The Silver Bullet…
Storage!

West Philly High
X–prize PHEV

Terry Boston

President & CEO
PJM Interconnection

July 12, 2011

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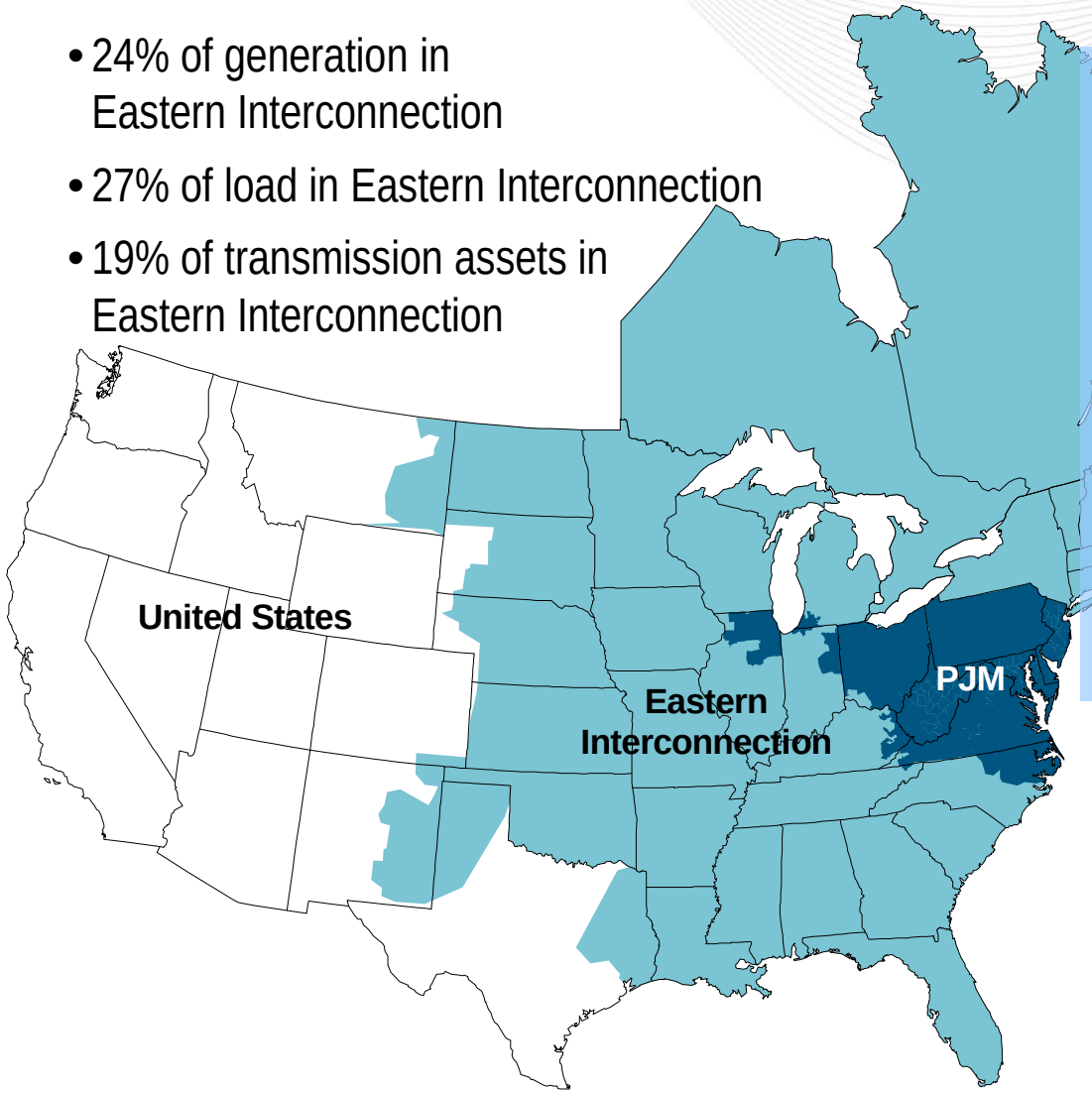
PJM as Part of the Eastern Interconnection

