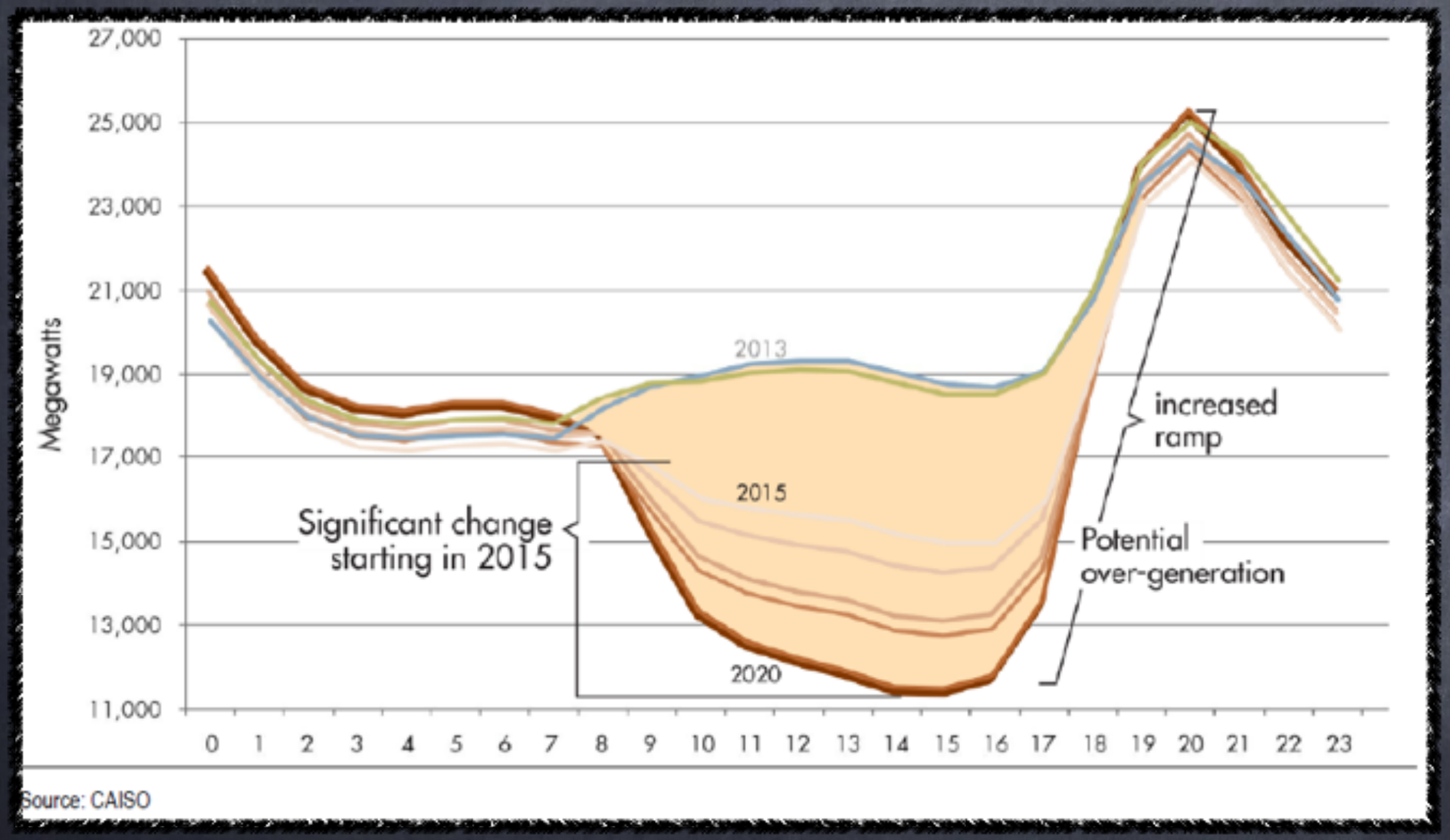
DR/EE/ES
and
Other Emerging Energy Technologies
or
How to Learn to Live With and Love the Duck Curve

California's Duck Curve: CAISO Projected Net Load, 2013-2020

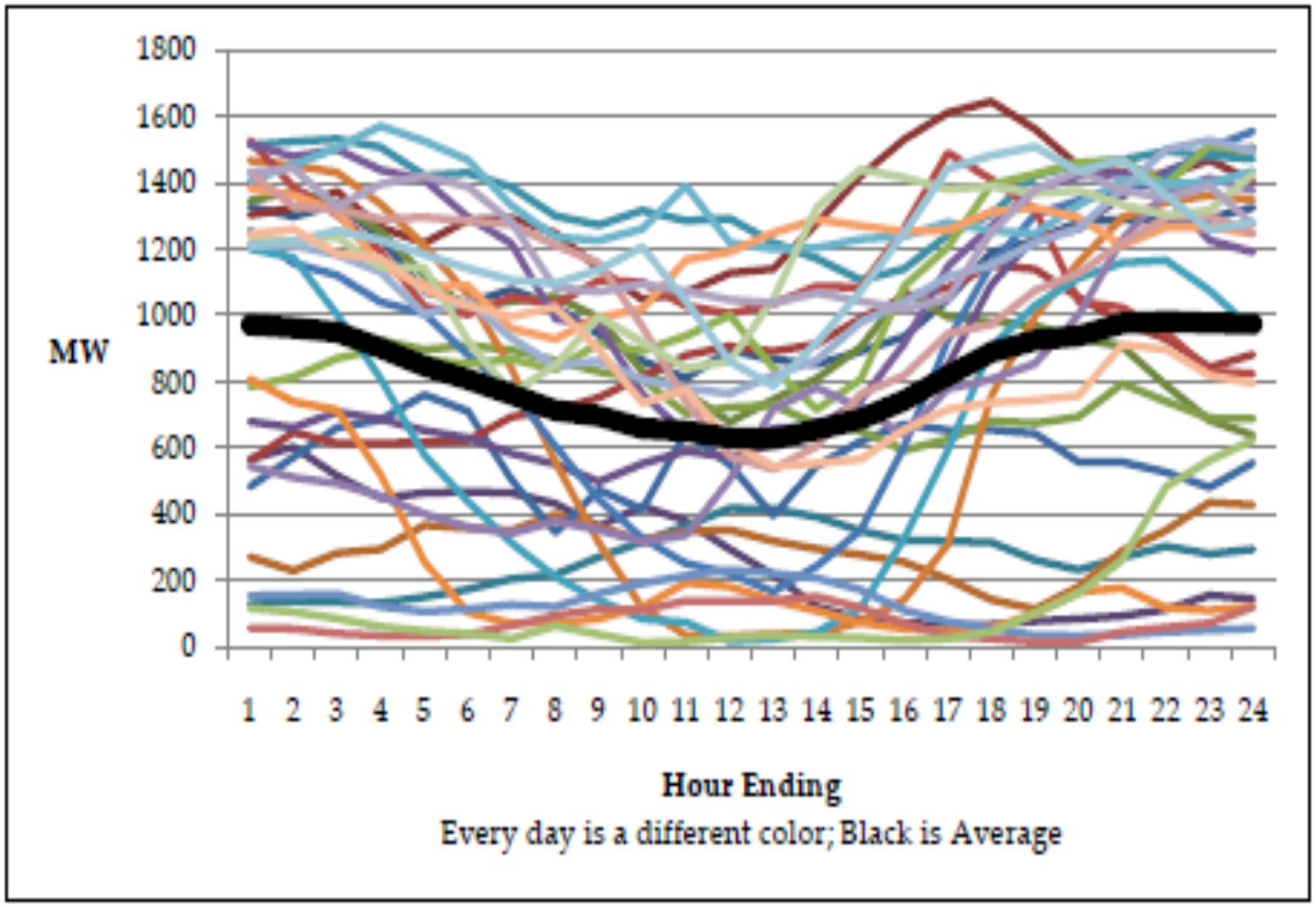


* Variability of wind/solar increase risk of overgeneration

*Overgeneration primarily concern during large/steep ramps

Source: Dumoulin-Smith, Julien. Not All Capacity is Created Equal. UBS Investment Research. June 19, 2013

