U.S. DEPARTMENT OF ENERGY

Office of Electricity Delivery & Energy Reliability

Energy System Resilience

36th Annual Seminar on Fuels, Power Markets and Resource Planning

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November is…

Critical Infrastructure Security and Resilience Month

ALL Americans

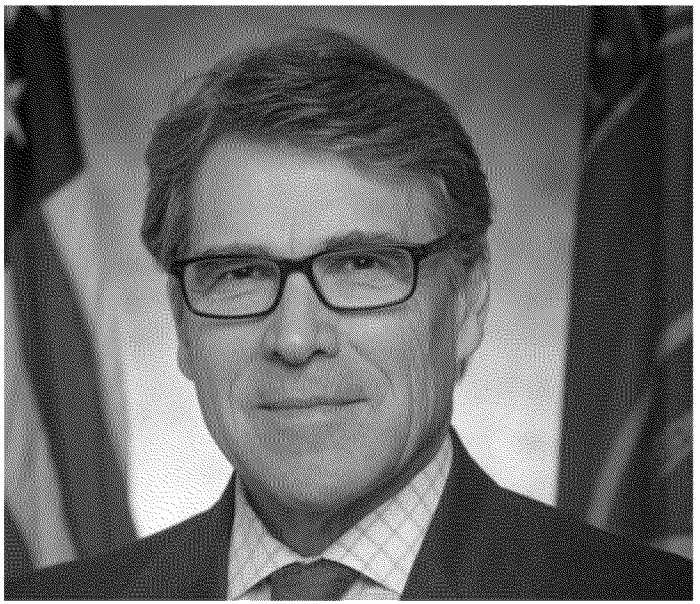
ACCESS

<u>Electricity underpins ALL</u>

Secretary Perry Requested a Grid Study in April 2017

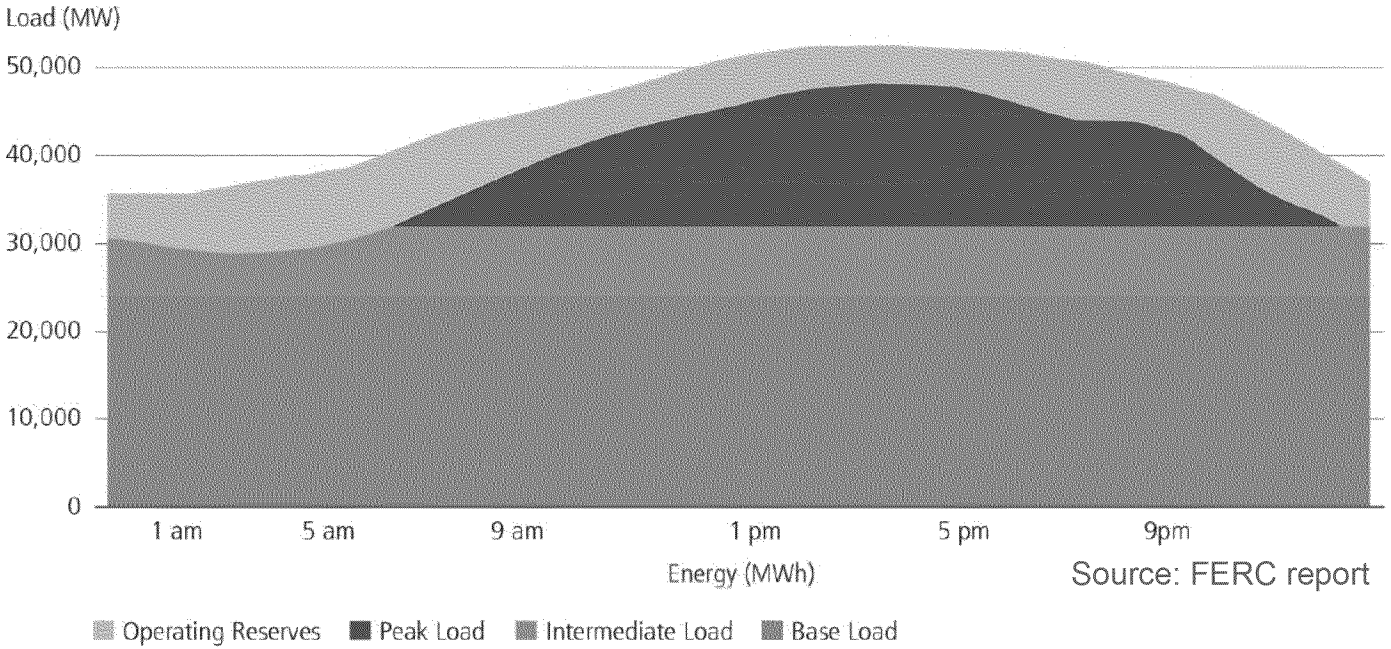
The memo asked staff to examine:

- The evolution of wholesale electricity markets
- Compensation for resilience in wholesale energy and capacity markets
- Premature baseload power plant retirements



Baseload generation: *defined by operation*

Figure 1.2. Schematic of Typical Daily Load Curve Showing Base Load[13]



Source: FERC report

<u>Baseload</u> power plants:

- High, sustained output levels
- High capacity factors
- Limited cycling or ramping

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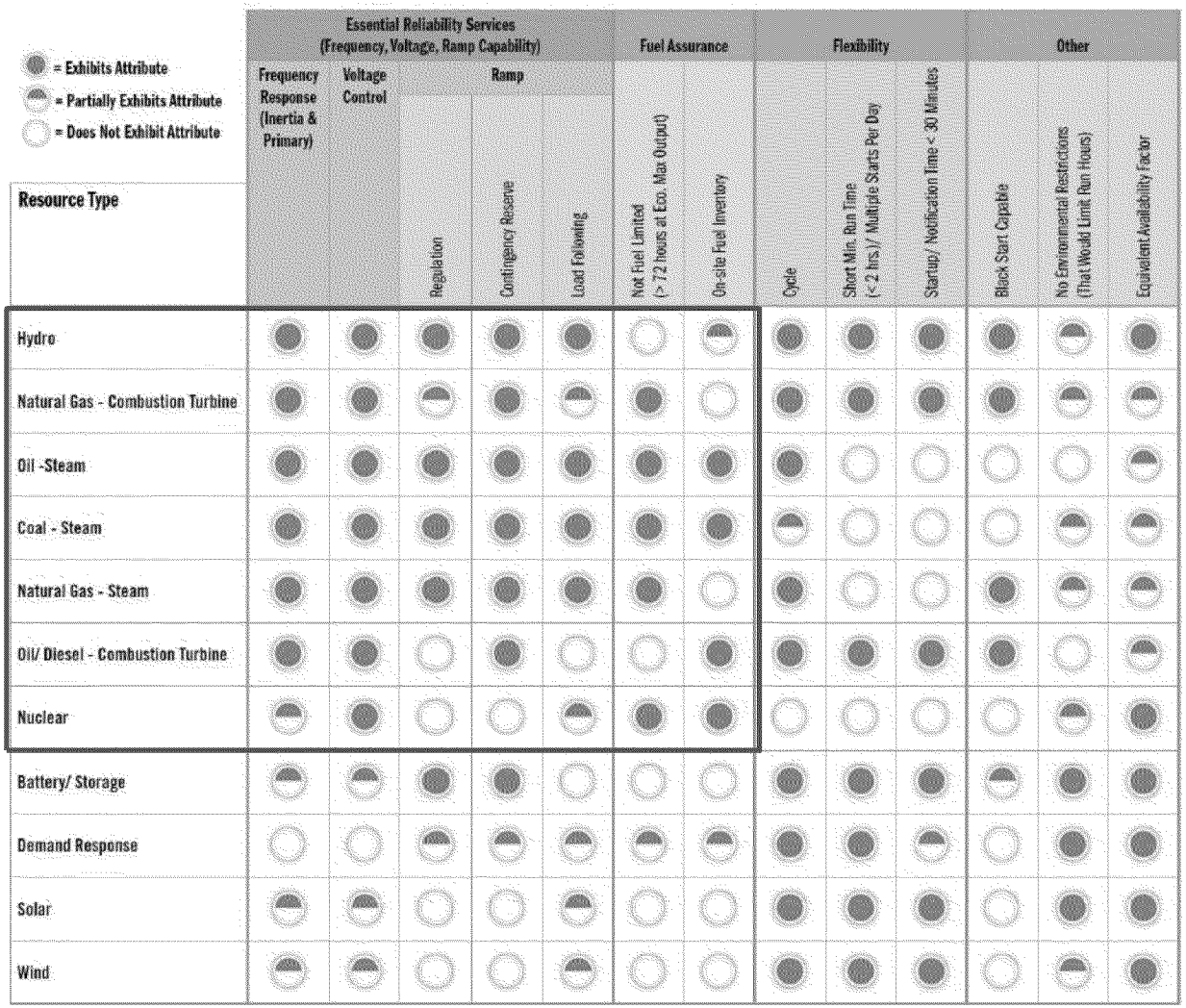
Premature retirement: *subjective term*

