AEP, Climate and Carbon Capture and Storage

Mountaineer Plant - New Haven, WV

AEP AMERICAN® ELECTRIC POWER

Northeastern Plant - Oologah, OK

Bruce Braine
Vice President - Strategic Policy Analysis

September, 2007

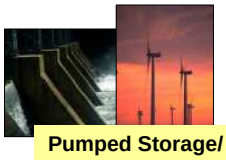
UN Expert Meeting on Sustainable Development and CCS

AEP Company Overview

Coal/Lignite
67%

Nat. Gas/Oil
24%

Nuclear
6%



Pumped Storage/ Hydro/Wind
3%

AEP's Generation Fleet
36,672 MW Capacity

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

Asset	Size	Industry Rank
Domestic Generation	~38,300 MW	# 2
Transmission	~39,000 miles	# 1
Distribution	~208,000 miles	# 1

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AEP's Climate Strategy

- **Being proactive and engaged in the development of climate policy**
  - International Emissions Trading Association (IETA)
  - Electric Power Research Institute (EPRI)
  - Pew Center on Global Climate Change
  - e8
  - Global Roundtable on Climate Change
- **Investing in science/technology R&D**
  - FutureGen Alliance
  - US DOE research on carbon capture and sequestration at our Mountaineer Plant
  - EPRI – combustion technologies
  - MIT Energy Laboratory
  - B&W – Oxy-Coal
- **Taking voluntary, proactive action now, making real reductions and setting policy precedents thru CCX**
  - Chicago Climate Exchange (CCX)
  - EPA Climate Leaders and SF-6 Program
  - Asia-Pacific Partnership
  - DOE 1605B- voluntary reporting of GHGs Program
  - Business Roundtable Climate Resolve
  - Numerous forestry activities
- **Investing in longer term technology solutions--new generation and carbon capture and storage (e.g., IGCC, Ultra-supercritical PC)**

AEP must be a leader in addressing climate change

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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

A reliable & reasonably-priced electric supply is necessary to support the economic well-being of the areas we serve

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AEP Supports Recent Bingaman-Specter CO_2 Bill

"Low Carbon Economy Act of 2007"

- Economy wide cap-and-trade program to limit Greenhouse Gas Emissions
  - Caps and Dates
    - 2006 Levels by 2020
    - 1990 levels by 2030
  - Industry Sectors "Regulated" under bill
    - Natural Gas and Petroleum regulated "upstream"
    - Coal regulated "downstream" at the power plant level
  - Allocations to Electricity Generators
    - Only fossil-fired electric generators receive allowances
  - Safety Valve (TAP)
  - Bonus Allowances for Carbon Capture and Sequestration
  - Early Reduction Credits and Offsets Included
  - Congressional Review of International Action

AEP Supports Reasonable Legislation on GHG

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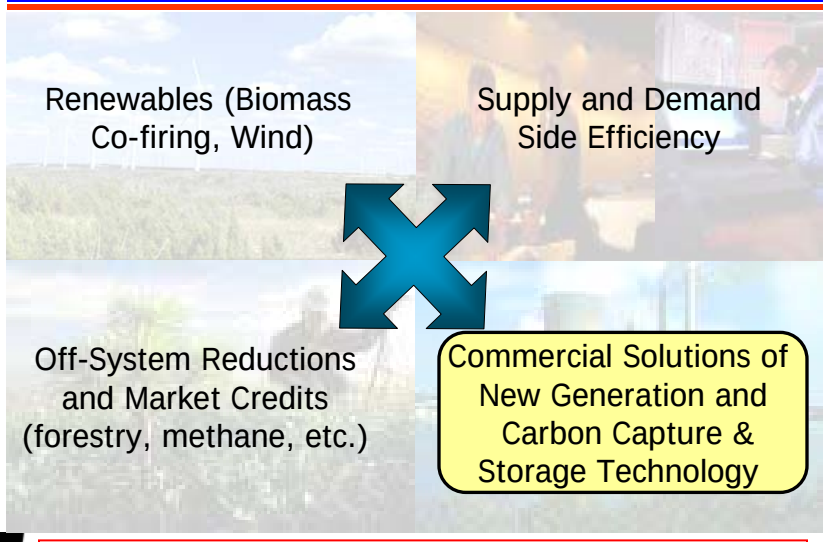
AEP's Long-Term GHG Reduction Portfolio



AEP is investing in a portfolio of GHG reduction alternatives

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A Portfolio Approach: AEP Long-Term CO_2 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 @ $500K/year
  - 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**

AEP's reductions/offsets of CO_2:
- **2003-2005: 31 MMT**
- **2006-2010 (proj.): Additional 15 MMT**

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/Aviation Offsets: 0.2MM tons/yr**
- **Additional actions--end use and supply efficiency, and biomass: 0.2MM tons/yr**