Day-to-Day Wind Variability in California, 2009

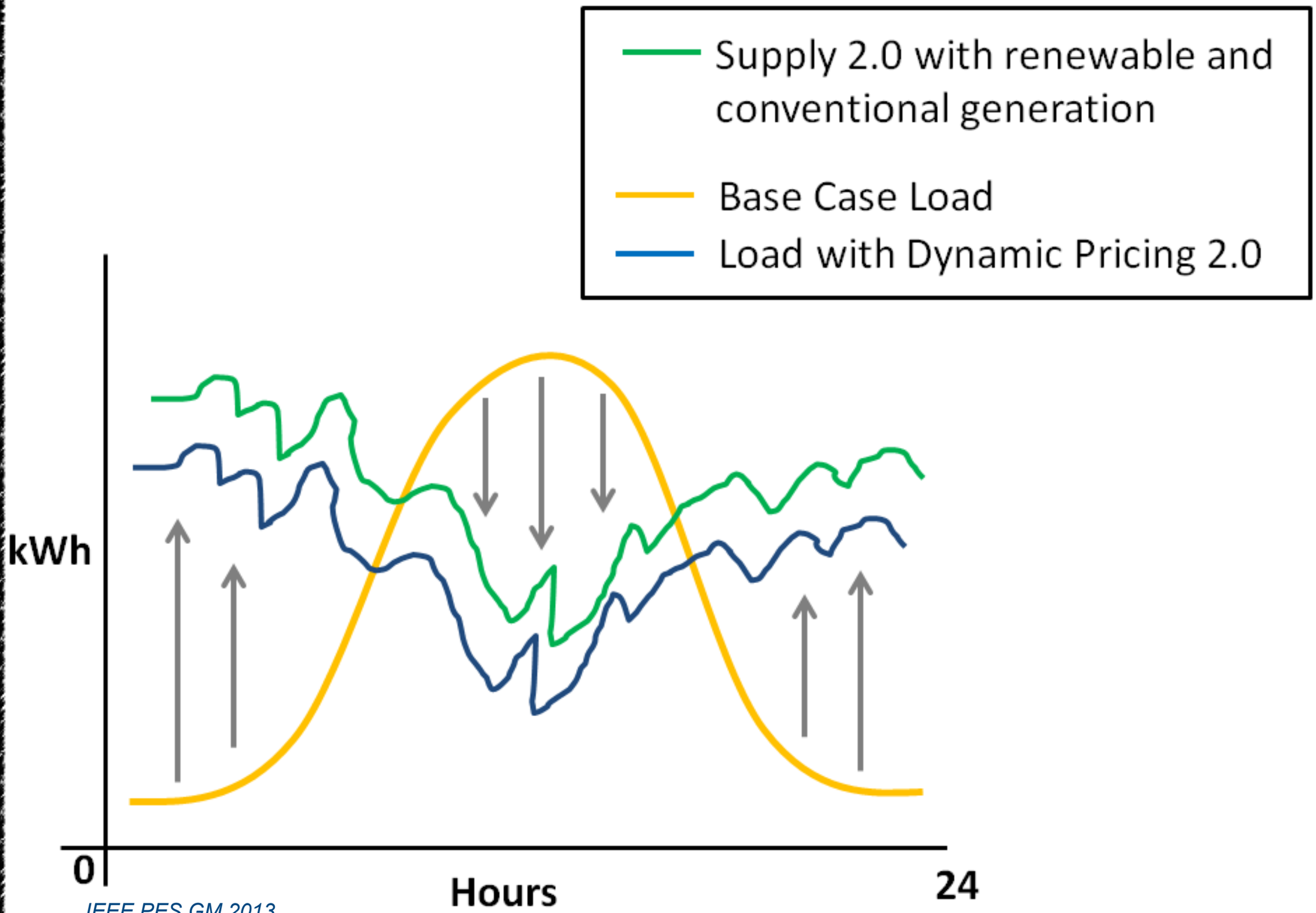


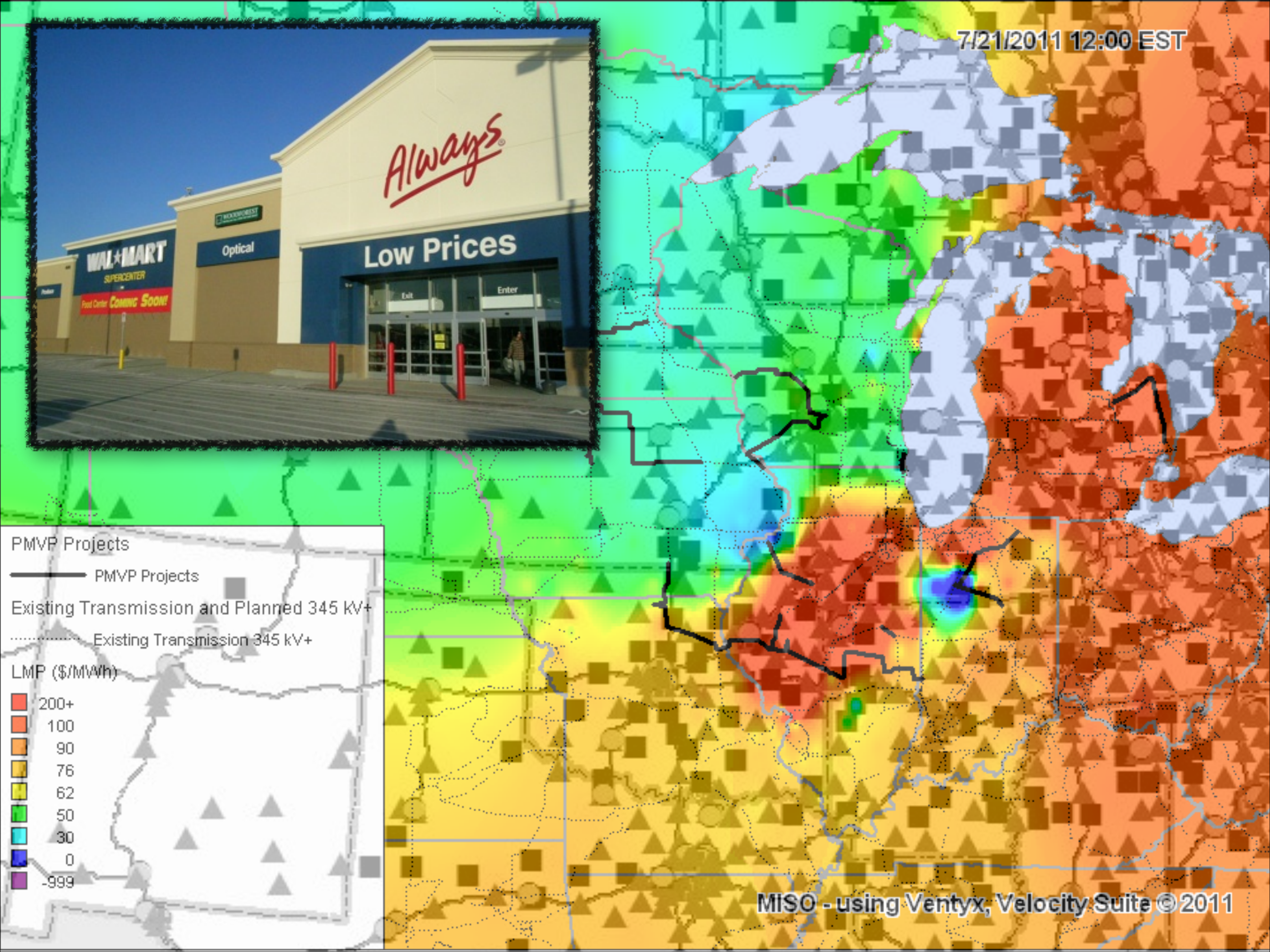
Source: April 2009 Wind Generation in the CAISO

*Wind and solar generation are highly variable, which leads to reliability concerns. Power plants have high start-up and shut-down costs, so not easy for them to fill in when variable generation lags