- 24% of generation in Eastern Interconnection
- 27% of load in Eastern Interconnection
- 19% of transmission assets in Eastern Interconnection



KEY STATISTICS	
PJM member companies	700+
millions of people served	58
peak load in megawatts	158,448
MWs of generating capacity	180,400
miles of transmission lines	61,200
GWh of annual energy	794,335
generation sources	1,365
square miles of territory	211,000
area served	13 states + DC
Internal/external tie lines	142

20% of U.S. GDP produced in PJM

As of 6/1/2011

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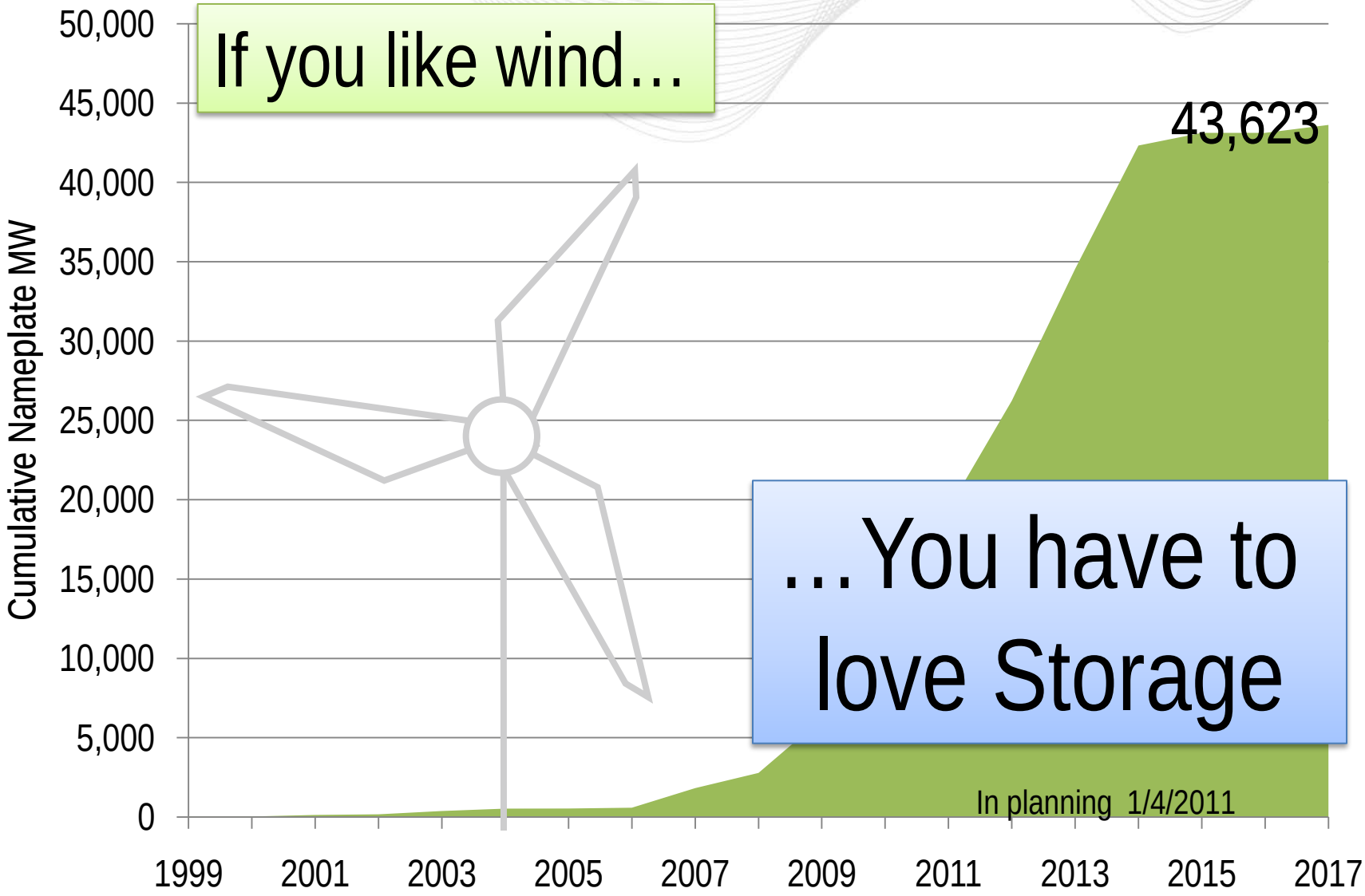
Why Storage – Wind Generation in PJM



