Distributed Generation

Presented by Ram Sastry
ARPA-E Workshop
June 1-2, 2011
### American Electric Power

#### Company Overview

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues (in billions)</td>
<td>$14.4</td>
</tr>
<tr>
<td>Net Income (in millions)</td>
<td>$1,211 (^1)</td>
</tr>
<tr>
<td>Earnings Per Share</td>
<td>$2.53 (^1)</td>
</tr>
<tr>
<td>Cash Dividends Per Share</td>
<td>$1.64</td>
</tr>
<tr>
<td>Service Territory</td>
<td>197,500 mi²</td>
</tr>
<tr>
<td>Transmission</td>
<td>39,000 miles</td>
</tr>
<tr>
<td>Distribution</td>
<td>215,800 miles</td>
</tr>
<tr>
<td>Generating Capacity</td>
<td>38,988 MW (^2)</td>
</tr>
<tr>
<td>Generating Stations</td>
<td>More than 80</td>
</tr>
<tr>
<td>Renewable Portfolio (hydro)</td>
<td>364 MW (^3)</td>
</tr>
<tr>
<td>Pumped Storage</td>
<td>586 MW</td>
</tr>
<tr>
<td>Renewable Portfolio (wind, solar)</td>
<td>1,406 MW (^4)</td>
</tr>
<tr>
<td>Total Kilowatt-hour Sales (in millions)</td>
<td>195,312</td>
</tr>
<tr>
<td>Total Assets (in billions)</td>
<td>$48.3</td>
</tr>
<tr>
<td>U.S. Customers (year-end, in thousands)</td>
<td>5,220</td>
</tr>
</tbody>
</table>

1. Generally Accepted Accounting Principles.
2. Represents nominal capacity; includes 270 MW of mothballed / decommissioned generation, AEP's interest in Ohio Valley Electric Corp., purchased power agreements and renewables.
3. Excludes pumped storage; includes owned capacity and purchased power.
4. Regulated wind and solar capacity on line or under contract.
# Current Initiatives at AEP

<table>
<thead>
<tr>
<th>Generation</th>
<th>Transmission</th>
<th>Distribution</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>I-765™</td>
<td>Distribution automation</td>
<td>• Customer programs and incentives</td>
</tr>
<tr>
<td>Projects</td>
<td>Electric Transmission</td>
<td>• Self-healing distribution circuits</td>
<td>• Energy efficiency</td>
</tr>
<tr>
<td>Wind</td>
<td>Transmission Texas JV</td>
<td>• Advanced metering</td>
<td>• Direct load control</td>
</tr>
<tr>
<td>IGCC</td>
<td>Electric Transmission America JV</td>
<td>• Communications infrastructure</td>
<td>• Peak demand reduction</td>
</tr>
<tr>
<td>Carbon Capture &amp;</td>
<td>AEP-ABB Alliance</td>
<td>• Mobile workforce</td>
<td>• Energy storage</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td>• Internal energy efficiency</td>
<td>• PHEVs</td>
</tr>
<tr>
<td>• Generation and transmission control systems</td>
<td>gridSMART™: bridging the gap to provide integrated two-way communications &amp; control across the electricity value chain</td>
<td>Home energy automation</td>
<td></td>
</tr>
</tbody>
</table>
Centralized Coal Fired Generation

- As of May 20, 2011, out of the U.S. installed coal-fired power capacity totaling 316 gigawatts (GW) and 1,400 units; 8.9 GW (3 percent of the fleet) are committed to retiring by 2020, 5.9 GW of which are set to retire by 2015.

- Another 8.5 GW (3 percent of the fleet) have been proposed to retire by 2020, 5.0 GW of which by 2015.

- AEP is likely to retire up to 20% of our goal fired generation (5,000 – 6,000 MW) by 2020.

Source: IHS CERA

Three – six percent of coal-fired centralized generation will be retired by 2020 creating an opportunity for cost competitive distributed generation technologies.
AEP’s renewable generating capacity is expected to almost double by 2020.
(Levelized) Life-Cycle Cost of Electricity (LCOE) in $ per MWh (2009 $ and 30 year life)

<table>
<thead>
<tr>
<th>Power Type</th>
<th>Install Cost per kW</th>
<th>LCOE per MWh</th>
<th>Heat Rate (Efficiency %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra-Supercritical Pulverized Coal</td>
<td>$3,100</td>
<td>$104</td>
<td>8,750 (38 – 40)</td>
</tr>
<tr>
<td>Natural Gas Combined Cycle</td>
<td>$1,250</td>
<td>$91</td>
<td>6,700 (50 – 52)</td>
</tr>
<tr>
<td>Nuclear</td>
<td>$7,500</td>
<td>$119</td>
<td>10,500 (32.5)</td>
</tr>
<tr>
<td>Wind</td>
<td>$2,100</td>
<td>$145</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Solar PV</td>
<td>$4,500</td>
<td>$300</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Solid Oxide Fuel Cell</td>
<td>$3,500 - $7,500</td>
<td>$120</td>
<td>7,500 (50 – 60)</td>
</tr>
</tbody>
</table>

To effectively compete with centralized generation, DG needs to have a LCOE less than or equal to $100/MWh.
Potential Opportunities for DG within AEP

Why would utilities consider DG?