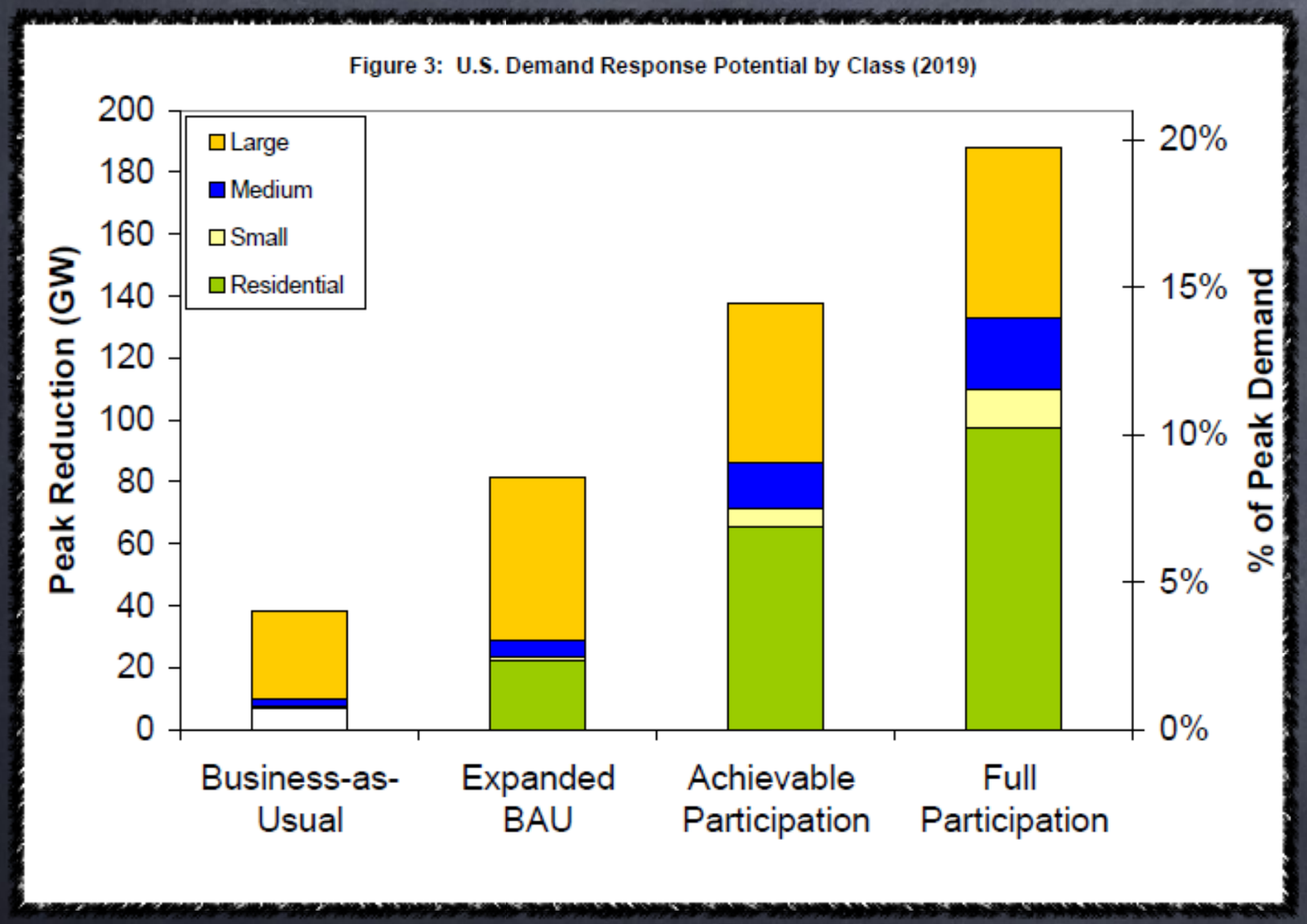
Source: Integrating Renewable Resources in California and the Role of Automated Demand Response. Lawrence Berkeley National Laboratory. November 2010.

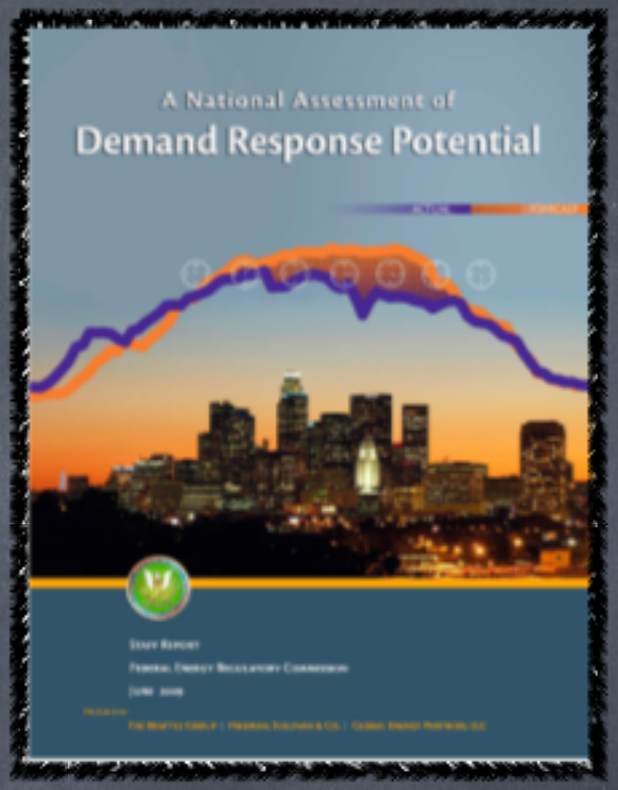
Dynamic Pricing: Integrating Renewables by Creating Around-the-clock Flexibility in Load

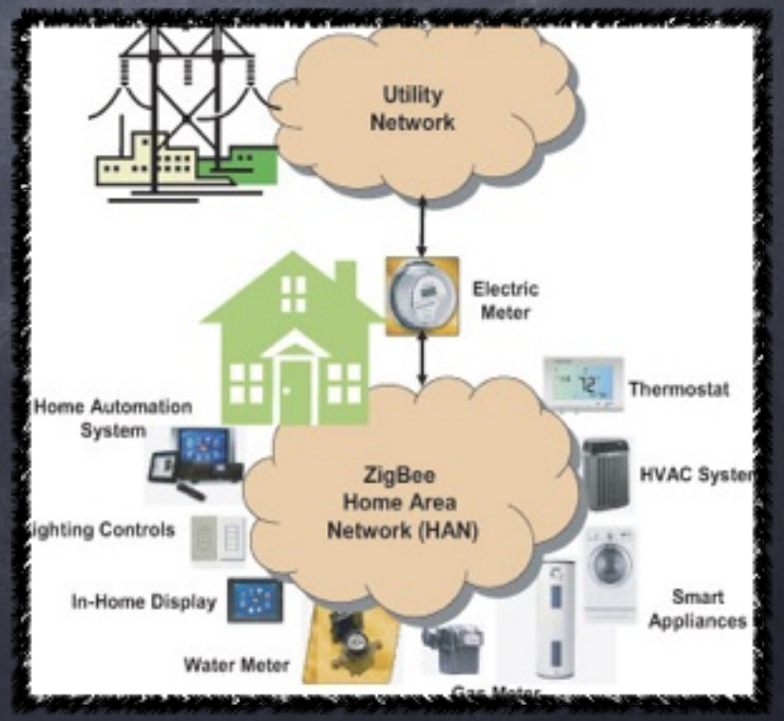



7/21/2011 12:00 EST
Always
Low Prices
Optical
WAL★MART
SUPERCENTER
Food Center COMING SOON!
Exit
Enter
PMVP Projects
PMVP Projects
Existing Transmission and Planned 345 kV+
Existing Transmission 345 kV+
LMP ($/MWh)
200+
100
90
76
62
50
30
0
-999
MISO - using Ventyx, Velocity Suite © 2011