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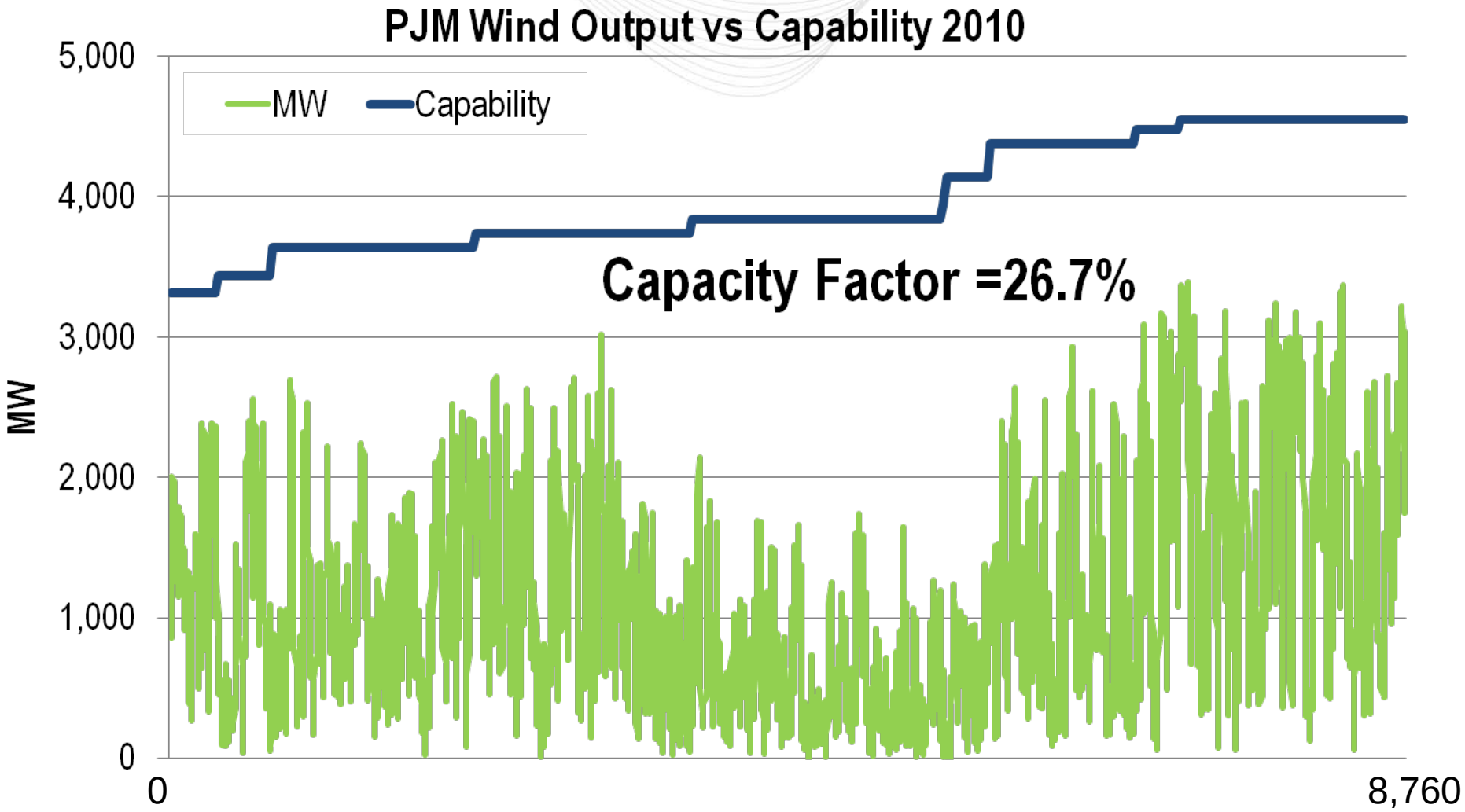
Intermittent Wind Generation



