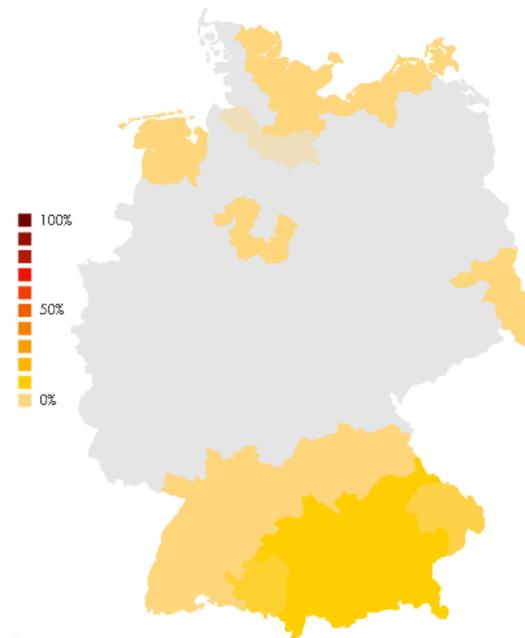
Relative Leistung vom 26.06.2011 - 15:00 Uhr



*Hochgerechnete, momentane Leistung aller lt. Bundesnetzagentur am Stichtag 30.04.2011 installierten PV-Anlagen mit insgesamt 18.02 GW Nennleistung.

Das leistet Photovoltaik in Deutschland

Relative Leistung vom 21.12.2010 - 11:30 Uhr



*Hochgerechnete, momentane Leistung aller lt. Bundesnetzagentur am Stichtag 30.11.2010 installierten PV-Anlagen mit insgesamt 15.87 GW Nennleistung.

June 26, 6am

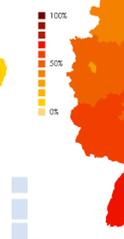
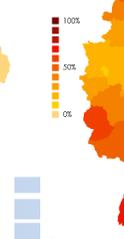
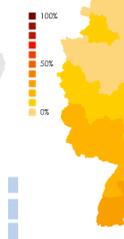
9am

12am

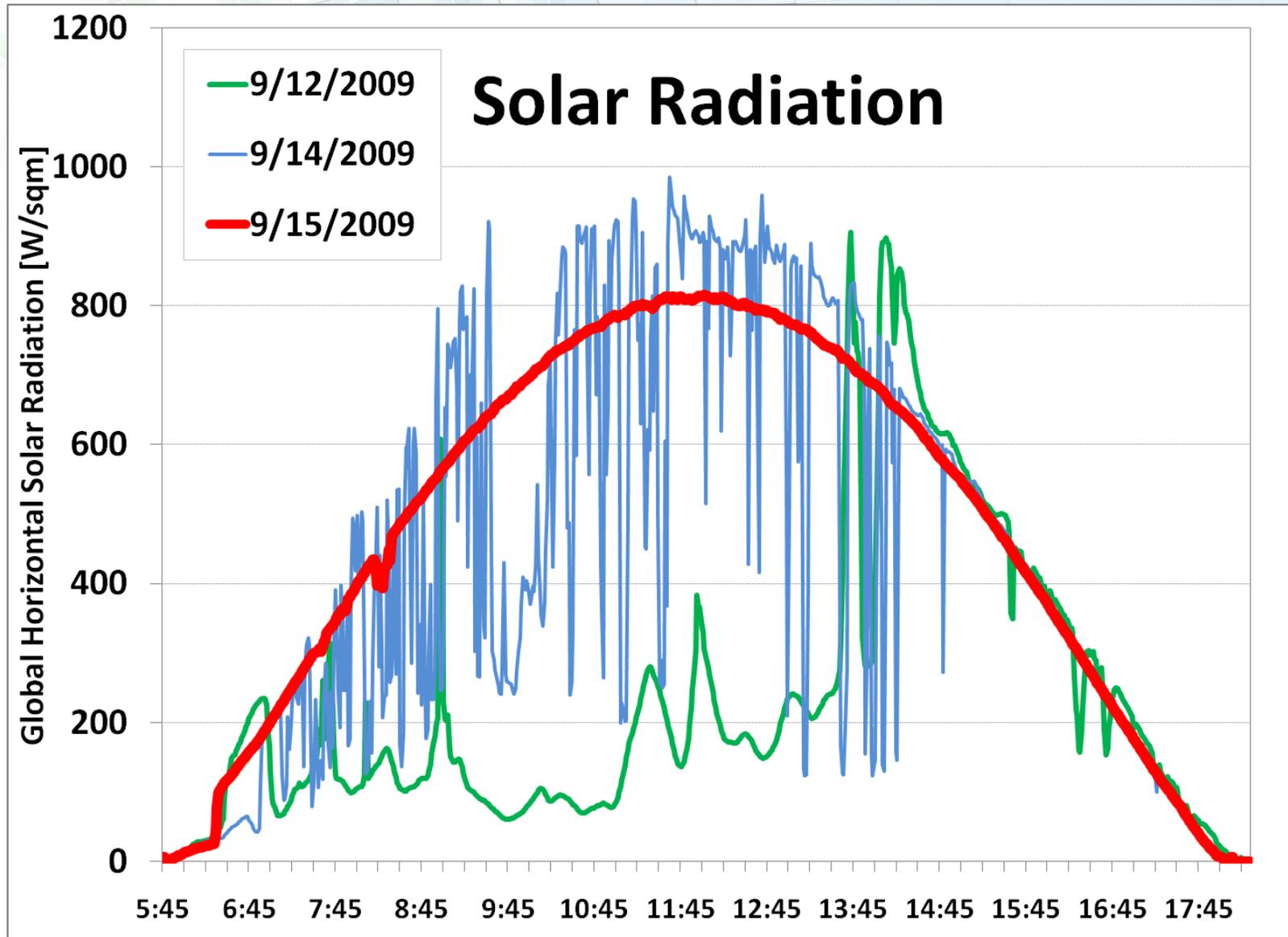
3pm

6pm

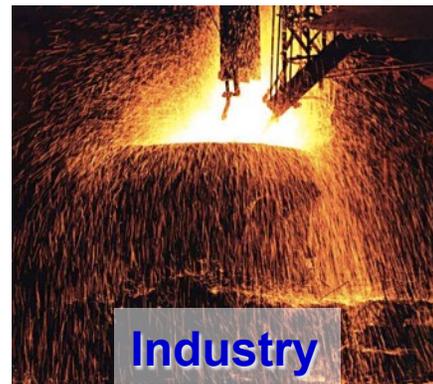
9pm



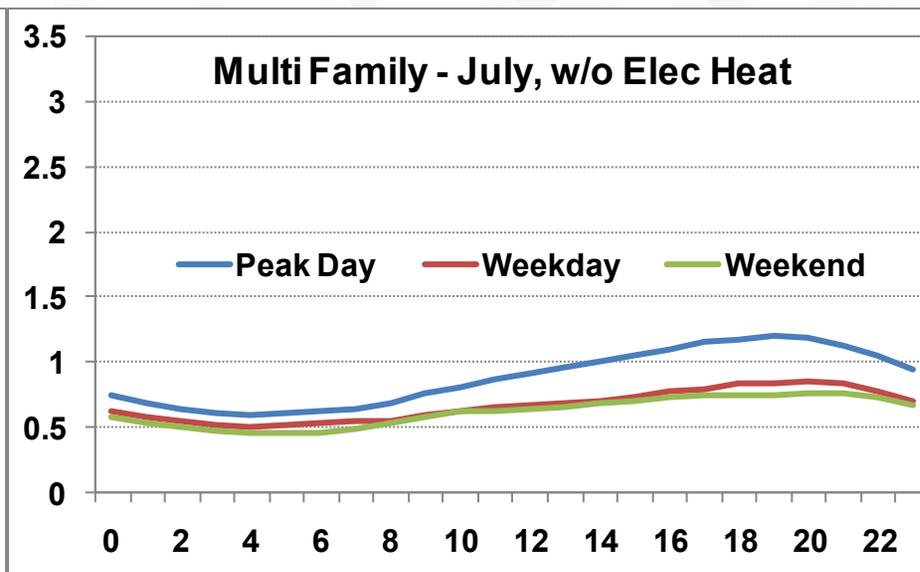
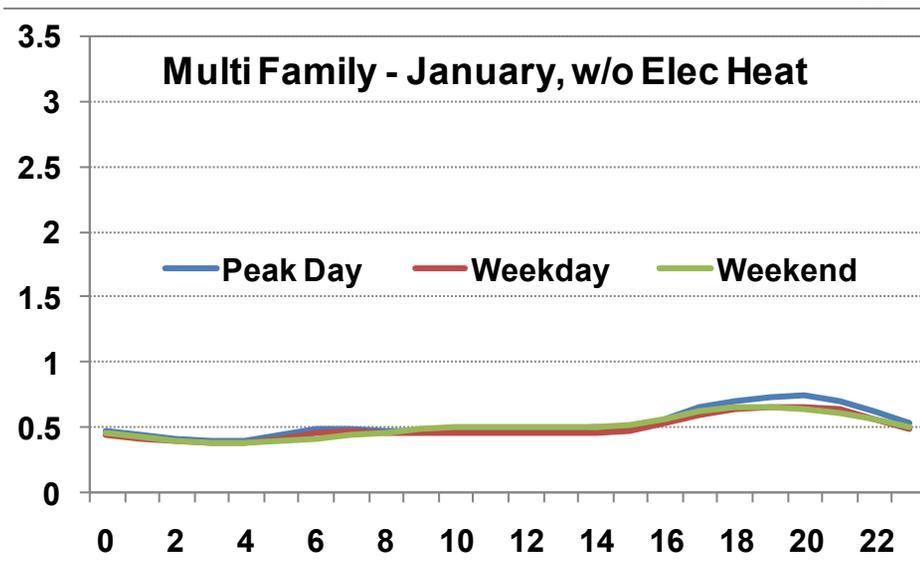
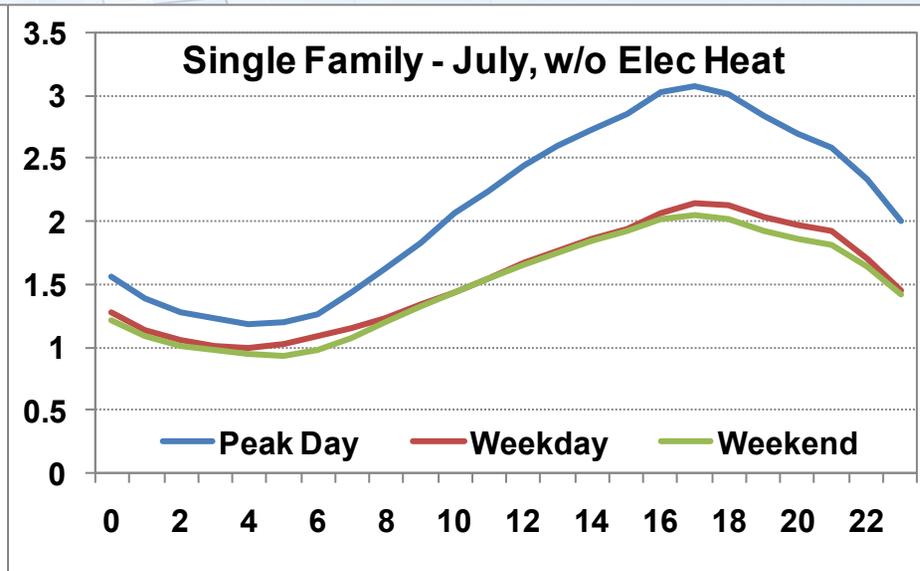
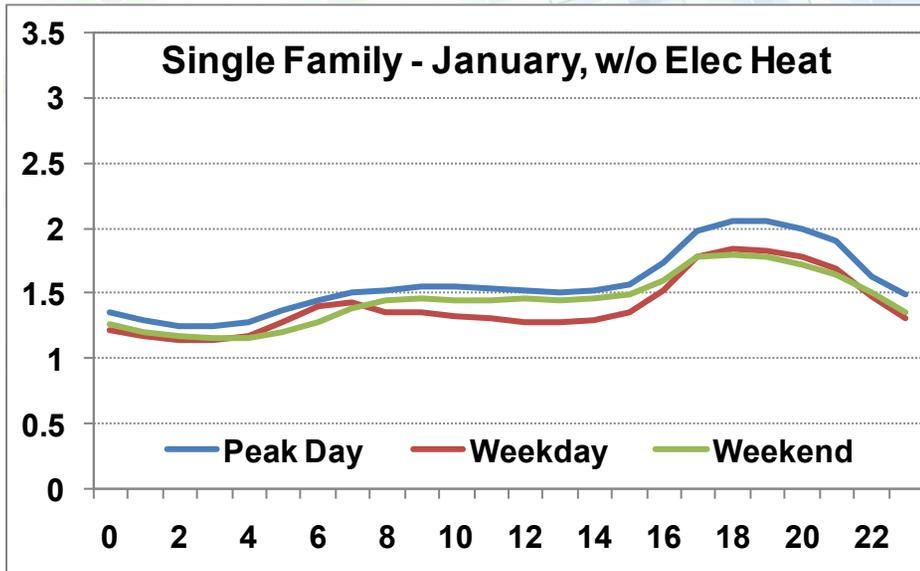
Drivers: Similarly, Solar Power is Variable but with Different Profile



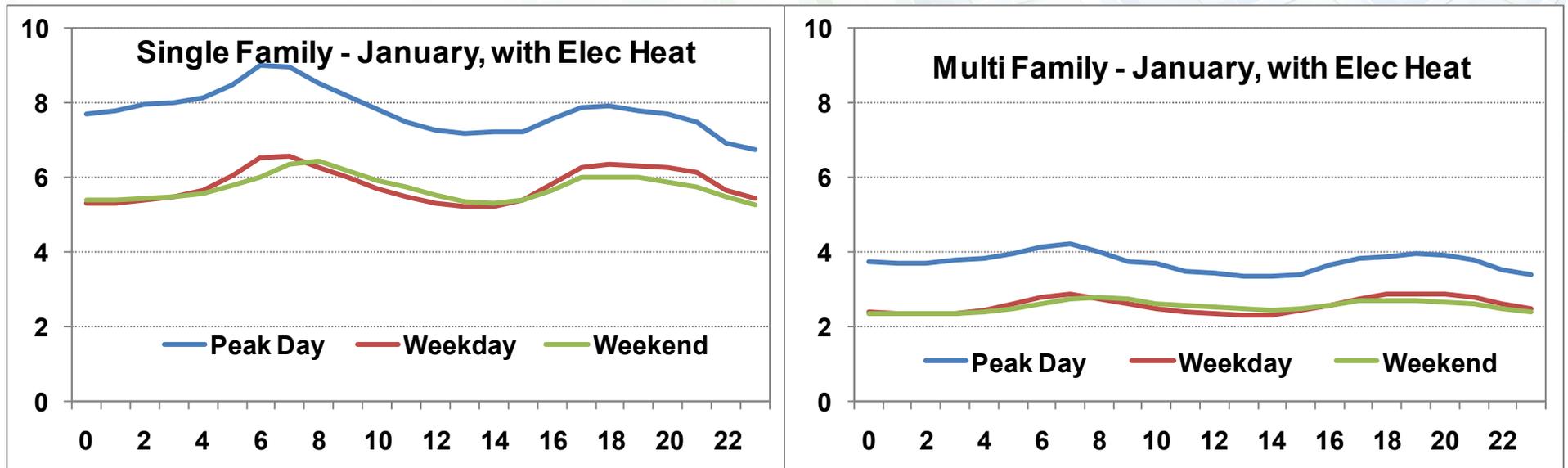
Different Consumers have Different Load Profiles and Potential for Demand Response



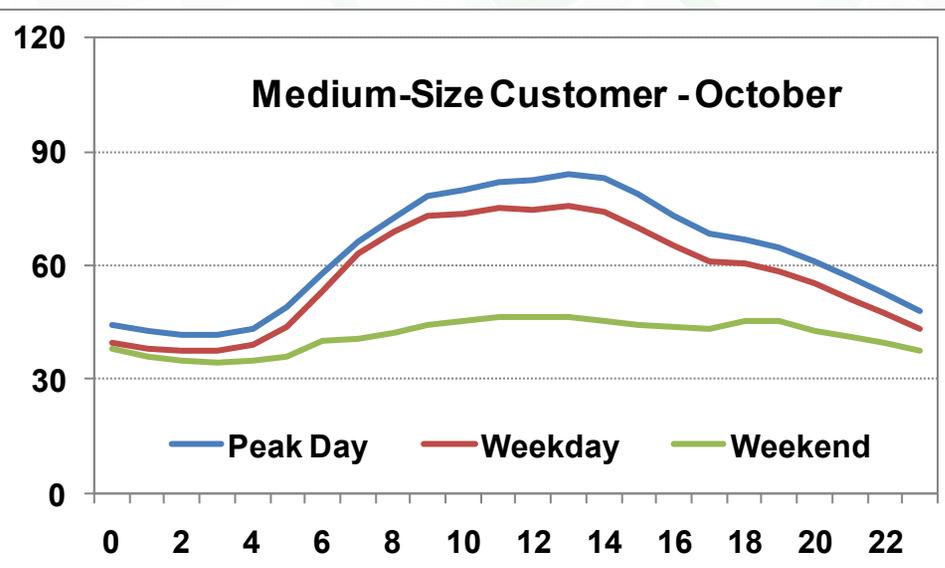
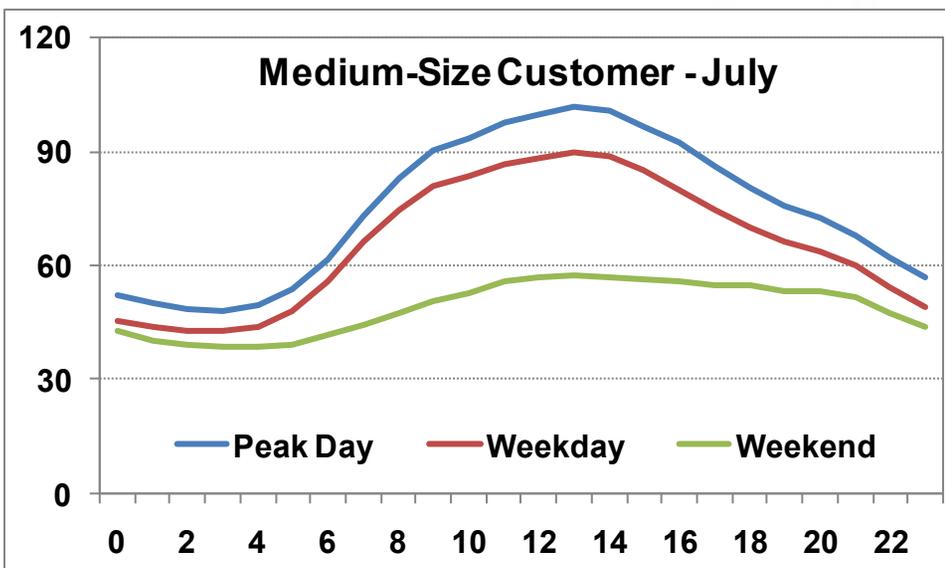
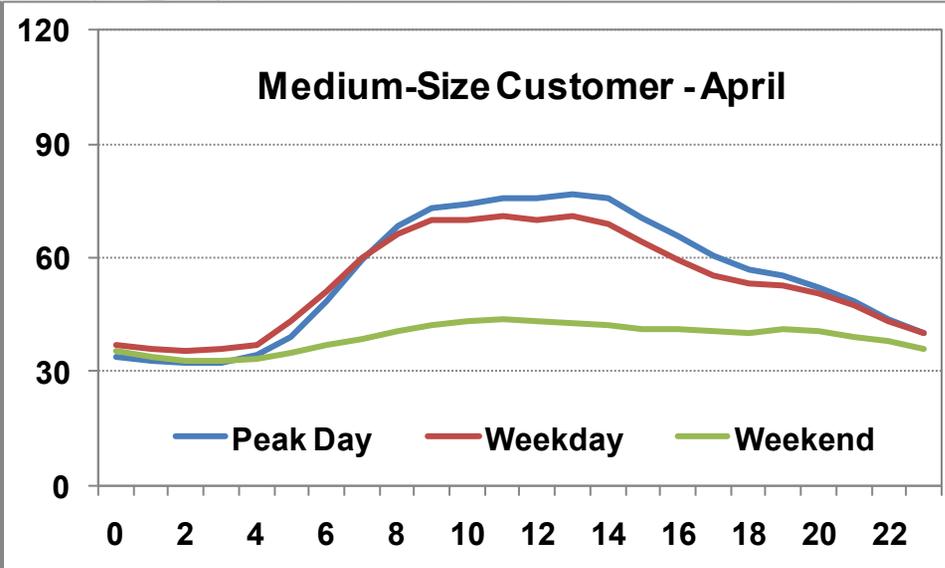
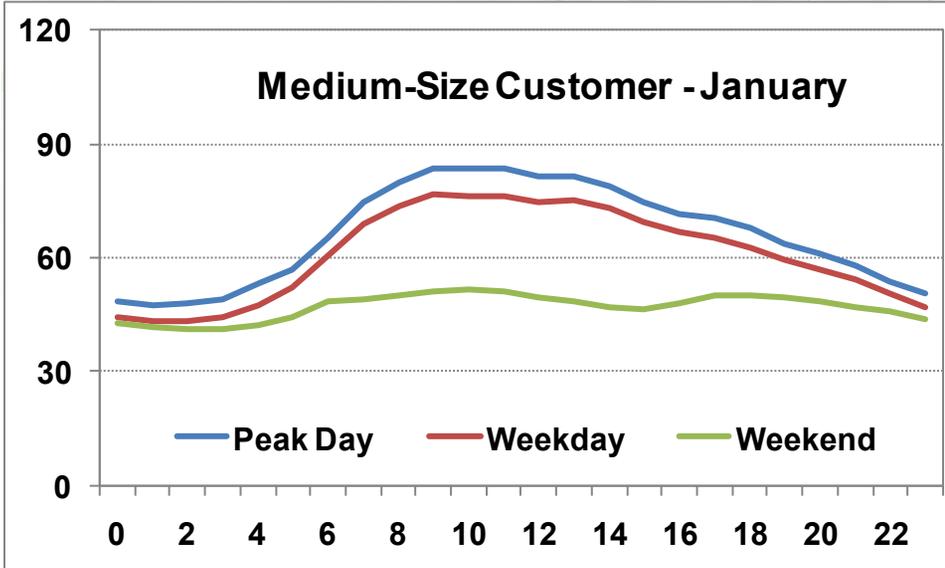
Different Consumers have Different Load Profiles and Potential for Demand Response: Residential (1)