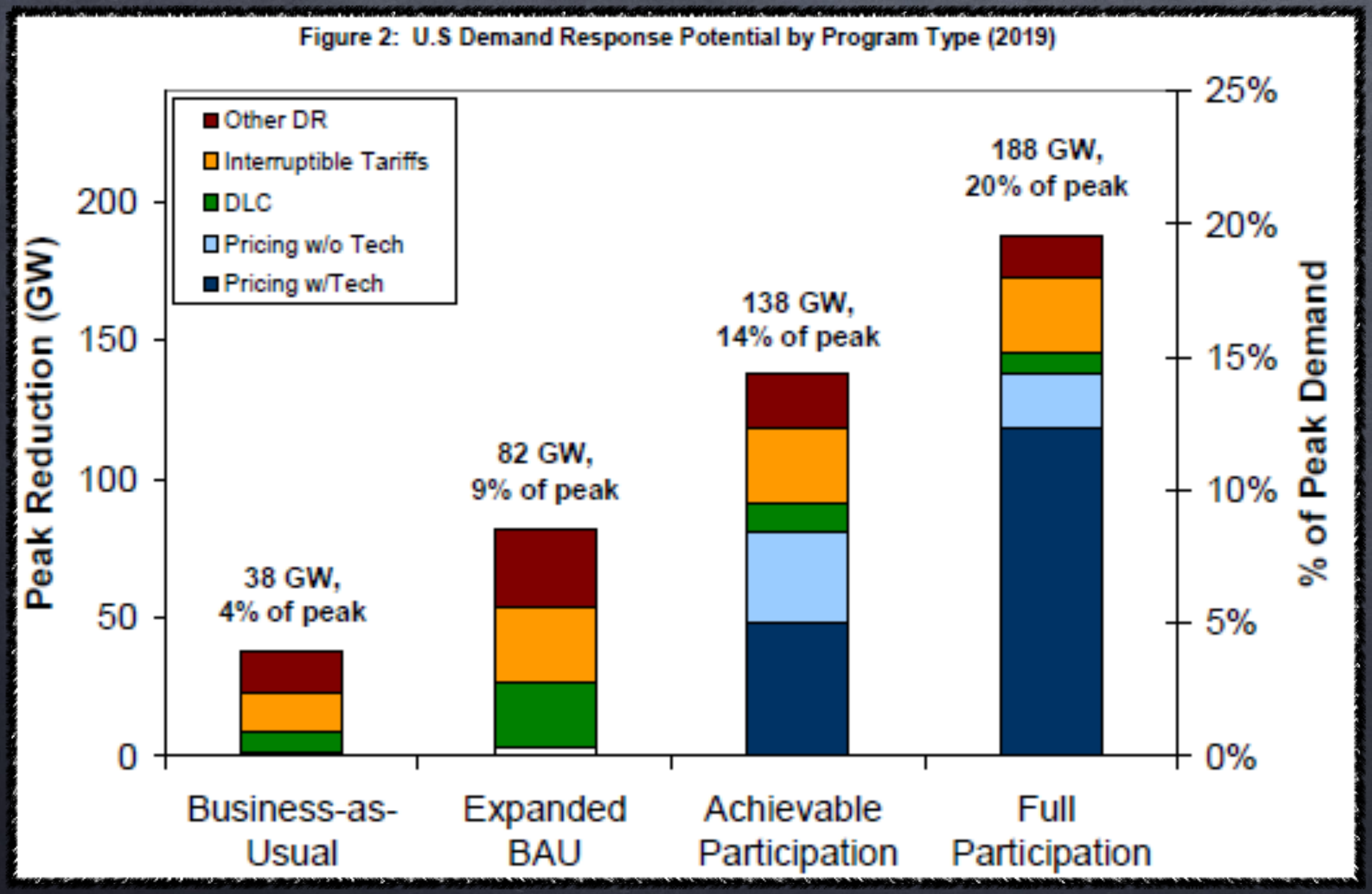
FERC Assessment of DR Potential - Prepared in 2009 - 10yr Scenarios