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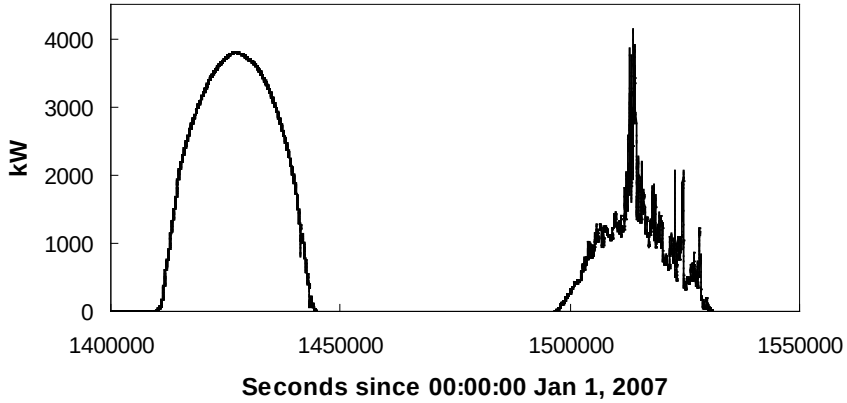
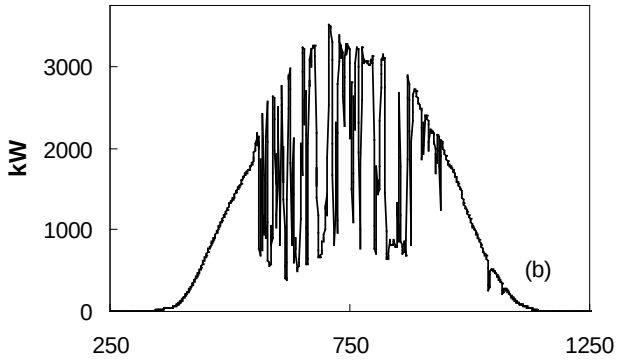
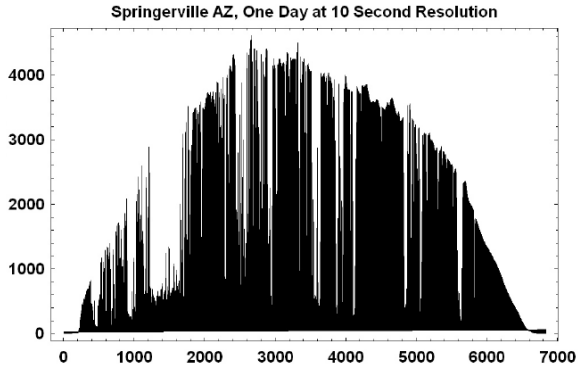
Comparison of Wind with Solar PV 4.6 MW TEP Solar Array (Arizona)