AEP's reductions/offsets of CO_2:
2011+: 5 MMT/YEAR
Longer Term—New Technology

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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

Desert Sky (2002)

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

Summary

- **Owned/Operated 385 MW**
- **Wind Purchases 392 MW**
- **Total Existing Wind: 777 MW**
- **New Wind by 2011: 1000 MW**

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AEP Leadership in Technology: IGCC/USC and Future Gen

NEW ADVANCED GENERATION

- **IGCC---AEP plans to build first two 600+ MW IGCC commercial-scale facilities in the US in OH and WV by the middle of next decade**
- **USC--AEP plans to build two of the new generation ultra-supercritical (steam temperatures greater than 1100ºF) coal plants in the US—in AR and OK**

FUTUREGEN- ***First Near Zero Emissions Hydrogen/ Electric (coal-fueled IGCC with CCS)-AEP and Alliance members***

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AEP's New Carbon Capture & Storage Initiative

In March 2007, AEP announced a major new carbon capture and storage initiative:

- **Chilled Ammonia CCS--We will install carbon capture on two coal-fired power plants, the first commercial use of technologies to significantly reduce carbon dioxide emissions from existing plants.**
  - **The first carbon capture project, at the Mountaineer plant in West Virginia, is expected to complete its product validation phase in 2009**
  - **The second, at the Northeastern plant in Oklahoma, will begin commercial operation in 2011.**
- **Oxy-Coal--AEP will also demonstrate (10MWe) and then install oxy-coal CO_2 capture & storage project at a commercial sized coal unit (about 200 MWe)—feasibility study completed in 2008.**

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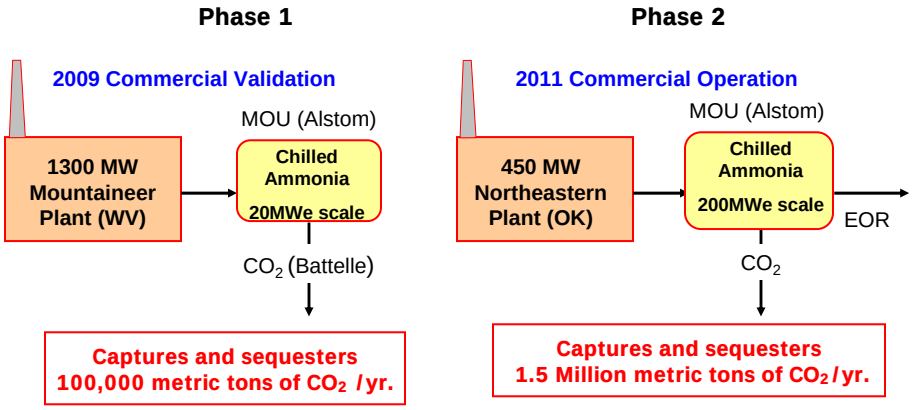
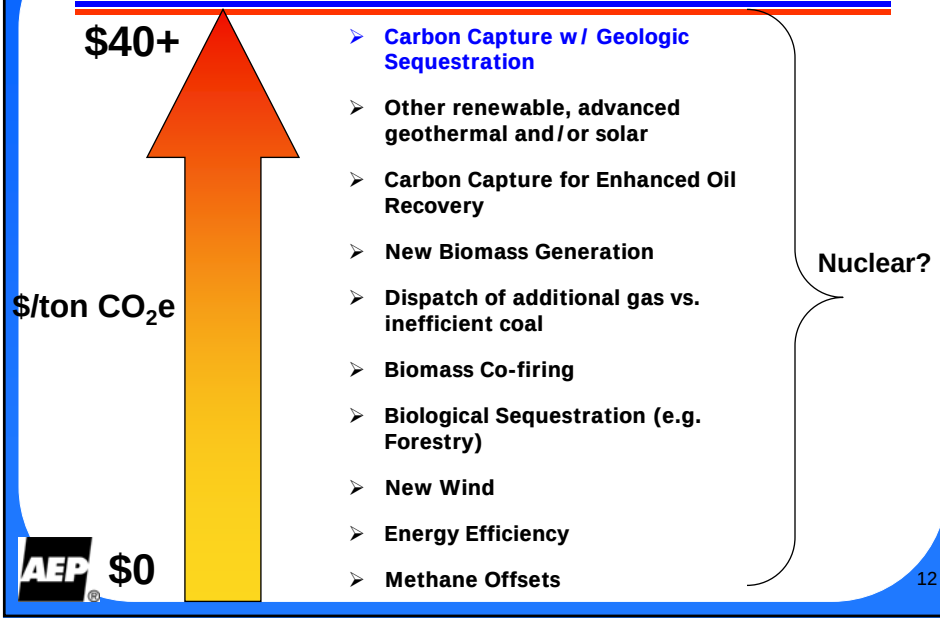
AEP Leadership in New Technology: Chilled Ammonia CCS