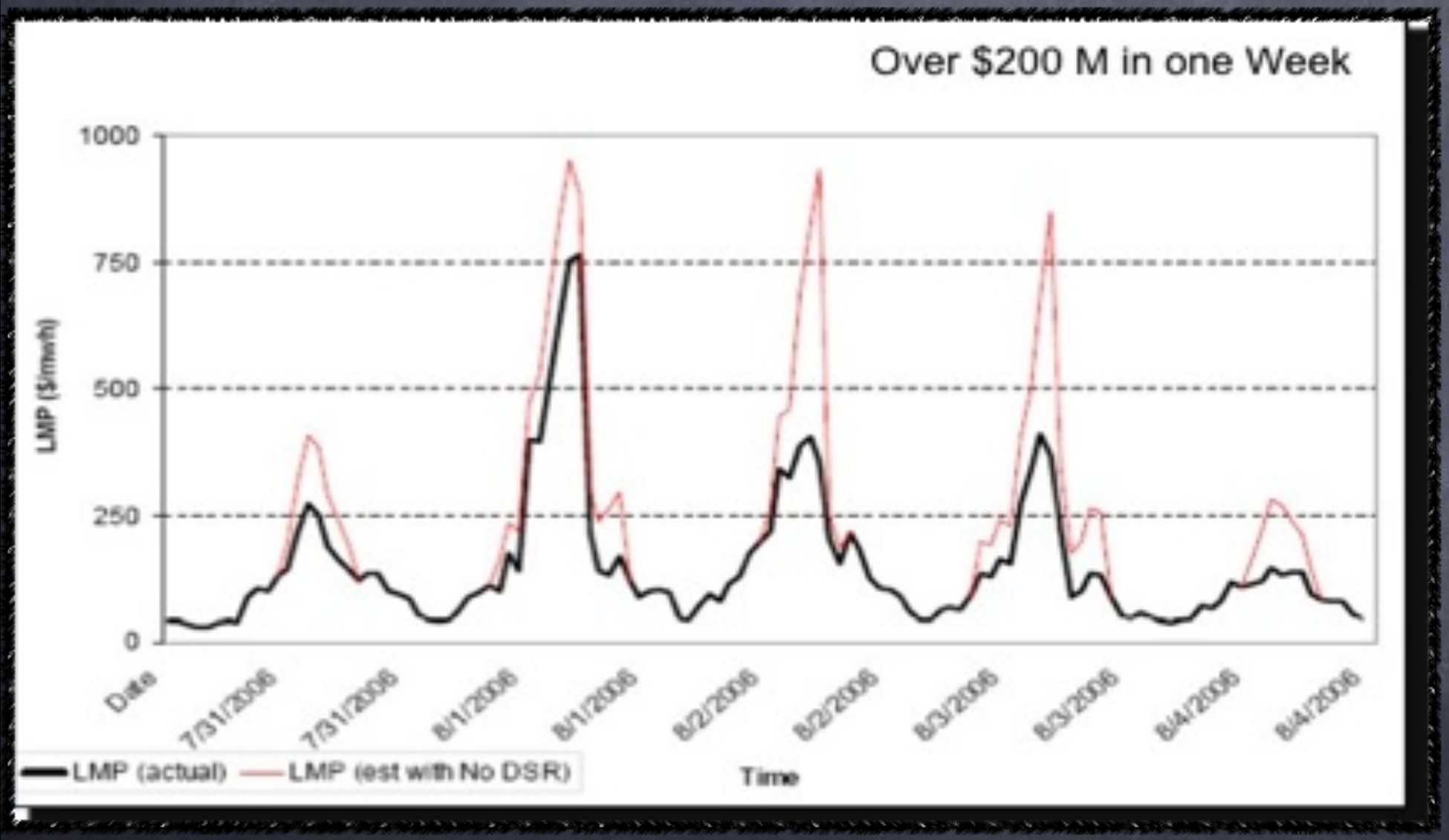




2009 FERC Assessment of DR Potential



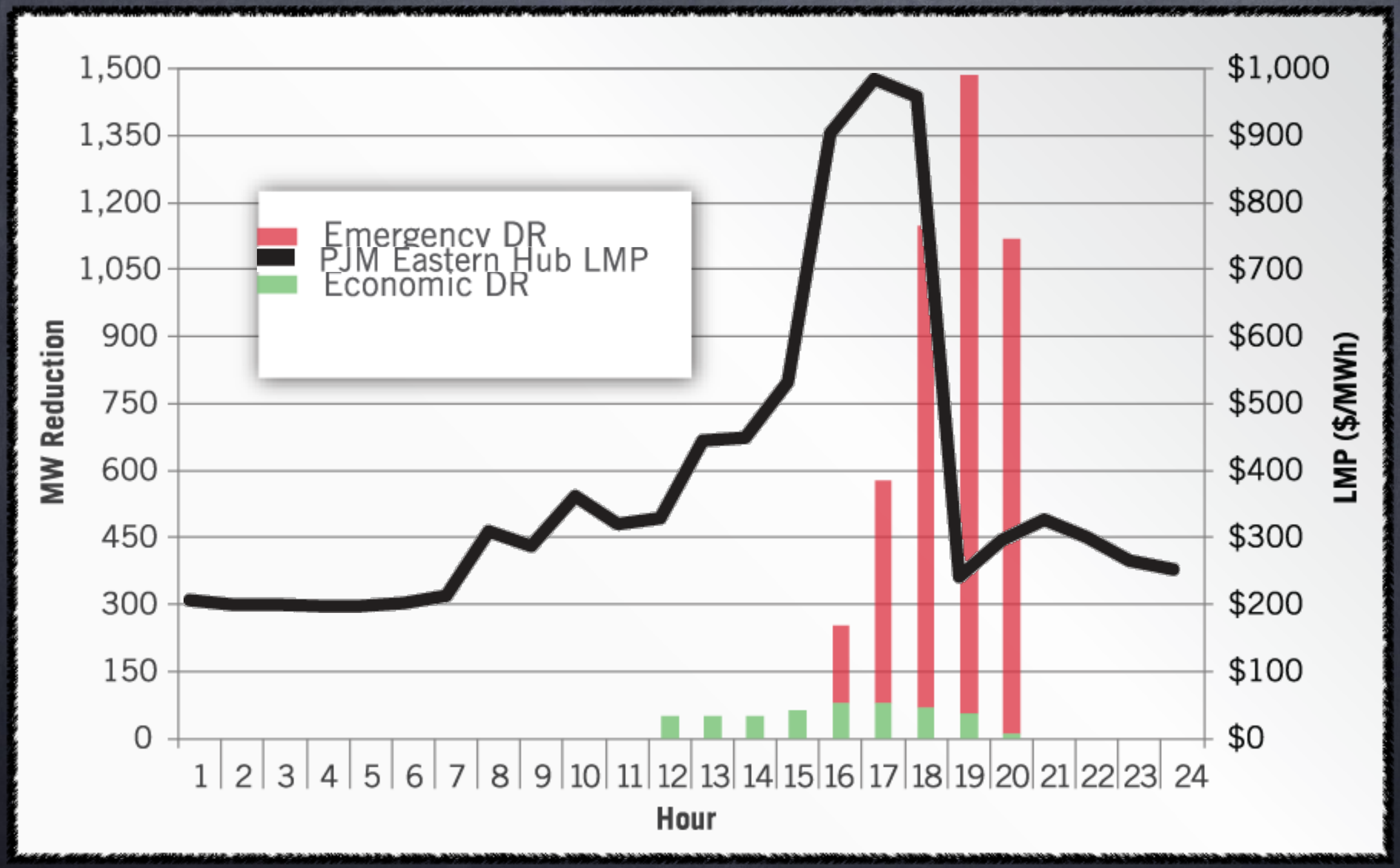
Grid Benefits of Demand Response



* PJM Study- a 3% Reduction in Demand of Top 20 5hr Blocks in 5 Mid-Atlantic States Could Save $280 Million annually

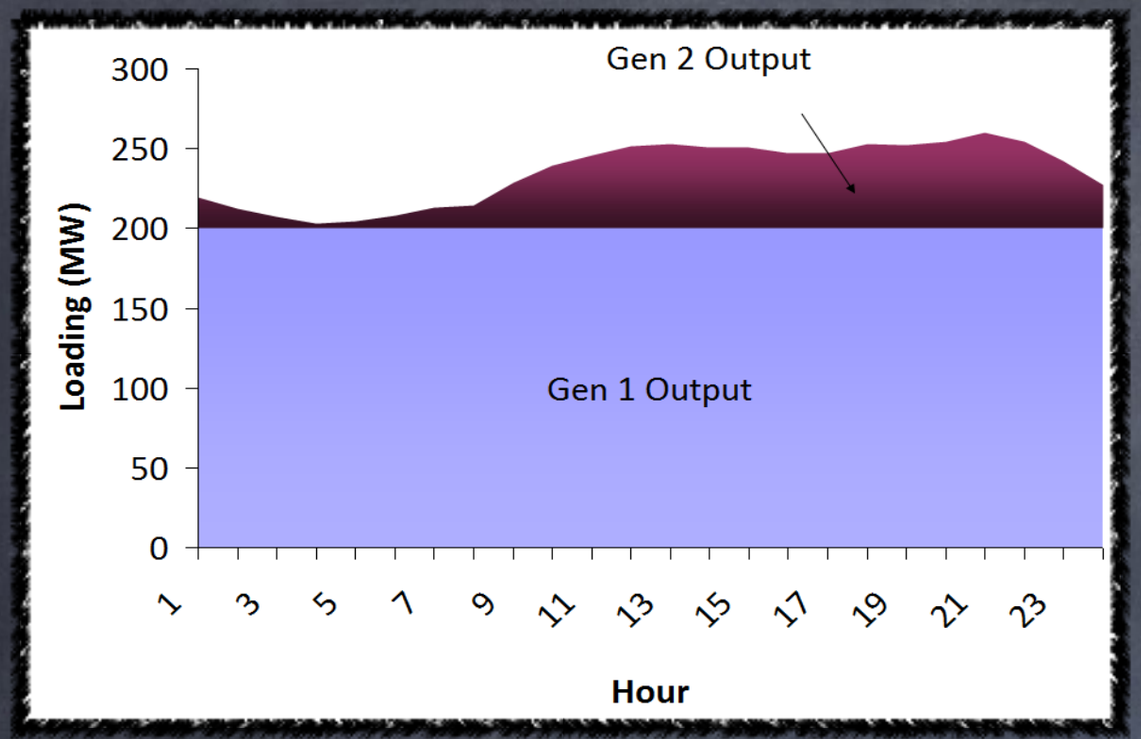
* Brattle Group- a 5% Reduction in Grid Peak Load Results in $3 Billion Savings Annually, for NPV Over 20 Yrs of $31 Billion