Source: Carnegie Mellon University

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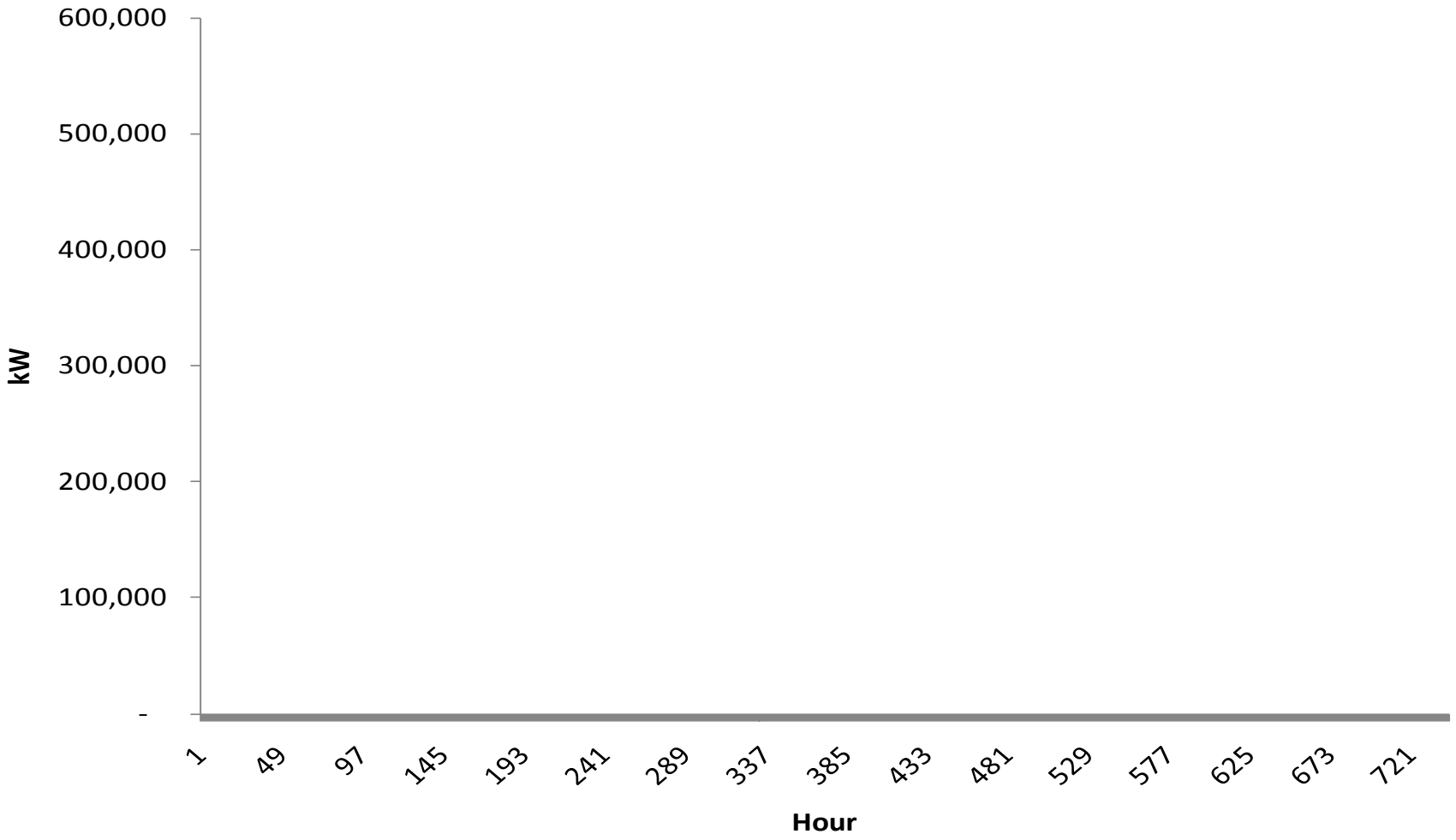
EPB Residential August 2009 Hourly Load



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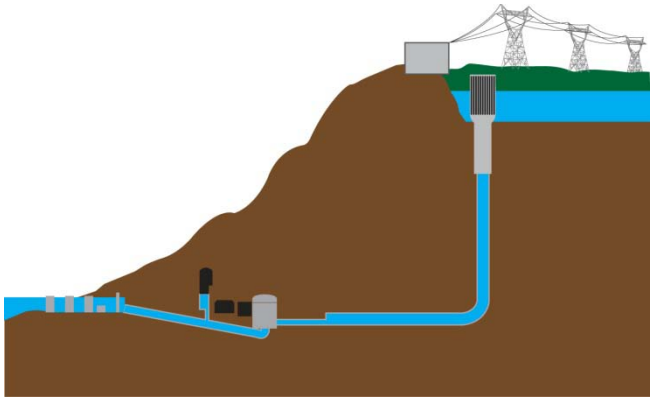
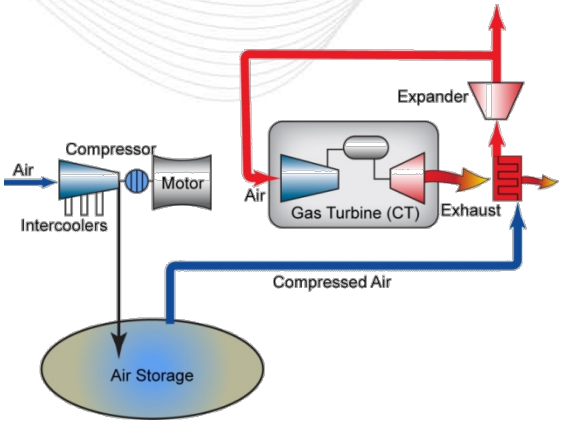
Innovation--What Storage in PJM?



