



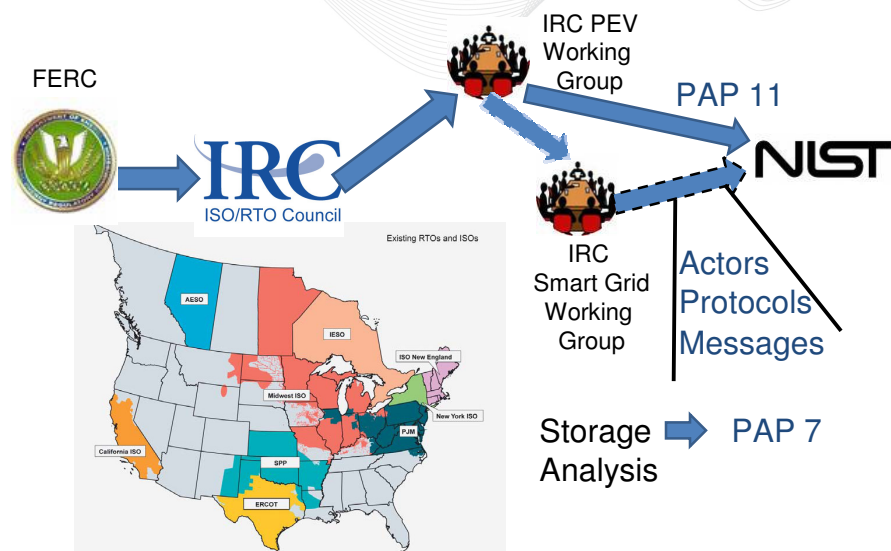
PJM's Energy Storage Initiatives

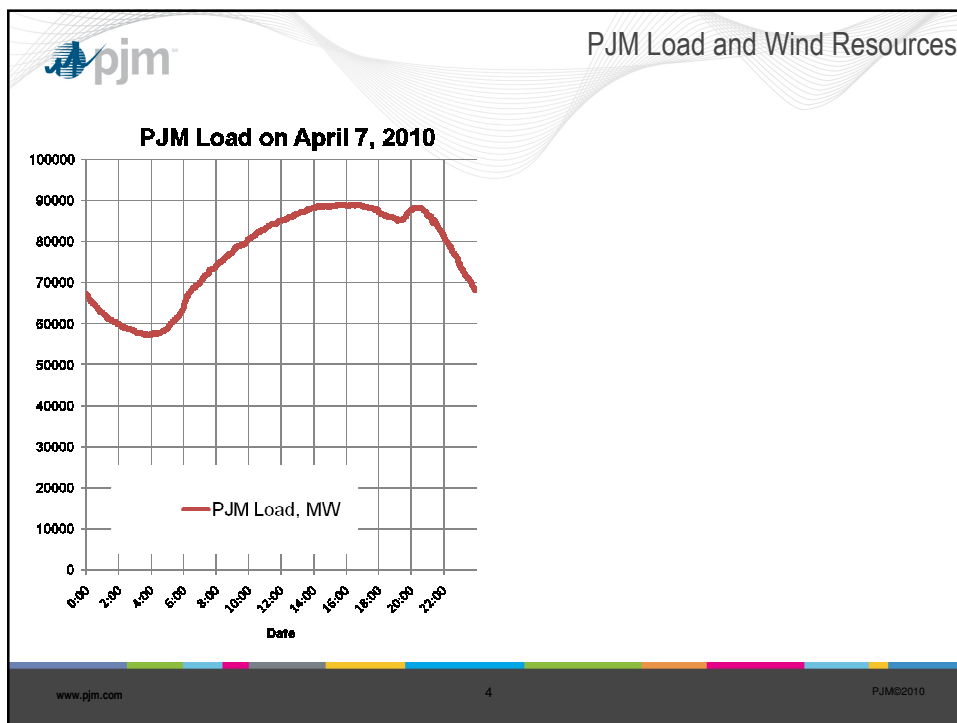
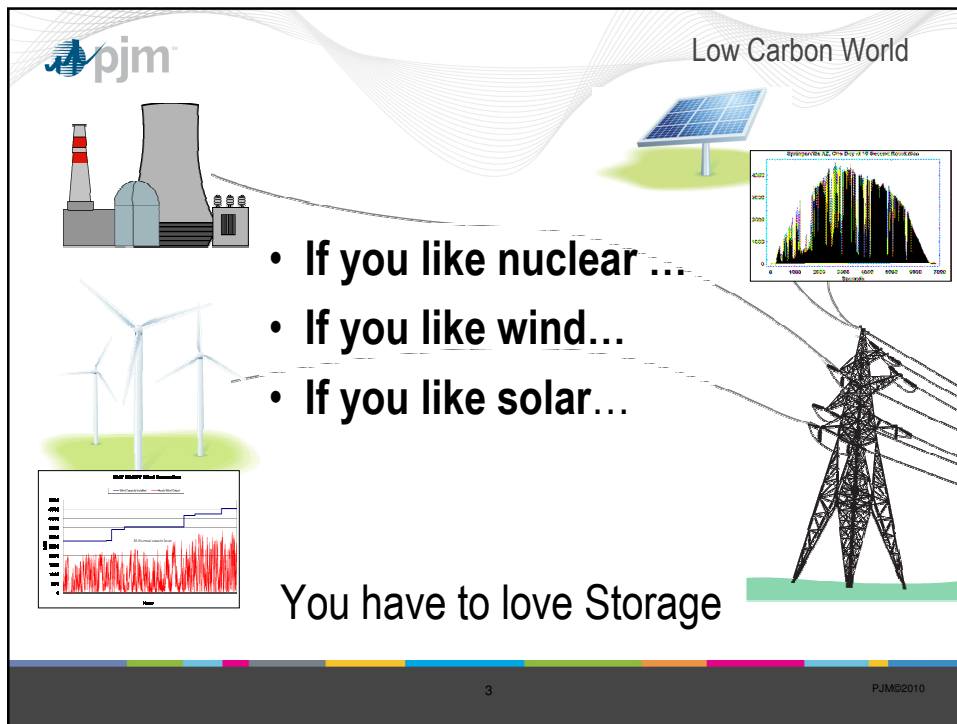
Marcus Evans Electric Energy Storage Conference