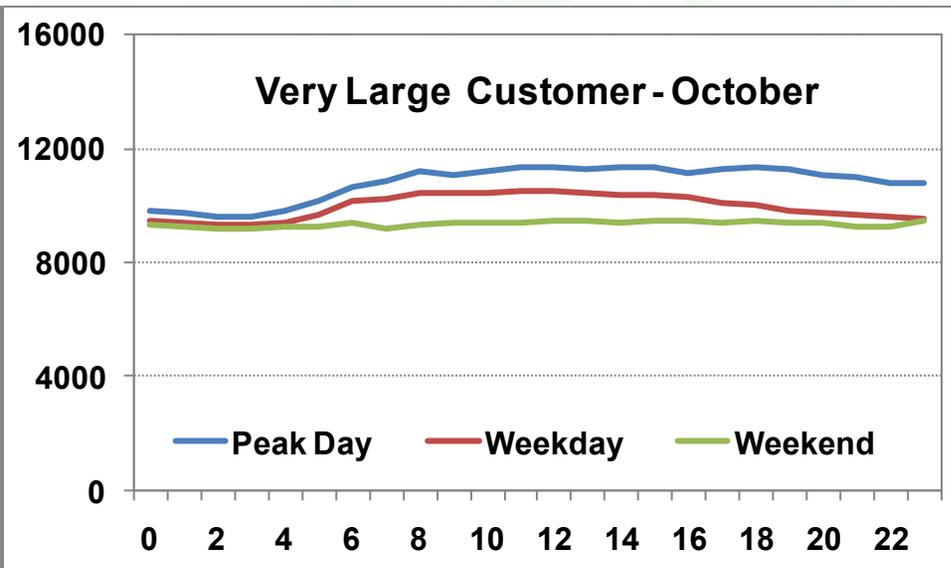
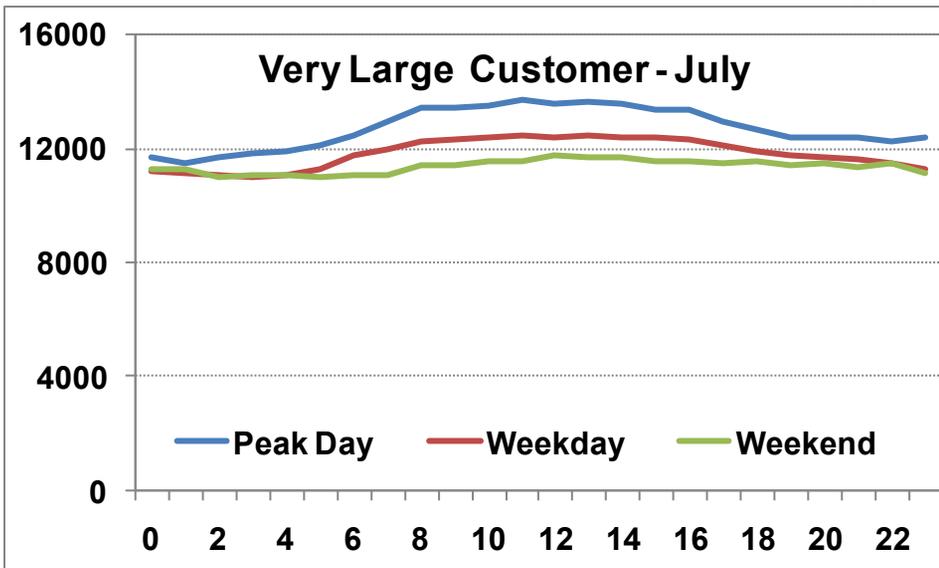
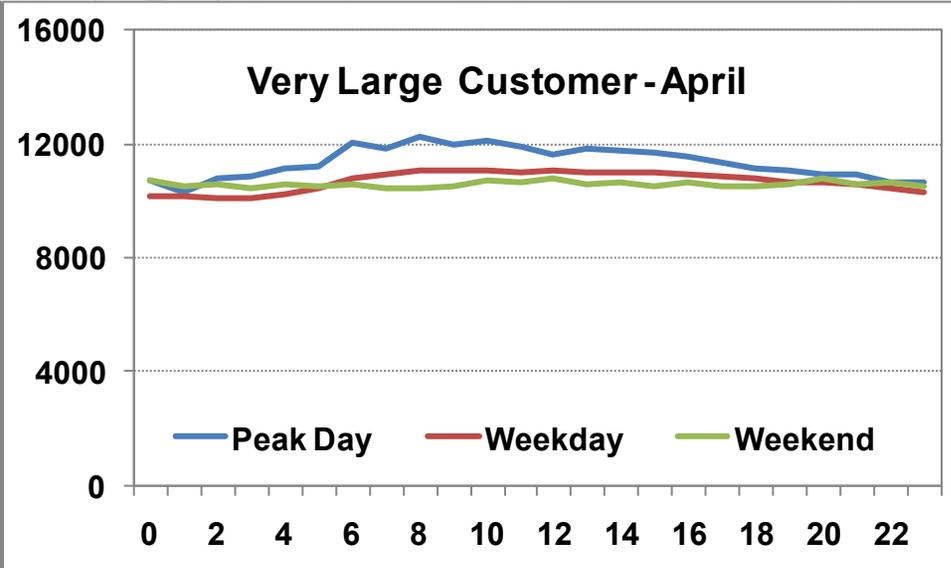
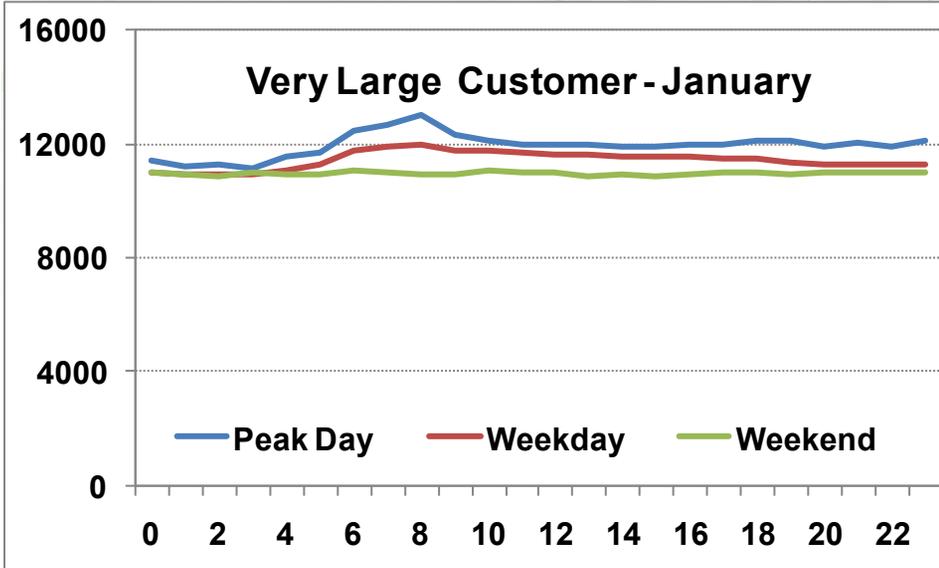
Different Consumers have Different Load Profiles and Potential for Demand Response: Residential (2)



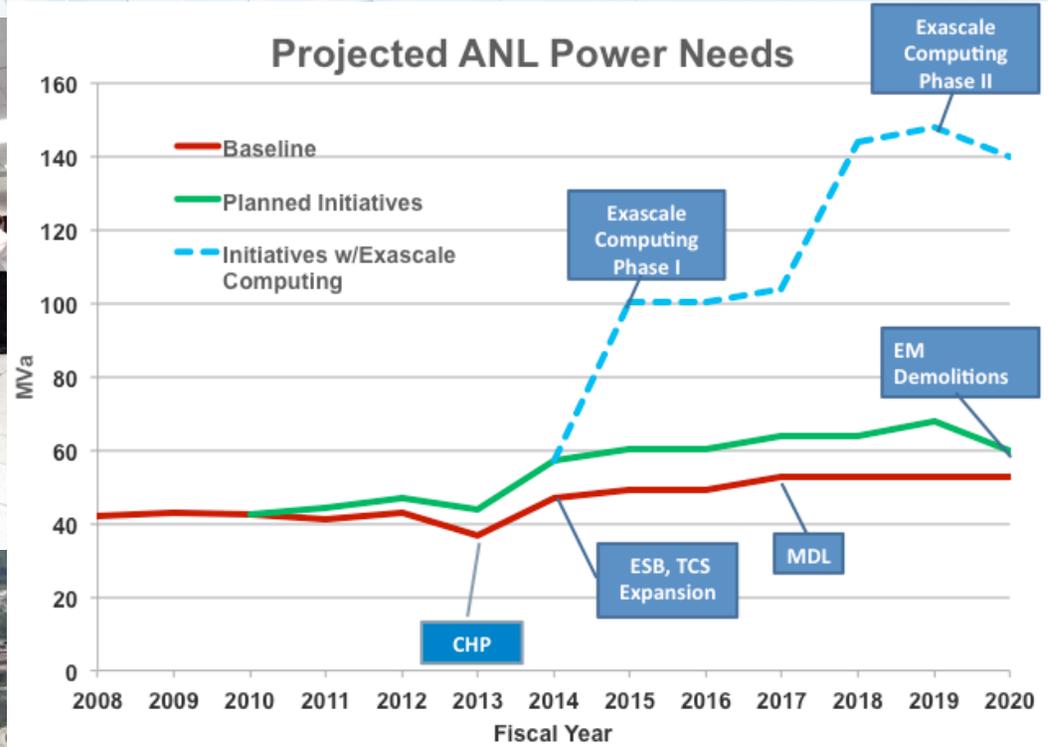
Different Consumers have Different Load Profiles and Potential for Demand Response: Commercial



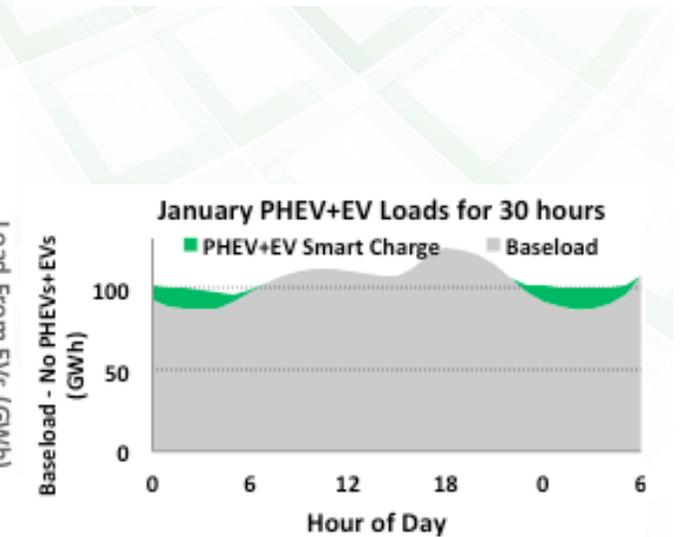
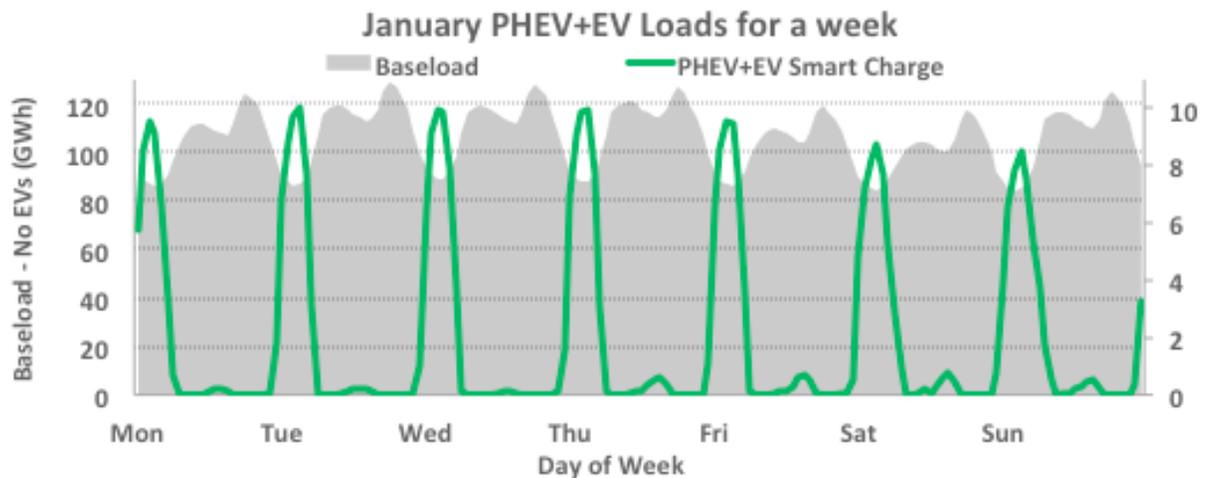
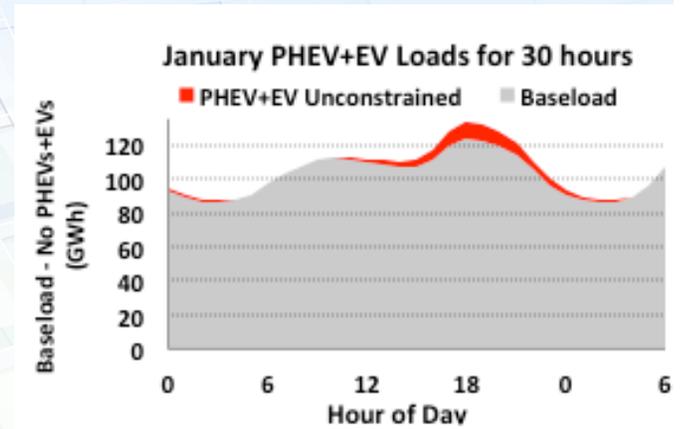
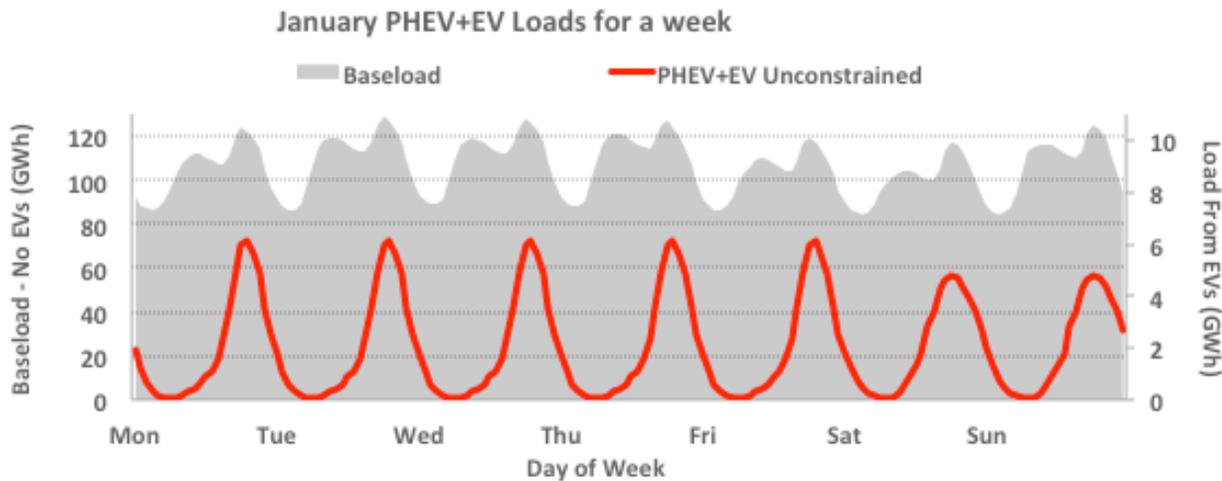
Different Consumers have Different Load Profiles and Potential for Demand Response: Industrial



Example of Large Consumer (Argonne)



Different Consumers have Different Load Profiles and Potential for Demand Response: Electric Vehicles



Example Residential Electricity Consumption: What Happens behind the Socket in the Wall...



Example Residential Electricity Consumption: When was the Last Time you Looked at your Utility Bill?

May need to be a rocket scientist...



(and actually understood it....)

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Page 1 of 1
Name [REDACTED]
Service Location [REDACTED]
Phone Number [REDACTED]
Account Number [REDACTED]

Issue Date April 24, 2008

Meter Information	Read Date	Meter Number	Load Type	Reading Type	Present	Diff	Mult x	Usage
	04/01		General Service	Tot kWh	ACT			
	04/24		General Service	Tot kWh	ACT			

Current Period Residential - Blended Single Customer Charge Service from 03/27/2008 to 04/24/2008 - 28 Days

Standard Metering Charge		\$7.26
Distribution Facilities Charge	kwh X	0.01965
Transmission Services Charge	kwh X	0.00389
Supply Administration Charge		
Energy Supply Charge	kwh X	0.0
Purchased Electricity Adjustment		
Gen Assembly Rate Relief Credit	kwh X	-0.00660
Environmental Cost Recovery Adj	kwh X	0.00005
Instrument Funding Charge Credit	kwh X	-0.00523
Instrument Funding Charge Debit	kwh X	0.00523
Franchise Cost		
State Tax		
Municipal Tax		
Total current charges		2.21

Other Charges Thank you for your payment of [REDACTED]

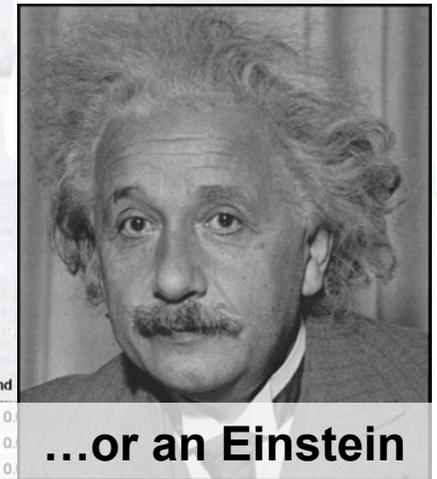
Total amount due

Your Usage Profile

13-Month Usage (Total kWh)

Month Billed	Total Demand
Current Month	0.
Last Month	0.
Last Year	0.