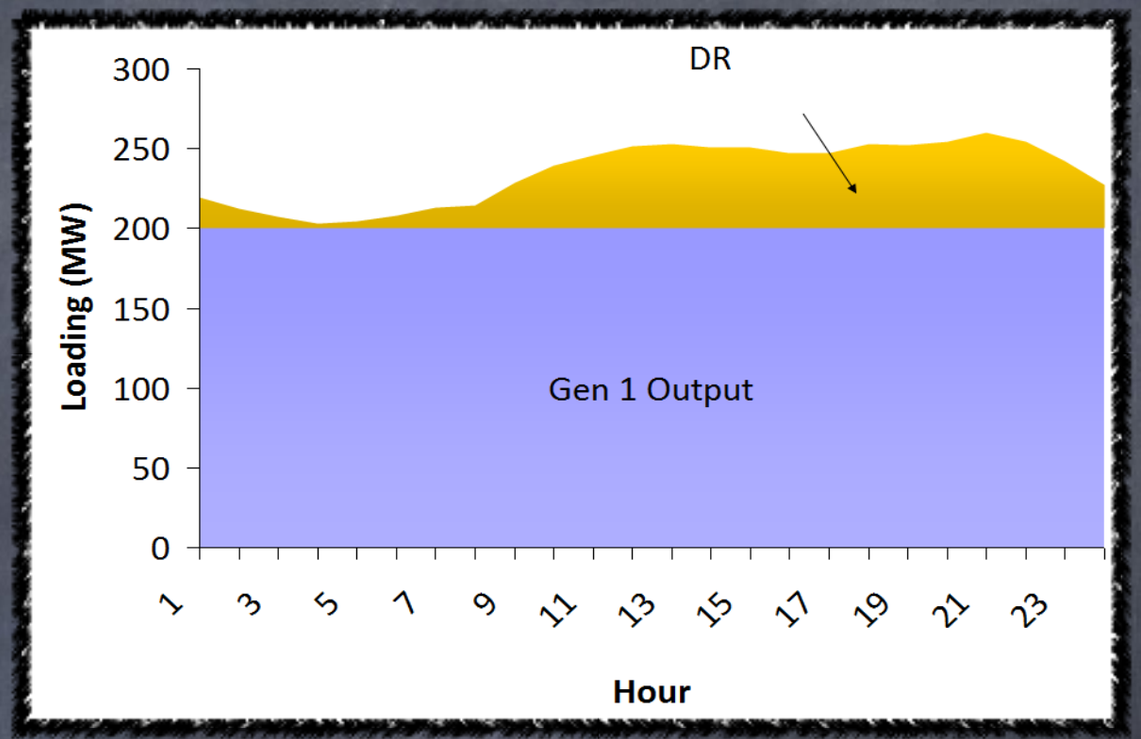
DR in PJM on May 31, 2011



Combustion Turbine Example - Fuel Usage with and without DR

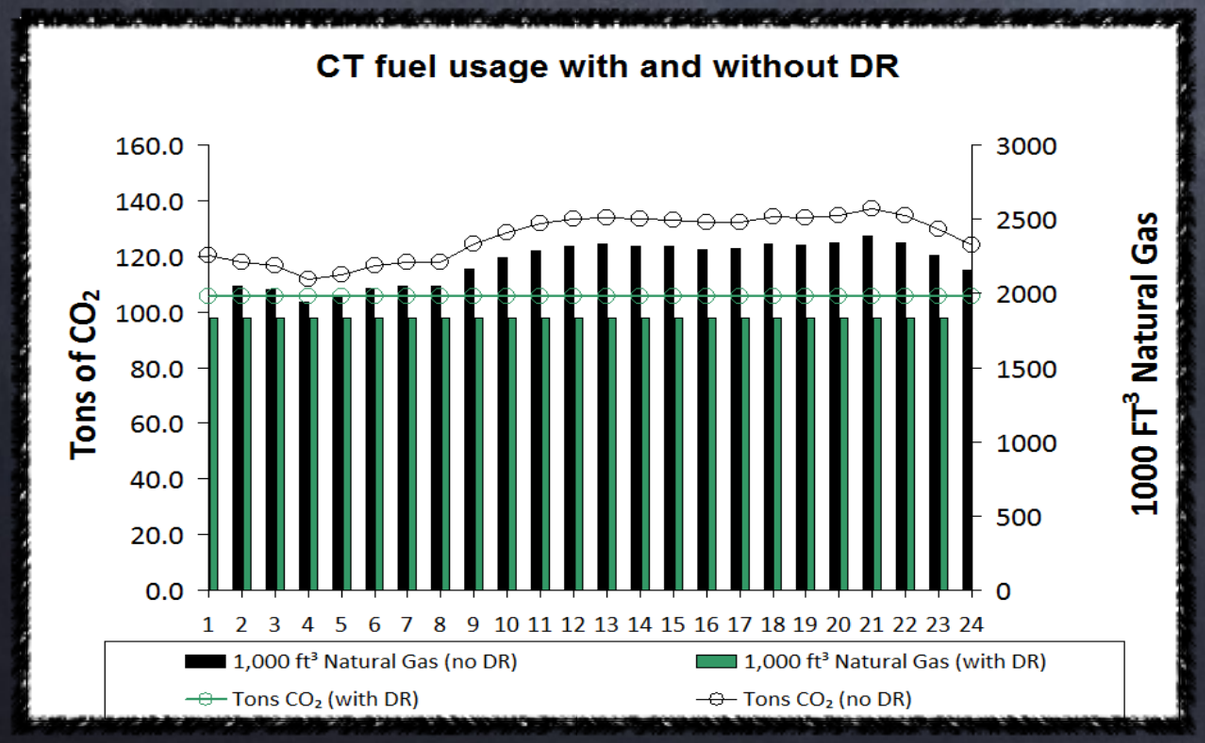
Note: Assumed that Gen 2 can be dispatched at very low levels for the example, a more realistic scenario would place a higher minimum run level on Gen 2

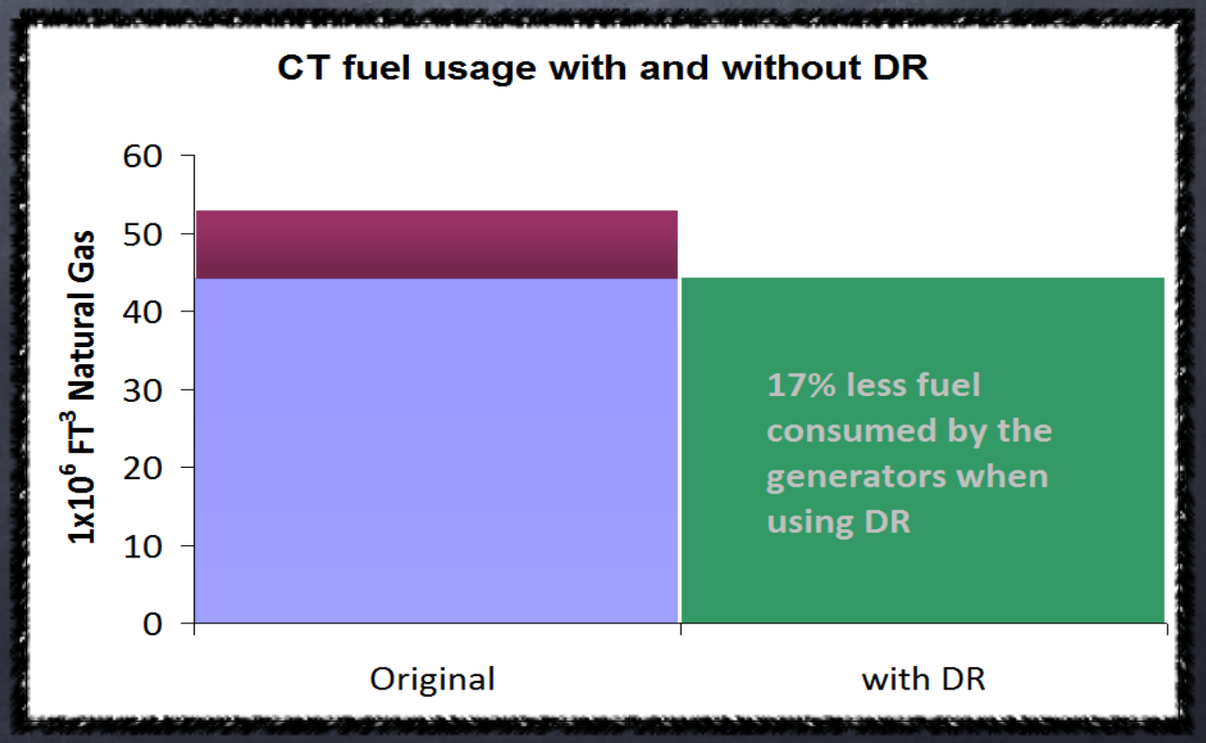




More total MWh reduced than in the coal example.

Emissions Reduction ~ 511 tons CO_2, 827 lbs NO_x





FERC: The Benefits of Demand Response:

* Lower demand/lower price
* Flatten load profile reducing costly generation
* Reduces generator market power
* Enhanced reliability
* Supports renewable power
* Reduces emissions & generator maintenance

Demand Response Utility-controlled or Consumer-controlled?

*Who will deliver DR?

- regulated utilities or firms competing in markets?

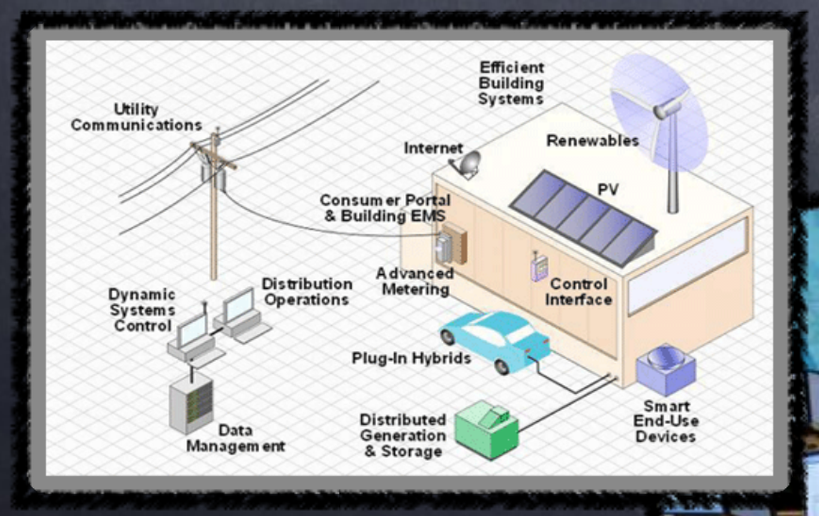
*Who will control the "smarts":

- utility or consumer, or both?
- Curtailment or Dynamic Pricing?

*And how do choices impact:

- energy, carbon, system integrity
- likelihood innovative business models will scale?

"You're not coming by to put this on my house, period."



- "I am against it. It's an infringement on our rights and our liberties."