- Less risk than traditional central generation
  - Less capital
    - Improves ability to finance
    - Limits rate recovery exposure
  - Limited permitting risk
- Avoided construction of transmission and distribution for stand alone or small loads
- Deferred investment in substations
- Meets Renewable Portfolio Standards (RPS) in many jurisdictions
- Peak shaving/peak shifting opportunities
- Standby/spinning reserve capacity
- Islanding – system reliability
- Power Quality
- Environmental concerns

DG applications that enable us to avoid/delay a large capital expenditure are prime candidates.
Meeting RPS requirements

- **Wind**
  - 310.5 MW wind owned in Texas
  - 1,771 MW wind PPA in Illinois, Indiana, Ohio, Oklahoma, Texas and West Virginia

- **Solar**
  - 10.9 MW solar PPA in Ohio
  - 49.5 MW solar under negotiation

- **Customer Programs** (pending)
  - Incentives for customer owned small wind/solar (AEP receives title to REC)
  - REC purchase for existing customer small wind/solar

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**AEP is currently primarily focused on PPA agreements that enable us to meet our RPS commitments. However, we are open to opportunities to partner with third party or end user on DG applications that make economic sense.**
Net Metering Residential & Commercial Customers

- **Solar**
  - 4 MW
  - 578 customers

- **Wind**
  - 2.3 MW
  - 141 customers

- **CHP/Cogen**
  - 1.2 kW
  - 1 residential customer

*In AEP Ohio, less than 25% of our small DG customers are registered with the state to sell their Renewable Energy Certificates.*
Opportunities for DG with Consumers

DG opportunities that meet more than one consumer need are more likely to be successful.

Multiple needs

- Locational advantages – Utility is constrained at node
- Need for steam (CHP)
- Need for uninterruptible power, premium power
- Low cost natural gas or renewable/storage available

Potential early adopters

- Hospitals
- University Campuses
- Data Centers
- Industrial sites
- Supermarkets

DG applications that meet a “need” other than solely supplying power have a greater opportunity of overcoming today’s significant cost disadvantage.
Distributed Generation

**Advantages**

- Relatively small footprint compared to renewables or central
- Little to no permitting required
- Quick time to power
- Modular design
- Public policy – incentives, tax credits, cost sharing, etc.
- Plug & play with existing T&D infrastructure
- Potential solution for uninterruptible power/critical power
- Applicable for Purchase Power Agreements (PPA)
- Limited staff

*Distributed Generation helps limit risk by enabling scalable deployment and requiring little to no permitting.*
Why isn’t small scale distributed generation widely adopted today?

- High initial capital cost & ongoing cost/kWh
- Lack of clarity on interconnection and local environmental rules
- No guarantee that primary fuel prices will remain low
- Limited system life (typical life for fuel cell stack is 3 - 5 years)
- Reliability concerns for some technologies
- Limited commercial availability of some technologies
- Limited incentives, which are then spread across all customers creating potential backlash
- Uncertain economy – DG not at the top of the list of investments for commercial customers

The primary barrier to widespread deployment of DG today is the cost, and it is coming down as technologies mature and become more commercially available.
### Comparison of Technologies

AEP is evaluating various technologies.

<table>
<thead>
<tr>
<th>Distributed Resources Programs</th>
<th>Value Proposition (Benefits)</th>
<th>Impacts to AEP (Requirements)</th>
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<tbody>
<tr>
<td></td>
<td>Customer Choice and Control</td>
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<td>AEP Operated Distributed Gensets</td>
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<tr>
<td>Customer Owned Generation</td>
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<tr>
<td>Distributed Renewable Resources</td>
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<tr>
<td>Fuel cells</td>
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<tr>
<td>Large Energy Storage (i.e. NaS Battery)</td>
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<tr>
<td>Small Energy Storage (e.g. Supercapacitors)</td>
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<tr>
<td>Stirling Engines</td>
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<td>Microturbine</td>
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</table>

AEP is evaluating various technologies.
Distributed Generation provides utilities with a number of potential business models including . . .

- Traditional ownership of generation and ability to use to support traditional loads or to meet Renewable Portfolio Standards (RPS) requirements
- “Green Power” rate applications
- “Premium Power” rate applications
- Consumer ownership of asset with utility utilizing a purchase power agreement (PPA) to meet RPS requirements

Distributed Generation provides utilities with increased flexibility in meeting RPS requirements and providing rate options to consumers.
AEP’s Microgrid Test Bed
Rolls-Royce Fuel Cell Systems

1 MW SOFC Test & Evaluation Program
ECHOGEN Waste Heat Engine

- 5 kW lab scale system built and demonstrated
- 15 kW pilot scale system built
  - Initial system demonstrations complete
  - Positive net power in August 2009
- 250 kW demonstration system field test
  - Installation @ Utility site – 1Q 2010
  - Shakedown and system testing – 2-4Q 2010
  - Installation at launch customer site – 1QQ 2011
    - Fully automated, unattended operation
    - Long-term durability demonstration
- Scale up to 5 - 8 MW system underway with demonstration project initiated in 2011
Key Take Aways

Distributed Generation allows us to...

- Use capital more efficiently
- Meet RPS requirements
- Leverage value streams
- Reduce financial and regulatory risk

...improve our financial flexibility...

- Low public policy risk (incentives, tax credits, cost sharing, cost shifting)
- Quick/easy/scalable projects, timely completion
- Siting/permitting is easier
- Natural gas delivery infrastructure widely available at low stable prices

....and provide our customers better service.

- Improved reliability
- Fewer long duration outages thru islanding
- Improved power quality