Joe Callis
Sr. Business Solutions Engineer
PJM Interconnection
January 24, 2011



Smart Grid Coordination

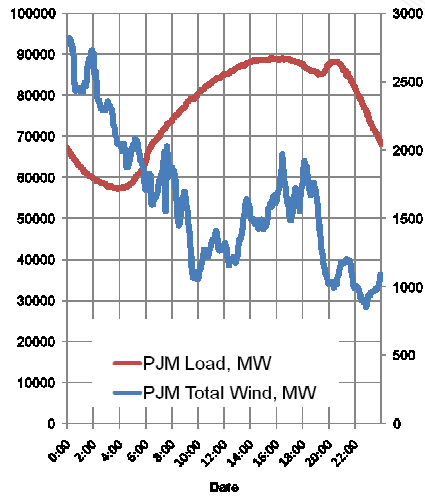






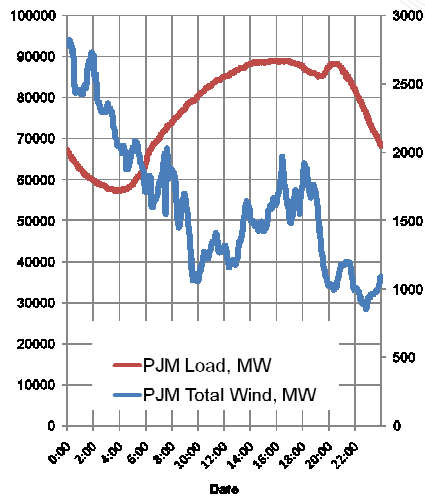
PJM Load and Wind Resources

PJM Load and Total Wind on April 7, 2010

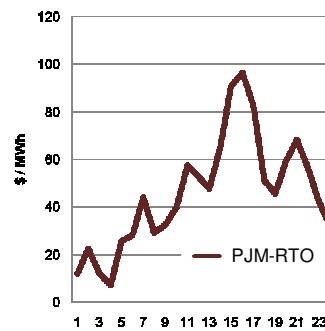


PJM Load and Wind Resources

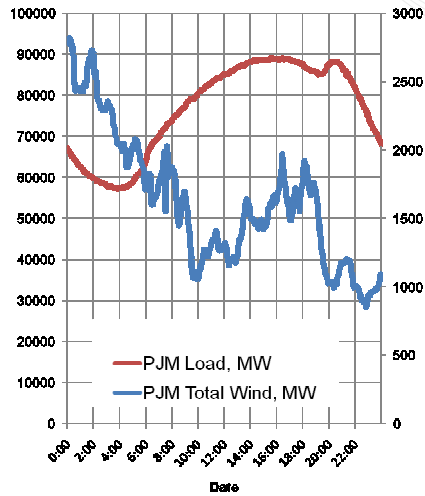
PJM Load and Total Wind on April 7, 2010



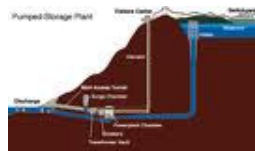
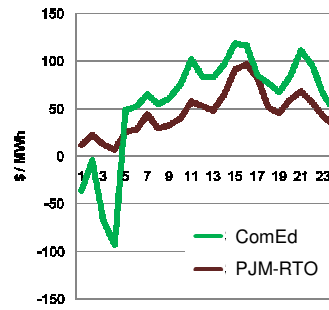
Locational Marginal Prices April 7, 2010