Power (kW)
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
10:00 PM
10:10 PM
10:20 PM
10:30 PM
10:40 PM
10:50 PM
11:00 PM
Mains
Refrigerator
Family room
Dishwasher
Laundry
A/C - Down
A/C - up
Air Handler - up
Furnace - down
Sump pump

Mountain View, CA
Klamath
Orick
Orleans
Etna
Weed
Siskiyou
Callahan
Mount Shasta
Dunsmuir
Cecilville
Lamoine
Blue Lake
Trinity
Weaverville
Big Bar
Fortuna
Redding
Platina
Anderson
Honeydew
Blocksburg
Whitethorn
Tehama
Paskenta
Corning
Leggett
Dos Rios
Willows
Hackamore
Lake City
Alturas
Likely
Ukiah
Lakeport
Clearlake
Calistoga
Santa Rosa
Sebastopol
Saint Helena
Napa
Petaluma
Vallejo
San Rafael
Concord
Berkeley
Stockton
San Francisco
Oakland
Alameda
Livermore
Daly City
Hayward
Modesto
Riverbank
Redwood City
Fremont
Milpitas
Sunnyvale
Patterson
Turlock
San Jose
Los Gatos
Morgan Hill
Santa Cruz
Capitola
Gilroy
Watsonville
Hollister
Marina
Salinas
Monterey
Seaside
Gonzales
Soledad
Greenfield
Big Sur
King City
Dos Palos
Firebaugh
Mendota
Fresno
Parlier
Selma
Kingsburg
San Joaquin
Hanford
Lemoore
Coalinga
Huron
Corcoran
Avenal
San Simeon
El Paso de Robles
Atascadero
Morro Bay
Buttonwillow
Bakersfield
Saltdale
California

FERC: Challenges to Getting to "Smart Response Grid":

*Full compensation to customers for smart response implementation

*Generators don't want to pay this compensation

*Must improve risk management and be integral to, rather than disruptive to, customer business/lifestyle

*Need implementation tools and must demonstrate benefits

*Need right tariffs in place to encourage investment

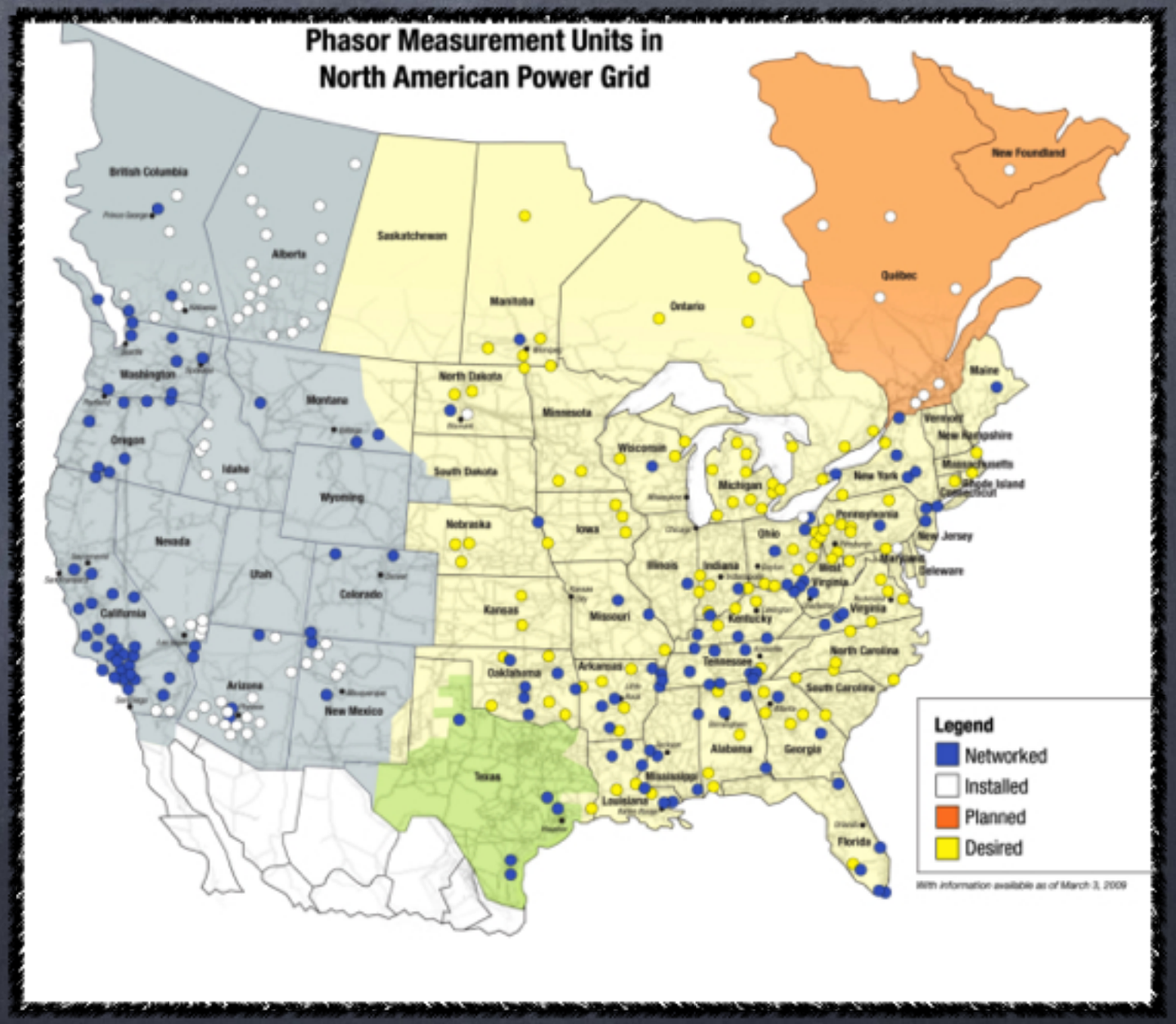
Conclusion:

*Consumers should be allowed to participate in wholesale markets to get money back from participating in stabilizing grid

*FERC Order 745

Transmission Smart Grid: US DOE Stimulus for PMUs

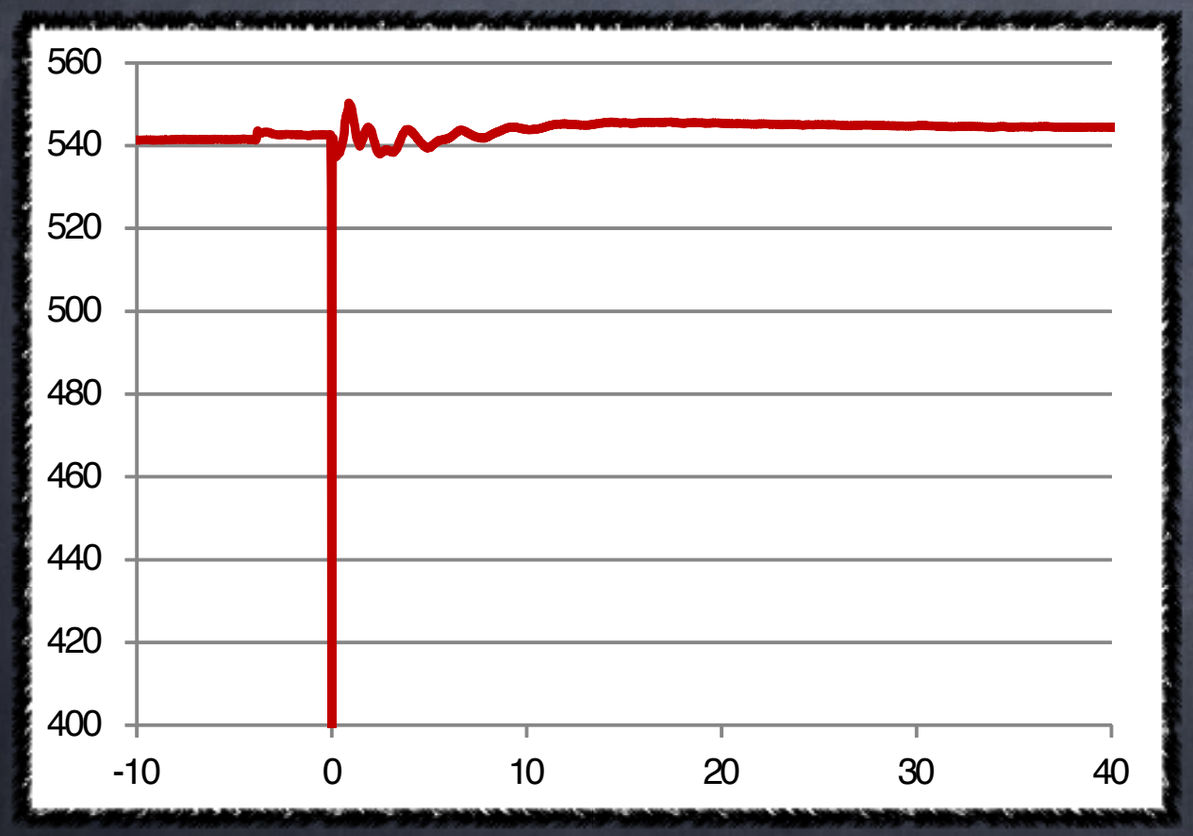
- WECC WISP: 300+ PMUs ($108M):
  WECC RC, PG&E, BPA, SCE, CISO, PAC, SRP, IPC, NVE
- PJM: 90 PMUs ($28M)
- NY ISO: 35 PMUs ($74M)
- MISO: 150 PMUs ($35M)
- ATC: 5 PMUs ($28M)
- Entergy: 18 PMUs ($10M)
- ISO New England: 30 PMUs ($9M)
- Duke Energy: 45 PMUs ($8M)
- Midwest Energy: 1 sub ($1.5M)