Pumped Hydro



Compressed Air

Flywheels

Stationary Battery

Mobile Batteries

Water Heaters

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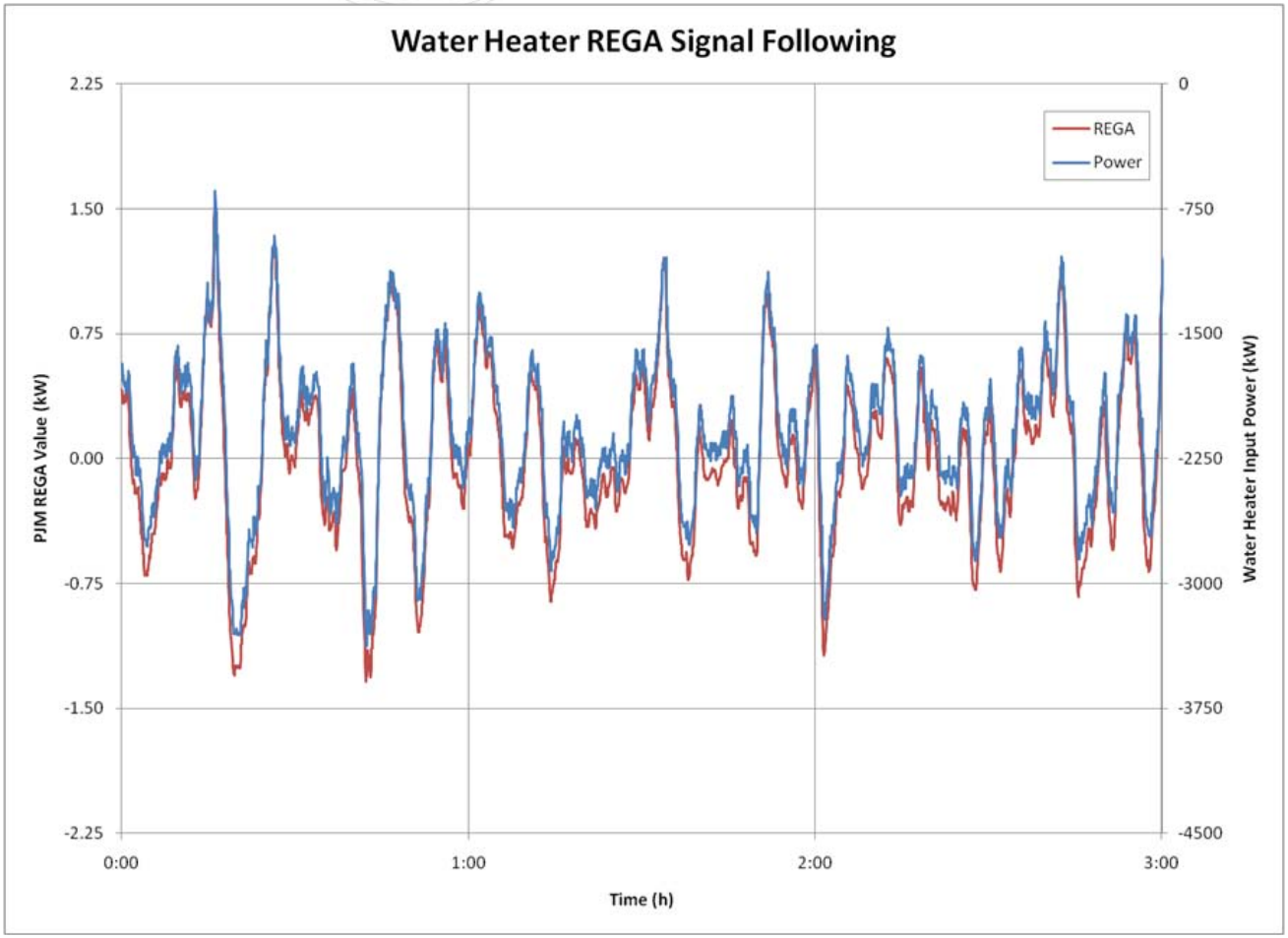
Fast Regulation: Speed Matters…