Examples of Relative GHG Mitigation Costs for Power Sector



Key Issues for CCS Development in US

- Overcoming the "Economic" Hurdle
- 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

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Possible Solutions for CCS Development

- Economic/Financial Incentives for CCS Commercial Deployment. Possible Examples:
  - Cap-and-trade, "reasonable" federal climate legislation,
  - Bonus Allowances in Bingaman- Specter,
  - CCS Tax Credits similar to Wind Production Tax Credits,
  - Investment Tax Credits or Cost Sharing
- Development of appropriate MMV (measurement, monitoring and verification) protocols and regulatory "clarity".
- Establish streamlined siting and permitting process.
- Dealing with potential liability/remediation issues up-front and realistically.

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Technical Appendix

Carbon Capture and Storage

CO_2 Capture Techniques

- **Post-Combustion Capture**
  - Conventional or Advanced Amines, Chilled Ammonia
  - *Key Points*
    - Amine technologies commercially available in other industrial applications
    - Relatively low CO_2 concentration in flue gas – More difficult to capture than other approaches
    - High parasitic demand
      - Conventional Amine ~25-30%, Chilled Ammonia target ~10-15%
    - Amines require **very** clean flue gas
- **Modified-Combustion Capture**
  - Oxy-coal
  - *Key Points*
    - Technology not yet proven at commercial scale
    - Creates stream of very high CO_2 concentration
    - High parasitic demand, >25%
- **Pre-Combustion Capture**
  - IGCC with Water-Gas Shift – FutureGen
  - *Key Points*
    - Most of the processes commercially available in other industrial applications
      - Have never been integrated together
    - Turbine modified for H_2-based fuel, which has not yet been proven at commercial scale
    - Creates stream of very high CO_2 concentration
    - Parasitic demand (~20%) for CO_2 capture - lower than amine or oxy-coal

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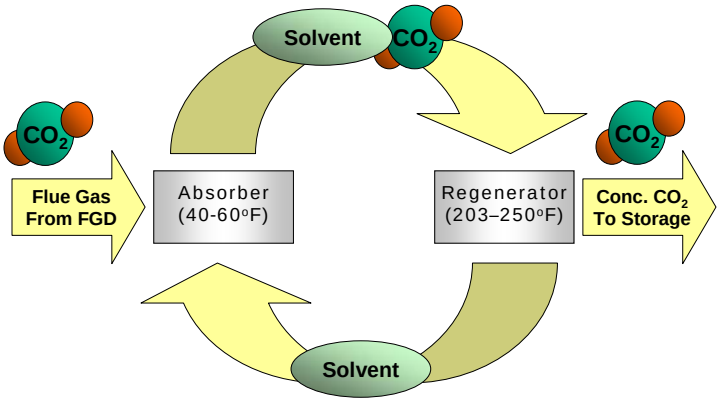
Alstom Chilled Ammonia Process

Post-Combustion Capture

(Ammonium Bicarbonate)



(Ammonium Carbonate – "Baker's Ammonia")

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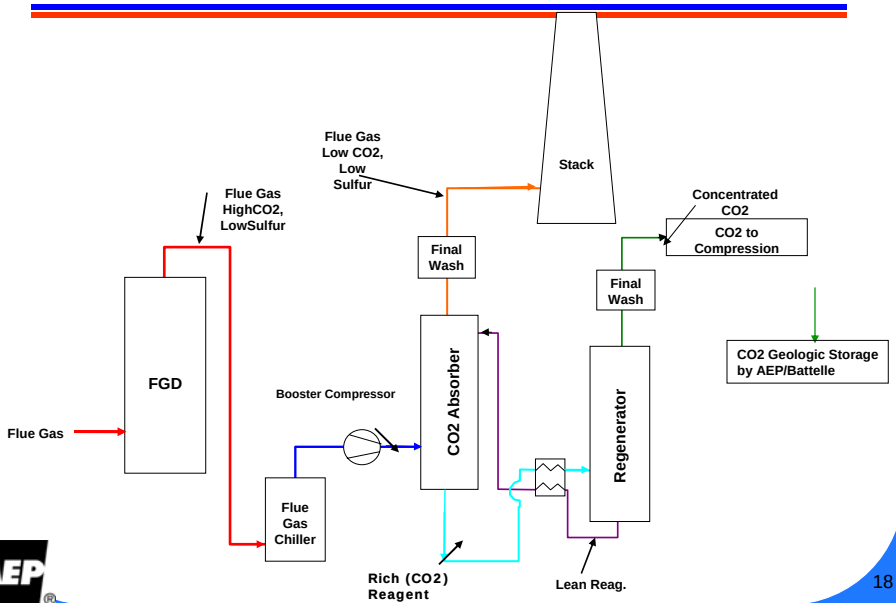
Alstom Chilled Ammonia Process