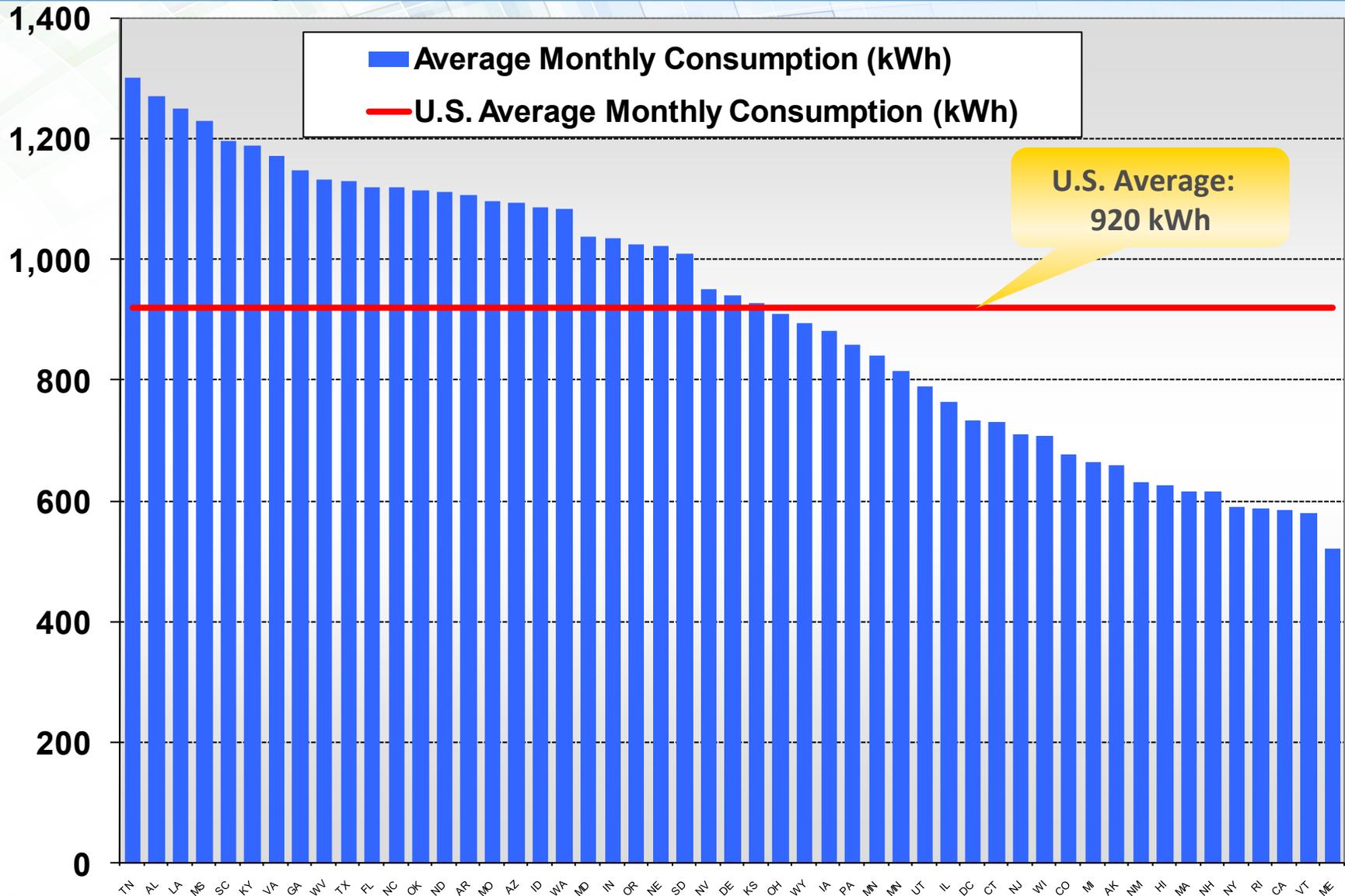
14 different fees, charges, taxes



...or an Einstein



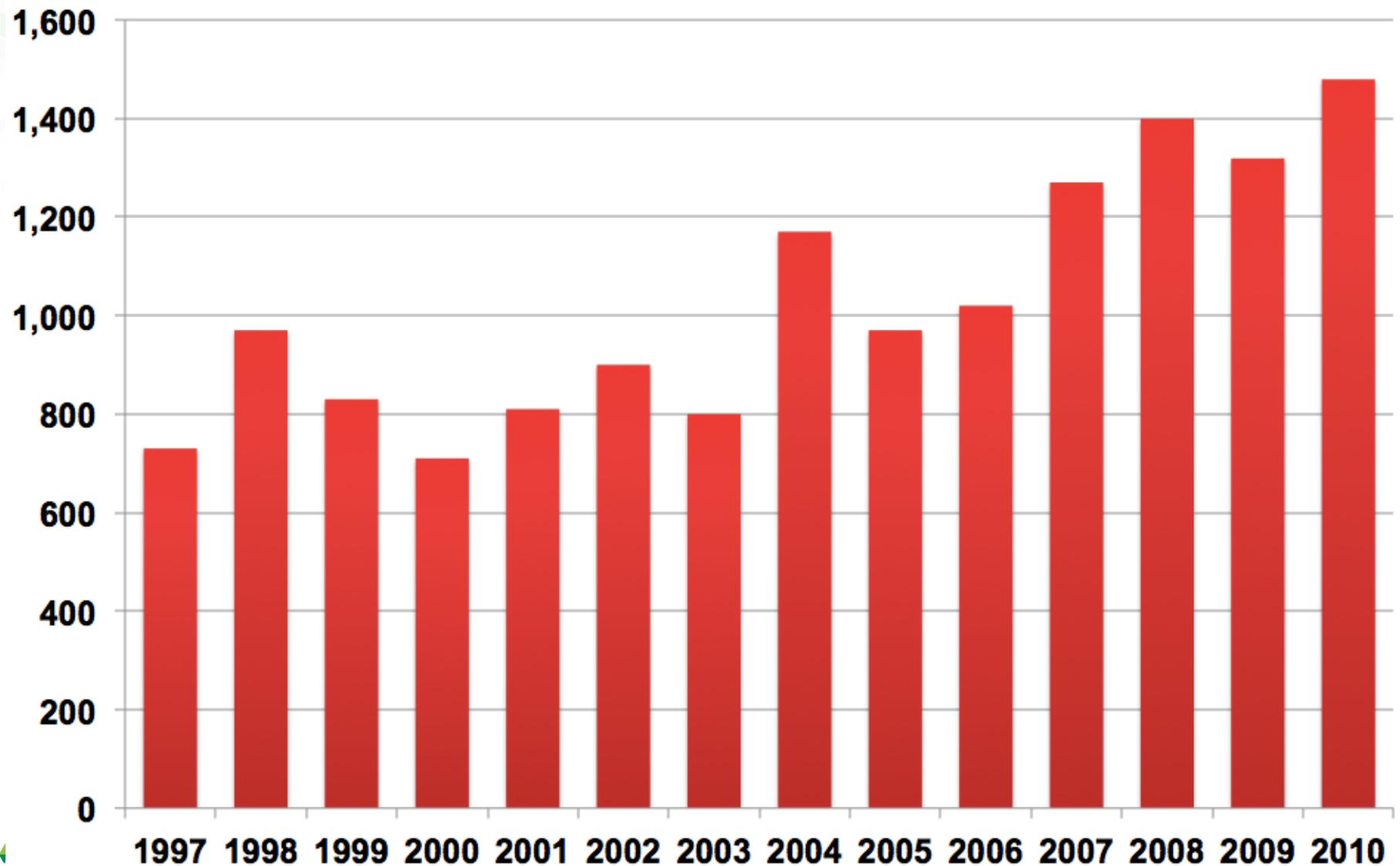
For Residential Sector, Do you Know How Much Electricity You Consume per Month?



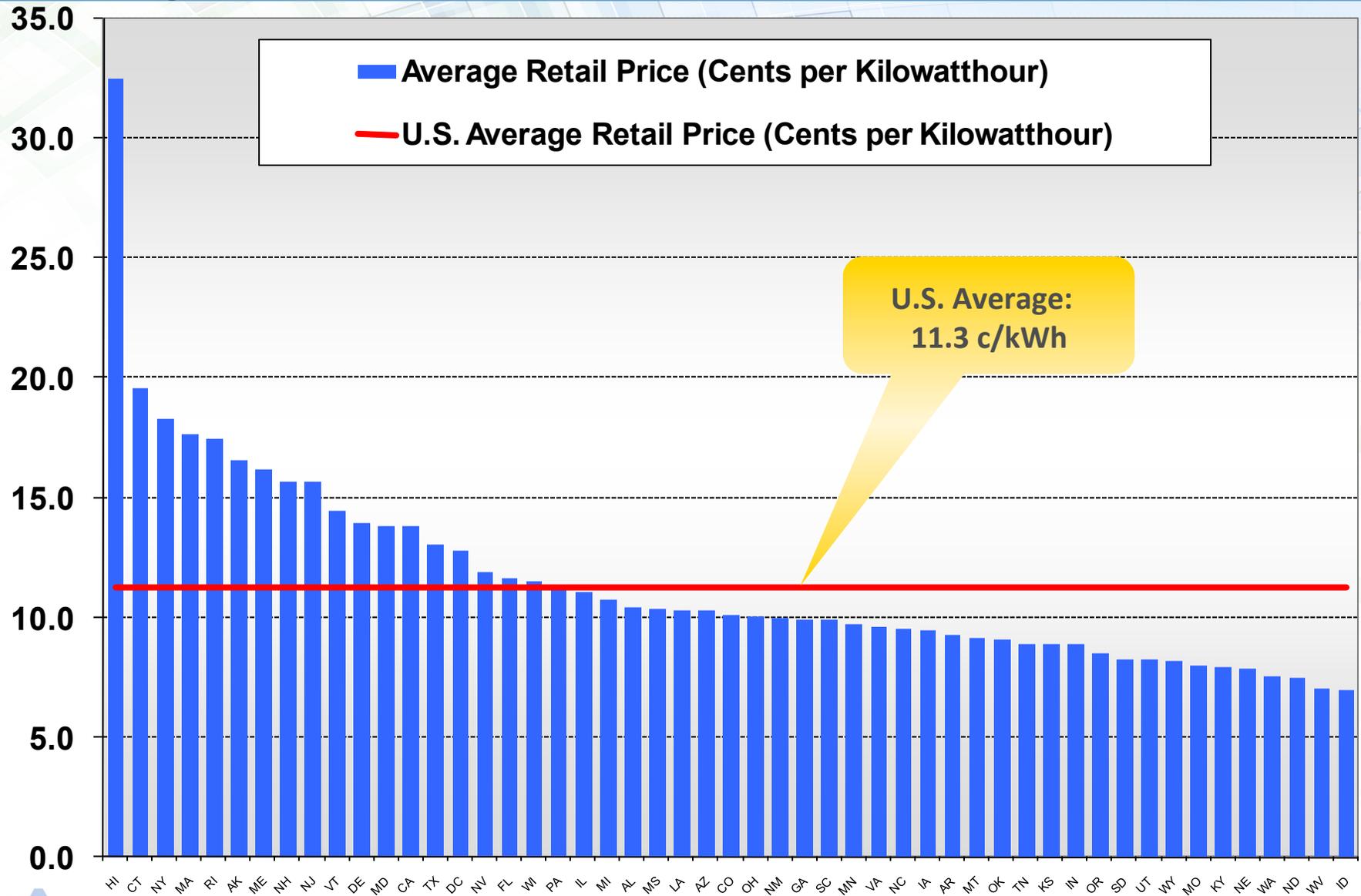
Source: EIA, 2010 (Electric Sales, Revenue, and Price, Table 5)

For Residential Sector, Do you Know How Much Electricity You Consume per Month? (2)

Conzelmann's Average Monthly Electricity Consumption



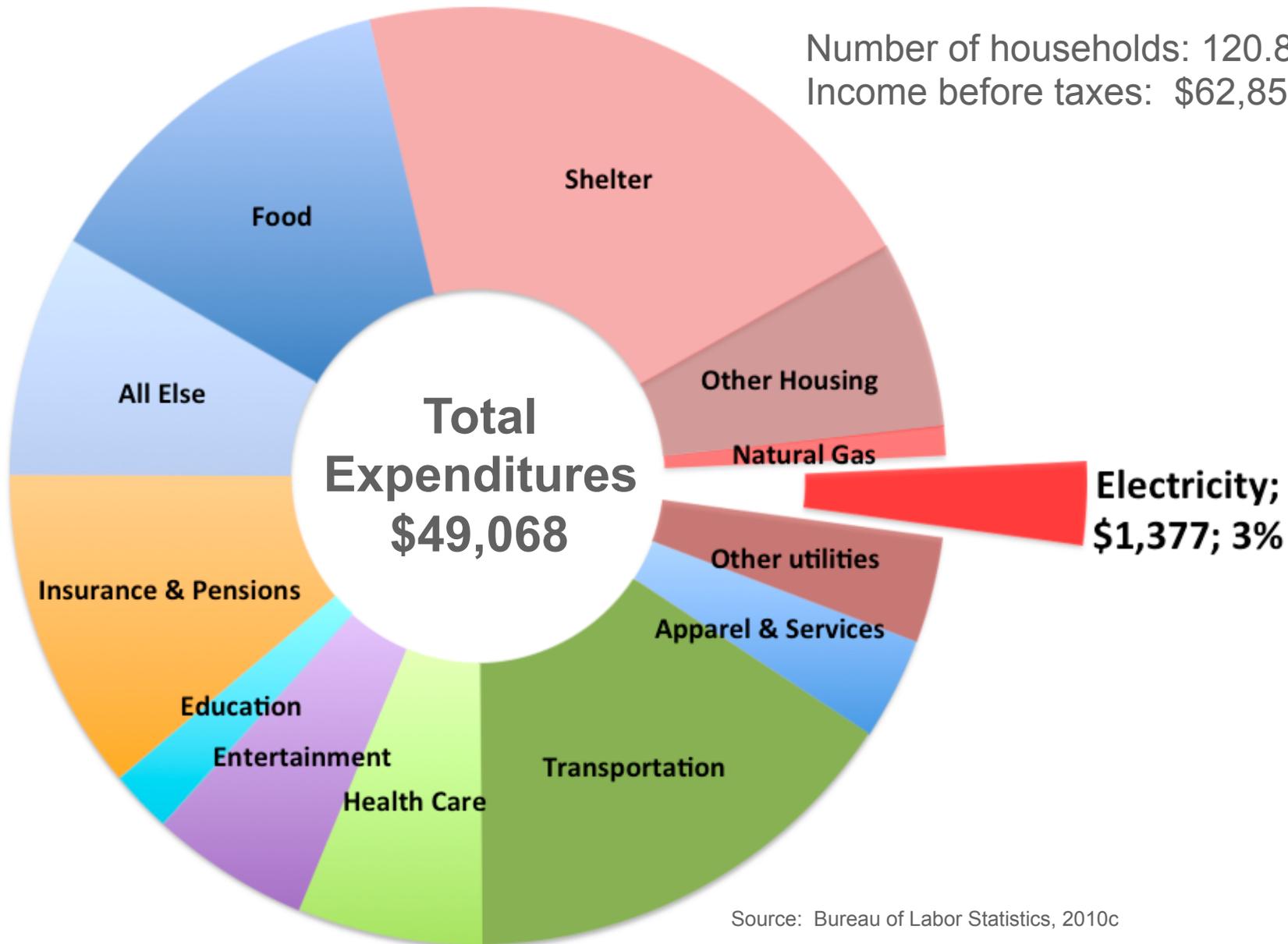
For Residential Sector, Do you Know How Much You Pay for Electricity?



Source: EIA, 2010 (Electric Sales, Revenue, and Price, Table 5)

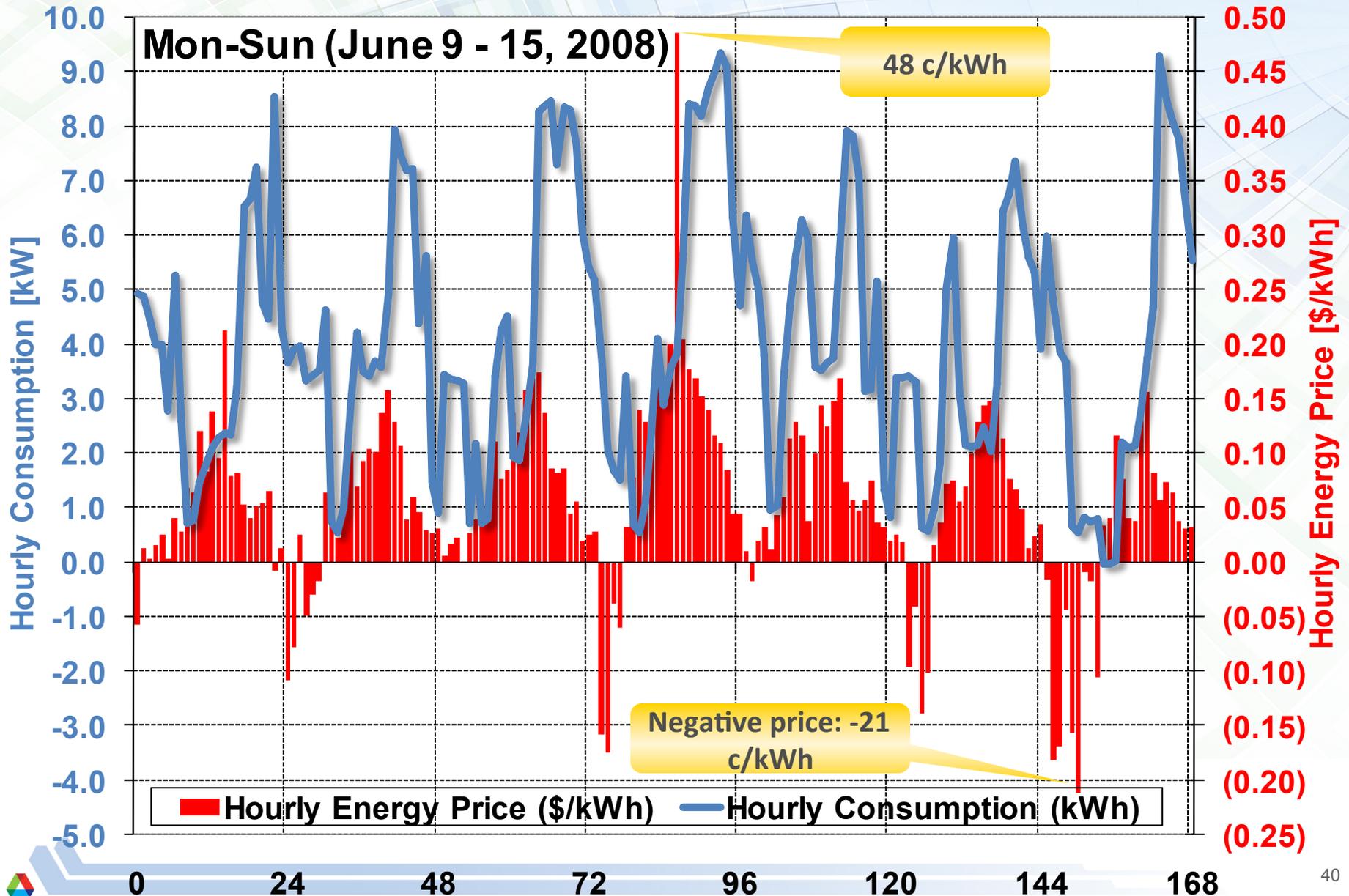
U.S. Average Household Income and Expenditures 2009