- PJM Frequency Regulation Signal

- Water heater power consumption +/- 2.25 Kw base point



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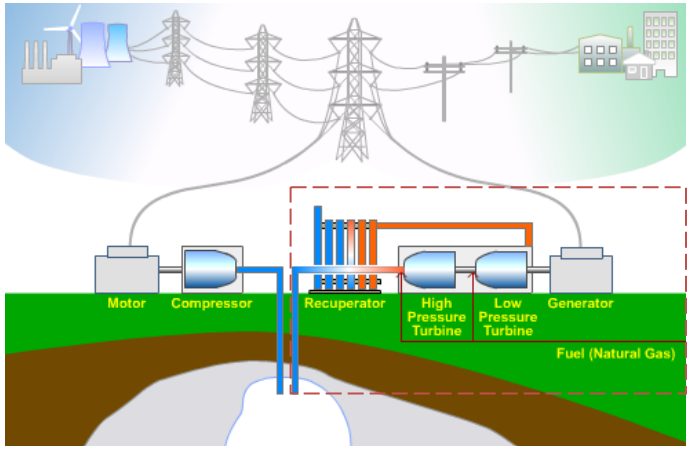
Compressed Air Energy Storage and Norton

- CAES – a highly responsive technology:
  - Combines gas turbine with compressed air
  - Compressor operates at low load periods; gas turbine serves load as needed
  - Smoothes out load/supply profile with quick response
- PJM is working with FirstEnergy on Norton CAES

Large size provides significant advantage:

- 338 million cubic foot cavern provides great flexibility (more than 4 times the size of the Pentagon)
- Approximately 130,000 MWhs of storage
- Longer storage period than typical pumped hydro
- Can add capacity in 150 MW increments, up to 2,700 MW total
- Fully dispatchable by PJM



