GRIDWEEK

Investing in our Energy Future

Secretary Steven Chu
U.S. Department of Energy
Washington, D.C.
September 21, 2009

Recovery Act is making a down payment on a clean energy economy

Creating jobs immediately

Investing in our energy infrastructure to provide lasting value

"The nation that leads the world in creating a new clean energy economy will be the nation that leads the 21st century global economy."

-- President Obama

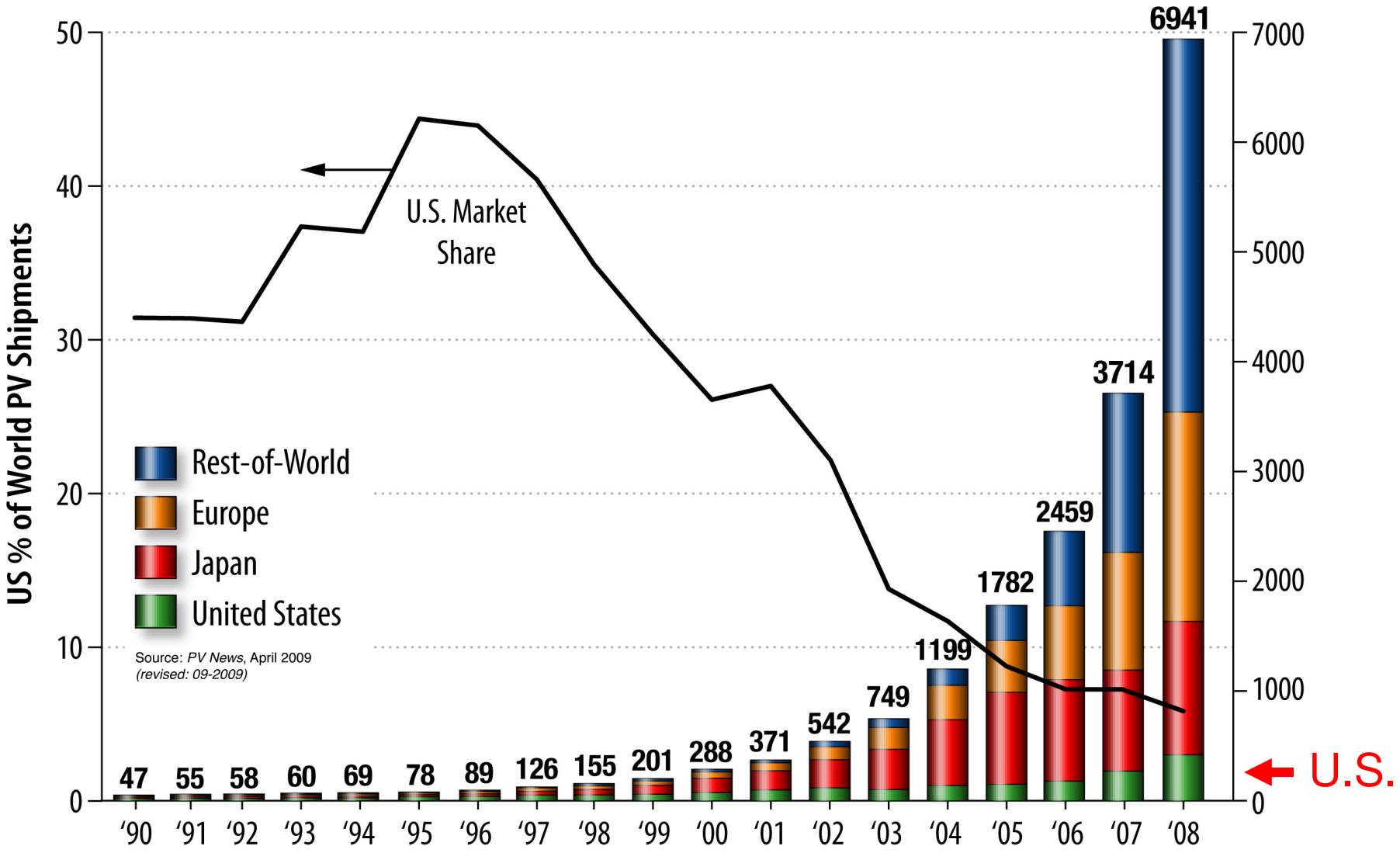
"We'll fund a better, smarter electricity grid and train workers to build it -- a grid that will help us ship wind and solar power from one end of this country to another."

"Think about it. The grid that powers the tools of modern life -- computers, appliances, even BlackBerrys -- looks largely the same as it did half a century ago."

President Barack Obama

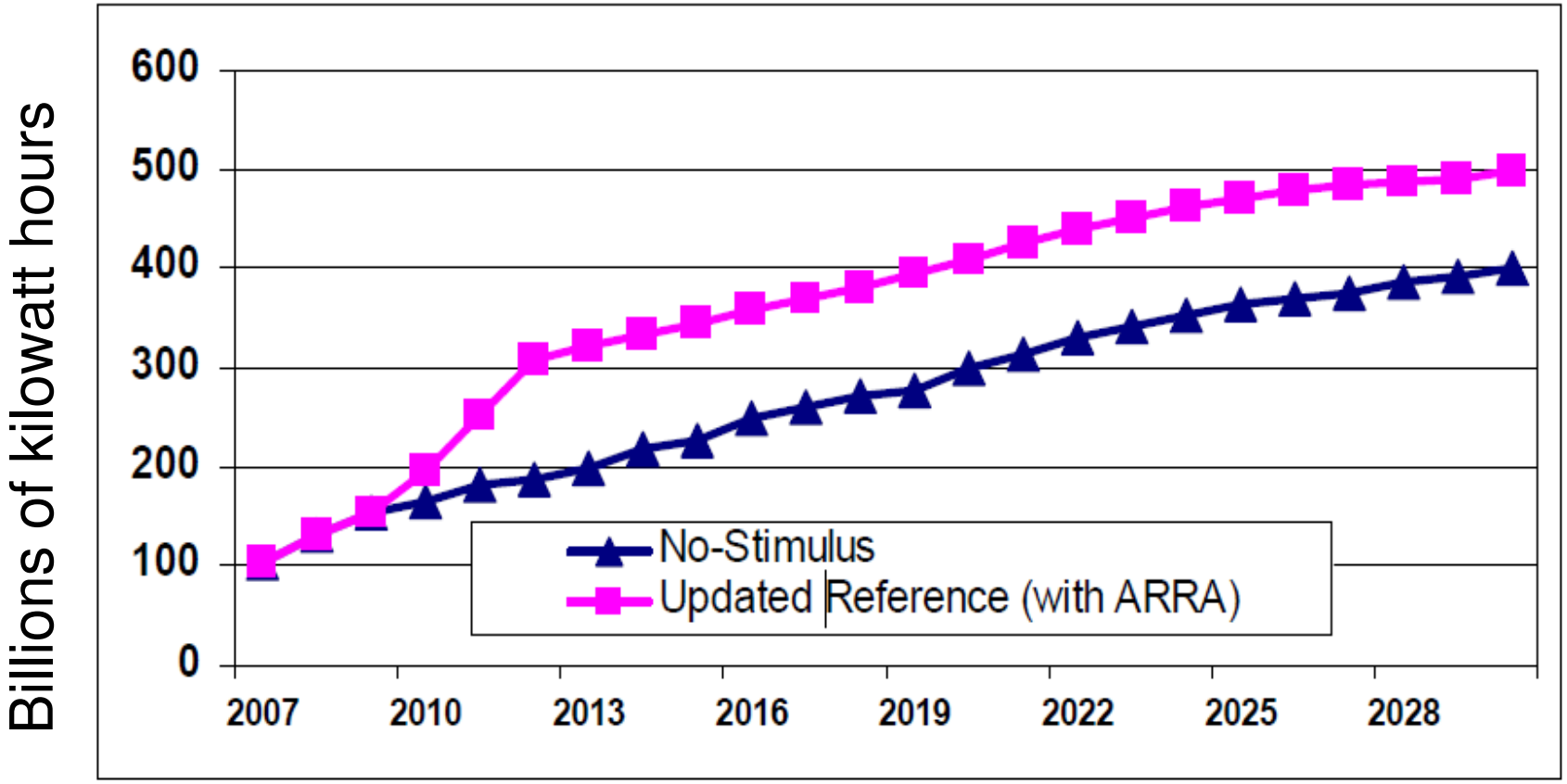
To meet the energy challenge and create a 21st century energy economy, we need a 21st century electric grid

U.S. falling behind in clean energy race



Worldwide shipments of Solar Photovoltaics – in Megawatts

Recovery Act will double non-hydroelectric renewable generation



Source: EIA -- An Updated Annual Energy Outlook 2009 Reference Case

Recovery Act will set the stage for widespread deployment of plug-in hybrid electric vehicles

Recently made $2.4 billion investment in advanced batteries – the largest battery investment in world history

Today, 99 percent of batteries for hybrids are made in Japan

The Recovery Act invests in grid modernization

Grid Modernization- $4.5 billion including Smart Grid Investment Grants and Demonstrations

$750 million for transmission loan guarantees

WAPA and BPA – total of $6.5 billion in borrowing authority

Today, we are announcing:

The availability of $100 million

To train a new generation of utility workers

$44.2 million in awards to State Public Utility Commissions

To hire and retrain PUC staff as utilities ramp up Smart Grid activities

The Smart Grid: What is it?