Number of households: 120.8 million
Income before taxes: \$62,857

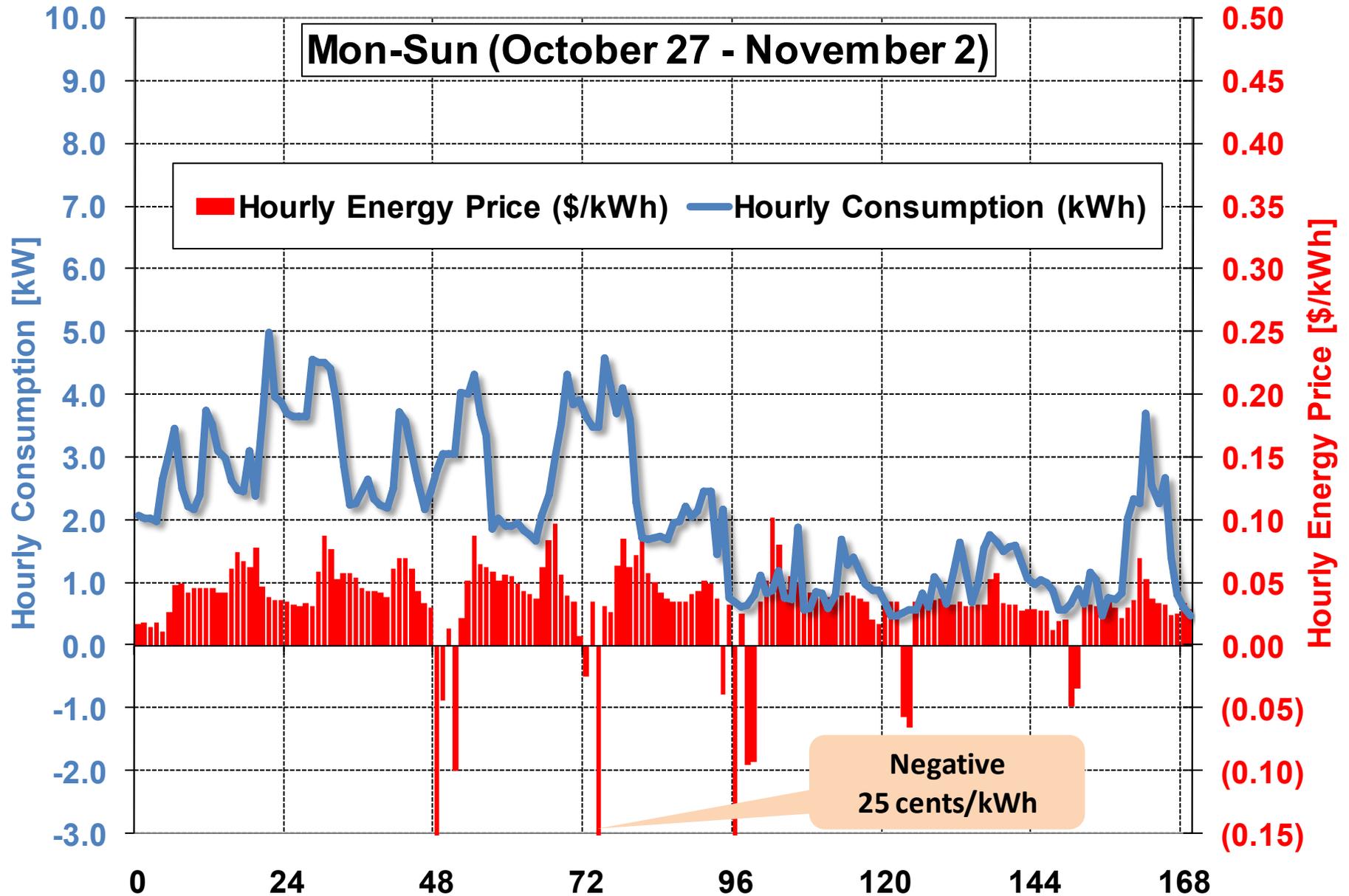


Source: Bureau of Labor Statistics, 2010c

Example of Hourly Load Profile: Conzelmann Household



Example of Hourly Load Profile: Conzelmann Household



Even More Detail Can be Added to Improve Understanding of Load Pattern and Identify Efficiency and DSM Potential



Cooking



Air Conditioning



Space heating



Water heating

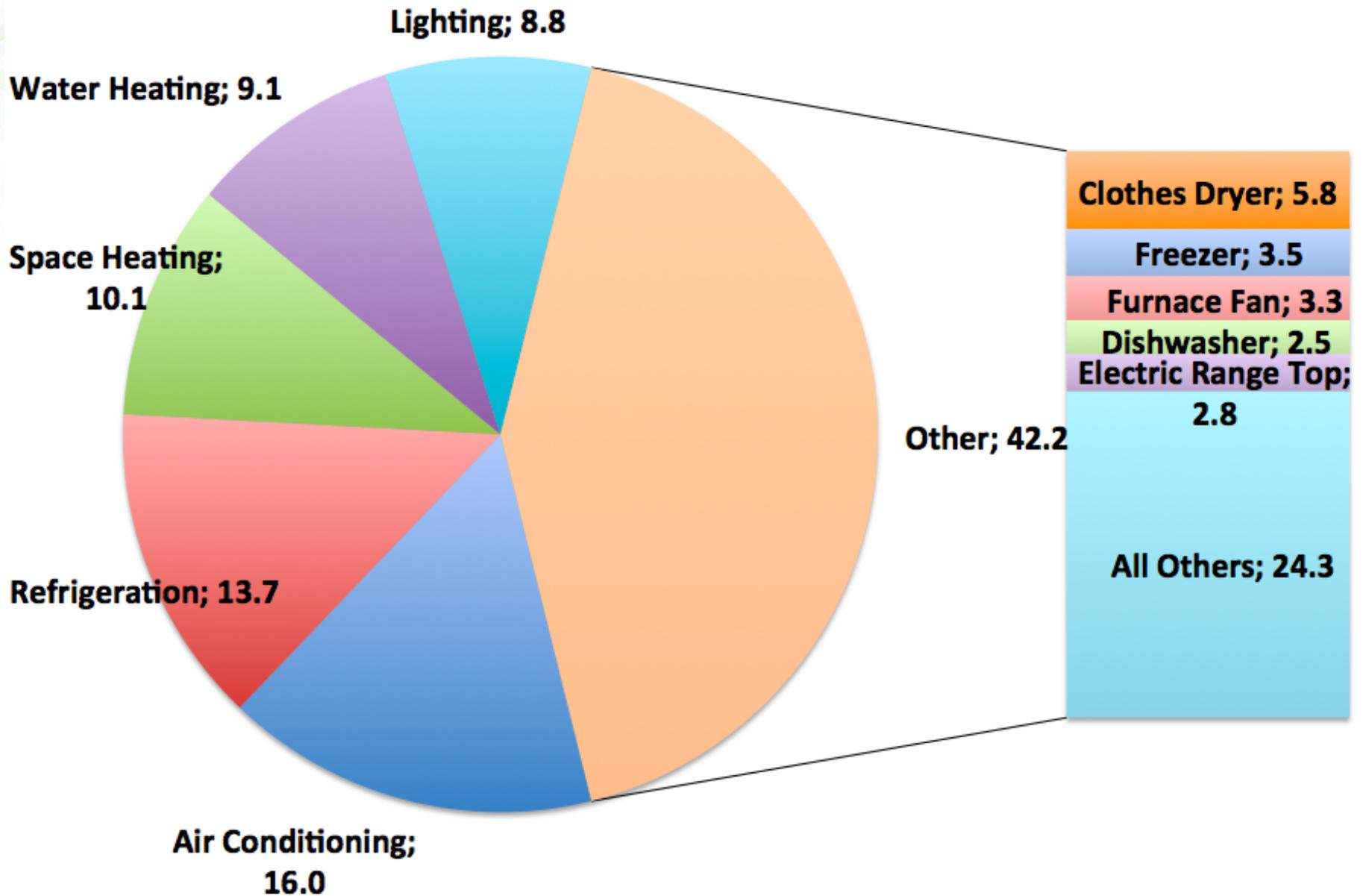
Lighting



Appliances

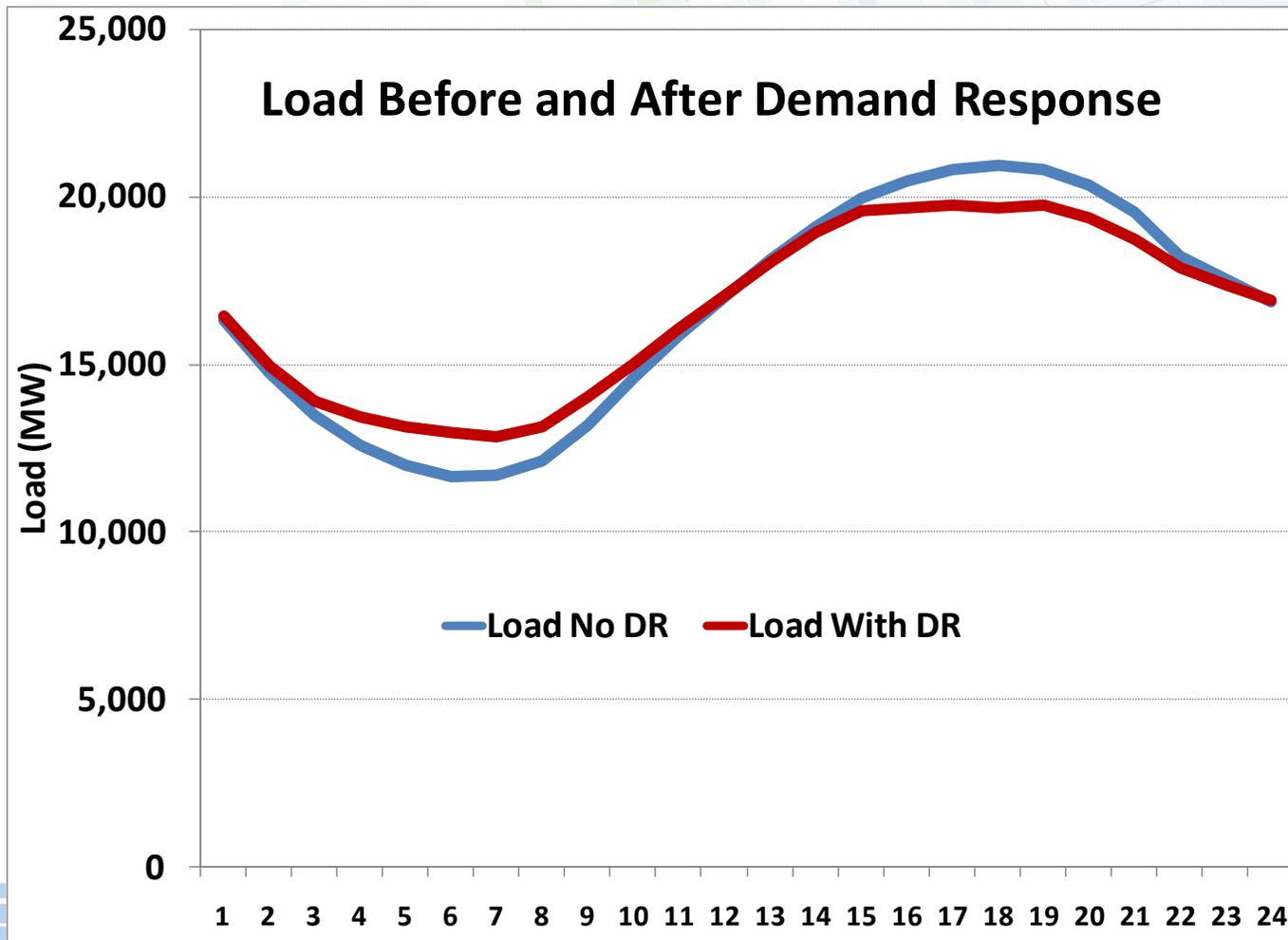


Average Residential Electricity Consumption Shares



Definition of Demand Response

- “Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.” U.S. Department of Energy)



There are a Number of Different Types of Demand Response Mechanisms (1)

- Incentive-based Programs
 - Direct Load Control
 - Interruptible/curtailable rates
 - Demand bidding/Buy-back programs
 - Emergency Demand Response Programs
 - Capacity Programs
 - Ancillary services markets program

- Time-based rates
 - Time-of-use
 - Critical peak pricing
 - Real-time pricing



There are a Number of Different Types of Demand Response Mechanisms (2)

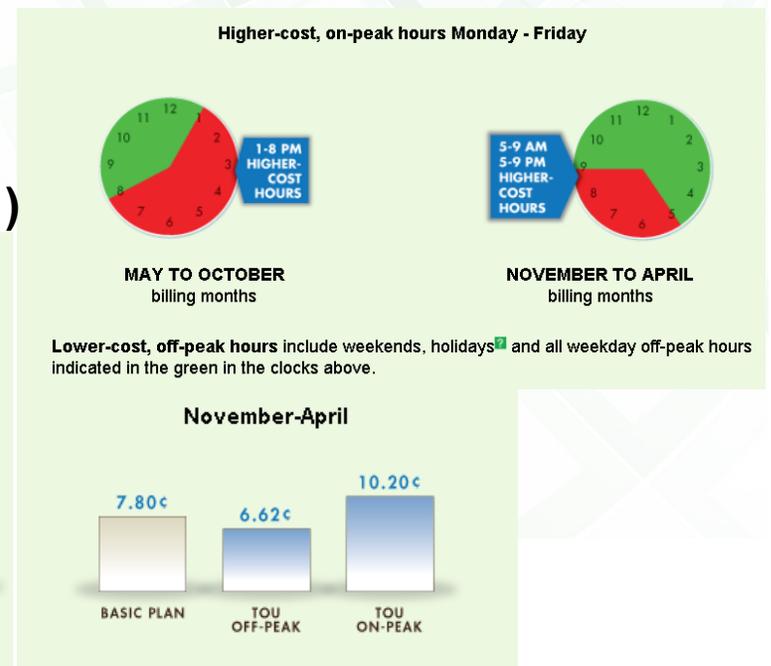
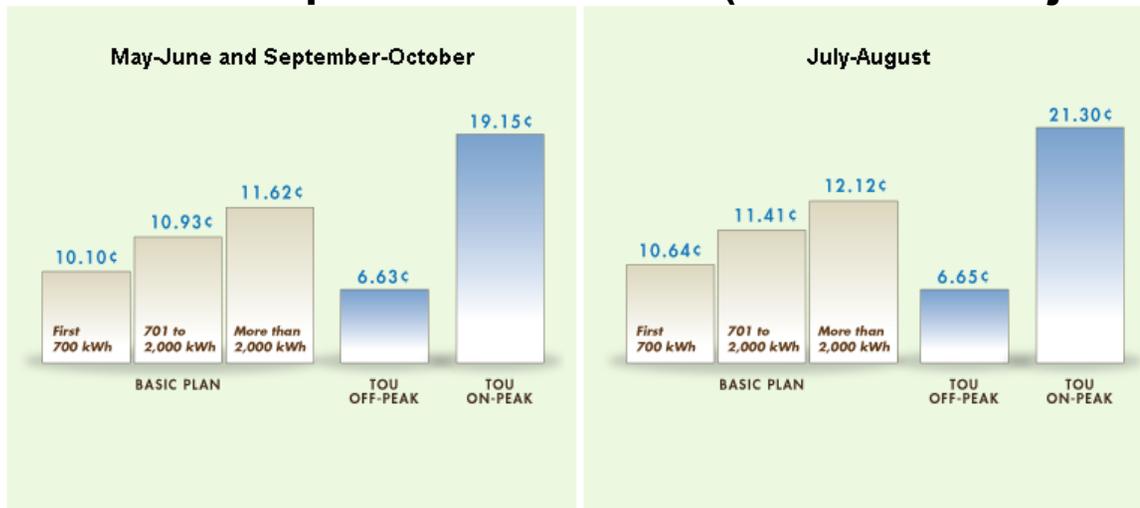
- **Direct Load Control:** In return for a financial incentive, customers agree to have their end-uses such as air conditioners and water heaters controlled by the utility via switches or programmable communicating thermostats
- **Utility Controlled Interruptible Rates:** Customers pay lower rates in return for agreeing to their service being interrupted by the utility
- **Load Curtailment (a nominated load or a contracted firm demand):** Customers are paid a specified amount per MWh curtailed in response to a call that is made on a day-of basis
 - Requires the specification of a baseline or normal usage
- **Demand Bidding/ Buyback:** Customers bid load curtailments in the day-ahead/real-time market in competition with supply-side resources
- **Emergency (Economic) Demand Response Program:** Emergency (economic) demand response programs provide incentive payments to customers for reducing their loads during reliability (economic)-triggered events, but curtailment is voluntary
- **Capacity Programs:** Customers offer load curtailments as a replacement to existing generation in the market
 - They are generally notified during the day when curtailment is needed. Large penalties are often assessed in the event of non-compliance



There are a Number of Different Types of Demand Response Mechanisms (3)

- Time-of-Use Pricing:** Prices vary by time-of-day
 - Prices are static over the year and are known to the customers
- Critical Peak Pricing:** Prices vary by time-of-day and are known to the customer for all pricing periods except that the customer does not know when prices in the critical-peak period may be called
 - These prices are called on a day-ahead or day-of basis
- Real Time Pricing:** Prices may vary on an hourly basis, and sometime on a sub-hourly basis
 - Prices are dynamic
 - Customers are provided the prices on a day-ahead and hour-ahead basis

Example for TOU Rates (Salt River Project)



There are a Number of Different Types of Demand Response Mechanisms (4)

- **Demand Response through Load Aggregators:** Load aggregators combine the load reductions of smaller participants and submit these reductions to capacity or other emergency or economic demand response programs
- **Peak Time Rebate:** Customers receive a cash rebate for each kWh of load that they reduce below their baseline usage during the event hours instead of paying higher rates during the critical event hours
- **Prepay Programs:** Customers prepay for their electricity and have in-home displays that provide information on consumption
 - While not a demand response program as such, prepay programs may increase the effectiveness of time-varying rates

Pre-paid Plans

Call to Enroll Today 877-768-2464

Don't Pay More for Prepaid Electricity



Start with \$49.99 or less*

Based on actual usage – Not on estimates like others do

With First Choice Power you get:

- Same price as regular electricity
- No deposit
- No credit check
- No contract
- No monthly fees
- Pay as you go

Prepaid from a Company that Puts You First

*Price based on a standard switch and approximately 12 days of electricity for a multi-family unit, calculated using the variable rate as posted on www.powerchoice.org on 6/10/2010.



