Electric Power Delivery System for the 21st Century

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PJ as Part of the Eastern Interconnection

- 27% of generation in Eastern Interconnection
- 28% of load in Eastern Interconnection
- 20% of transmission assets in Eastern Interconnection

**KEY STATISTICS**

- PJM member companies: 900+
- Millions of people served: 61
- Peak load in megawatts: 165,492
- MWs of generating capacity: 183,604
- Miles of transmission lines: 62,556
- 2013 GWh of annual energy: 791,089
- Generation sources: 1,376
- Square miles of territory: 243,417
- Area served: 13 states + DC
- Externally facing tie lines: 191

21% of U.S. GDP produced in PJM

As of 4/1/2014
PJM – Focus on Just 3 Things

Reliability
• Grid Operations
• Supply/Demand Balance
• Transmission monitoring

Market Operation
• Energy
• Capacity
• Ancillary Services

Regional Planning
• 15-Year Outlook
Top Challenges Facing the Industry

• Electricity Demand
• World’s Largest Fuel Switch
• Natural Gas Interoperability
• Integration of Intermittent and Demand Side Resources
• Natural and Unnatural Disasters

Each Challenge is Also an Opportunity

Adapted from: EPRI
Managing a Sea-Change

PJM Installed Capacity Cleared

ICAP MW

Delivery Year


6/1/2013

Gas, Coal, Nuclear, Demand Response, Wind & Solar
Need Four Quadrant Voltage Control

Smart Inverter

Quad II: Inductive
Quad I: Inductive
Quad III: Capacitive
Quad IV: Capacitive

280,000 in NJ can do voltage control!
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Germany to Replace 1,000,000 Inverters

![Graph showing grid frequency over time with different scenarios: PV does nothing, PV switches off, and PV droop controlled. The graph highlights the concept of the droop function.](image-url)
• Required for a conventional generator interconnection
  – Automatic voltage regulators
  – Automatic frequency response
  – Droop control function

Smart Inverters Can Do This!

Why can’t we require this for asynchronous generators
Potential Solutions

Run additional conventional generators dedicated to voltage and frequency support

- Not cost effective
- Causes negative Locational Marginal Prices
- Limits the percentage of renewables (50% in Spain & Ireland)

Forward Looking Smart Inverters = A Smart Choice

- Proactive response
- Most cost effective, only small incremental cost (0.2% increase)*
- Gain distributed control (not all eggs in one basket)
- Close to loads to lower distribution losses.

*EPRI estimate
Call to Action

Can we substitute speed for inertia/rotating mass?

- Need industry collaboration
- Need method to value reactive support
- Prove speed $\cong$ inertia
- Need to address both transmission and distribution level requirements
- Require smart inverters