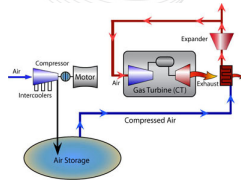
PJM Load and Total Wind on April 7, 2010



Locational Marginal Prices April 7, 2010



Pumped Hydro



Compressed Air



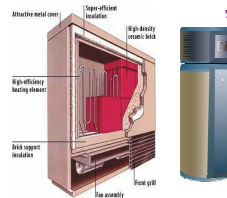
Flywheels



Stationary Battery



Mobile Batteries



Thermal Storage



Stationary Storage Activity in PJM

Currently in the Market

- AES 1 MW Lithium-Ion Battery (aggregated with seven PEVs)

Currently in Queues

- 40 MW in Flywheels
- 52 MW Lithium-Ion Batteries (32 MW integrated with wind farm)
- 3 MW Nickel-Iron Battery

Information Sharing and Support

- FirstEnergy CAES (2.7 GW Possible)

Pilot Activities

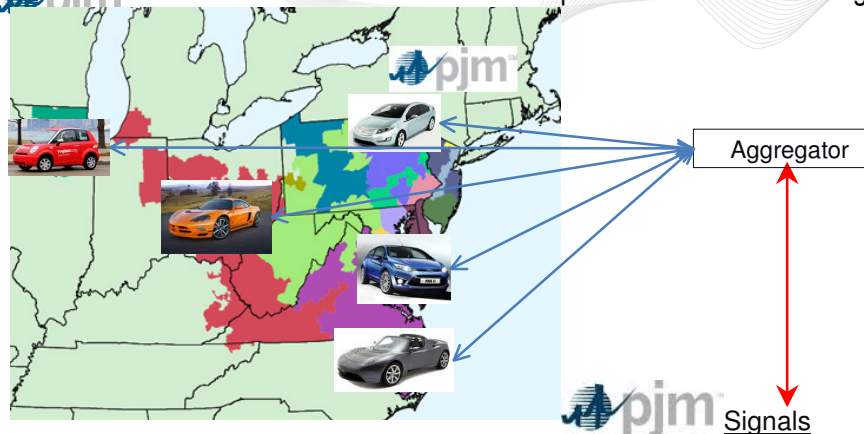
- AEP Community Energy Storage
- Metropolitan Buildings, variable speed motor
- Simulation of 1,000,000 electric vehicles in eastern megalopolis
- 18+ potential pilot projects under evaluation

Data Sharing

- Stationary Batteries, Buildings, Flywheels



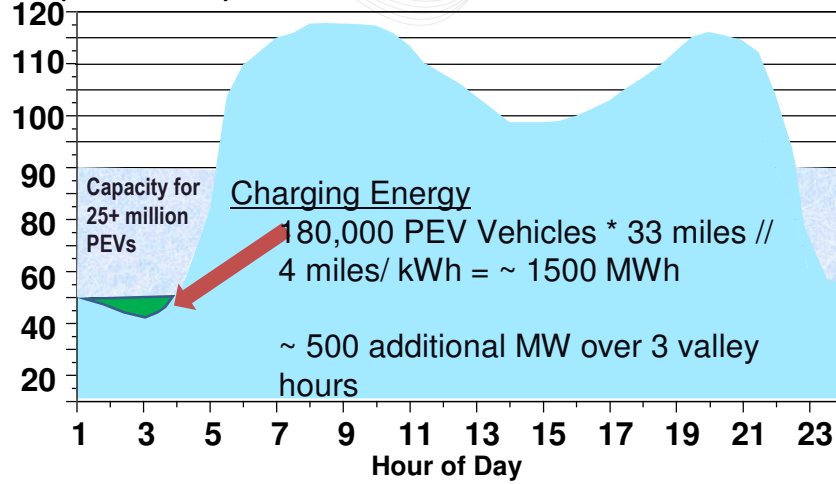
PJM Participation – Standard Messages



- Ancillary Services Signals
- Price Signals
- Generation Mix
- Reliability Control
- Load Curtailment