- Dynamic optimization of grid operations and resources
- Incorporation of demand response and consumer participation

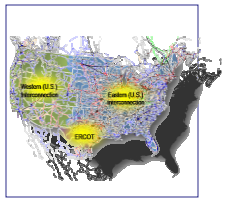
Measurement → Visualization → Automation

Smart Grid is a key *enabler* to Grid Modernization

Renewable Integration – *Addressing variability and intermittence of large-scale wind generation*

Energy Storage – *Providing regulation and load shaping*

Load Management – *Making consumer demand an active tool in reducing the peak*



System Transparency – *Seeing and operating the grid as a national system in real-time*

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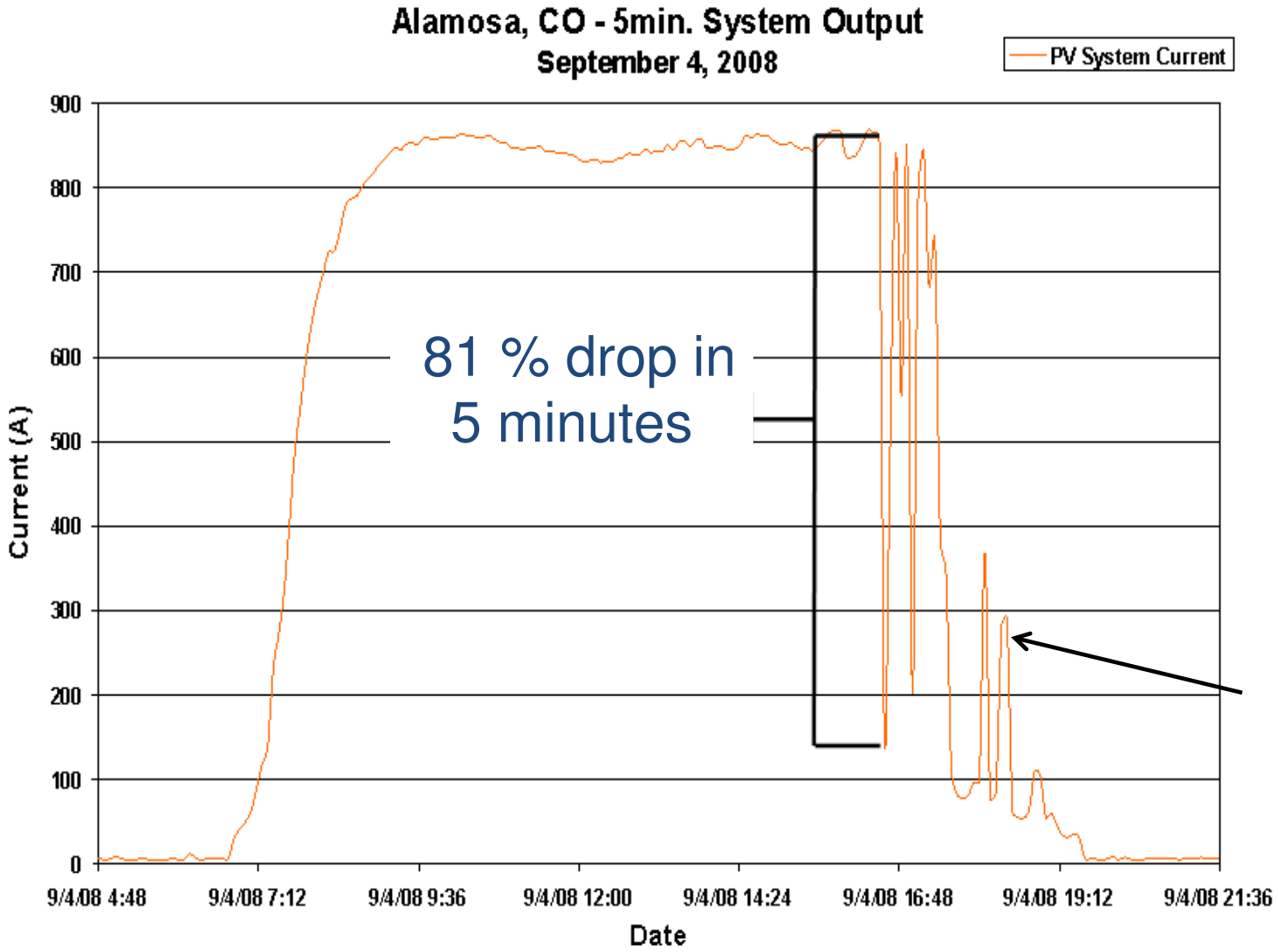
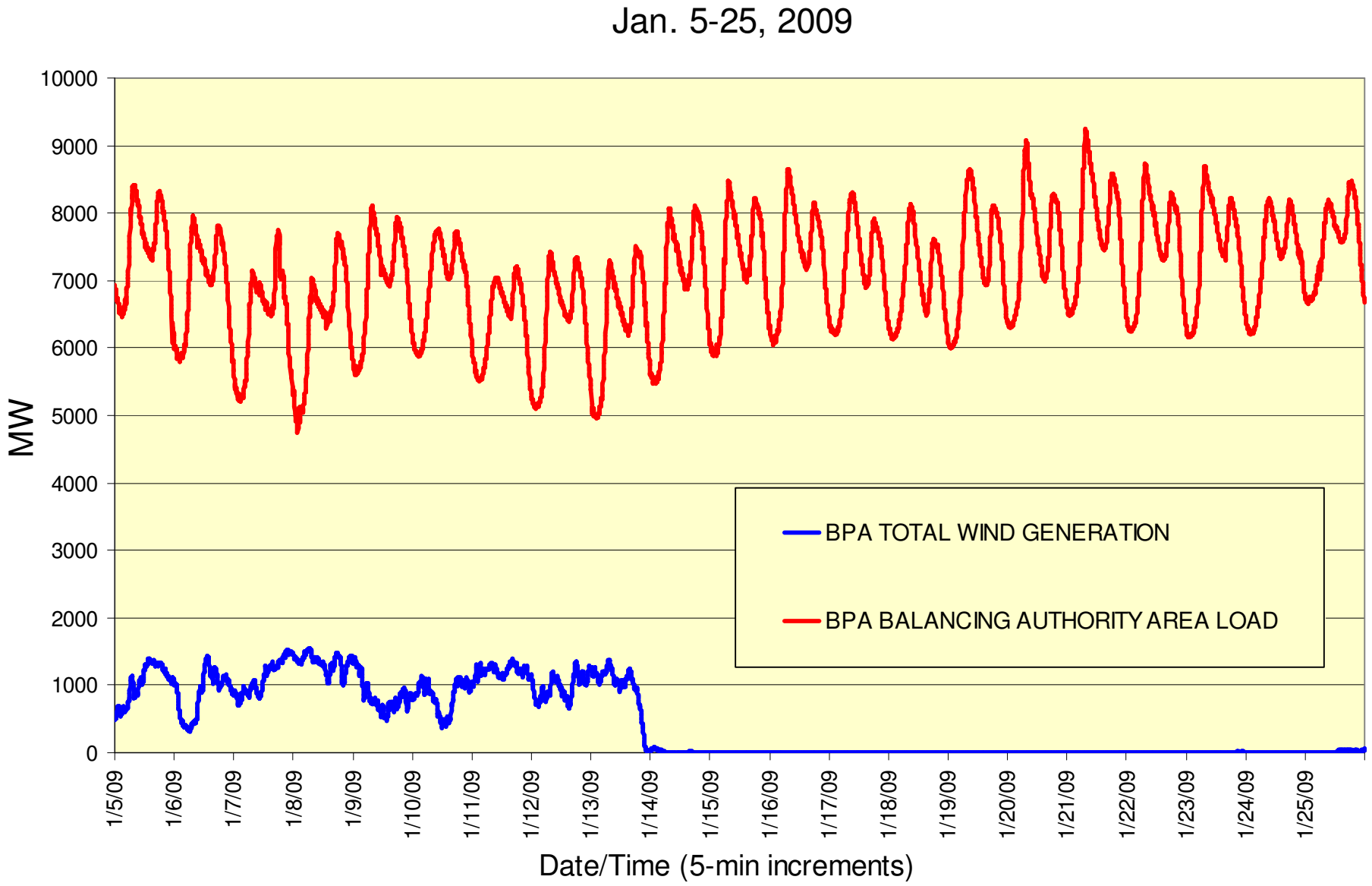
Solar energy sources are highly variable