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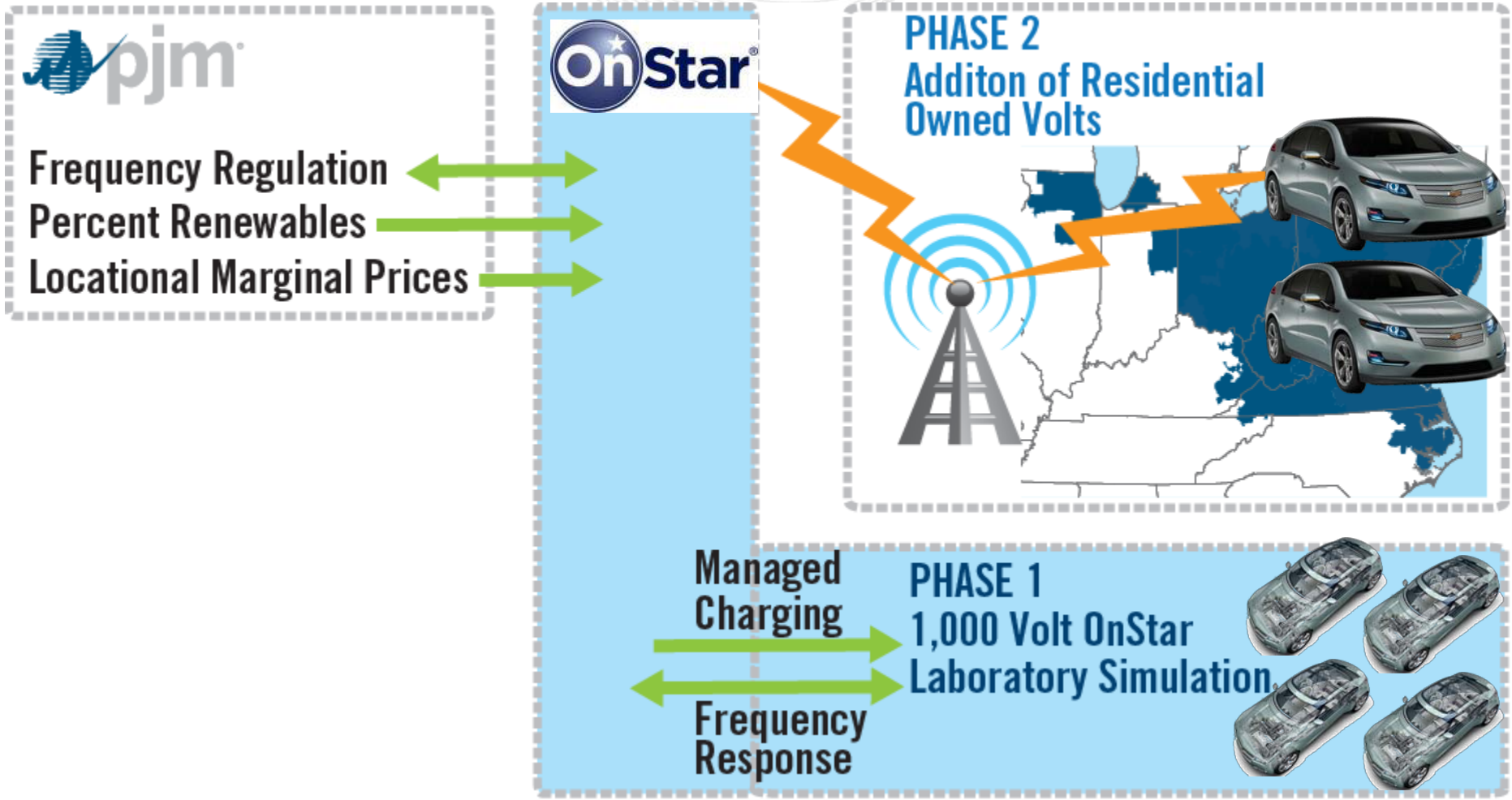
A 1,000 Volts – General Motors OnStar / PJM Pilot



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Fleet Electrification – Energy Storage, Energy Security

"Unleash us from the tether of fuel" – Lt. Gen. James Mattis, USMC

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Beneficial Electrification – DOD, non-tactical fleet

Price of fuel on the battlefield:
+/- $300/gallon

Project Focused on Four Areas:

1. Volume Pricing
   - 10,000 units annually
2. Battery Right-sizing
   - 6,000-3,000 miles/year
3. Infrastructure Planning
4. **Ancillary Services**

Total # Non-Tactical Vehicles: ~194,710		
Vehicle Type	**% of Fleet**	**Ave. Annual Miles**
MD Trucks*	22%	6251
LD 4x2 Trucks	15%	7690
LD Pass. Vans	11%	9043
Compact Sedans	9%	~16325
Midsize Sedans	9%	~16325
HD Trucks	9%	3516

*Largest fuel consumer in non-tactical fleet: 43M gallons of petroleum/year

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Will Work for Fuel

Available for full-time Summer job.

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1) **Create a DOE water heater storage standard**
   - Storage water heaters to enable renewables will save more energy grid-wide than efficiency standards for heat pump water heaters >55 gallons
2) **FERC allows some cost recovery for storage**
   - Like Transmission, storage benefits the entire system and enables renewables
3) **FERC approves LFC Pay-for-Performance**
   - Compensate for the advantages that speed and accuracy bring to the system

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4) **Predictable cost recovery for storage**
   - Longer-term markets for capacity/ancillary services
   - Incent community storage (For a digital economy)
5) **States simplify time-of-use retail rates/real-time pricing**
   - Expedite the use of electric cars as storage
6) **Incentives/loans for fleet conversion**
   - Fleets (school buses, DOD, post office) have huge storage potential
7) **25% of RPS = Storage Portfolio Standard**

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