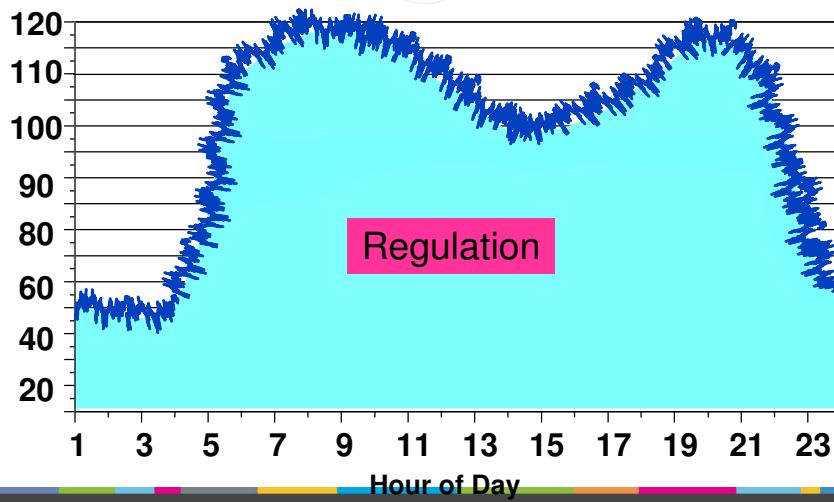
Vehicle Charging Impact on PJM

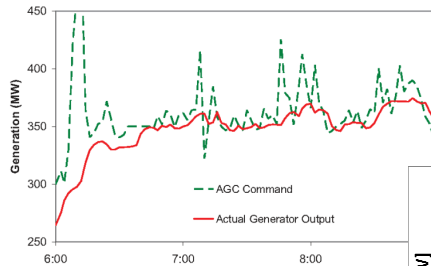
Load (MW x 1000)



Grid Benefits – Frequency Regulation

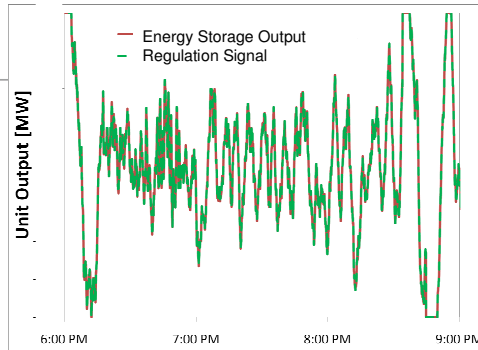
Load in GW





A fossil power plant following a regulation command signal

Energy Storage (batteries / flywheels) accurately following a regulation command signal



\$42/day
0.090 MW



\$700/day
1 MW

Aggregator

1.090 MW



Grid Signal

Frequency Regulation Signal

AES Aggregat ion



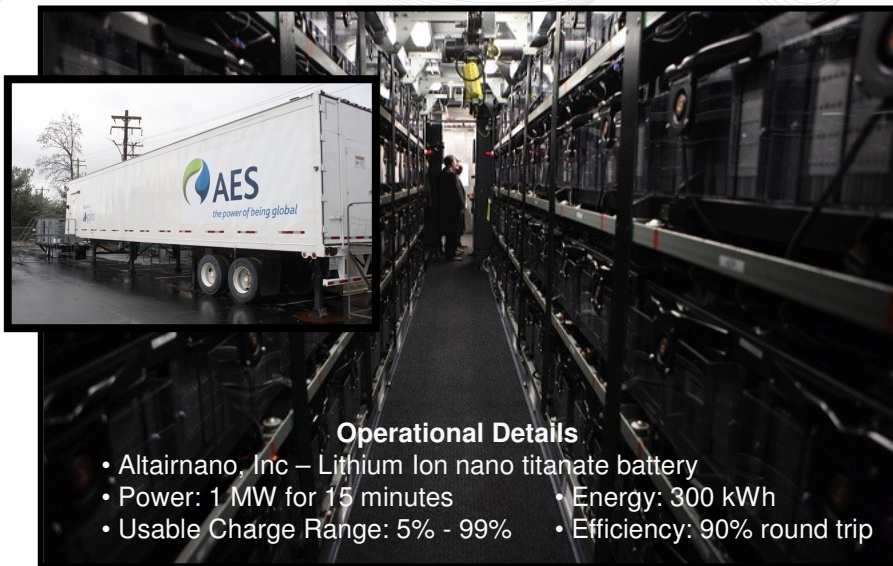
MAGICC – PJM's PHEV Demonstration Project



- Smart Metering enables smart cars
- Mid-Atlantic Grid Interactive Car Consortium (MAGICC)
- **Over three years experience**



AES Grid-Scale Energy Storage System



Operational Details

- Altairnano, Inc – Lithium Ion nano titanate battery
- Power: 1 MW for 15 minutes
- Usable Charge Range: 5% - 99%
- Energy: 300 kWh
- Efficiency: 90% round trip



Enabled on 12/10

- Steffes – Grid-interactive Water Heater
- 105 gallon capacity
- 26 kWh energy
- Nominal two day supply of hot water
- Currently responding to pricing signals

Fleets are of particular interest

- Typically well established, consistent routes
- Return to same location for long term parking
 - Controlled infrastructure costs
 - Parked for 10-12 hours in low electric load periods
- Electric vehicle promotion