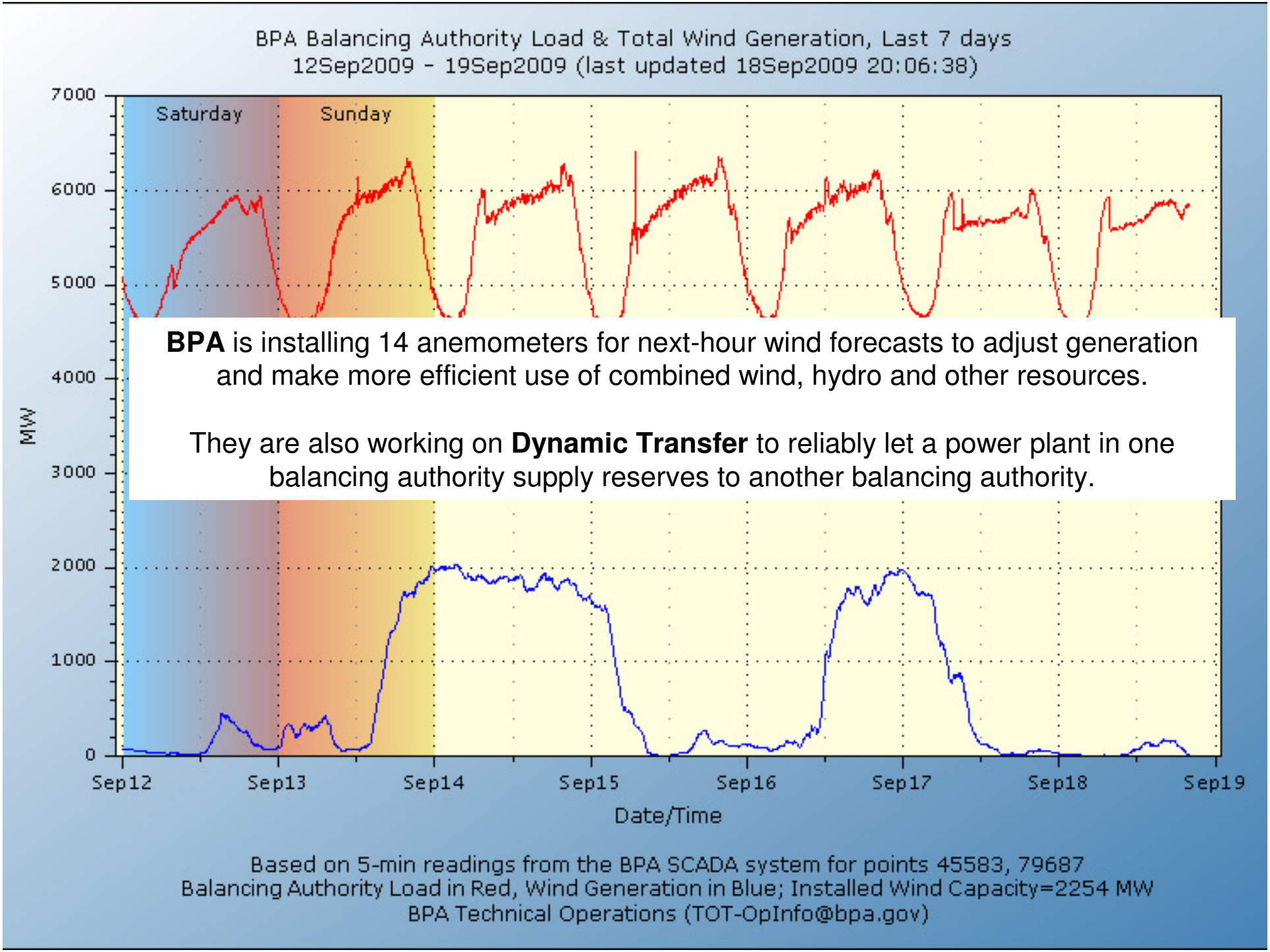


Output from an 8MW solar PV panel in Colorado on 9/4/08

High variability due to clouds

Wind requires substantial balancing reserves



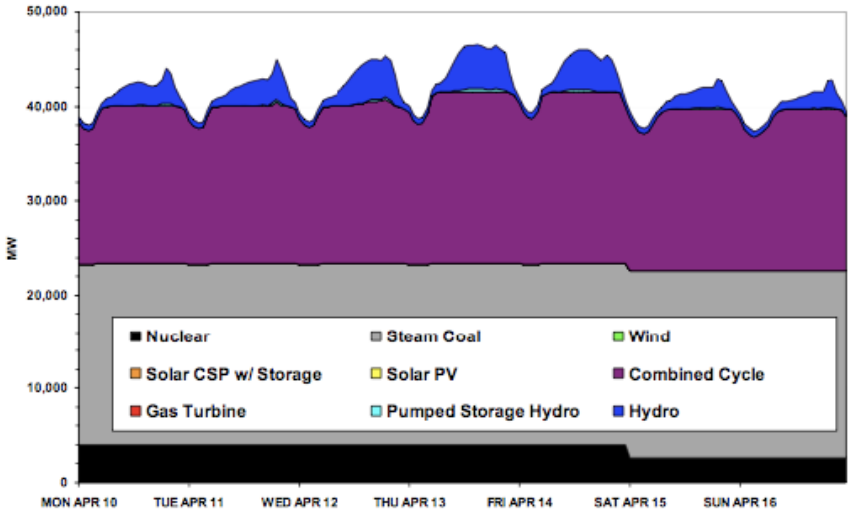


BPA is installing 14 anemometers for next-hour wind forecasts to adjust generation and make more efficient use of combined wind, hydro and other resources.

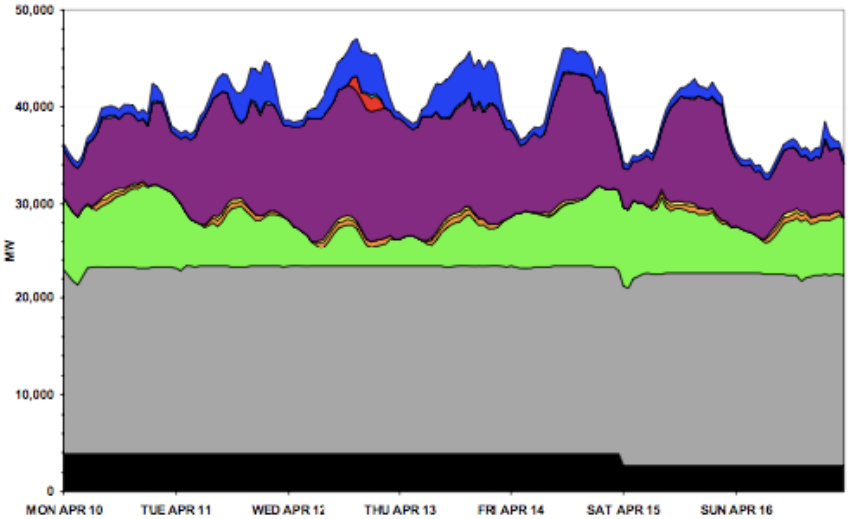
They are also working on **Dynamic Transfer** to reliably let a power plant in one balancing authority supply reserves to another balancing authority.

Variable Generation Affects Grid Operations

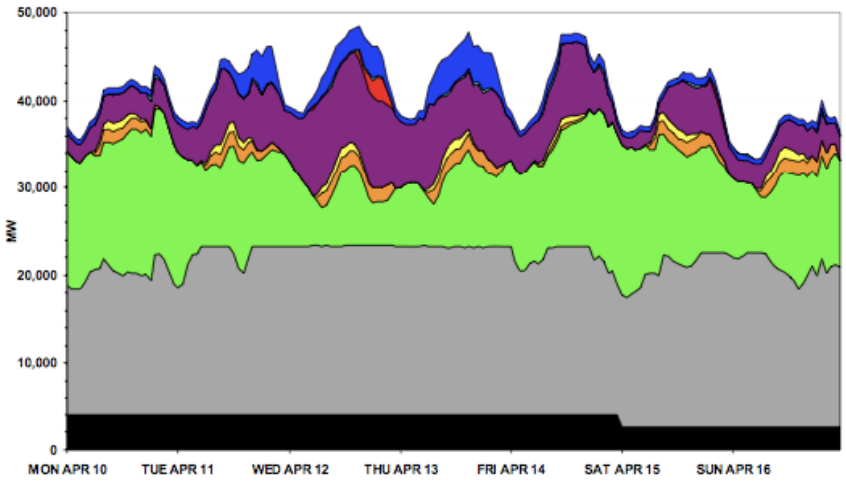
No wind



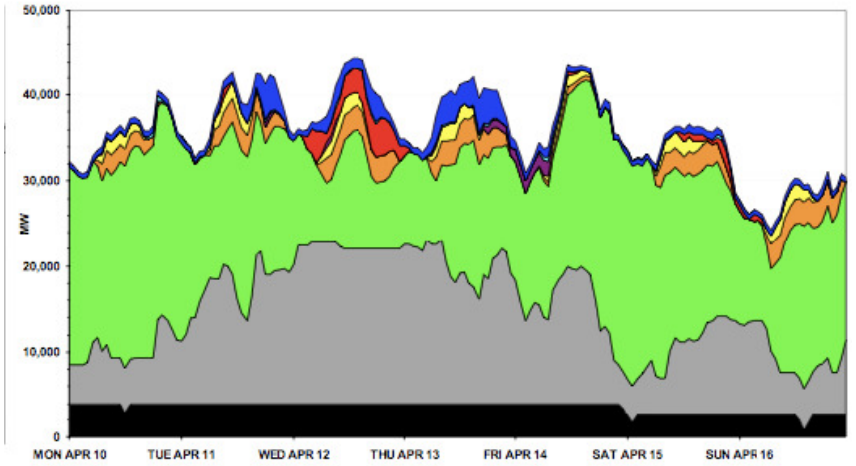
11% renewables



23% renewables



35% renewables



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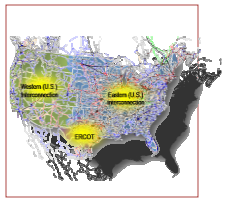
Energy Storage – *Providing regulation and load shaping*

