AEP Climate Change Strategy

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Company Overview

AEP’s Generation Fleet
38,388 MW Capacity

Coal/Lignite
67%

Natural Gas/Oil
24%

Nuclear
6%

Pumped Storage/
Hydro/Wind
3%

5.1 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>~208,000 miles</td>
<td># 1</td>
</tr>
</tbody>
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AEP’s Climate Strategy

- Being proactive and engaged in the development of climate policy
- Investing in science/technology R&D
- Taking Voluntary action now, making real reductions thru CCX (2003-07: 40 MM Tons reductions); 2011 Voluntary Commitment (additional 5 MM Tons/year reductions).
- Investing in long term technology (e.g., IGCC, Ultra-supercritical PC and CCS)

AEP must be a leader in addressing climate change
AEP’s Climate Position

- A certain and consistent national policy for reasonable carbon controls should include the following principles:
  - Comprehensiveness
  - Cost-effectiveness
  - Realistic emission control objectives
  - Monitoring, verification and adjustment mechanisms
  - **Technology development & deployment**

- Inclusion of adjustment provision if largest emitters in developing world do not take action

Achieving all targets is aggressive, but potentially feasible

EIA Base Case 2007

<table>
<thead>
<tr>
<th>Technology</th>
<th>EIA 2007 Reference</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Load Growth ~ +1.5%/yr</td>
<td>Load Growth ~ +1.1%/yr</td>
</tr>
<tr>
<td>Renewables</td>
<td>30 GWe by 2030</td>
<td>70 GWe by 2030</td>
</tr>
<tr>
<td>Nuclear Generation</td>
<td>12.5 GWe by 2030</td>
<td>64 GWe by 2030</td>
</tr>
<tr>
<td>Advanced Coal Generation</td>
<td>No Existing Plant Upgrades</td>
<td>150 GWe Plant Upgrades New Plant Efficiency by 2020; 49% in 2030</td>
</tr>
<tr>
<td></td>
<td>40% New Plant Efficiency by 2020-2030</td>
<td></td>
</tr>
<tr>
<td>CCS</td>
<td>None</td>
<td>Widely Deployed After 2020</td>
</tr>
<tr>
<td>PHEV</td>
<td>None</td>
<td>10% of New Vehicle Sales by 2017; +2%/yr Thereafter</td>
</tr>
<tr>
<td>DER</td>
<td>&lt; 0.1% of Base Load in 2030</td>
<td>5% of Base Load in 2030</td>
</tr>
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</table>

Load Growth ~ +1.1%/yr
AEP is investing in a portfolio of GHG reduction alternatives.

- **Renewables (Biomass Co-firing, Wind)**
- **Off-System Reductions and Market Credits (forestry, methane, etc.)**
- **Supply and Demand Side Efficiency**
- **Commercial Solutions of New Generation and Carbon Capture & Storage Technology**
### A Portfolio Approach: AEP’s Long-Term CO₂ Reduction Commitment

#### Existing Programs
- **Existing plant efficiency improvements**
- **Renewable Energy**
  - 800 MWs of Wind
  - 300 MWs of Hydro
- **Domestic Offsets**
  - Forestry - 0.35MM tons/yr
  - Over 63MM trees planted through 2006
  - 1.2MM tons of carbon sequestered
- **International Offsets**
  - Forestry projects have resulted in 1MM tons of carbon sequestered through 2006
- **Chicago Climate Exchange**

#### New Program Additions (by 2011)
- 1000 MWs of Wind PPAs: 2MM tons/yr
- Domestic Offsets (methane): 2MM tons/yr
- Forestry: Tripling annual investment to increase to 0.5MM tons/yr by 2015
- Fleet Vehicle/Airline Offsets: 0.2MM tons/yr
- Additional actions--end use and supply efficiency and biomass: 0.3MM tons/yr

#### New Technology Additions
- New Generation – IGCC and USC
- Commercial solutions for existing fleet
  - Chilled Ammonia
  - Oxy-Coal

#### AEP’s reductions/offsets of CO₂:
- **2003-2005:** 31 MMT
- **2006-2010 (proj.):** Additional 15 MMT
- **2011+:** 5 MMT/YEAR

**Longer Term—New Technology**
AEP Wind Operations/Purchases

Trent Mesa (2001)
- **150 MW** (100 - 1.5 MW turbines)
- Abilene/Sweetwater, TX

Southwest Mesa (1999)
- **75 MW** (107 – 700kW turbines)
- McCarney, TX
- Power Purchaser

- **160 MW** (107 - 1.5 MW turbines)
- Bakersfield, TX

Summary
- Owned/Operated 385 MW
- Wind Purchases 392 MW
- Total Existing Wind at end of 2006: 777 MW
- New Wind Purchases in 2007: 275 MW

Will acquire an additional 725 MW of new wind to attain goal of 1,000 MW by 2011
**Off-System Reductions**

**New AEP Offset Commitment by 2011:**
- 2 MM tons/year additional CO₂ offsets

**Latest Announcement:**
- Methane Capture Deal with Environmental Credit Corp.
  - 0.6 MM Tons CO₂e per year
  - 2010 through 2017
  - 51% of credits sourced from “AEP States”

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**Cows to Credits for Coal**
American Electric Power plans to capture methane from rotting animal manure. It hopes that it will earn “credits” against a future global-warming cap, but the plan will cover only a fraction of AEP’s total emissions.

A cow, weighing 1,329 lbs.