The Role of Demand Side Management (1)

- Opportunities for demand side management drive investments in smart-grid and advanced metering infrastructure
- Goal is to shift load to reduce peak loads
 - Flattens demand curve
 - Reduces generation cost by shifting to low-cost base-load generation
 - Reduces maintenance costs
 - Avoids/delays infrastructure investments (generation, transmission, distribution)
 - Can reduce overall consumption
- Early DSM program (starting in 1980s) have primarily focused on commercial and industrial consumers
 - Mostly direct load control and tiered pricing
- Smart-grid technology will impact DSM program focus
 - Shift from direct load control to dynamic pricing
 - Inclusion of residential and small-to-medium businesses



The Role of Demand Side Management (2)

- Direct load control is offered by many utilities
 - One-third of utilities offer direct load control for residential AC
 - Average participation 15%
 - About two-thirds offer direct load control to industrial and commercial costumers
 - Programs have proven cost-effective with substantial savings
 - 29% average peak load reduction across a sample of 24 programs (Source: eMeter Strategic Consulting, 2007)
- Dynamic Pricing
 - Almost 1/3 of utilities offer some form of dynamic pricing (Time of use, critical peak pricing, real-time pricing)
 - Current pilot programs show significant variation in residential peak load reduction with an average of about 22%
 - Impact on overall consumption may be very small



The Role of Demand Side Management (3)

Smart Grid Marketing Message: Empowering the Consumer

- It's all about giving customers the tools and the know-how to be smarter energy consumers. Educate, educate, educate!
- “Build it and they will come”
- Education is key to engagement
- In the end, though, it comes down to: will the consumer care; and are savings large enough to motivate and incite change in behavior



Home Smart Devices—UFO Powerstrip



Voluntary Program Enrollment is Often Low and Slow (Example Illinois)

- Total customer base
 - ComEd: 3.2 million
 - Ameren Illinois: 1 million
- Participation by early 2010
 - ComEd: 0.25% (9,040)
 - Ameren Illinois: 1% (9,133)

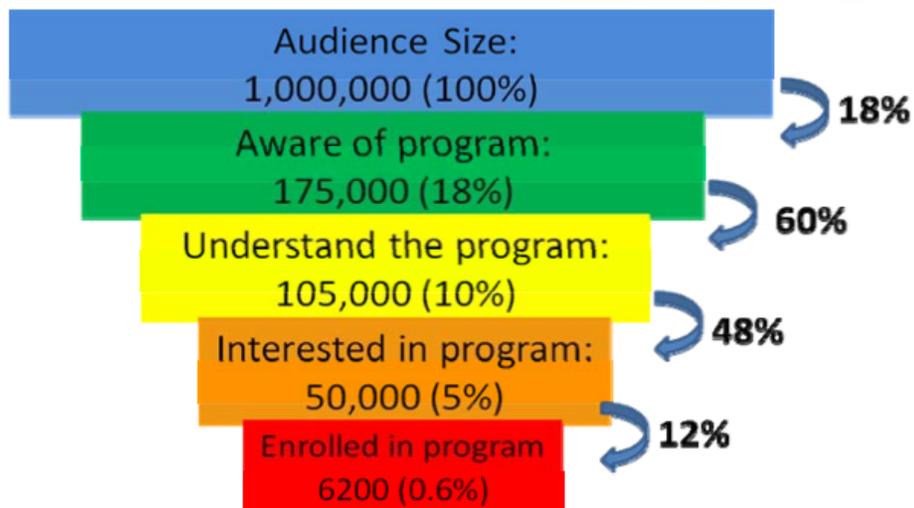
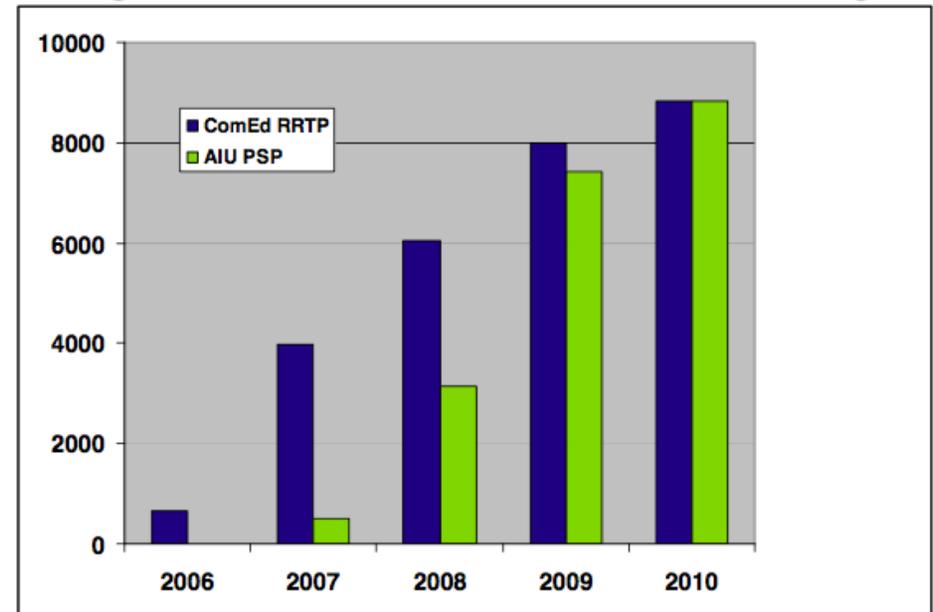


Figure 1: Growth in Enrollment in Real-Time Pricing



Marketing Messages are Sometimes not Entirely Clear

ComEd RRTP price for Mar 14, 2011 Hour Ending 12:00 PM CT **0 6 . 1** ¢ per kWh Current Price @ 12:50 PM CT **0 3 . 6** ¢ per kWh [Today](#) [Predicted Price](#)

It's time to get real with ComEd Residential Real-Time Pricing

Get more control over your monthly electricity bills, and help the environment,



[My Home](#) • [My Business](#) • [My Community](#) • [Business Partners](#) • [Careers](#) • [Media](#) • [About Us](#)

My Home

[Customer Service Center](#)
[Outage Center](#)
[Energy Efficiency](#)
[PowerSwitch \(IL Choice\)](#)
[Residential Rates](#)
[Residential Construction](#)
[Safety](#)
[Safe Trees](#)
[Contact Us](#)

Real-Time Pricing (RTP) for Residential Customers

As an added alternative for electric supply, Ameren Illinois offers real-time pricing options that allow all customers access to variable hourly prices for power.

Standard RTP

Real-time prices fluctuate based on market supply and demand. Generally speaking, market prices are highest during times of peak demand (between 5 a.m. and 9 p.m. daily and during the summer months of June through September). Customers can use the price signals available through RTP to guide their energy use and potentially save money when compared to the standard rate. RTP customers are encouraged to check [day-ahead prices](#).

Power Smart Pricing

Residential customers can choose to sign up for Power Smart Pricing (PSP), a user friendly supplement to our standard real-time pricing program that provides additional services to help them get the best possible value from this rate option. [Learn more about Power Smart Pricing](#).

Ameren Illinois does not profit from electric supply charges, including those for real-time pricing. We pass along the price we pay for electricity to our customers, dollar for dollar.

Regardless of your choice for electric supply, Ameren Illinois will remain your delivery company and will continue to respond to service calls, outages and emergencies, and issue your monthly bill.

For specific details, see the tariffs related to Rider RTP and Rider PSP in the [Rates](#) section of our web site.

Share [f](#) [t](#)

Power Smart Pricing: Enhanced Real-Time Pricing for Residential Customers

Ameren Illinois offers residential customers Power Smart Pricing (PSP), an optional, user-friendly supplement to our basic real-time pricing program. Power Smart Pricing is administered for us by CNT Energy, an independent, non-profit organization. CNT Energy offers customers a package of services - including educational materials, personalized updates and online tools - to help them maximize their savings with this rate option.

Power Smart Pricing participants will continue to be billed by Ameren Illinois for their real-time pricing electric supply. Customers who enroll in Power Smart Pricing are required to remain in the program for a period of one year, after which they can change their electric supply option.

Residential customers interested in Power Smart Pricing may request additional information and enrollment materials directly from CNT Energy by calling 877.655.6028 or via the web site: www.powersmartpricing.org.

For specific details, see the tariffs related to Rider RTP and Rider PSP in the [Rates](#) section of our web site.

Power Smart Pricing

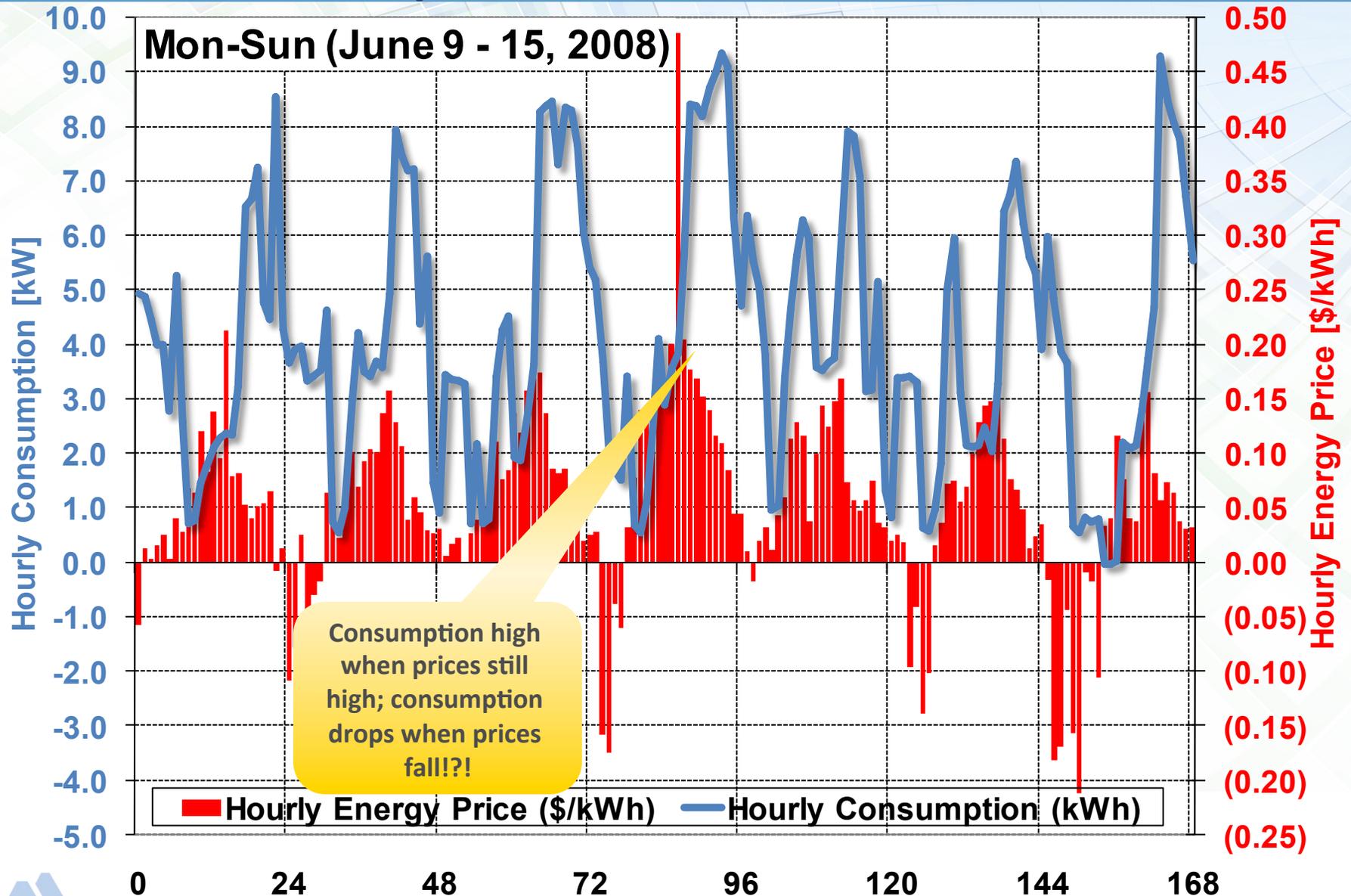
Respect



It's being treated fairly and listening to the ideas of others. [\(more\)](#)



A Real-World DR Example: Conzelmann Household BEFORE Real-time Price Response



A Real-World DR Example: Conzelmann Household

DR Tools: Technology



Loadguard Price Point
10 cents/kWh
14 cents/kWh



GLOSSARY OF WARNING AND INDICATOR LIGHTS

Refer to your Owner's Manual for more details and explanations.

- | | | |
|---|---|---|
| <ul style="list-style-type: none"> Check Engine
Engine malfunction Charging System
Charging system malfunction Powertrain Malfunction/Reduced Power BSM OFF (Blind Spot Monitoring) Check Engine | <ul style="list-style-type: none"> Brake
Parking brake on/low brake fluid/malfunction Turn Signals/Hazard Warning Automatic Transmission
Transmission malfunction A/T Shift Position Headlight High Beam Traction Control System (TCS)/Dynamic Stability Control (DSC)
On: TCS/DSC malfunction
Flashing: TCS/DSC operating Airbag/Front Seat Belt Pretensioner System
On or Flashing: Airbag malfunction | <ul style="list-style-type: none"> Low Engine Oil Pressure Security Indicator Door Ajar 4WD
Dealer inspection is required if this light is flashing, indicating high temperature differential oil, or if the light stays illuminated, indicating an abnormality with the system. Seat Belt
Seat Belt unbuckled/malfunction Cruise Main Indicator Light (AMBER)/Cruise Set Indicator Light (GREEN) Low Washer Fluid |
|---|---|---|



A Real-World DR Example: Conzelmann Household

DR Tools: Technology

Save Energy Automatically

Conserve Smart AV™

Auto-Off Surge Protector

- Control power to 6 devices with your TV's on/off button
- Reduce standby power automatically



Kill A Watt® EZ



A Real-World DR Example: Conzelmann Household

DR Tools: The Shame Factor

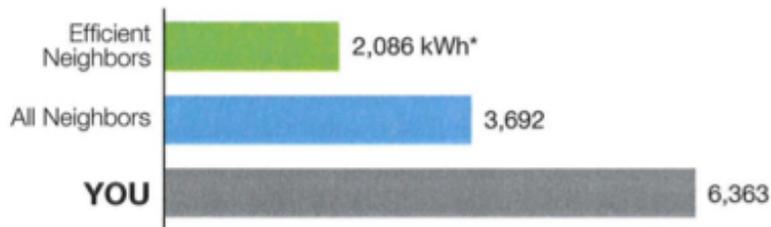
 **Last Summer Comparison** | You used **72% MORE** electricity than your neighbors.

Your usage last summer: May '10 – Sep '10

Home **My Energy Use**

My usage details

My usage details



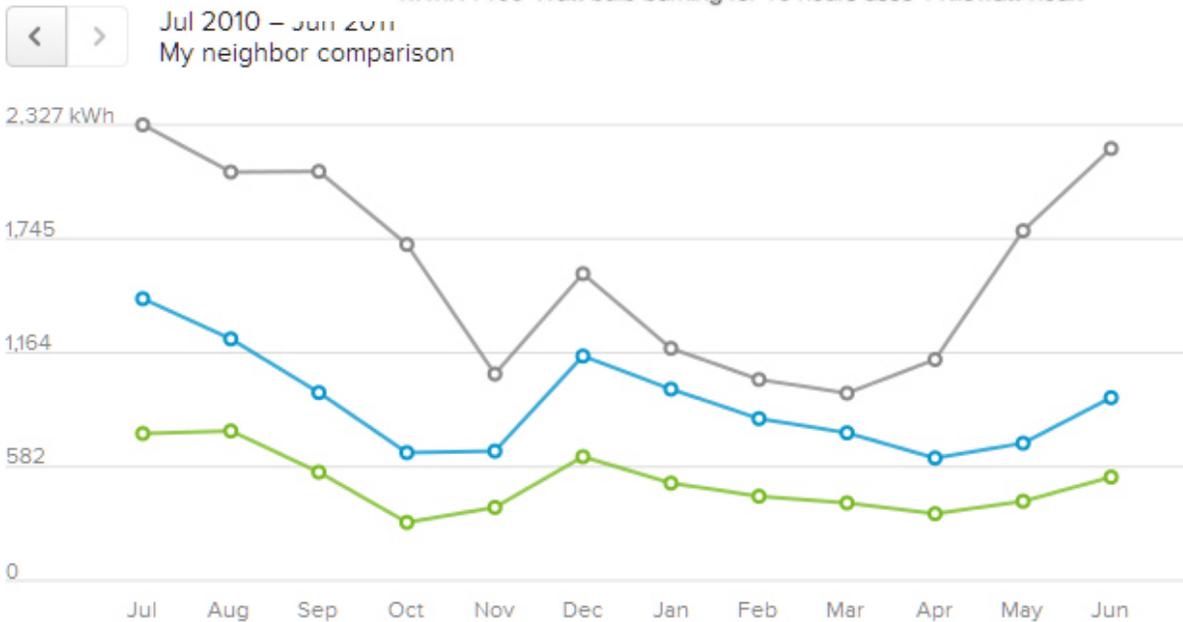
How you did last summer:

You used more than average

Turn over for ways to save

→

* kWh: A 100-Watt bulb burning for 10 hours uses 1 kilowatt-hour.



Find tips to reduce your use:

- Free steps to take
- Smart purchases
- Great investments

Neighbors Usage Costs Weather

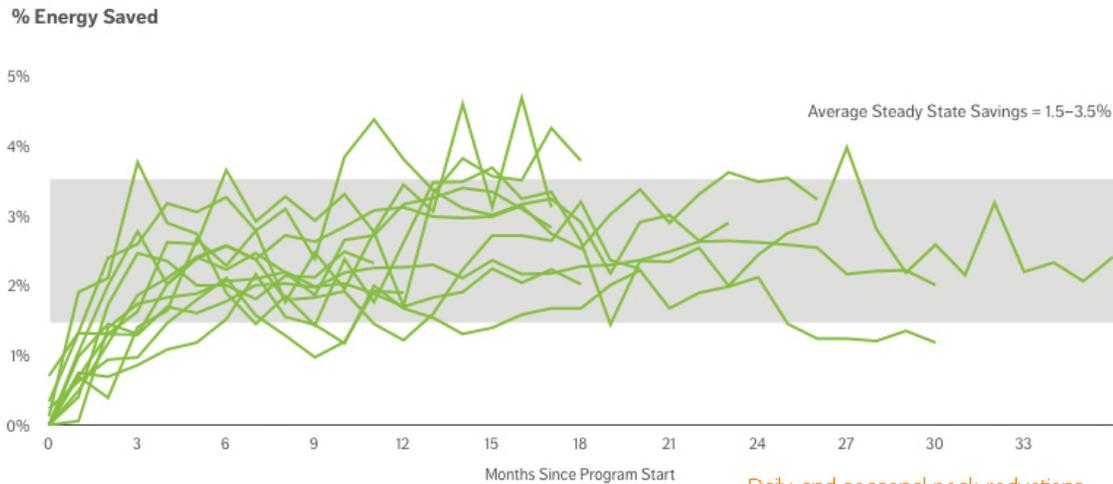
■ You
■ All neighbors
■ Efficient neighbors

A Real-World DR Example: Conzelmann Household

DR Tools: The Shame Factor

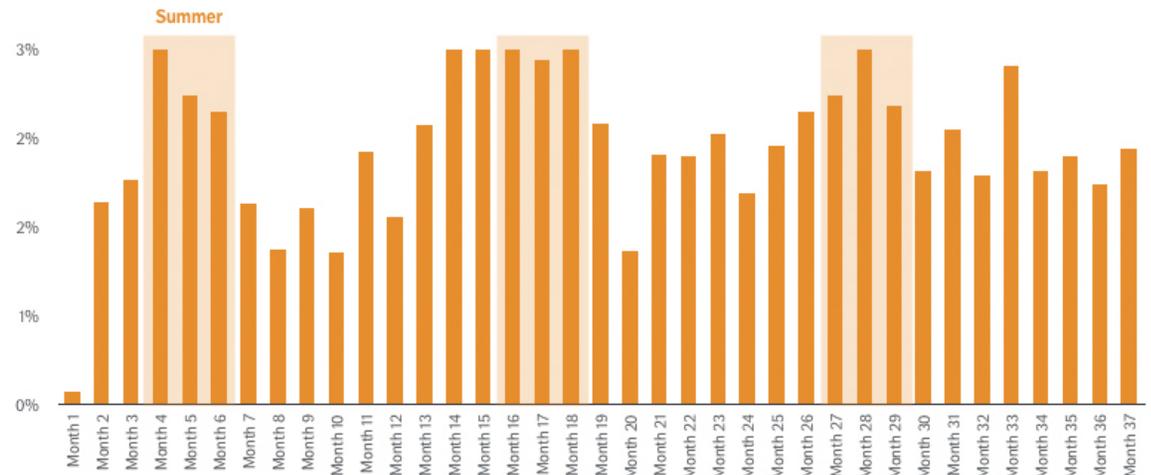
Cost-effective energy savings

Consistent and Sustained Savings Across All Geographies



Daily and seasonal peak reductions

Monthly Peak Savings at Longest Running Program



Source: Opower, 2011

A Real-World DR Example: Conzelmann Household DR Tools Price Alerts Received from the System Operator

From: The Watt Spot [wattspot_admin@powerportal.com]
To: Conzelmann, Guenter
Cc:
Subject: ComED RRTP - Real-Time Price Alert

Don't miss our emails! [Add wattspot_admin@powerportal.com to your address book](mailto:wattspot_admin@powerportal.com).
Having trouble with this message? [View it online](#).

theWattSpot.com

ComEd RRTP Real-Time Price Alert

This is your Real-Time High Price Alert for today, 08/01/2010 from the ComEd Residential Real Time Pricing program (ComEd RRTP). Real-Time Prices for last 30 minutes exceeded the 10 cents/kWhr level starting at 11:25 AM.