Load Management – *Making consumer demand an active tool in reducing the peak*



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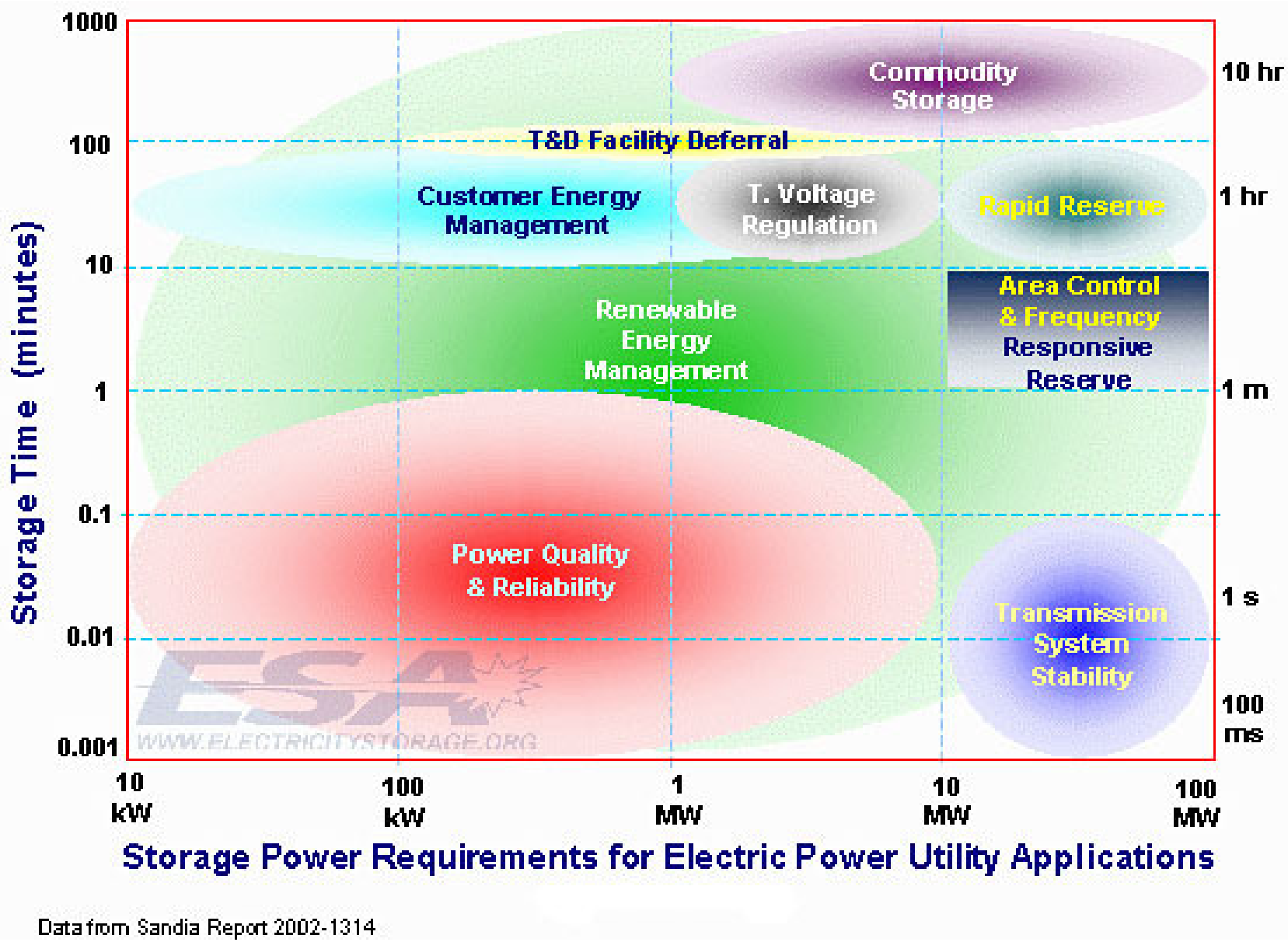
Energy Storage is critical to grid operations



Data from Sandia Report 2002-1314

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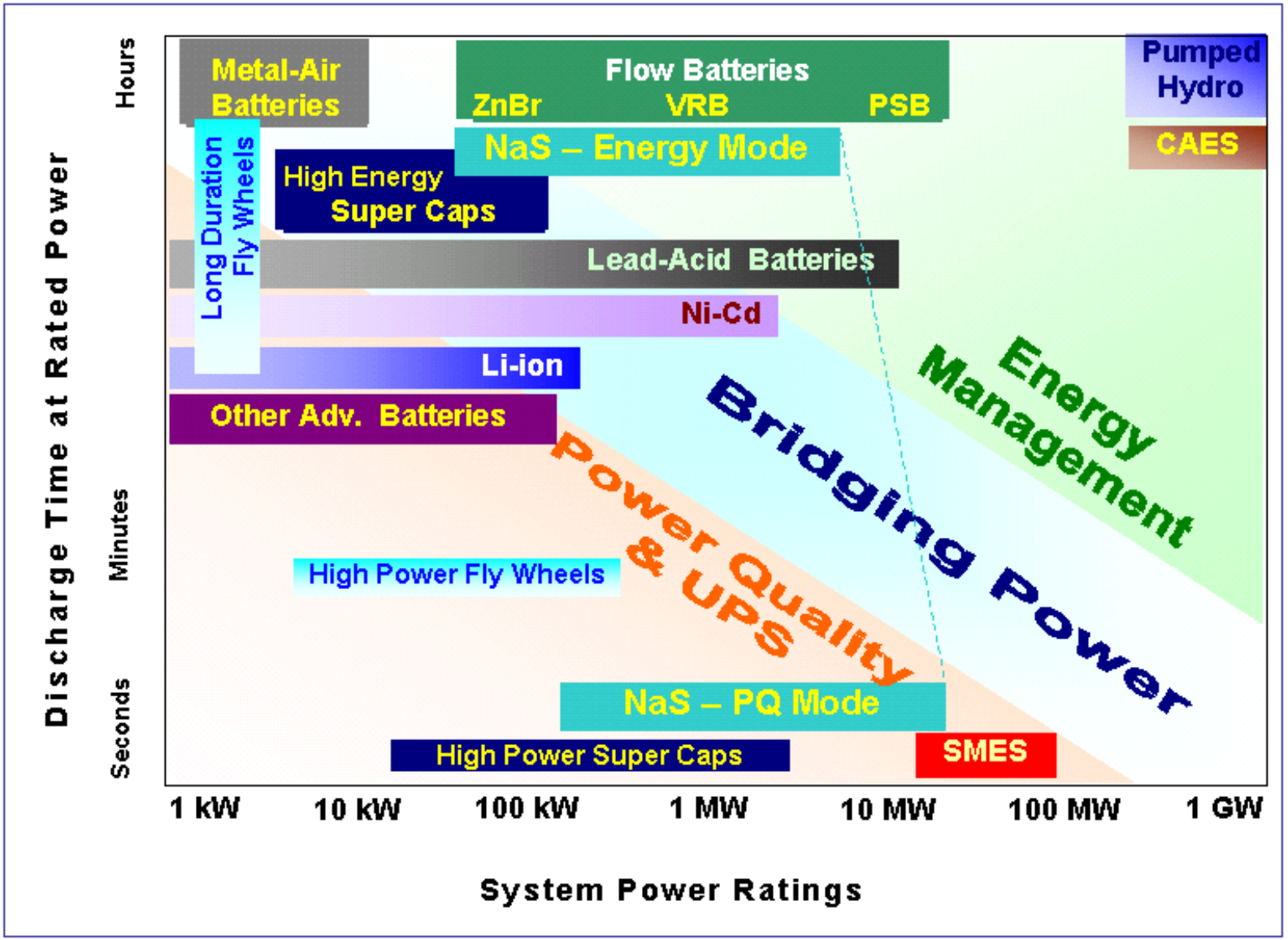

Pumped Storage

Grand Coulee Dam

Pumped Storage can provide:

- Rapid response in "pump-up" and generating modes to offset wind generation variability
- Store wind energy during lower value periods
- Prevent wind curtailment and avoid new transmission investments

- Additional capital and operating costs have to be compared to the cost of spinning reserves
- Energy losses (~20%) related to storage

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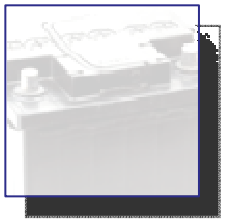

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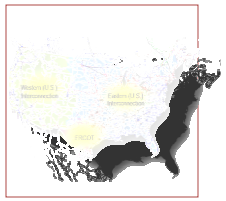