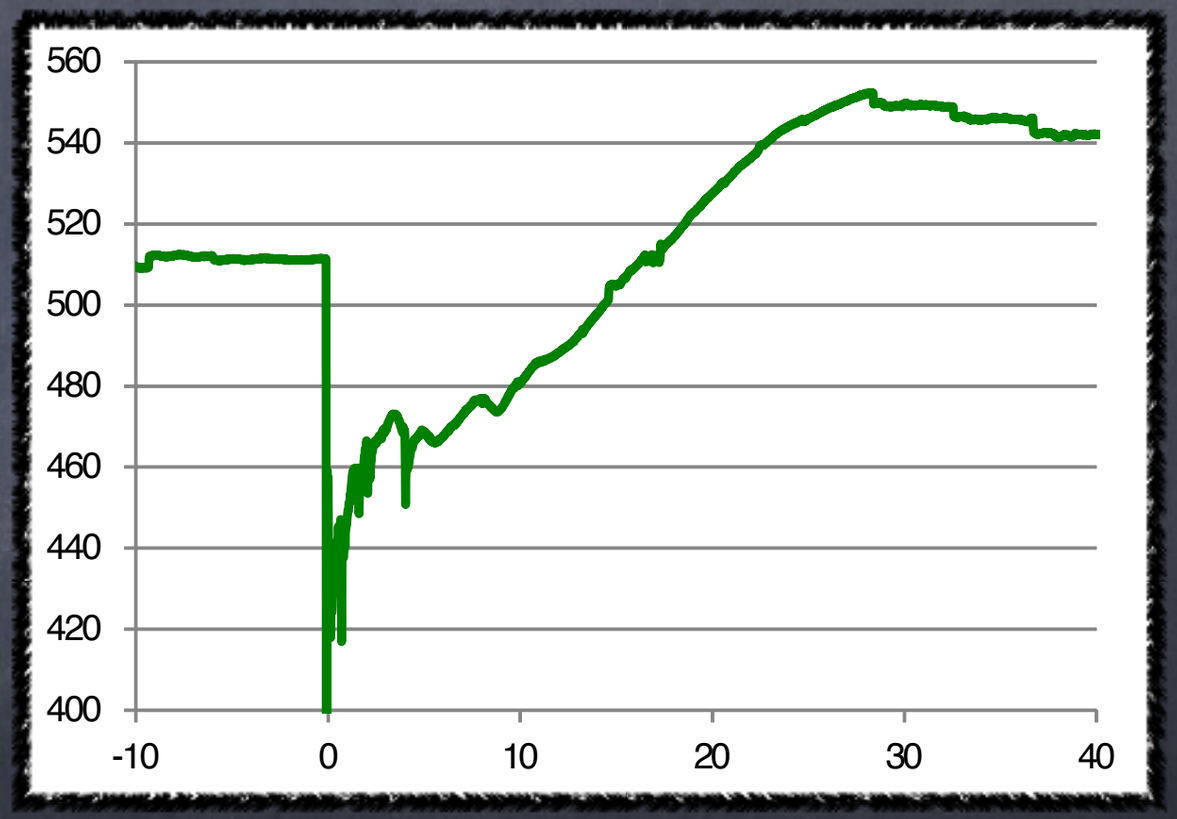
Source: NASPI (www.naspi.org)

Changing Nature of Electrical Loads

Synchro-phasor data help transmission planners better understand implications of changing electrical loads, so they can make timely and appropriate capital investments.



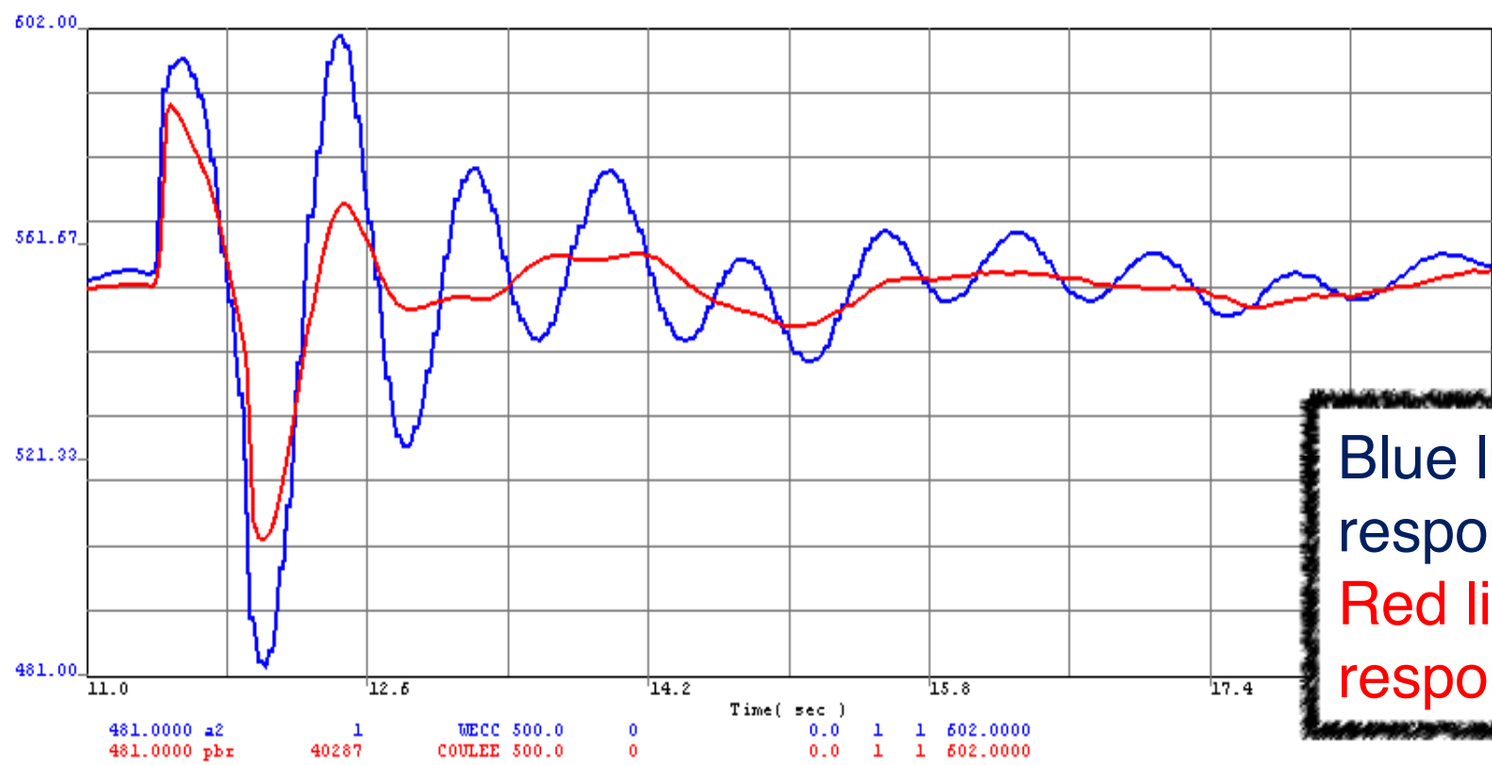
Transmission voltage during a fault in area with mainly resistive loads



Transmission voltage during a fault in area with high amount residential air-conditioning load

Using PMU Data for Detecting Generator Control Failures

* Controller status at generator indicated normal
* PMU, disturbance data indicated actual response
* Power plant contacted, controls inspected, failure found



Blue line = actual response

Red line = expected response

UTILITY
CONSUMER
Integrated Enterprise-Wide Advanced Control Systems
Consumer Energy Management Systems & Networks
Soft Grid: Data Storage, and Analytics
Grid Support: Managing distributed energy
Network Operations: Network monitoring and control
Demand Side Management: Energy management systems, portals and apps
Meter Data
REMOTE BUILDING ANALYTICS
Communication Layer (H/W, S/W/ Control)
Power Layer Infrastructure
Generation
Transmission
Substation
Distribution
Home/Building/Data Centers
Distributed Generation and Storage
Utility
Infrastructure
Consumer
Security
Integration and
Platform and
Industrial Defender
OPOWER
FIRSTFUEL
BUILDING ENERGY ANALYTICS
ENERNOC
Power flow control for the Grid
Swg
GRIDCO SYSTEMS