AEP CCS Program Overview

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Characterization...

Simulation...

Validation...
American Electric Power Overview

AEP’s Generation Fleet
>38,000 MW Capacity

Coal/Lignite
66%

Nat. Gas/Oil
22%

Nuclear
6%

Pumped Storage/
Hydro/Wind
6%

5.2 million customers in 11 states
Industry-leading size and scale of assets:

<table>
<thead>
<tr>
<th>Asset</th>
<th>Size</th>
<th>Industry Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Generation</td>
<td>~38,300 MW</td>
<td># 2</td>
</tr>
<tr>
<td>Transmission</td>
<td>~39,000 miles</td>
<td># 1</td>
</tr>
<tr>
<td>Distribution</td>
<td>~213,000 miles</td>
<td># 1</td>
</tr>
</tbody>
</table>
The more coal used, the lower the consumers electric costs
Technology is the Key to Clean Coal

Emissions Continue to Decline While Coal-Fueled Generation Increases Through 2030

Sources: EPA National Air Pollutant Emission Trends; EIA Annual Energy Review and EIA AEO ‘09 AARA
Site Characterization and Feasibility Study
The foundational work for AEP’s CCS program began in 2003

Seismic Survey
Summer 2003

Drilling and Testing
2003 - 2005

Modeling and Analysis
2006 - 2007

More than $7.5 million for site characterization and feasibility assessment conducted by Battelle under funding by DOE and others
Alstom’s Chilled Ammonia Process

Post-Combustion Capture

Reactions:
\[
\begin{align*}
\text{CO}_2 (g) & \rightleftharpoons \text{CO}_2 (aq) \\
(\text{NH}_4)\text{HCO}_3 (aq) + \text{CO}_2 (aq) + \text{H}_2\text{O} & \rightleftharpoons 2(\text{NH}_4)\text{HCO}_3 (aq) \\
(\text{NH}_4)\text{HCO}_3 (aq) & \rightleftharpoons (\text{NH}_4)\text{HCO}_3 (s) \\
(\text{NH}_4)\text{HCO}_3 & \rightleftharpoons (\text{NH}_4)\text{NH}_2\text{CO}_2 + \text{H}_2\text{O}
\end{align*}
\]
AEP CCS Validation Facility
1,300 MWe Mountaineer Plant, New Haven, WV

- **Scale:** 20 MWe slipstream
  - ~1.5% of power plant flue gas

- **Cost:** >$100M
  - Project initiated in September 2007
  - Funding by AEP, Alstom, RWE, & EPRI

- **Capture:** Alstom Chilled Ammonia Process
  - Ammonium Carbonate/Bicarbonate Reaction
  - >85% CO₂ capture rate

- **Sequestration:** Deep saline formation storage
  - ~100,000 tons CO₂ per year
  - ~1.5 miles below the plant surface

- **First CO₂ Capture:** September 1, 2009
- **First CO₂ Storage:** October 1, 2009
- **Planned operation:** 1 to 5 years
Monitoring System Design
At Mountaineer Plant

- Passive Seismic/Tiltmeters
- Injection Wells
- Surface CO₂ H&S Gas Meters
- Groundwater/Soil Gas
- System CO₂ PVT Monitoring
- Periodic Wireline Logging
- Periodic Brine Sampling
- CO₂ Pipeline
- Slipstream Capture
- CO₂ Capture and Separation
- Pressure Gauges
- Deep Monitoring Wells
- Crosswell Seismic
- Rose Run Storage Reservoir
- Copper Ridge
Validation Facility Progress Update
First Year of Operation

- ~4,400 hours operation
- ~21,000 metric tons captured
- ~15,000 metric tons stored
  - ~13,500 into AEP-1
    - Copper Ridge
  - ~1,500 into AEP-2
    - Rose Run
- Process availability approaching 100%
  - Both capture and storage
- >90% CO₂ capture rate
AEP CCS Commercialization Project
1,300 MWe Mountaineer Plant, New Haven, WV

- **Scale:** Full commercial demonstration
  - 235 MWe Slipstream

- **Cost:** ~$668M

- **Funding:** CCPI Round III Selection
  - DOE awarded 50% cost share, up to $334M
  - Cooperative agreement signed in January, 2010

- **Capture:** Alstom Chilled Ammonia Process
  - ~90% CO₂ capture rate

- **Sequestration:** Battelle is Storage Contractor
  - Deep saline reservoirs
  - ~1,500,000 tons CO₂ per year
  - ~1.5 miles below the surface
  - Pipeline system with off-site wellheads

- **NEPA Process Underway**

- **Geologic Experts Advisory Group:** Actively Meeting
  - Battelle, CONSOL, MIT, Univ. of Texas, Ohio State, WVU, Virginia Tech, LLNL, WV Geo. Survey, OH Geo. Survey, WV DOE, NETL, RWE, & CATF

- **Planned Operation:** Startup in second half of 2015
AEP and China Huaneng Sign MOU

**CCS technology assessment**

- Evaluate Amine Process Developed by China Huaneng
  - Parasitic load consumption
  - Compatibility with existing power generating unit
  - Characterization of process effluent streams
- Perform “Apples-to-Apples” Comparison with Other Known Technologies
  - Standardize comparison conditions
    - With compression included or without?
    - Product CO₂ quality and pressure
    - Steam and power sources
  - Parasitic load
  - Land requirements (footprint)
  - Capability to handle load-swinging nature of generating unit
- Consider Path Forward for Technology Commercialization
  - Demonstrations and/or deployments