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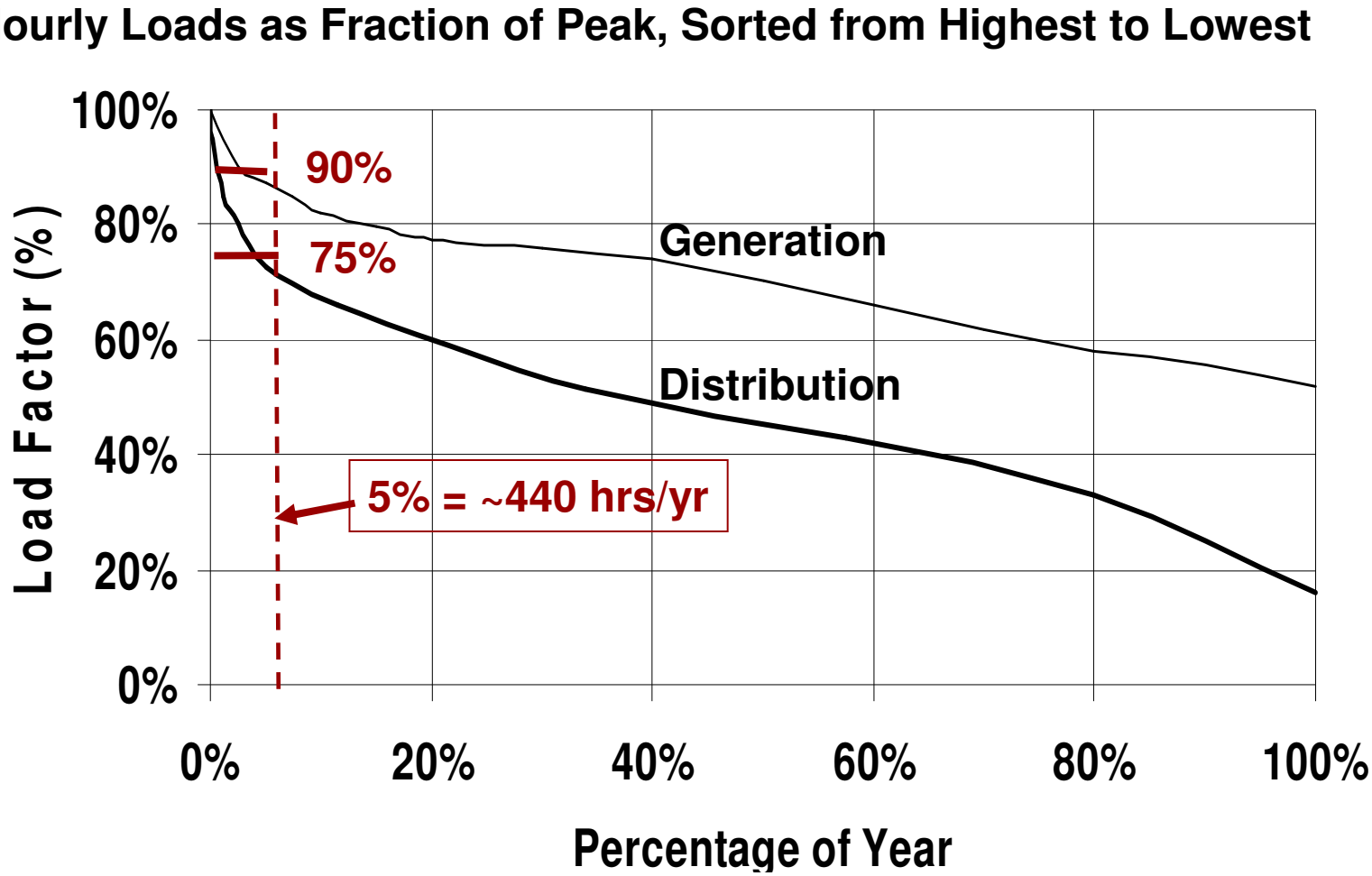
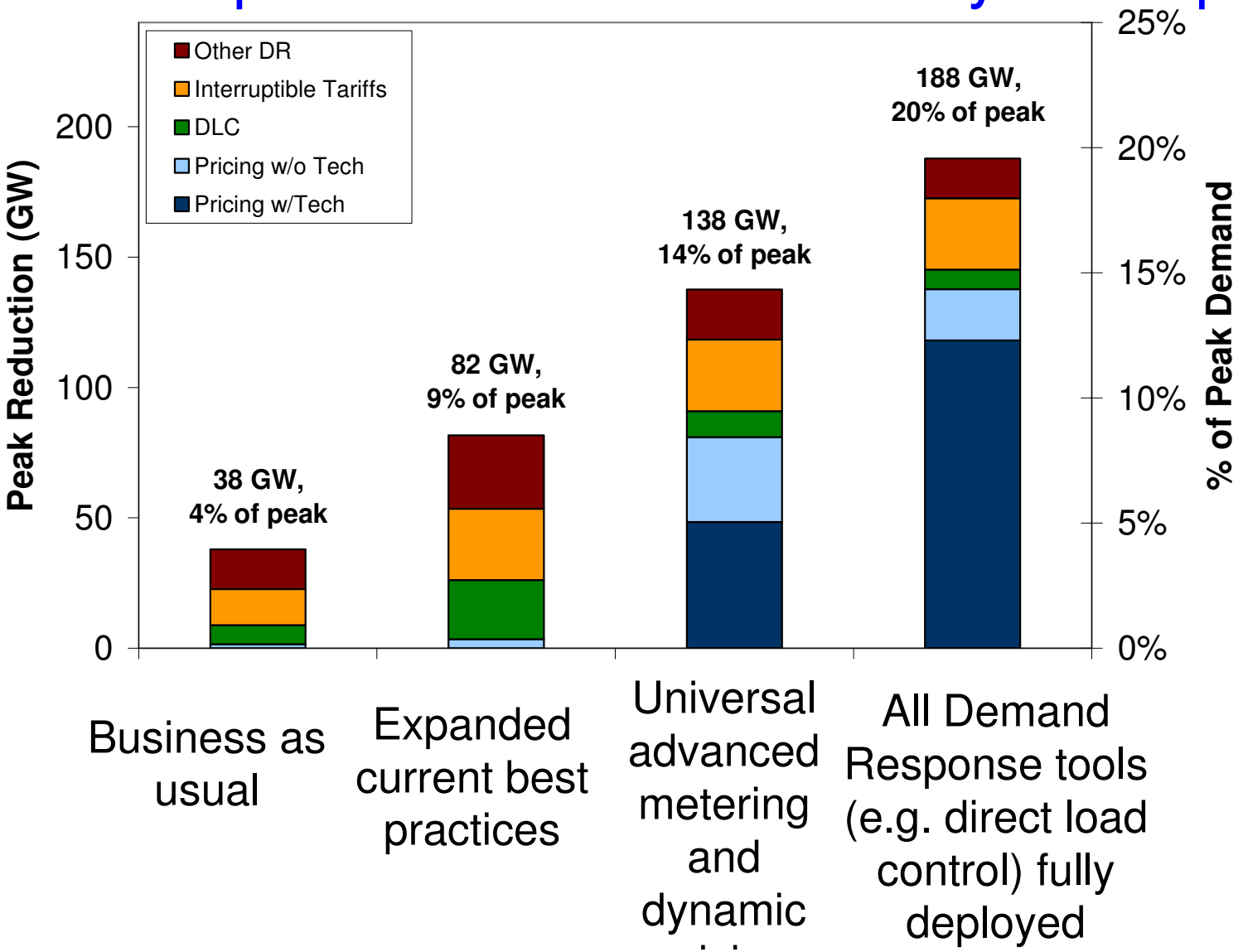
Peak Reduction is Paramount



>25% of distribution and >10% of generation assets are needed less than 5% of the time ($100s of billions of investments)