- Power plant engineers
- RTO/ISO/reliability organization
- Policy maker or legislator
- Mayor or employee
- Merchant competitor
- Vertically integrated utility executive
- Nuclear or hydroelectric plant owners and regulators
- Electricity economists

Retirements: Key drivers

1. Advantaged economics of natural gas-fired generation
2. Low growth in electricity demand
3. Investments in environmental regulations
4. Dispatch of VRE

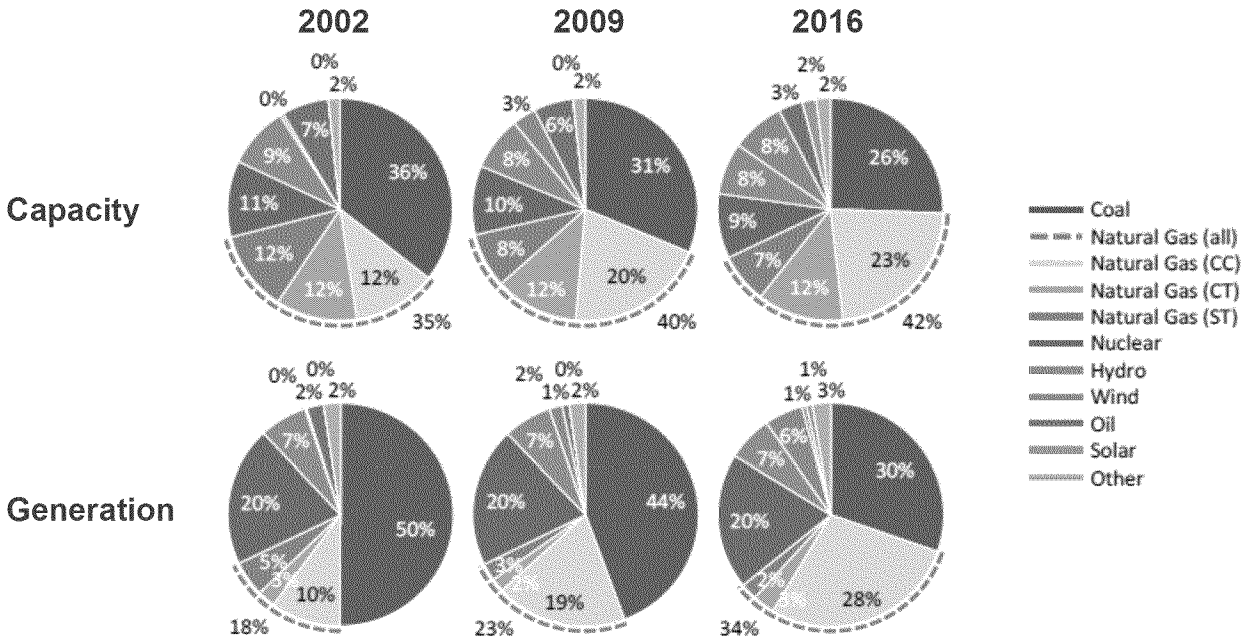
Reliability: PJM's perspective



Resource Type	Essential Reliability Services (Frequency, Voltage, Ramp Capability)					Fuel Assurance		Flexibility			Other		
	Frequency Response (Inertia & Primary)	Voltage Control	Ramp: Regulation	Ramp: Contingency Reserve	Ramp: Load Following	Not Fuel Limited (> 72 hours at Eco. Max Output)	On-site Fuel Inventory	Cycle	Short Min. Run Time (< 2 hrs.)