Now is the ideal time for you to conserve electricity by shifting use of large power consuming appliances to less costly time periods.

Specific things you may want to do at this time include:

- Adjust the temperature on your thermostat by season to use less electricity.
- Use ceiling fans or portable fans to help keep air circulating
- Turn off lighting that is not needed
- Defer dishwasher, clothes washer and dryer use until late evening
- Use the microwave for cooking instead of the stove
- Turn off your hot water heater until evening

You will NOT receive another Real-Time Price Alert for the NEXT FOUR hours. In the meantime visit www.theWattSpot.com for hourly price updates. Other helpful planning links include:

<http://www.weather.com>
<http://www.energyguide.com>

Thank you

To unsubscribe to this price notification, please log into your WattSpot account and change your notification preferences or call 1-877-WATTSPOT

To unsubscribe, please [log into your WattSpot account](#) and change your notification preferences.

(c) 2009 Comverge, Inc.
120 Eagle Rock Avenue, Suite 190
East Hanover, NJ 07936



From: The Watt Spot [wattspot_admin@powerportal.com]
To: Conzelmann, Guenter
Cc:
Subject: ENVIRONMENTAL LoadGuard Event Kick-off Notification

Don't miss our emails! [Add wattspot_admin@powerportal.com to your address book](mailto:wattspot_admin@powerportal.com).
Having trouble with this message? [View it online](#).

theWattSpot.com

ComEd RRTP price for the past half-hour has been above 10 cents.
A LOADGUARD Event has been activated for 2 hours starting 08/01/2010 08.00 PM

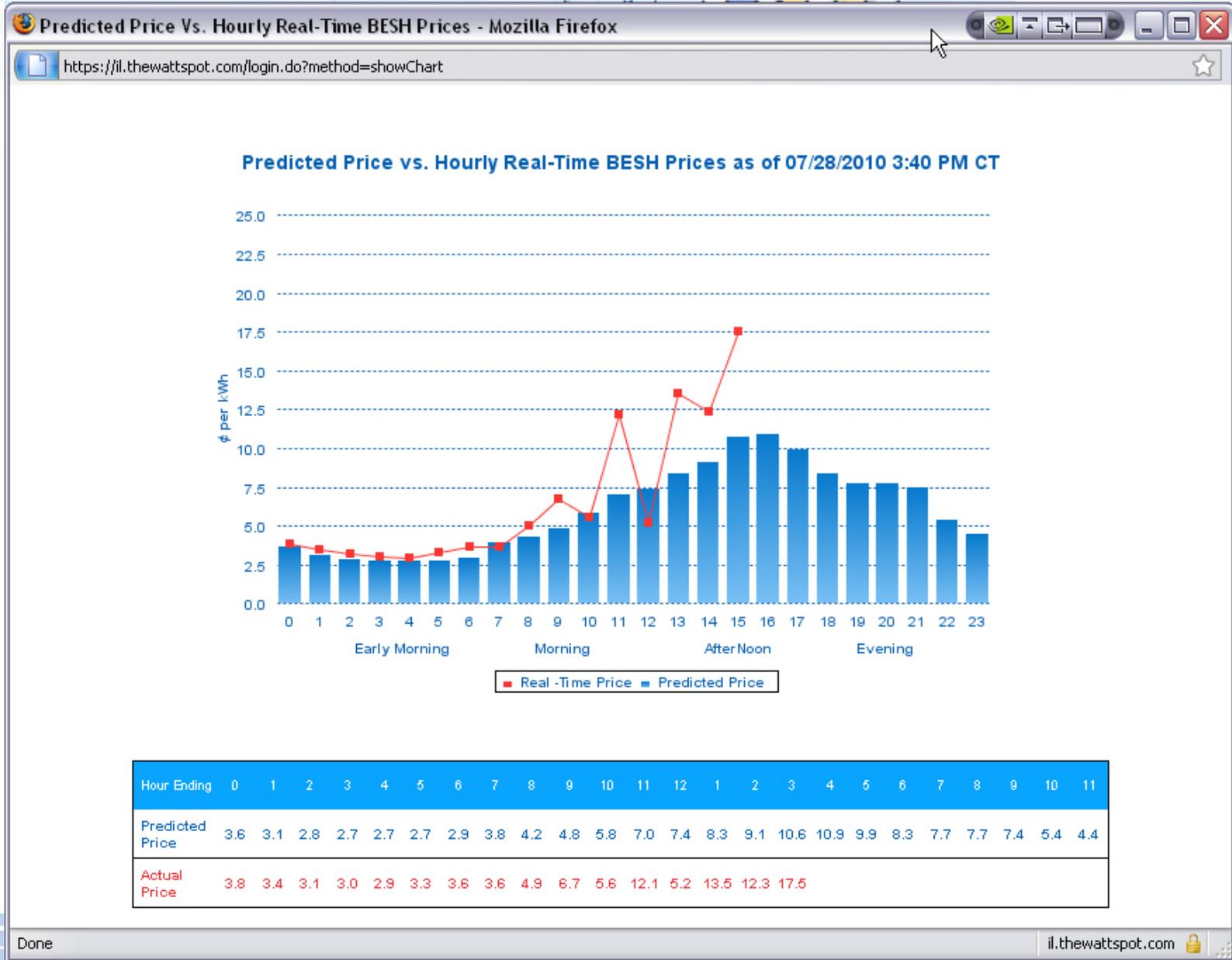
theWattSpot Administrator

To unsubscribe, please [log into your WattSpot account](#) and change your notification preferences.

(c) 2009 Comverge, Inc.
120 Eagle Rock Avenue, Suite 190
East Hanover, NJ 07936



A Real-World DR Example: Conzelmann Household DR Tools Price Alerts Received from the System Operator

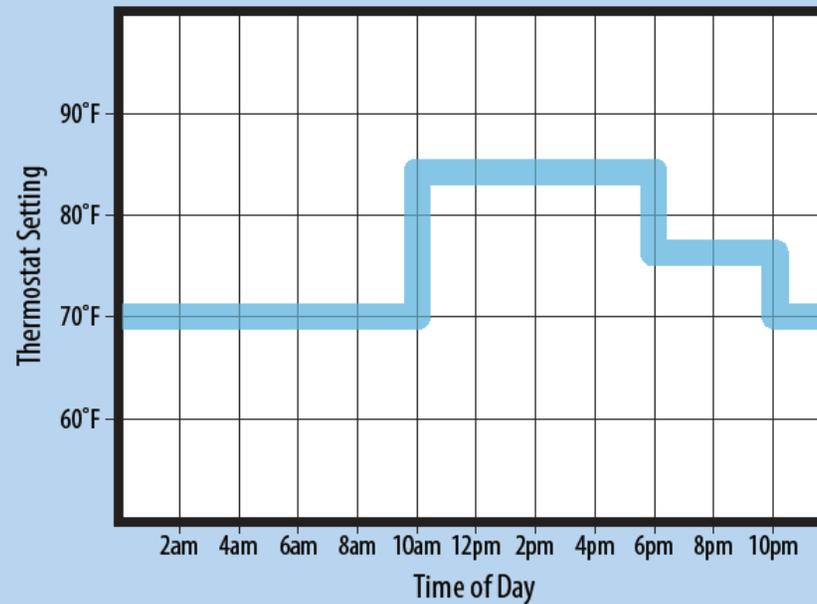


A Real-World DR Example: Conzelmann Household Thermostat Setpoints versus Real-Time Prices

Recommended Temperature Settings

Time	Phase	Temperature Setting
10 p.m. - 10 a.m.	Pre-cooling	69°F - 72°F
10 a.m. - 6 p.m.	Idle	82°F - 85°F
6 p.m. - 10 p.m.	Comfort	75°F - 78°F

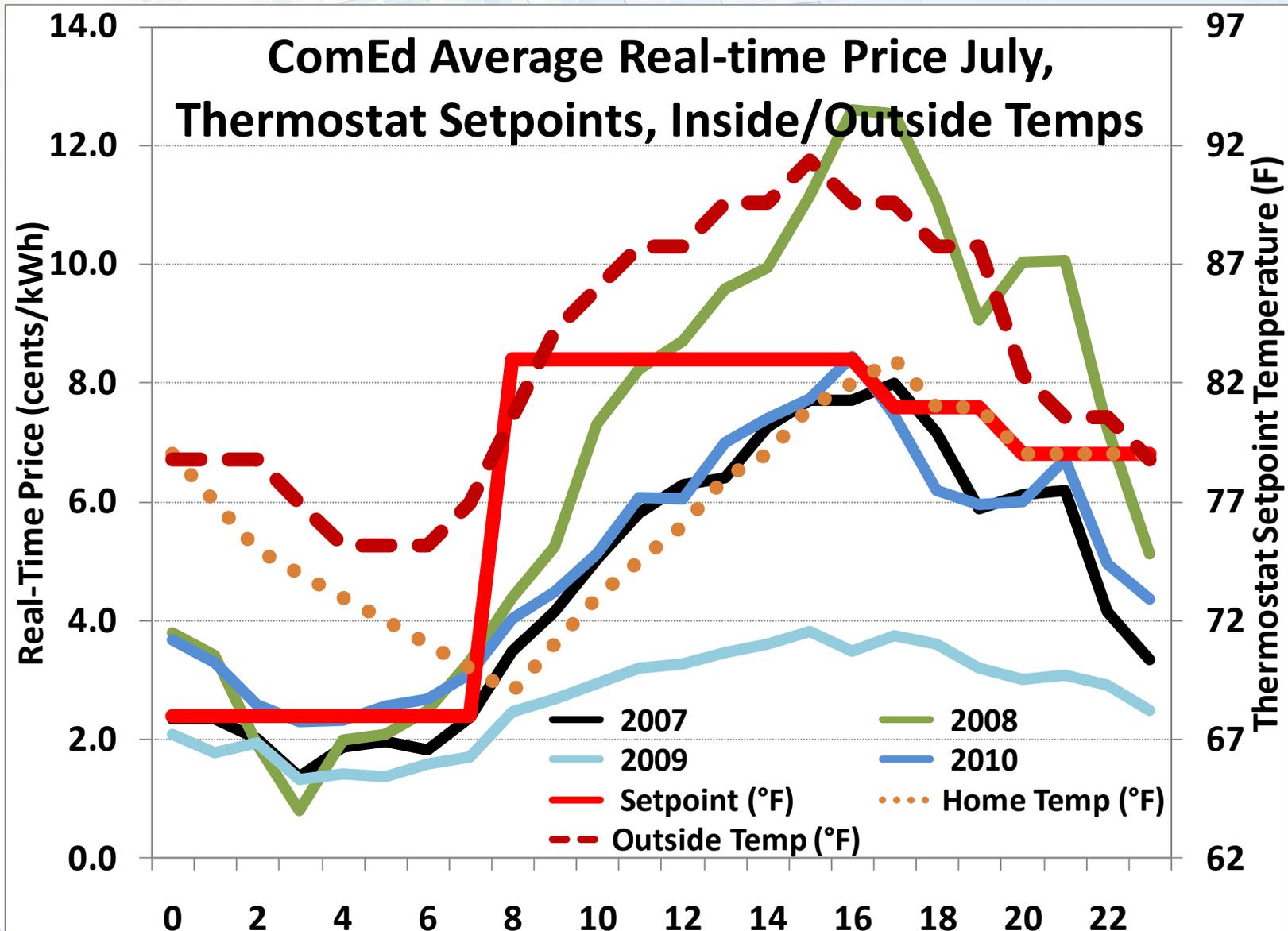
Thermostat Settings for Pre-Cooling



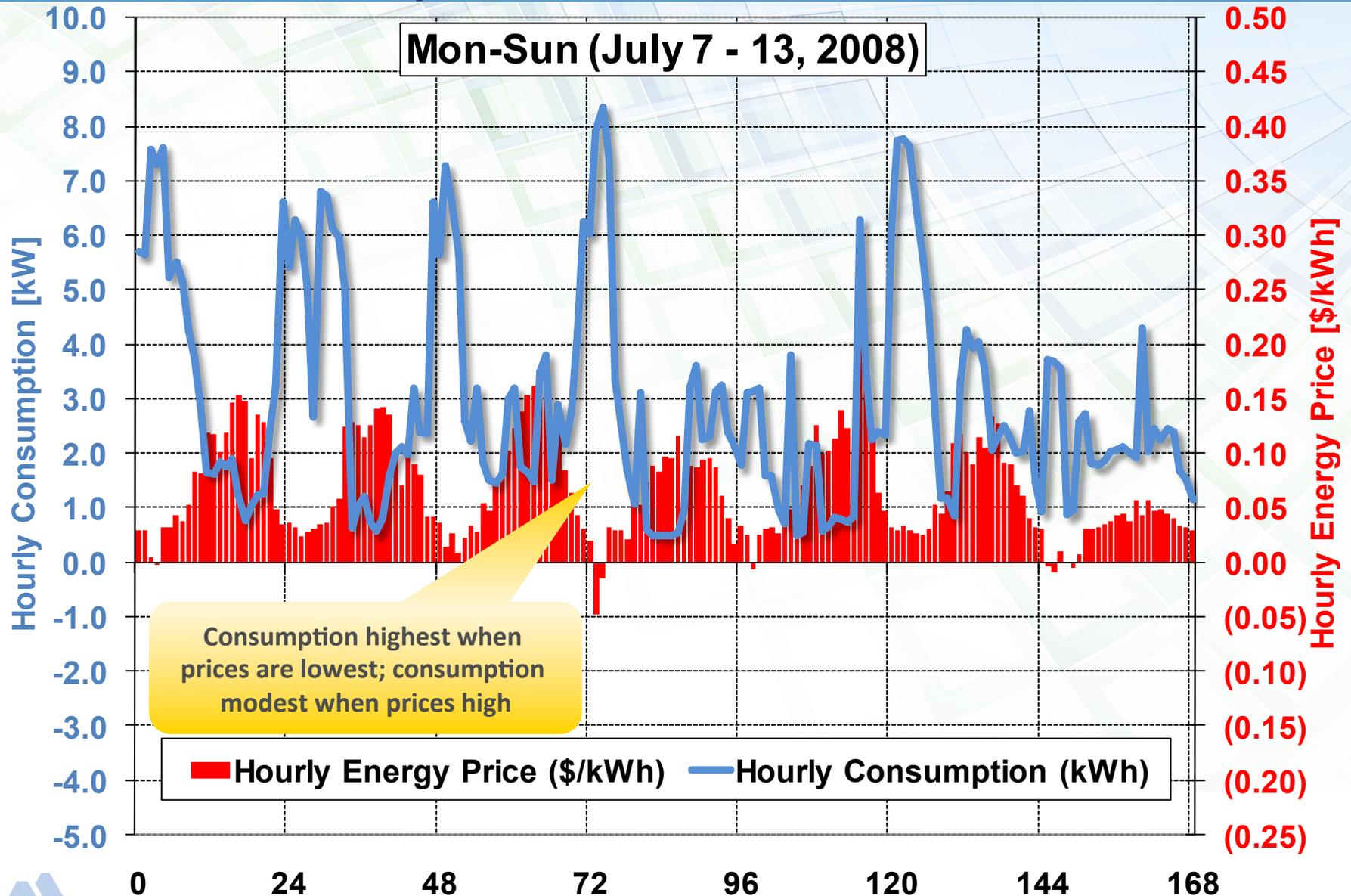
ComEd R RTP 2010 Summer Energy Kit



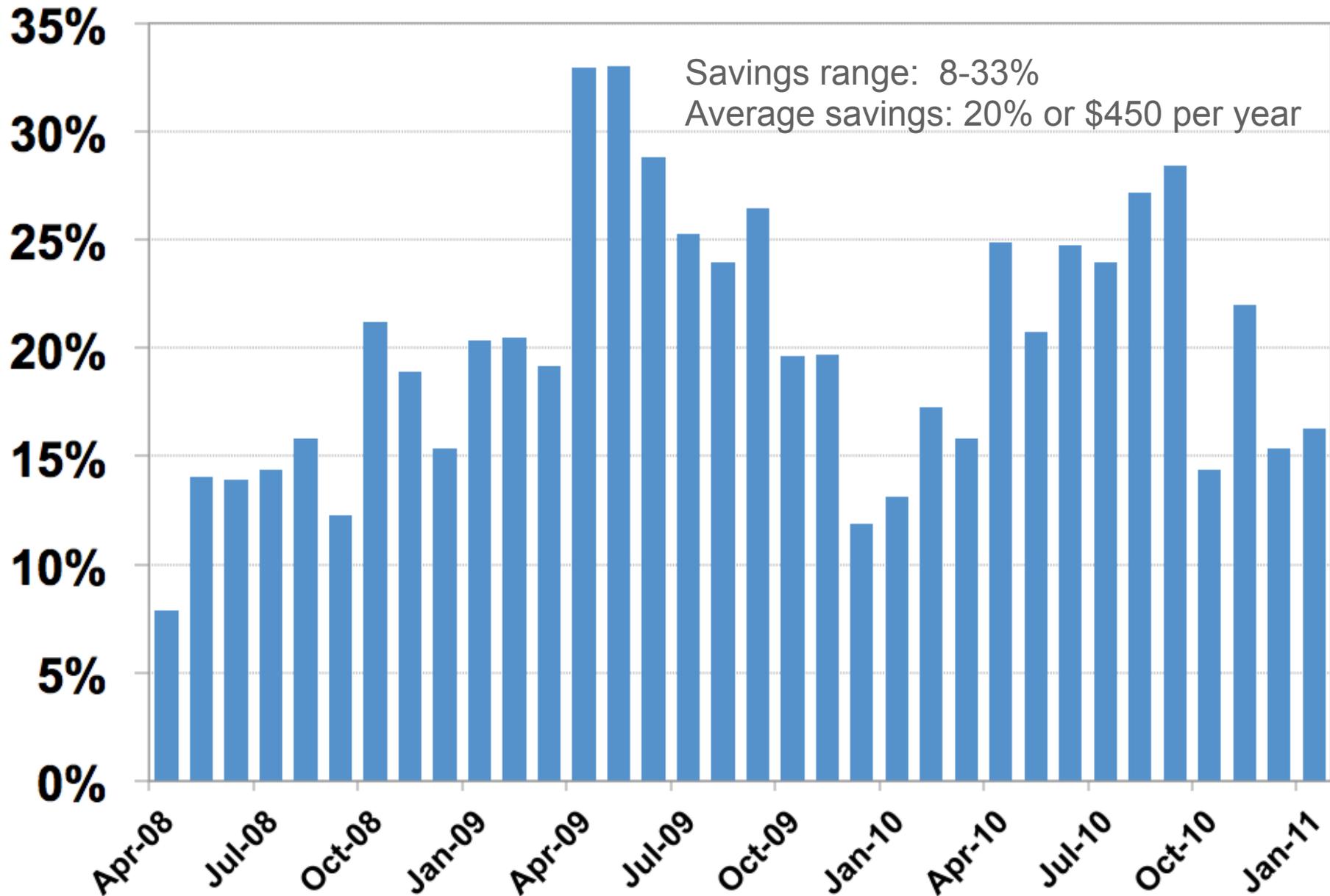
A Real-World DR Example: Conzelmann Household Thermostat Setpoints versus Real-Time Prices