Achieving peak demand reduction requires a Smart Grid and dynamic pricing

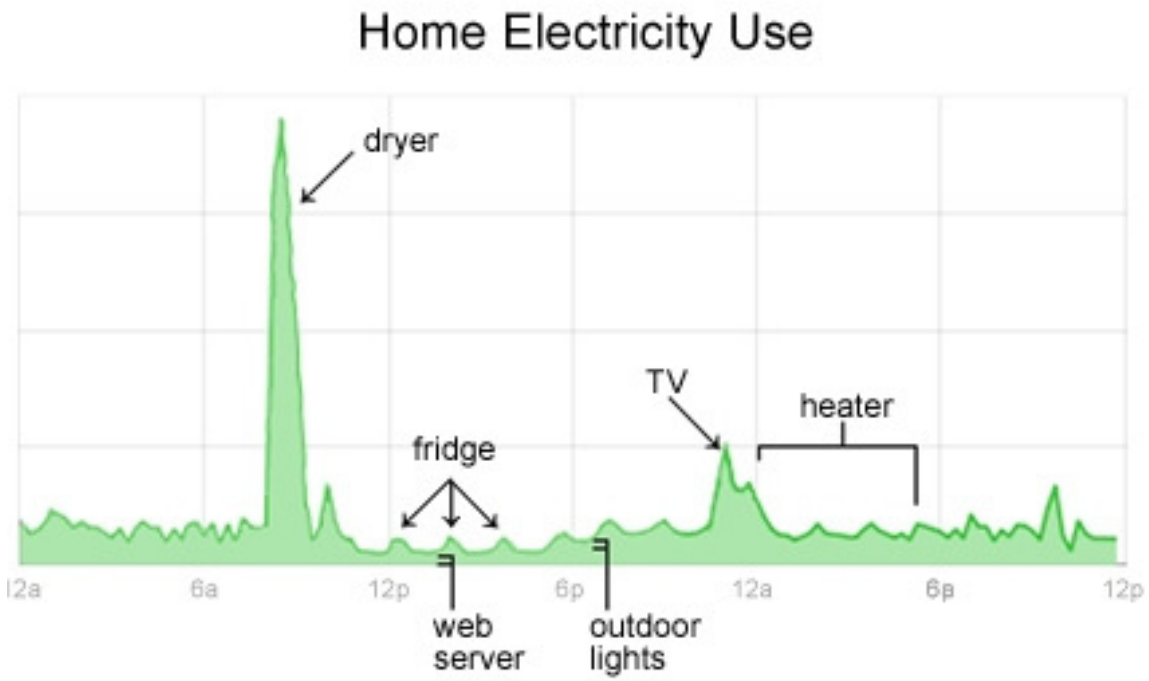


Light blue: *reductions through dynamic pricing*

Dark blue: *reductions through Smart Grid technology*

Source: FERC, June 2009 National Assessment of Demand Response Potential

Changing Consumer Behavior



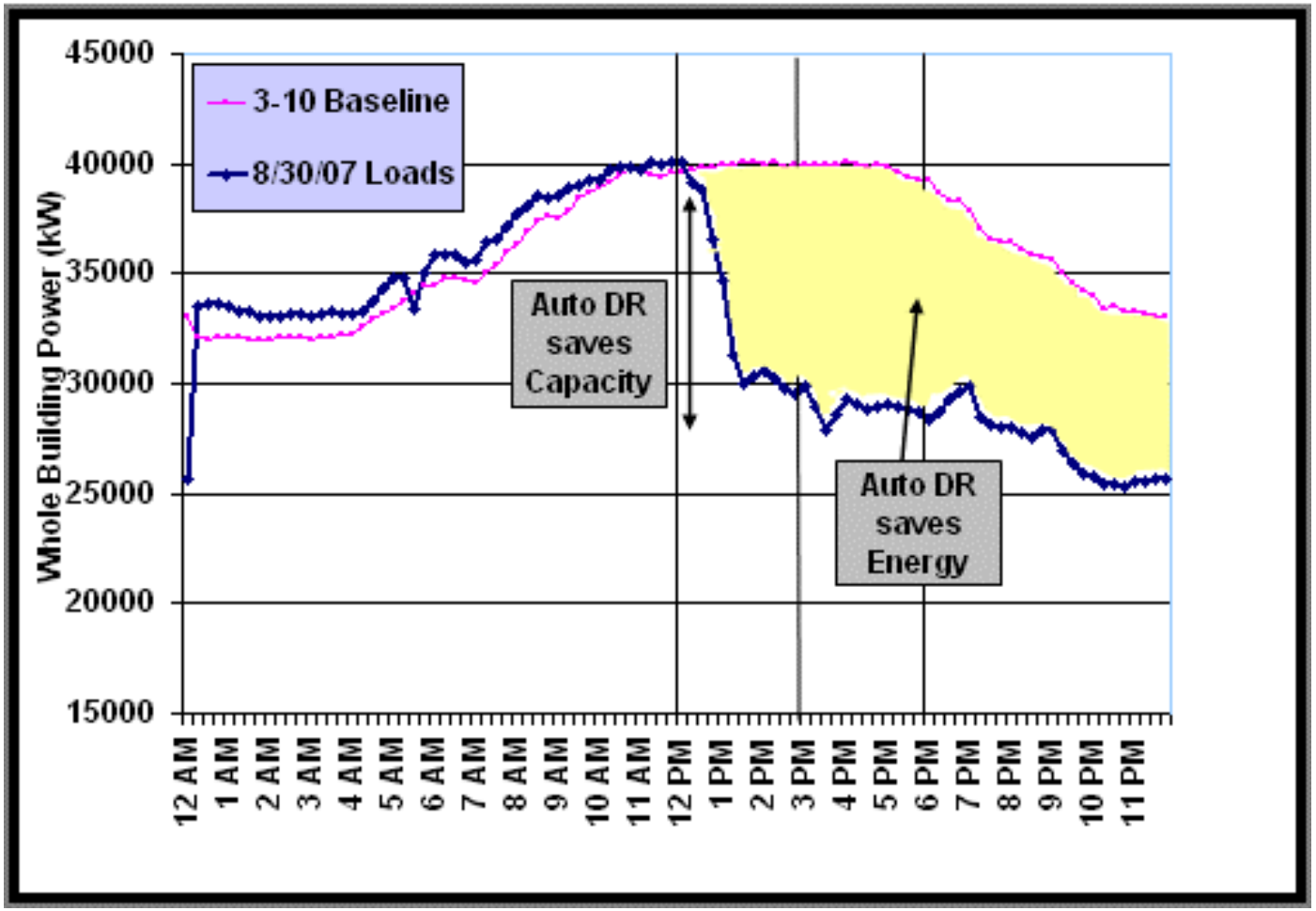
Empower consumers through better information

Give consumers the tools and incentives to *manage* their energy use and *eliminate waste*

Demand response programmability must be as easy and automatic as possible.

Automated Demand Response Saves Capacity and Energy

Electric load profile for PG&E participants on 8/30/2007



Is the grid ready for Plug-In Hybrids?

Plug-in Hybrid Vehicles:

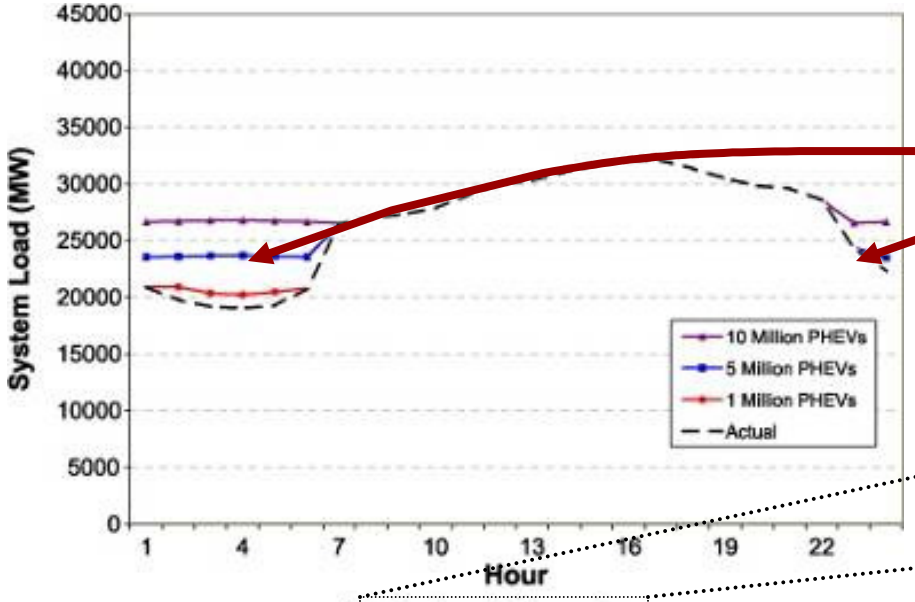
2009	Fisker Karma S
2010	Toyota Plug-in Prius
2010(?)	BMW Mini E
2010	Saturn VUE
2011	BYD F3DM
2012	Ford
2012	Volvo

Battery Electric Vehicles:

2010	Chevy Volt EREV
2010	Chrysler EV
2010	Miles EV
2010	Mitsubishi iMiEV BEV
2010	Nissan BEV
2010	Ford Battery Electric Van
2010	Tesla Roadster Sport EV

Source: Electric Drive Transportation Association (Updated June 1, 2009)

Typical Charging Scenarios

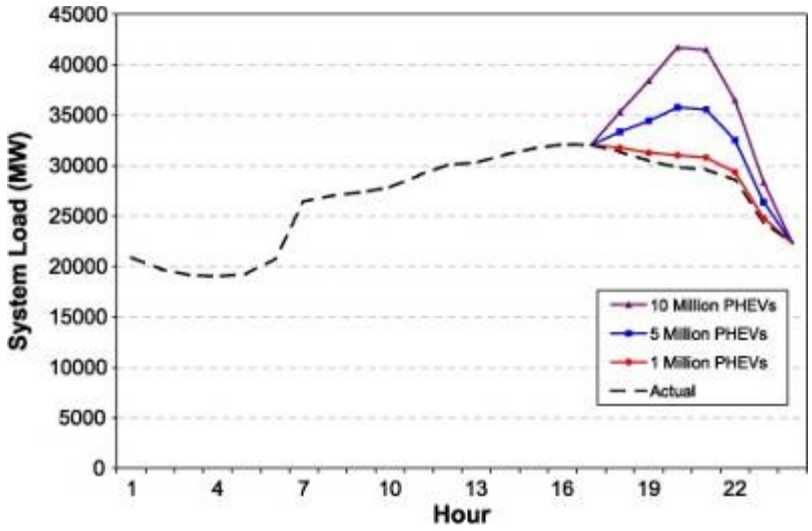


(a) Optimal Charging

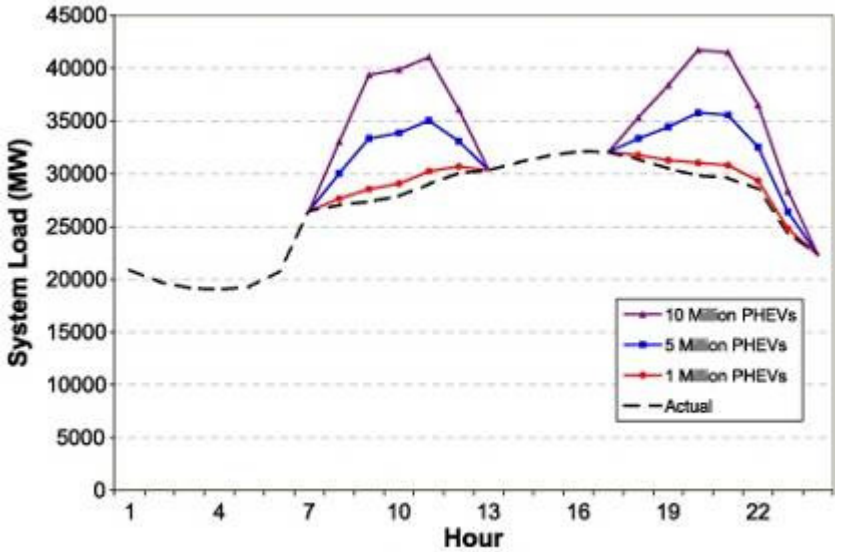
Filling the Valley

=

(a) Optimal Charging???