/ Multiple Starts Per Day	Startup/ Notification Time < 30 Minutes	Black Start Capable	No Environmental Restrictions (That Would Limit Run Hours)	Equivalent Availability Factor
Hydro	●	●	●	●	●	○	◔	●	●	●	●	◔	●
Natural Gas - Combustion Turbine	●	●	◔	●	◔	●	○	●	●	●	●	◔	◔
Oil -Steam	●	●	●	●	●	●	●	●	○	○	○	○	◔
Coal - Steam	●	●	●	●	●	●	●	◔	○	○	○	◔	◔
Natural Gas - Steam	●	●	●	●	●	●	○	●	○	○	●	◔	◔
Oil/ Diesel - Combustion Turbine	●	●	○	●	○	○	●	●	●	●	●	○	◔
Nuclear	◔	●	○	○	◔	●	●	○	○	○	○	◔	●
Battery/ Storage	◔	◔	●	●	○	○	○	●	●	●	◔	●	●
Demand Response	○	○	◔	◔	◔	◔	◔	●	●	◔	○	●	●
Solar	◔	◔	○	○	◔	○	○	●	●	●	○	●	●
Wind	◔	◔	○	○	◔	○	○	●	●	●	○	◔	●

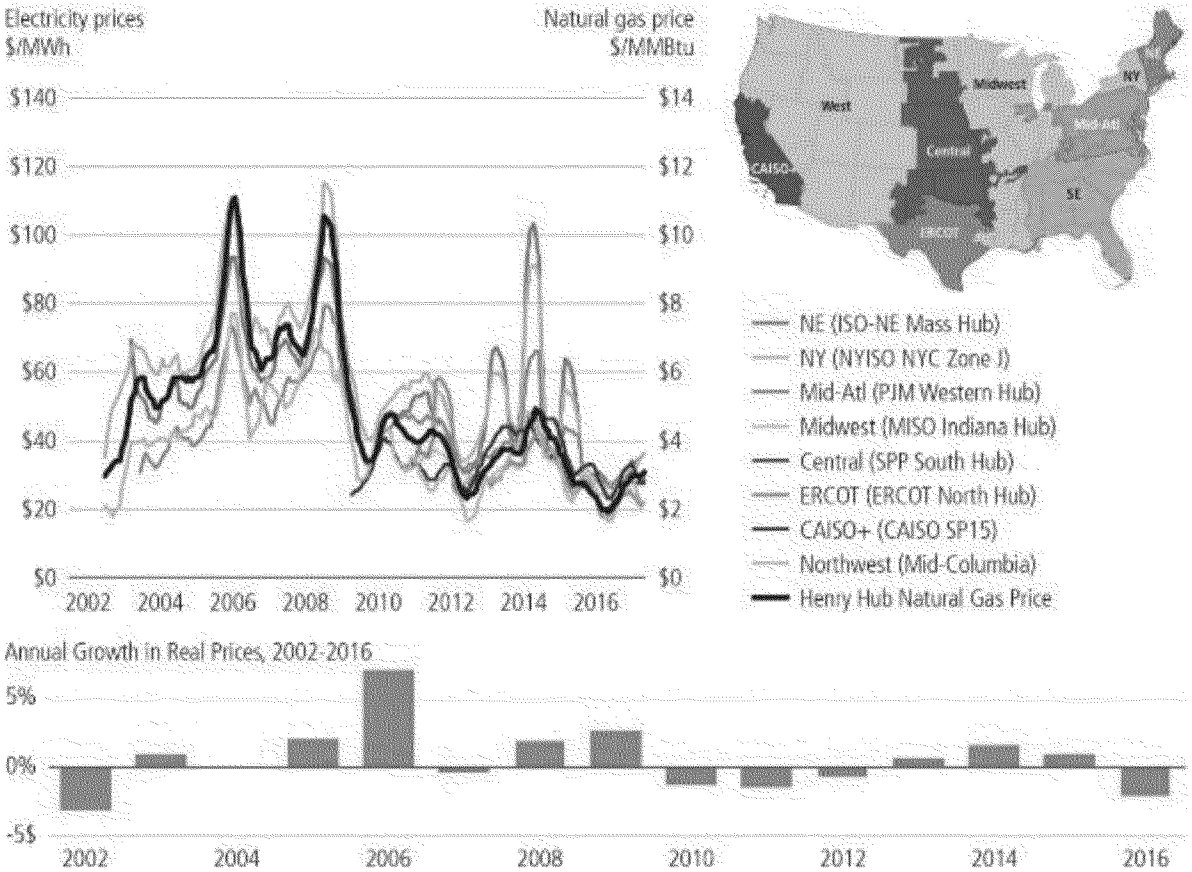
- **PJM: determine how different resources can provide ERS**
- **More work is needed to fully define, value, procure, and compensate ERS**