- Produces 115 lbs. of manure a day
- 11 lbs. are “volatile solids”

Those solids produce 1 cubic meter of methane a day, 365 cubic meters per year

About 5 tons CO₂ equivalent; or 5 CO₂ credits per year

AEP’s annual CO₂ emissions, 145 million tons

One plant 17 million tons

AEP will buy at least 600,000 CO₂ credits from farms, which equal 0.6 million tons of CO₂ equivalent

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*For a typical farm; precise yield varies by state.*
*“AEP’s largest coal-fired plant.*

AEP Leadership in New Technology: IGCC and USC

**NEW ADVANCED GENERATION**

- **IGCC** -- AEP first to announce plans to build two 600+ MW IGCC commercial size facilities in US (OH and WV) by mid next decade

- **USC** -- AEP will be first to employ new generation ultra-supercritical (steam temperatures >1100°F) coal plant in U.S (AR)
**CO₂ Capture Techniques**

**Pre-Combustion Capture - IGCC with Water-Gas Shift**
- Most of the processes commercially available in other industrial applications
  - Have never been integrated together
- Turbine modified for H₂-based fuel, which has not yet been proven at commercial scale
- Creates stream of very high CO₂ concentration
- Parasitic demand (~15-20%) for CO₂ capture - lower than amine or oxy-coal

**Modified-Combustion Capture - Oxy-Coal**
- Technology not yet proven at commercial scale
- Creates stream of very high CO₂ concentration
- High parasitic demand, >25%

**Post-Combustion Capture - Conv. or Advanced Amines, Chilled Ammonia**
- Amine technologies commercially available in other industrial applications
- Relatively low CO₂ concentration in flue gas – Thus difficult to capture
- **High parasitic demand**
  - Conventional Amine ~30%, Chilled Ammonia target ~10-15%
- Amines require **very** clean flue gas
IGCC Water-Gas Shift Process

Pre-Combustion Capture

[Diagram of the IGCC Water-Gas Shift Process]

- Air Separation
- Gasifier
- Gas Clean-Up
- CO₂ Separation
- Electricity Generation
- H₂ Product
- H₂O
- Sulfur Recovery
- Deep Saline Formation

Inputs:
- Air
- O₂
- Coal

Outputs:
- Electricity
- H₂ Product
- CO₂

By-Products:
- MARKETABLE ASH/SLAG
- MARKETABLE SULFUR
- MARKETABLE ASH/SLAG
- MARKETABLE SULFUR

Other Points:
- Unmineable Coal Beds
- Enhanced Oil Recovery
- Depleted Oil and Gas Reservoirs

TRANSPORTATION
REFINERY
Babcock & Wilcox Oxy-Coal Process
*Modified Combustion Capture*

**Oxygen Combustion Process**

- **Air In**
  - Air Separation Unit
  - Pure Oxygen (O₂)
  - Boiler
  - Recycled Flue Gas
  - Environmental Cleanup Equipment
  - CO₂ and Flue
  - CO₂ (vapor)
  - CO₂ Compression
  - CO₂ Capture (liquid)
  - Ash
  - SO₂
  - Other captured emissions

- **Coal In**
- **Nitrogen (N₂) Out**

- **Points**
  - No SCR (typically)
  - No CO₂ scrubber
Alstom’s Chilled Ammonia Process

Post-Combustion Capture

Flue Gas
High CO$_2$, Low Sulfur

FGD

Flue Gas Low CO$_2$, Low Sulfur

CO$_2$ Absorber

MD

Boosted CO$_2$ Absorber

Rich (CO$_2$) Reagent

Lean (CO$_2$) Reagent

CO$_2$ Geologic Storage by AEP/Battelle

CO$_2$ to Compression

Concentrated CO$_2$
AEP Leadership in New Technology: Chilled Ammonia CCS

Phase 1

2009 Commercial Validation

1300 MW Mountaineer Plant (WV) → MOU (Alstom) → Chilled Ammonia 20MWe scale → CO₂ Storage (Battelle) → Captures and sequesters 100,000 metric tons of CO₂ / yr.

Phase 2

2012 Commercial Operation

450 MW Northeastern Plant (OK) → MOU (Alstom) → Chilled Ammonia 200MWe scale → CO₂ Storage → EOR → Captures and sequesters 1.5 Million metric tons of CO₂ / yr.
The Challenge: CCS is Expensive

- Carbon Capture w/ Geologic Sequestration
- Other renewable, advanced geothermal and/or solar
- Carbon Capture for Enhanced Oil Recovery
- New Biomass Generation
- Dispatch of additional gas vs. inefficient coal
- Biomass Co-firing
- Biological Sequestration (e.g. Forestry)
- New Wind
- Energy Efficiency
- Methane Offsets

$/ton CO_2 e$

-$50+$

-$0$
CCS: The Business Case

- CO2 Legislation Requiring Very Substantial Long Term Reductions is Likely
- A Portfolio of Reduction Options Will Be Needed
- Future Electricity Demand Requires New “Baseload” Power Options (Predominantly Coal and Nuclear)
- Half of Existing Demand is Met By Coal and Early Retirement of Coal is Expensive. Thus, Retrofit CCS becomes essential.
Key Issues for CCS Development

- Overcoming the “Economic” Hurdle—Bonus Allowances and Other Financial Support
- High Up-Front Capital Investment - Getting Adequate Financing and Recovery in Rates
- Commercial Demonstrations of CCS at Large Coal-Fired Power Plants
- National Standards for Permitting of Storage Reservoirs
- Potential Institutional, Legal and Regulatory Barriers to Carbon Storage