(b) Evening Charging



(c) Twice Per Day Charging

Source: Lemoine, Kammen, and Farrell 2008. *An Innovation and Policy Agenda for Commercially Competitive Plug-In Hybrid Electric Vehicles*

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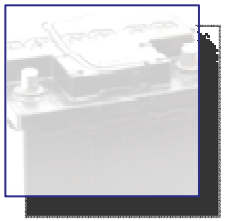

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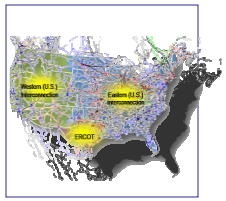

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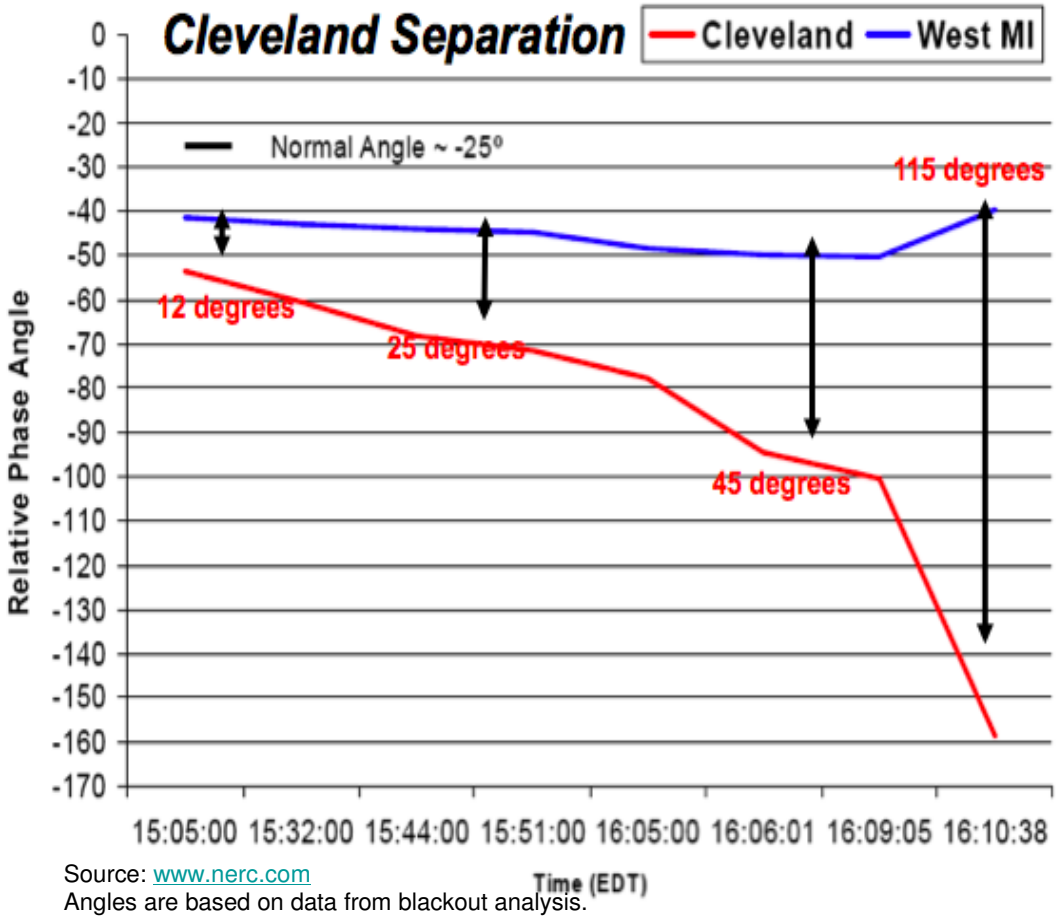
Phasors could have prevented the 2003 blackout



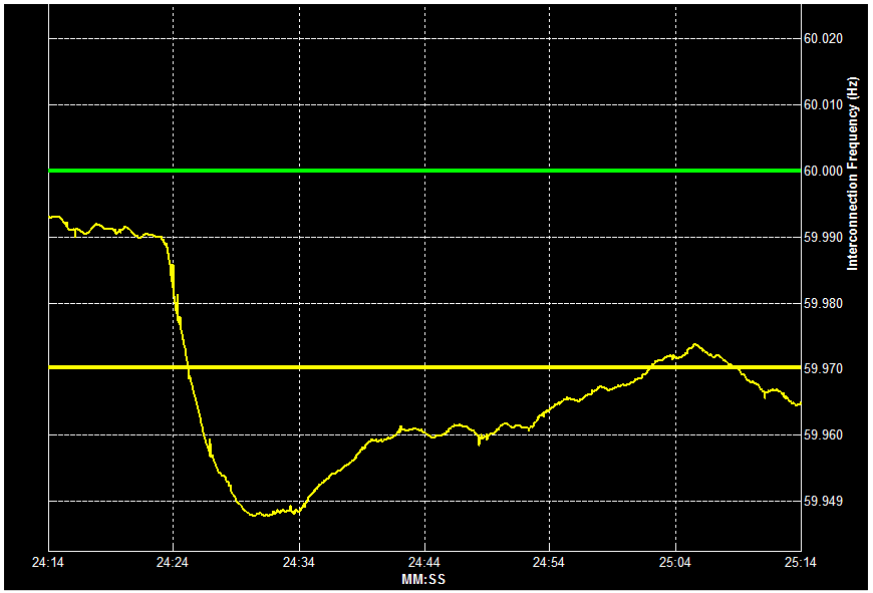
Source: www.nerc.com
Angles are based on data from blackout analysis.
Angle reference is Browns Ferry.

Phasors would have given grid operators 30-40 minutes warning that problems were developing in Northern Ohio

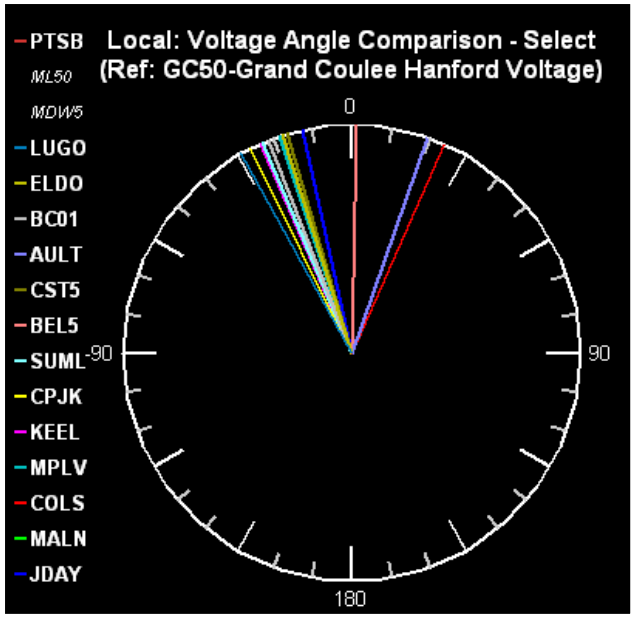
Estimates of 2003 blackout's cost: $6 – 10 billion

Goal: sensor-based operations and dynamic modeling

Frequency and response to system events



Grid stress -
Angle separation



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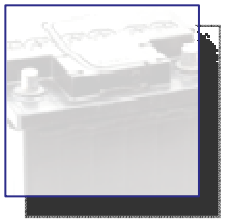

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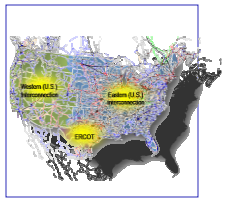

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Control systems for critical applications must be designed, operated and maintained to survive and intentional assault with no loss of critical function

Advanced Tools/Technology

- Encryption
- Authentication
- Diagnostics
- Monitoring
- Forensic Analysis

Challenges

- **Data Sharing/Data Ownership**
- **Standards**
- **Transmission Planning**

We're making progress on Smart Grid Interoperability standards

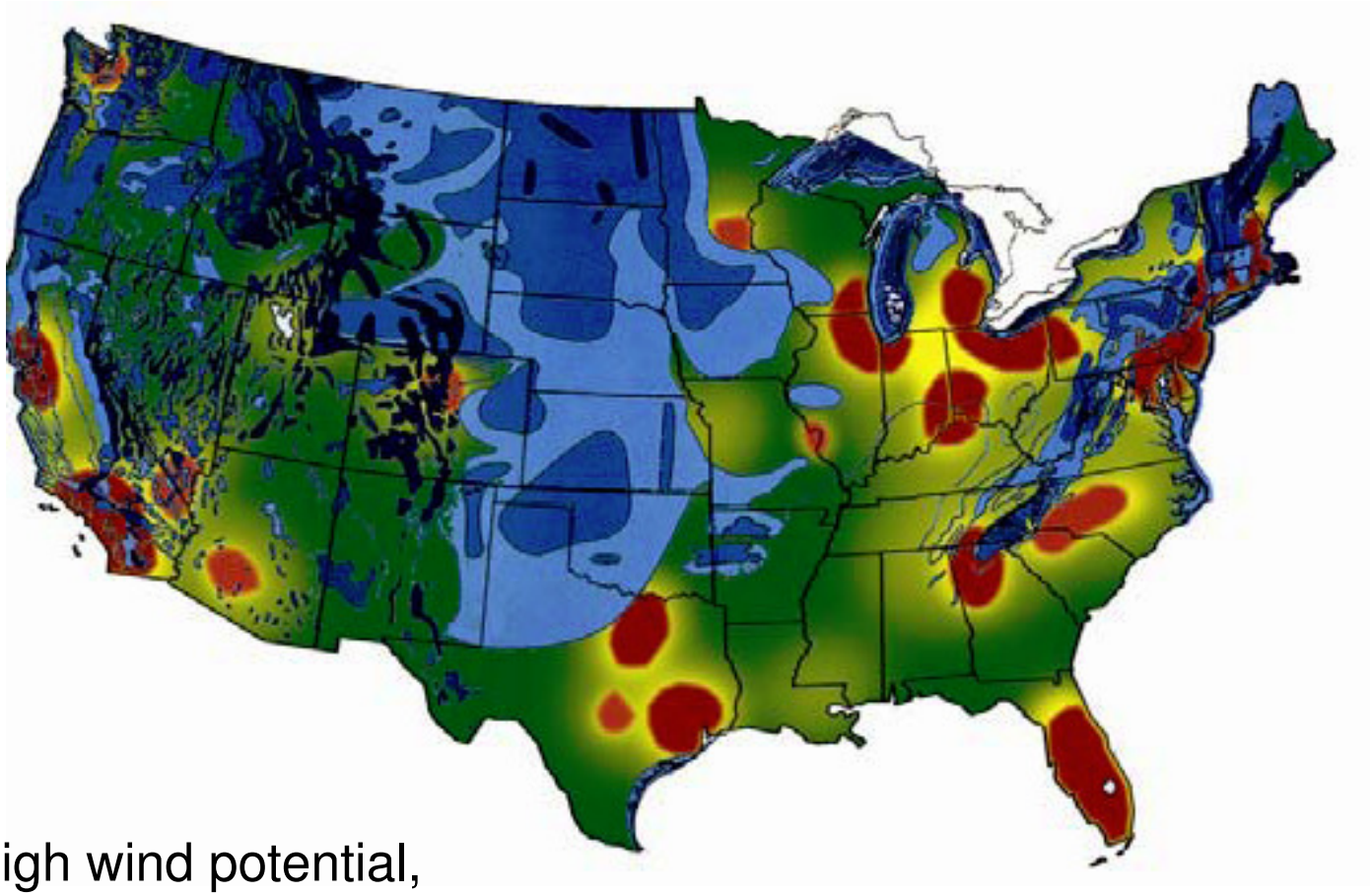
We've hosted two Smart Grid Interoperability Standards workshops

