AEP/EPRI Smart Grid Demo

Virtual Power Plant Simulation
Project Overview

Smart Grid Advisory Meeting
June 23, 2009

Tom Jones / Tom Walker

Virtual Power Plant Simulation Project

• Virtual Power Plant (VPP)
• VPP Simulation (VPPS)
• Real world components
• Practical application of VPPS
• Conclusion
Our Operational Mission

Sustaining the Balance of Energy Supply and Demand in “Real Time”

Before Smart Grid:

One-way power flow, simple interactions
Growing complexity = challenge and opportunity

Enter The Smart Grid

- Two-way communication network
- Smart meters at customer locations
- Remote control of end-use devices
- Information exchange between customers and utility
- Remote monitoring and control of distribution line devices
- Integration and control of distributed energy resources
1. Power System Infrastructure

2. Communications and Information Infrastructure

After Smart Grid:

Two-way power flow, multi-stakeholder interactions
Virtual Power Plant Simulation Project Objective

Assess the functionality, performance and benefits of a fully integrated and robust smart grid as a Virtual Power Plant, from end-use to RTO, by leveraging Real system and device information and data with a comprehensive modeling and Simulation tool.

Tariff Demand Storage PHEV
Fossil DG Solar Wind Fuel Cell External
Output (e.g. Cost) 24.57

Optimize for Cost
Optimize for Efficiency

Internal Power
Supply Demand
Surplus Energy
Energy Deficiency
Daily Time Cycle

Smart Grid Advisory Meeting 06/23/09
Virtual Power Plant Simulation Project Objective

Assess the *functionality, performance* and benefits of a fully integrated and robust smart grid as a Virtual Power Plant, from end-use to RTO, by leveraging Real system and device information and data with a comprehensive modeling and Simulation tool.

**Resource Types for Integration**

- Distributed energy resources that are in operation or under test across AEP will be assessed on location and will be virtually installed on the South Bend VPPS foundational system, including:
  - MW-scale battery installations (e.g. sodium sulfur or NaS),
  - kW-scale flat panel photovoltaic systems (e.g. roof-top),
  - kW-scale concentrating solar systems (electrical and thermal),
  - kW-scale natural gas fired reciprocating engines (with CHP)
  - Plug-in hybrid electric vehicles,
  - Ice Bear air conditioning system,
  - kW-scale wind turbines,
  - kW-scale community energy storage systems,
  - and others.
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Regional Market Structure

- **Wholesale**
  - PJM “Time-Stamped” Pricing
  - Aggregated “Time-Stamped” VPP Resources
  - Calculate Wholesale Market Value of VPP
- **Retail (South Bend Pilot)**
  - Summer on-peak period during the weekday for the months of May through September with an associated off-peak rate during the remaining hours
  - Incentive for participation in thermostat control program
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Communication & Control Infrastructure

- Assess impacts and performance of protocols and standards
- Determine requirements for hierarchical control system (communication within and across “zones”)
- Evaluate requirements for and impacts of control prioritization (e.g., transmission constraint within regional system vs. energy efficiency targets)

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VPPS Foundational System
South Bend, Indiana

AMI / AMR
- 10,000 Smart Meters
- Mesh Network Communications
- End-use Tariffs
- End-use Controls (Thermostat)

South Bend Distribution Automation
Dynamic circuit reconfiguration
- 8 Circuits
- 18 Reclosers

VAR Automation
- 24 Capacitor Banks
Integrated Volt VAR Control:

1. Utilize communications and computerized intelligence to control voltage regulators and capacitors on the distribution system, resulting in lower demand and increased energy efficiency

2. Optimize power factor and voltage levels based on selectable parameters

3. Finer control of voltage levels can cause a 0.7% reduction in KW demand and a similar or better reduction in kVAR demand

4. Benefits are highly predictable because customer consumption is reduced with no action required on their part
CES is a distributed fleet of small energy storage units connected to the secondary of transformers serving a few houses or small commercial loads.
Community Energy Storage Unit Specifications

<table>
<thead>
<tr>
<th>Key Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>25 kW</td>
</tr>
<tr>
<td>Energy</td>
<td>50 kWh</td>
</tr>
<tr>
<td>Voltage</td>
<td>240 / 120V</td>
</tr>
<tr>
<td>Round Trip AC Efficiency</td>
<td>&gt; 85%</td>
</tr>
<tr>
<td>Life</td>
<td>&gt; 3000 cycles, 15 years</td>
</tr>
<tr>
<td>Audible Noise</td>
<td>&lt; 48dBA (no fans or filters)</td>
</tr>
<tr>
<td>Size</td>
<td>Comparable to a Pad-mount transformer</td>
</tr>
</tbody>
</table>

www.aeptechcenter.com/ces

Community Energy Storage Fleet Deployment

- Capital deferral of Transmission, Station, and Circuit improvements
- Scalable, flexible deployment by location and phase
- Integration into circuit voltage and VAR control
- Improved reliability, including reduction of momentary interruptions
- Improved operations including reduction of cold load pick-up
- Improved power quality, flicker (transformer size)