Reliability vs. Resilience



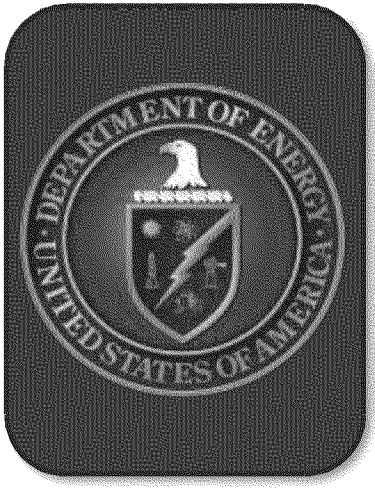
PJM simulation: when 98 *reliable* portfolios were subjected to a polar vortex event, only 34 were also *resilient*

Affordability



- **Wholesale-retail disconnect**
- **Limited work done to-date on the affordability of the BPS as a system or portfolio**

Policy recommendations



Department of Energy

- Support industry efforts and focus R&D to enhance system resilience (for example, OE awards)
- Accelerate and reduce costs for re/licensing and permitting
- Facilitate programs for workforce development
- Prioritize energy dominance and EO 13783
- Increase coordination of electric and natural gas industries

Federal Energy Regulatory Commission (FERC)

- Expedite efforts to reform energy price formation
- Value new/existing essential reliability services

Environmental Protection Agency (EPA)

- Allow coal-fired power plants to improve efficiency and reliability without triggering new regulatory approvals and associated costs

Nuclear Regulatory Commission (NRC)

- Revisit nuclear safety rules
- Ensure safety without unnecessarily adding costs

Areas for further rese

Market Structure and Pricing	Reliability and Resilience
Study mechanisms to enable equitable, value- based remuneration for desired grid attributes	Develop policy metrics and tools for evaluating system-wide provision of these attributes
Evaluate ongoing capacity market reforms	Examine ways to improve power generator fuel delivery data collection

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Cost and Affordability	Regulatory
Estimate system-wide costs of different generation mixes and sensitivities to fuel price fluctuations	Explore potential to utilize existing authorities to ensure system reliability and resilience
Update analysis of subsidies and support for electricity production	Explore costs and benefits of states applying cost-of-service regulation to at-risk plants

Electricity Underpins All Infrastructures

Moving forward…

Be proactive

Cultivate an ecosystem

Reliable, affordable, resilient energy