$10 million in Recovery Act funding transferred to NIST

NIST

Secretary Locke will have more to say on Thursday

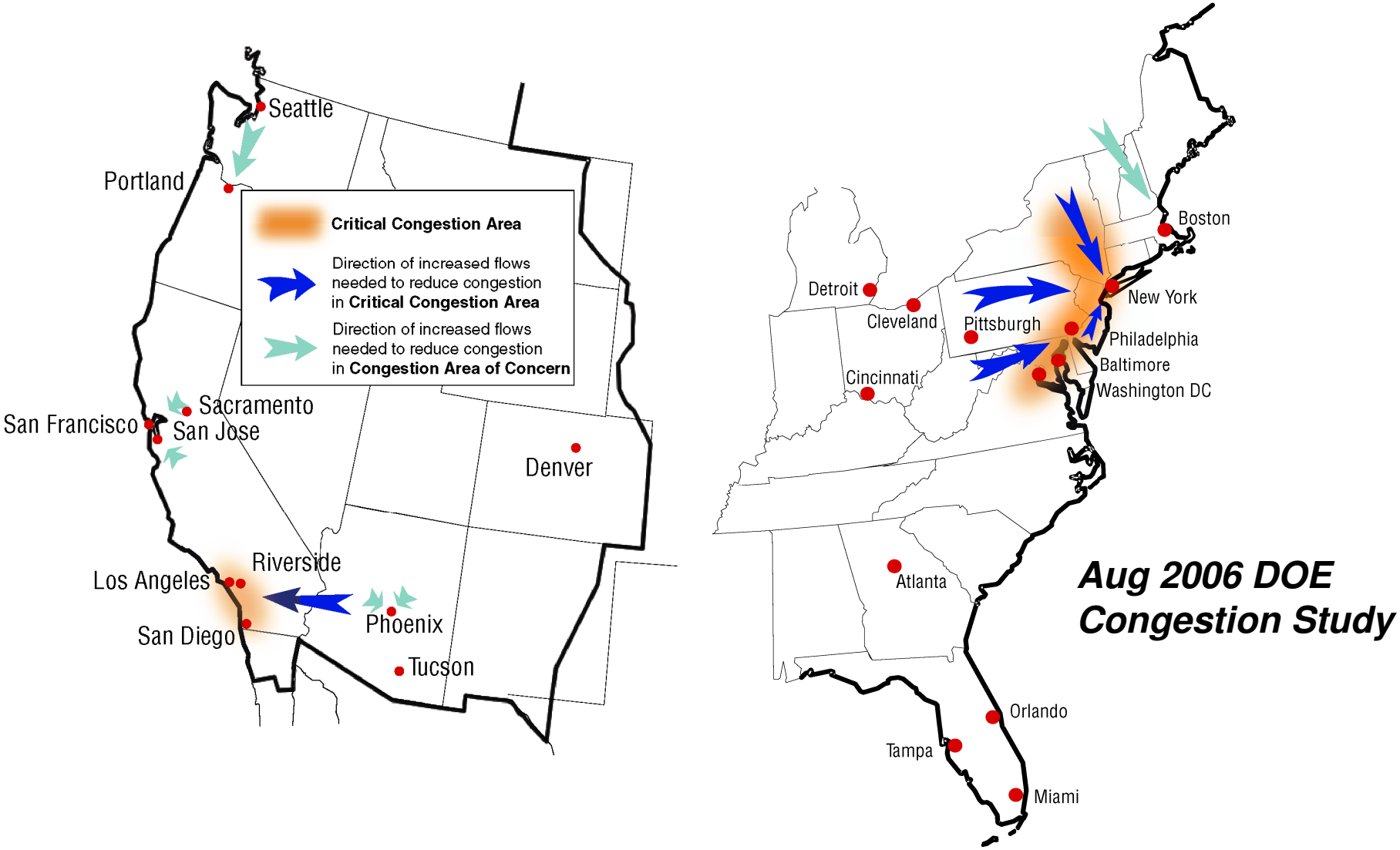
Seven Percent of the U.S. Population Inhabits the Top Ten States for Wind



Blue - high wind potential,
Red - large demand centers, and
Green - little wind and smaller demand centers.

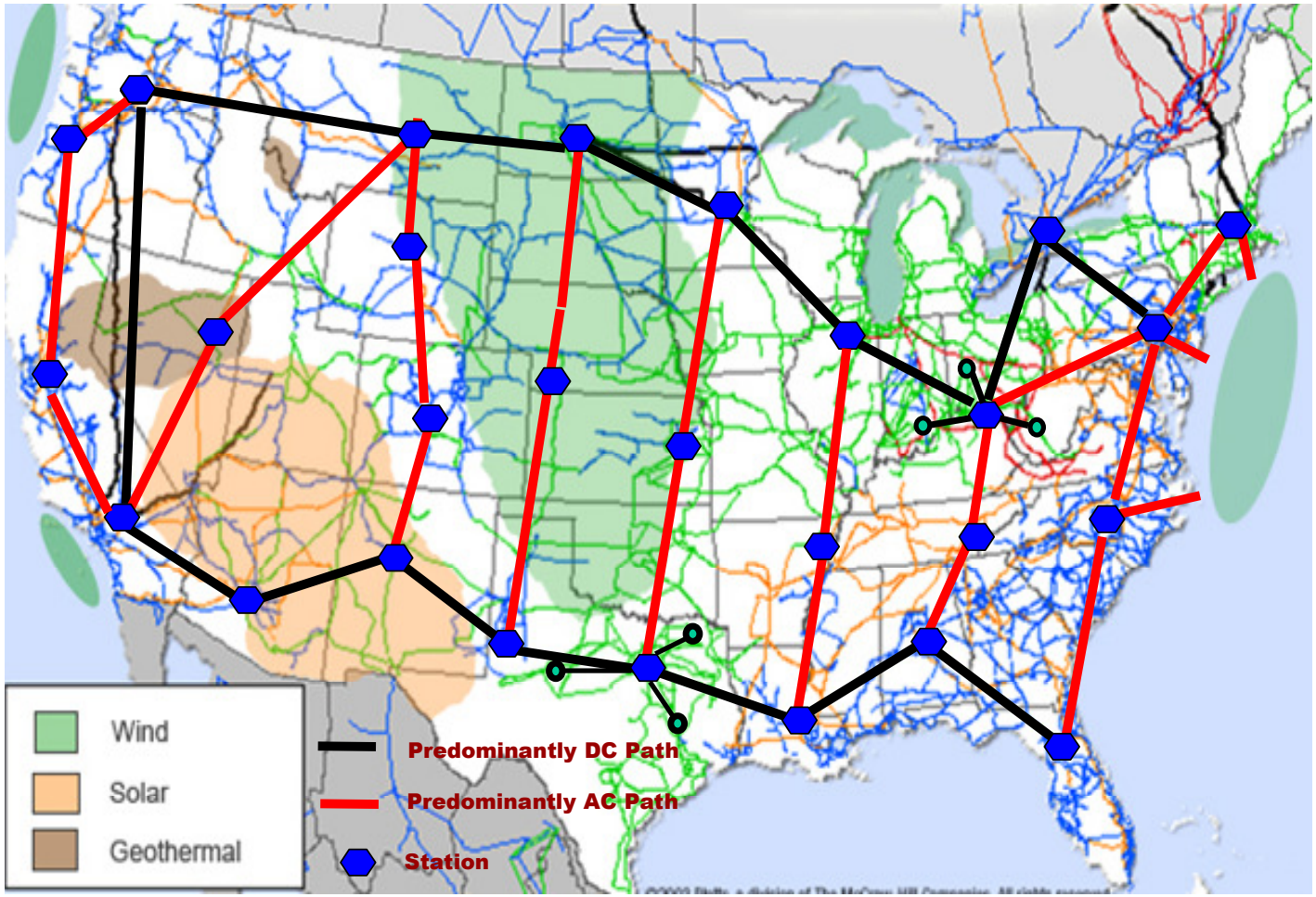
NERC, April 2009

Reduce congestion – another priority



Aug 2006 DOE Congestion Study

Does the U.S. require an Extra High Voltage Grid?



Questions?