The Role of Electricity as a Transportation Fuel

Sean McNamara
Manager, Member Relations
PJM Interconnection, LLC
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PJM’s Responsibilities

- Ensures the reliability of the high-voltage electric power system
- Coordinates and directs the operation of the region’s transmission grid
- Administers a competitive wholesale electricity market
- Plans regional transmission expansion improvements to maintain grid reliability and relieve congestion
Operators of for Energy Markets…

Air Traffic Controllers for the Transmission Grid….

SIMULTANEOUSLY!

RELIABLY!

Match Generation to Load
21% of U.S. GDP produced in PJM

PJM as Part of the Eastern Interconnection with ATSI & Duke Integration

KEY STATISTICS
- PJM member companies: 730+
- Millions of people served: 61
- Peak load in megawatts: 162,230
- MWs of generating capacity: 184,992
- Miles of transmission lines: 62,214
- GWh of annual energy: 832,331
- Generation sources: 1,340
- Square miles of territory: 213,900
- Area served: 13 states + DC
- Internal/external tie lines: 247

- 26% of generation in Eastern Interconnection
- 28% of load in Eastern Interconnection
- 19% of transmission assets in Eastern Interconnection

As of 4/1/2011
The Smart Grid is realized by merging data from these areas of automation to achieve a total end-to-end systems view by integrating information technology and operational technology.

Two-Way Communication and Control

ISO/RTO

SCADA and Phasor Measurements

Substation Automation

Transmission & Sub-transmission

Distribution

Generation

Energy Storage

Smart Metering, Demand Response, PHEV, Energy Conservation and Distributed Resources

Customer
Smarter Grid Network – Smart Home

- Smart Appliance Energy Management
- Smart Charger (PHEV) Storage

- Ancillary Services Signals
- Price Signals
- Generation Mix
- Reliability Control
- Load Curtailment
Integrate SMART Grid with PHEVs

- Enable greater penetration of PHEVs through coordination with state SMART Grid and retail tariff innovation initiatives
- Develop infrastructure to support non-traditional demand based regulation resources
- Develop operational tools and forecasting techniques to enable PHEV deployment

- Develop Vehicle to grid / Plug-in hybrid electric vehicles (PHEVs) protocol
- Participate in Mid-Atlantic Grid Interactive Cars Consortium (MAGICC) – electric companies, research institutes, and vehicle manufacturers
- Test storage batteries in regulation markets
Fast Regulation: Speed Matters…

A fossil power plant following a regulation command signal

Energy Storage (batteries / flywheels) accurately following a regulation command signal
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
“Cash Back” for Storage

0.018 MW → 1 MW

~ $850/day

0.018 MW → 1.018 MW

~ $10/day (20 Hrs.)

Smart Grid Network

- Frequency Regulation Signal

ISO/RTO

Reliability

Grid Signal

System Planning

Load Management

Security

Smart Appliance

Home
Vehicles
• ~18% of U. S. Population is within the PJM territory
• 180,000 PEV Vehicles in the PJM Territory

V2G Equipped PEVs within PJM
• Assume 10% of Vehicles have V2G capability
• Bi-Directional Power (with inverter) – 15 kW
• 18,000 vehicles * 15 kW = 270 Mw

Availability for Participating in Regulation
• Plugged In 12 hours each day (6 pm–6 am)
  365 days * 12 hours = 4380 hours/year

Payment for participation in the PJM Regulation Market
• PJM average historic price paid for regulation = $35/MWh
• PJM Regulation price during valley load periods = $28/MWh
• Per Vehicle: 4380 hrs * $28 * .015 MW = $1800 annually
• PJM Overall: 4380 hrs * 270 MW * $28 = ~$33,000,000 annually
PJM Load and Wind Resources – August 26, 2009

PJM Load and Wind Contribution
August 26, 2009

- PJM Load, MW
- PJM Total Wind, MW
PJM Load and Wind Resources – August 26, 2009

PJM Load and Wind Contribution
August 26, 2009

Locational marginal Price - $/MWh

Chicago LMP
August 26, 2009
Vehicle Charging Impact on PJM

Charging Energy

180,000 PEV Vehicles * 33 miles // 4 miles/ kWh = ~ 1500 MWh

~ 500 additional MW over 3 valley hours

Capacity for 25+ million PEVs

Load (MW x 1000)
Assumptions
• 1,000,000 PEV Vehicles by 2015
• ~18% of U. S. Population is within the PJM territory
• ~ 180,000 PEV Vehicles in the PJM Territory
• ~ 33** Miles traveled per vehicle per day
• ~ Average vehicle fuel usage: 22** mpg
• ~ No tax compensation

Daily cost per PEV Vehicle
Gasoline: 33 miles/day * $3.00 /gal // 22 miles/gal = $4.50
Electric: 33 miles/day * $.07 / kWh // 4 miles/kWh = $0.60

Annual cost/savings
Cost:
Gasoline: 365 days * $4.50 /day = $1650
Electric: 365 days * $0.60 /day = $220
Savings:
~ $1400 annually per vehicle
180,000 vehicles (within PJM) = ~ $250,000,000 annual

** U.S. Bureau of Transportation Statistics
MAGICC – PJM’s PHEV Demonstration Project

- Smart Meter allows car to roam
- Mid-Atlantic Grid Interactive Car Consortium (MAGICC)
- Over one year experience
• Modeling of PHEVs and interactions with the grid
• PHEV Energy Management
• PHEV-Grid Connectivity Issues
• PHEV Fleet Studies

The Ohio State University
Smart@CAR Current Research Activities
Smart@Car-a connection to the grid
Silver Buck Shot – 1,000,000 Plug-In Electric Vehicle Better Place / PJM Simulation Study

The Study
- Modeled the market and pricing impact of 1,000,000 PEVs on the greater Washington DC / Baltimore area
  - Transmission congestion issues
  - Targeted area for PEV deployment

The Analysis
Three grid impact charging scenarios
- Unmanaged charging
- Consumer-price-incentivized charging (via time-of-use pricing)
- Managed charging via an aggregator

The Findings

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

Frequency Regulation
Percent Renewables
Locational Marginal Prices

PHASE 2
Additon of Residential Owned Volts

PHASE 1
1,000 Volt OnStar Laboratory Simulation

Managed Charging
Frequency Response