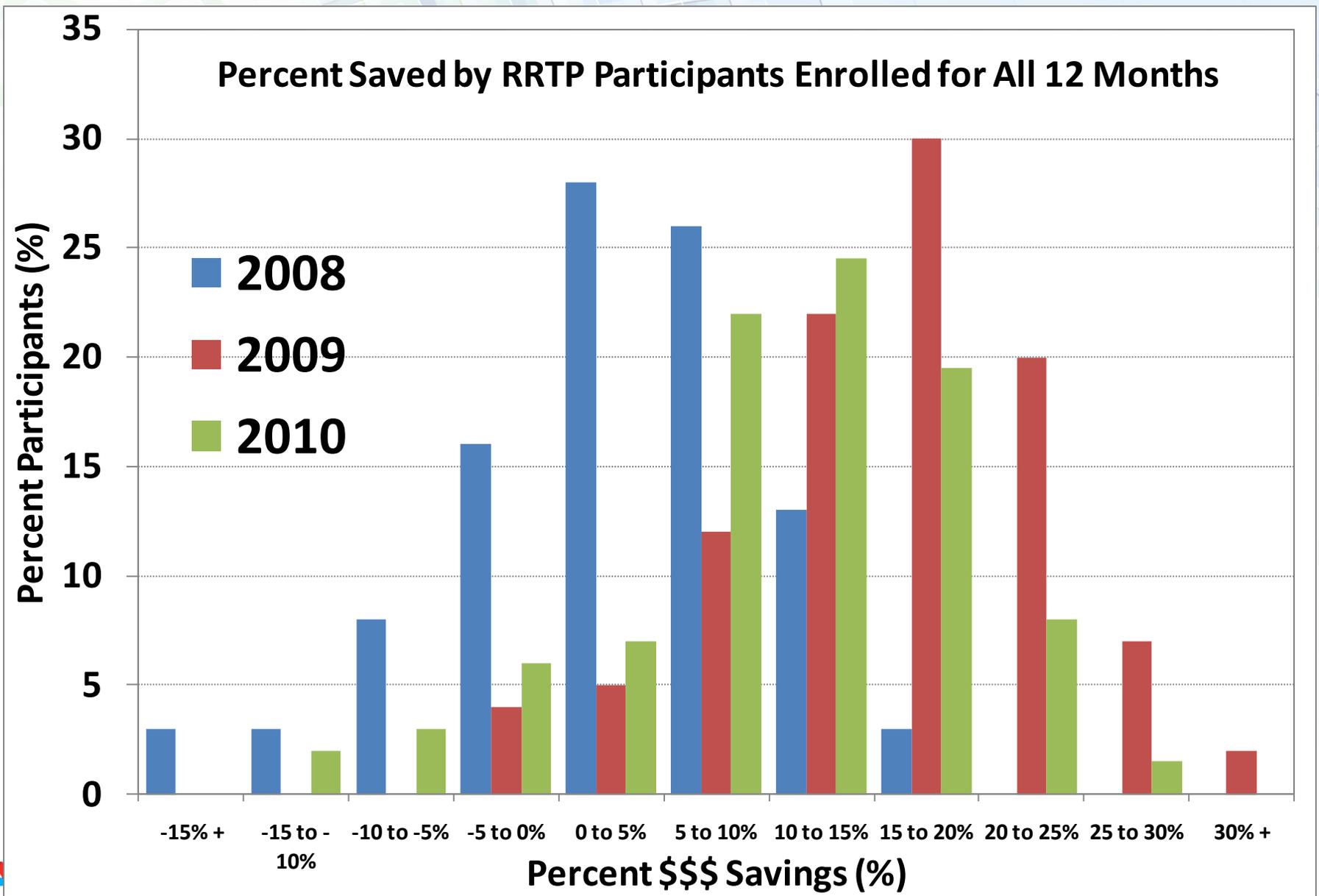
A Real-World DR Example: Conzelmann Household AFTER Real-time Price Response



A Real-World DR Example: Conzelmann Household Monthly Savings Compared to Regulated Tariff



A Real-World DR Example: Savings Varied Substantially Across Households in the ComEd Program



Responding to Prices by Pre-Cooling Home May not be for Everyone

Here is how it feels like when you wake up



Responding to Prices by Pre-Cooling Home May not be for Everyone



Here is how it looks like when you wake up



Responding to Prices by Pre-Cooling Home May not be for Everyone



Here is how it looks like when you wake up

Responding to Prices by Pre-Cooling Home May not be for Everyone

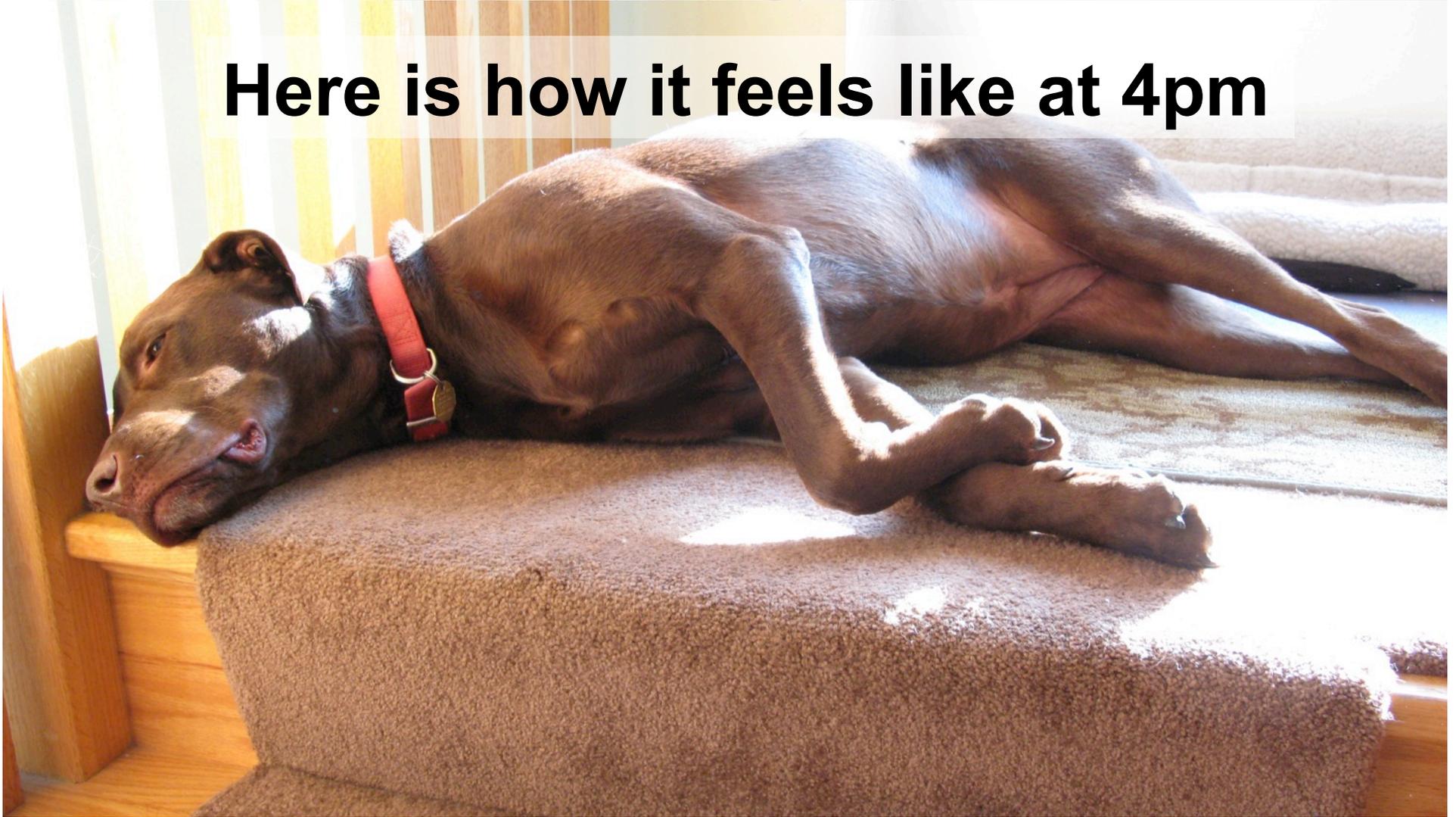
Here is how it feels like at 4pm

Steam Room



Responding to Prices by Pre-Cooling Home May not be for Everyone

Here is how it feels like at 4pm



A Few Additional Observations on my Personal Dynamic (Real-time) Pricing Experiment

- Substantial cost savings, energy savings unclear
 - For ComEd, savings are estimated around 1.5% annually (highest in summer, as much as 6%)
- Potential for information overload
 - Hourly consumption data
 - Combined with hourly data appliance by appliance
- Feedback is slow (delayed by a month)
 - Will be different with full AMI meter and in-home display but see above

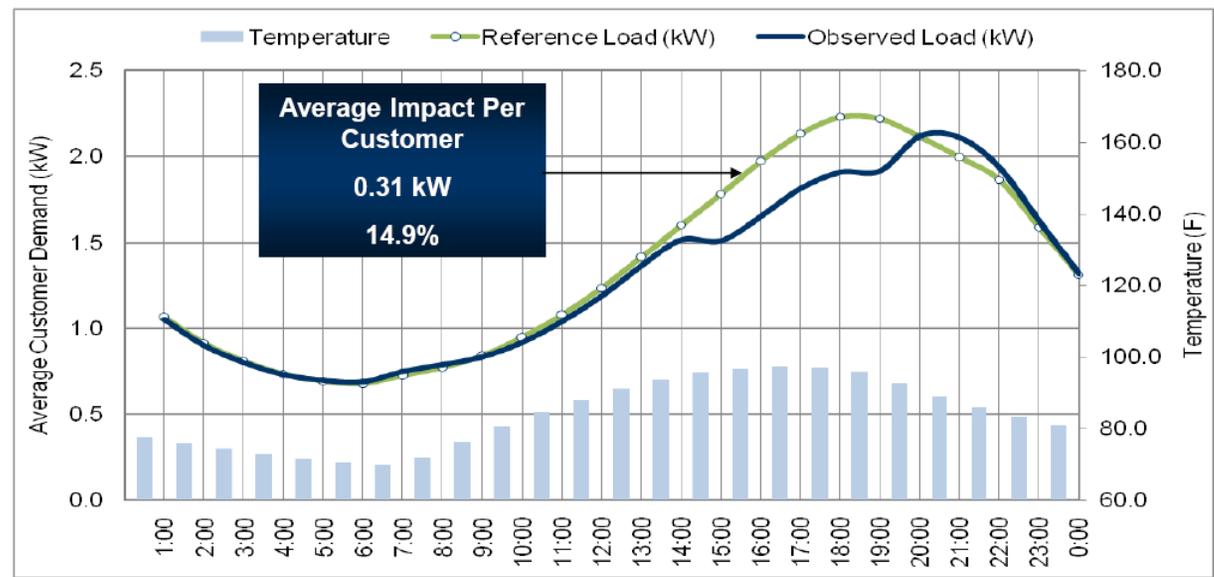
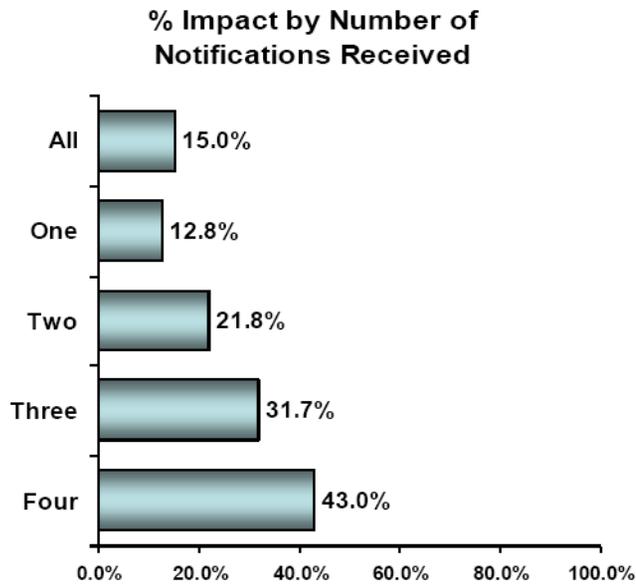


Results from PG&E Demand Response Program

- About 25,000 active participants
- The average peak period load reduction across 15 event days in 2009 equaled almost 15%
- Smart rate has 60 ¢/kWh adder from 2-7 pm on up to 15 event days each summer
- Multiple channel notifications (phone, email)

Tier	E-1 ¢/kWh)	SmartRate Peak Period Price	Peak Period Price Ratio (SR/E1)
1	11.5	61.5	5.4
2	11.7	61.7	5.3
3	14.9	64.9	4.4
4	21.0	81.0	3.9
5	26.7	86.7	3.3

Average Reference Load and Load Impact Across 15 SmartRate Days



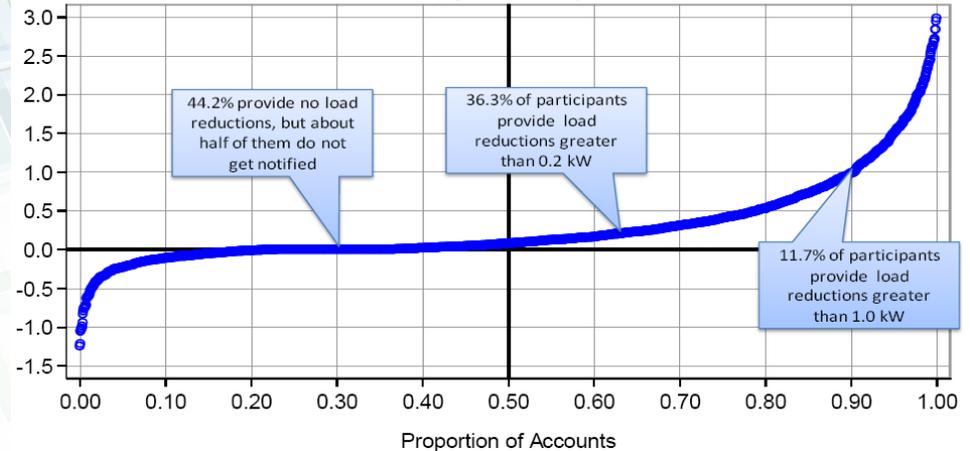
Source: Freeman, Sullivan & Co, 2010



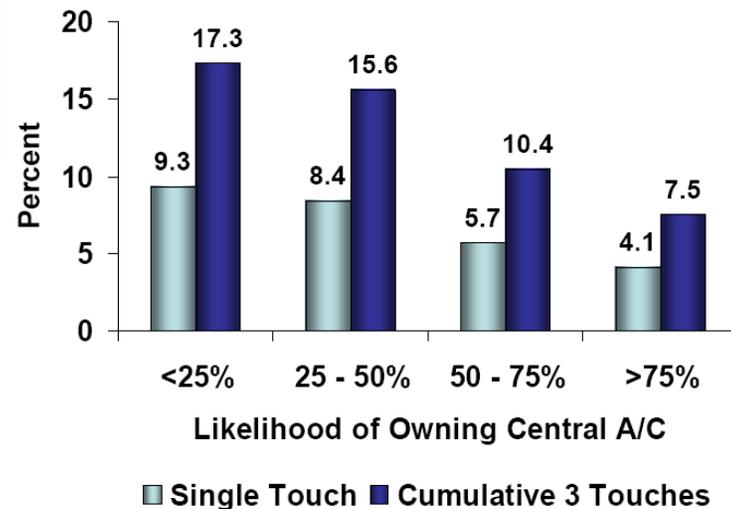
Results from PG&E Demand Response Program

- A relatively small % of customers provided large load reductions
 - Households with central AC more likely to provide large reductions
- Marketing matters
 - Customer enrollment varies significantly with variation in the features, timing and targeting of the marketing offer
- A modest incentive dramatically improves enrollment based on direct mail
- Customers already part of a load control program are significantly more likely to enroll in dynamic pricing program than others
- Customers with the highest potential (those with central AC) are the hardest to enroll

Cummulative Distribution of Average Event Load Reduction (by Customer)



% Of Customers Who Enroll



Results from ComEd Opt-Out Pilot Program

- Enrollment at start 8,522 customers randomly selected (168 opted out)
- 5%-8% of customers showed a “robust price response”
 - In line with the findings from other opt-in pilots from around the U.S.
 - Peak to off-peak usage was shifted by more than 30% by those participants
 - Price event notification made a significant difference
- Sample size may have been too small (phase 1 report only covers 3 months)
 - Participation trend was from higher use customers
 - Enabling technology did not appear to have an impact on usage up or down

Average Load Impacts of Customer Deemed to be Responders, by Rate Type⁴¹

Rate	Number of Responders	Responders' Share out of Total Rate Sample	Average Estimated Event Reference Load (kW)	Average Estimated Event Load Impact (kW)	% Load Impact
CPP	108	6.7%	1.50	0.56	37%
PTR	40	4.9%	1.17	0.38	32%
RTP-DA	75	8.7%	1.73	-0.12	-7%
TOU	50	4.2%	1.72	0.39	22%
IBR	18	2.9%	1.57	0.20	12%
Flat	21	2.7%	1.28	0.35	27%

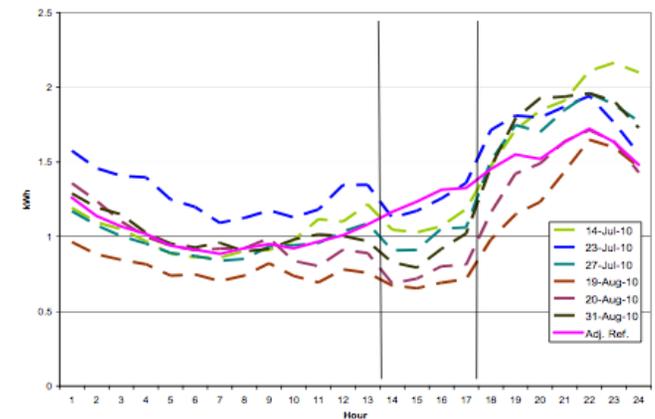


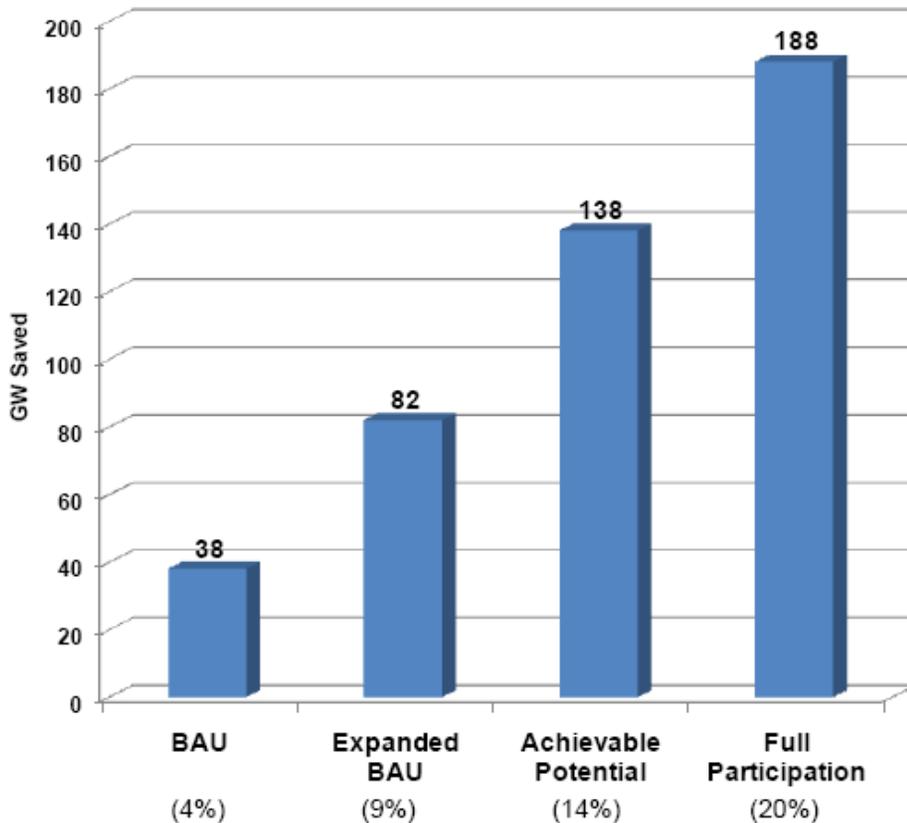
Figure 5-4
CPP Responder Usage Patterns, Average Non-Event Weekday vs. Event Days



Projected Peak Demand Reductions Vary Widely

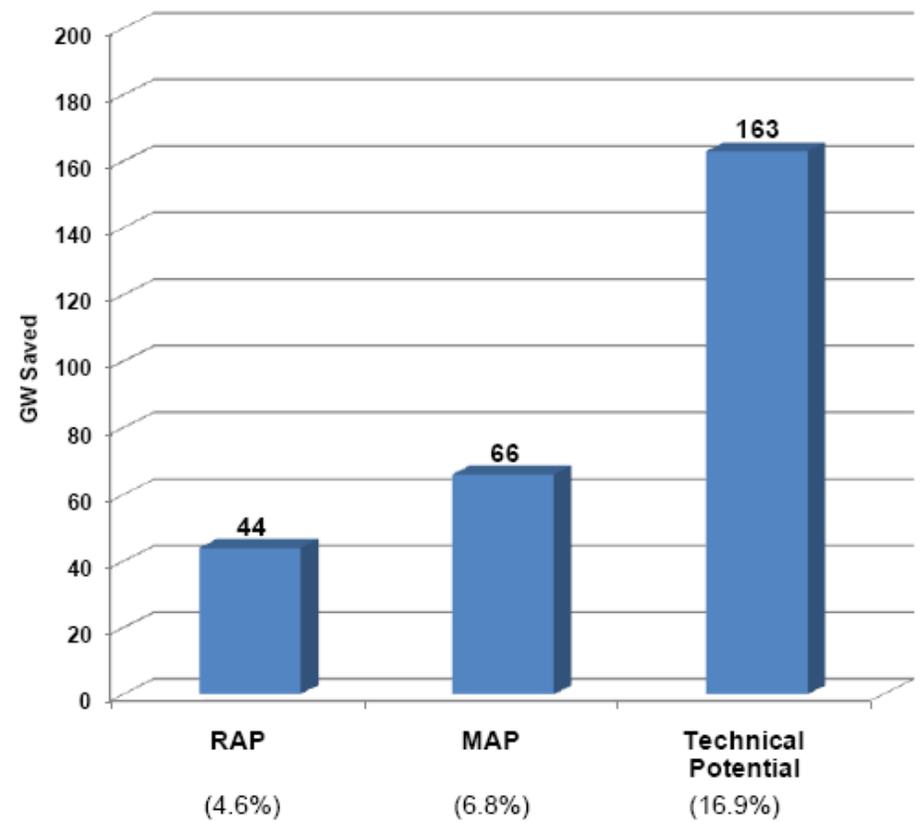
FERC (June 2009):

Peak Demand Savings due to Demand Response



EPRI (January 2009):

Summer Peak Demand Savings due to Demand Response

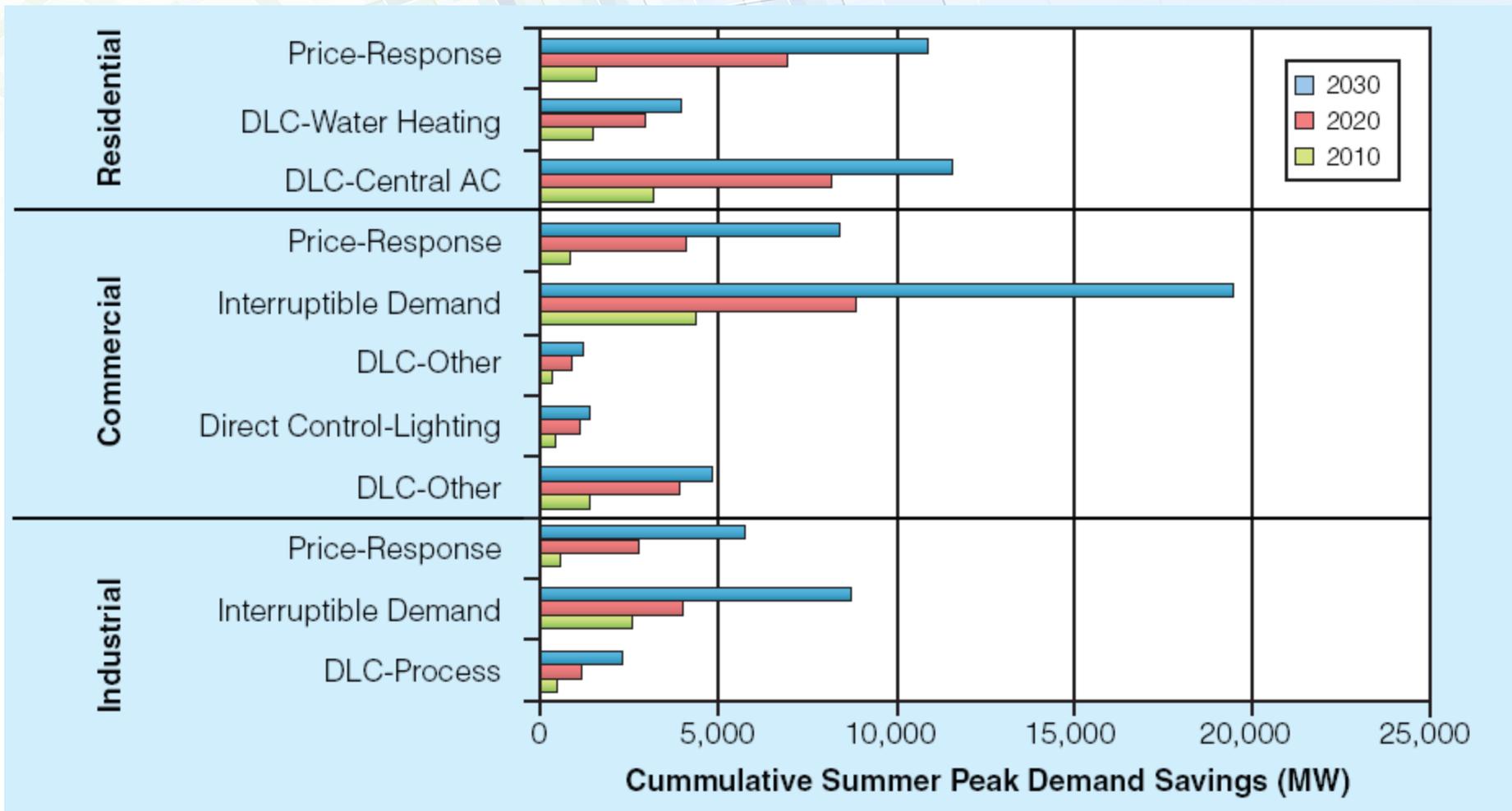


Baseline Forecast (NERC): 950 GW by 2019

**Baseline Forecast: 964 GW by 2020
(951 GW by 2019)**



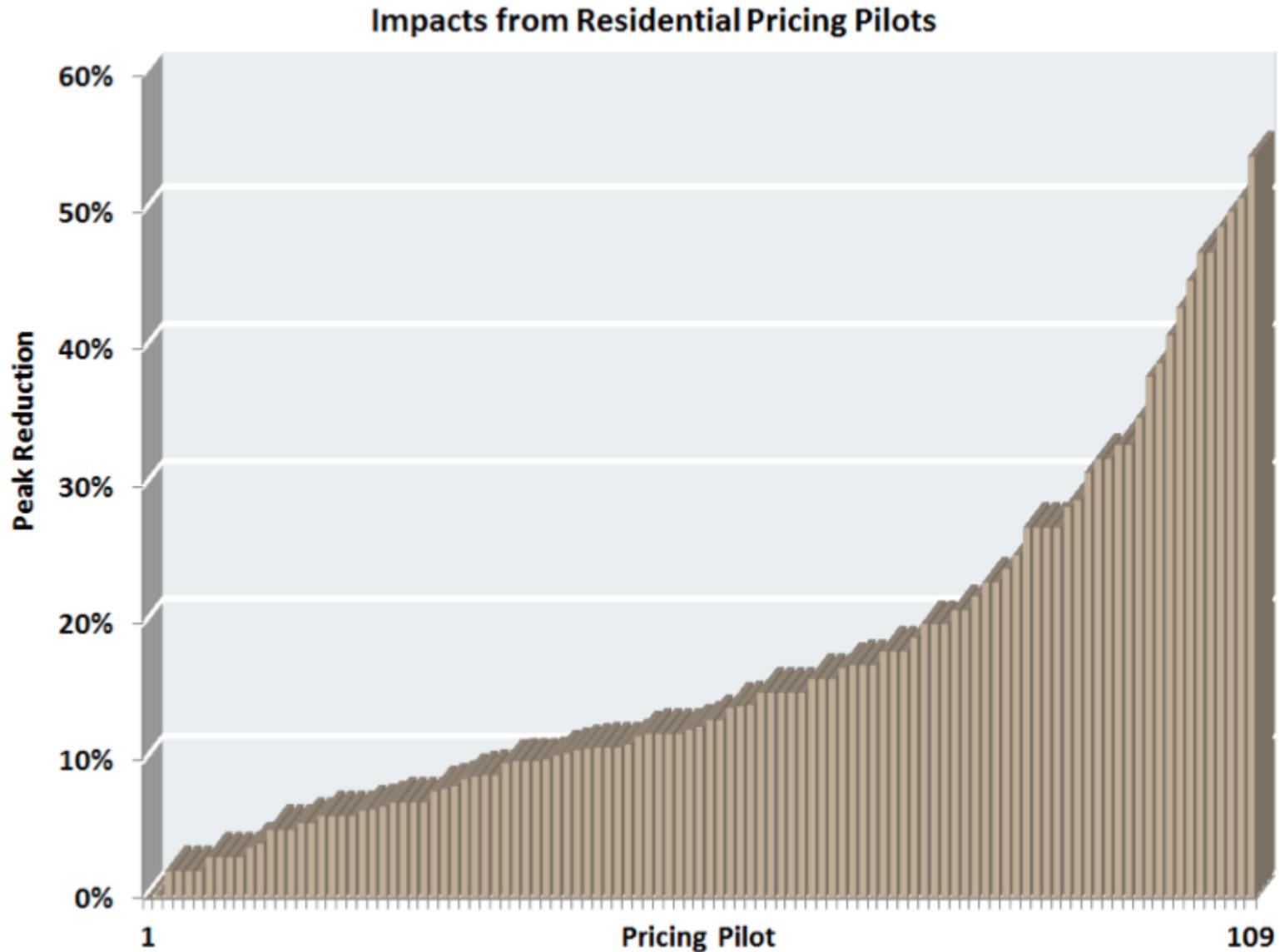
Demand Response Includes a Portfolio of Options (Realistic Achievable Potential)



EPRI, 2009



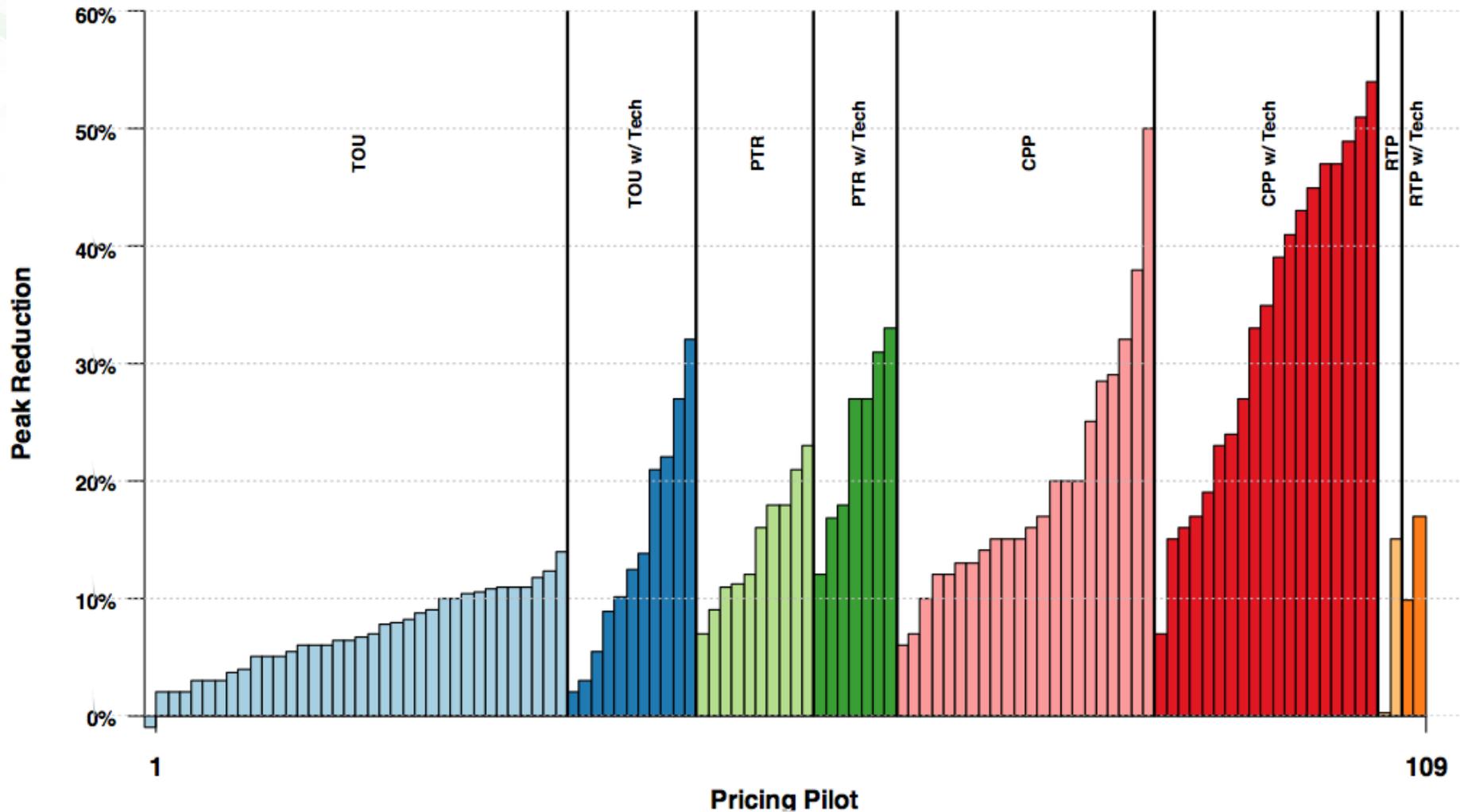
Price Response Observed in Pilot Programs Varies Widely



Source: Brattle Group, 2011

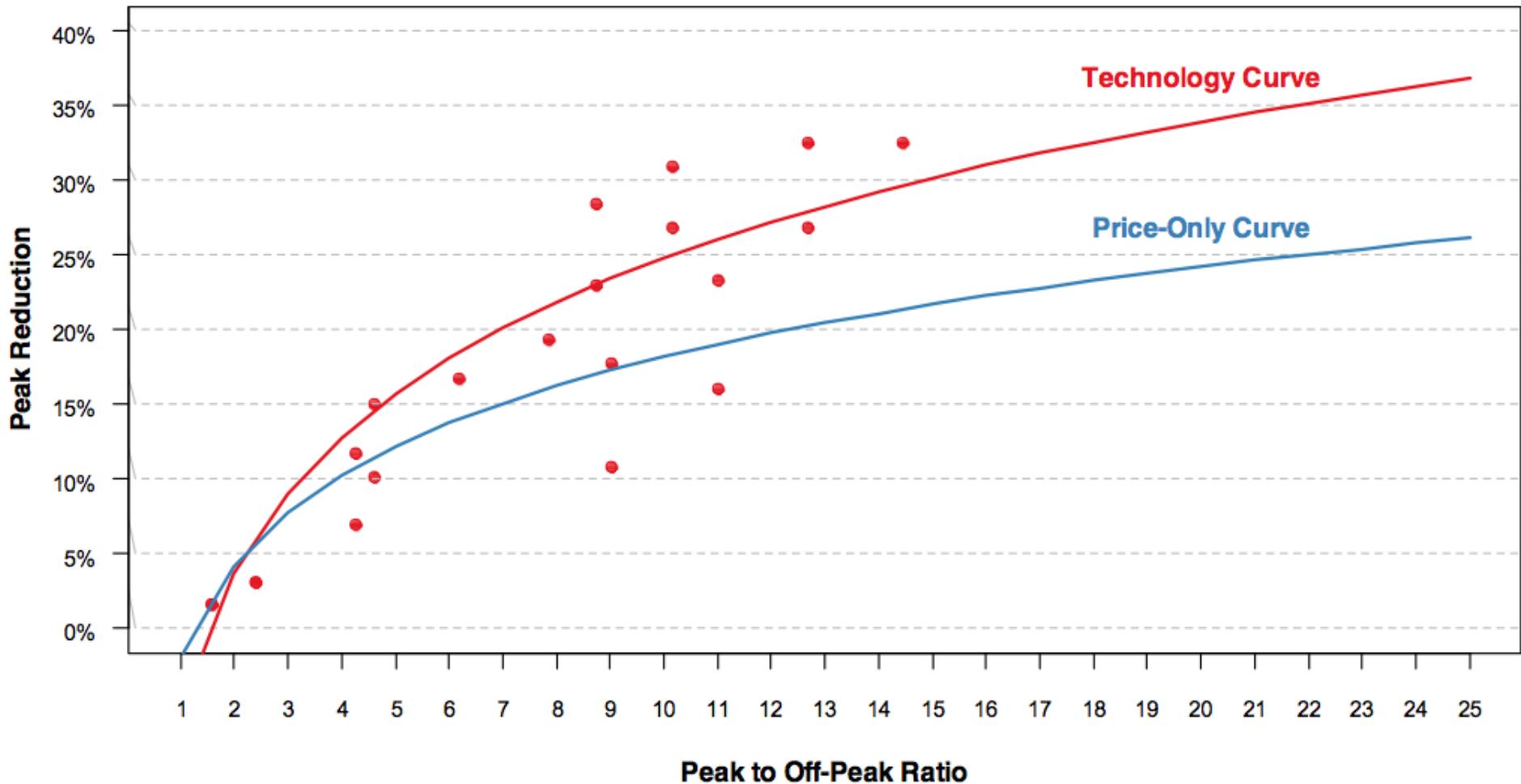
Price Response Observed in Pilot Programs Varies Widely (2)

Peak Reductions by Rate and Technology



Price Response Increases with Price and is Impacted by the Use of Technology

**Pilot Results by Peak to Off-Peak Ratio
Results with Enabling Technology**



Summary

- Current focus is primarily on reliability-centered demand response programs, such as direct load control of end-uses for residential customers and curtailable and interruptible rates for large commercial and industrial customers
- Near to mid-term will likely bring a shift toward price-responsive programs
 - Symmetrical treatment of supply AND DEMAND
- Achieving projected 20% peak reduction (FERC) will require universal deployment of smart meters
 - Currently about 10% are smart meters
 - Over the next 5 years, over 65 million (of about 130-150 million) meters are projected to be smart
- Will require a major change in the way we view (and pay for) electricity
 - Are consumers ready? Will they care? Will they understand?
 - Are savings/incentives sufficient to induce change?
 - Estimated savings of \$60 per year shifting all laundry to night-time?
 - Consider recent issues in California, Texas, and Maryland
 - Better consumer education will be critical for success