Post-Combustion Capture



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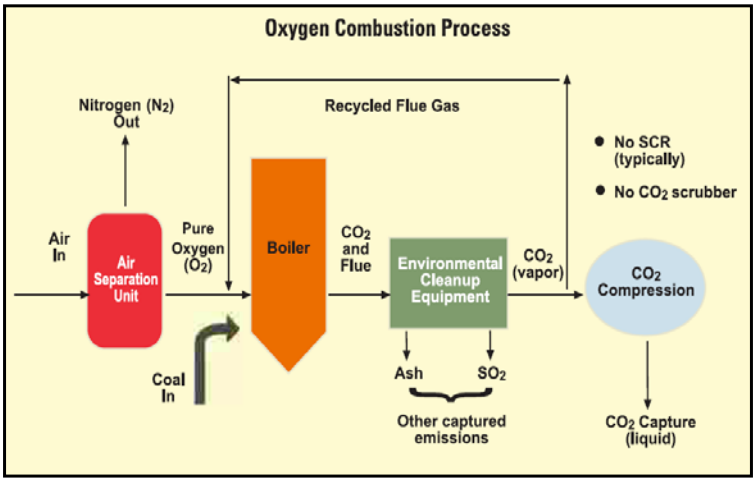
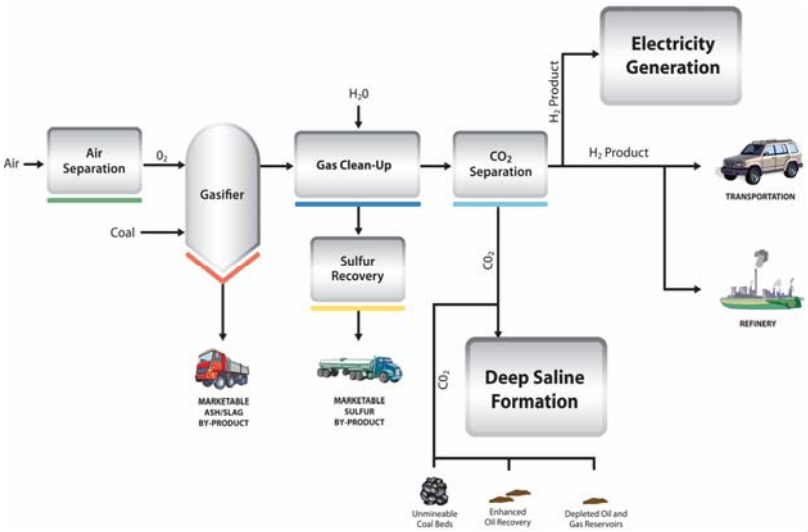
B&W Oxy-Coal Process

Modified Combustion Capture

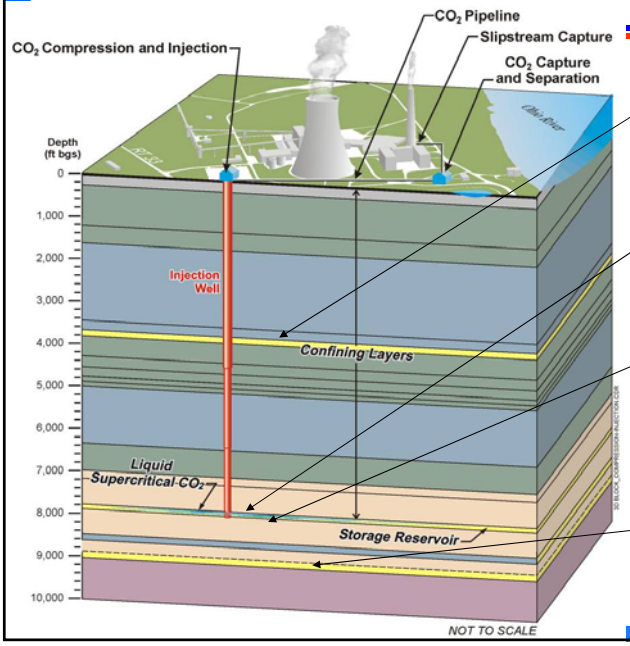


FutureGen Water-Gas Shift Process

Pre-Combustion Capture



CO_2 Injectivity in the Mountaineer Area



CO_2 injection should also be possible in shallower sandstone and carbonate layers in the region

Rose Run Sandstone (~7800 feet) is a regional candidate zone in Appalachian Basin

A high permeability zone called the "B zone" within Copper Ridge Dolomite has been identified as a new injection zone in the region

Mount Simon Sandstone/Basal Sand - the most prominent reservoir in most of the Midwest but not desirable beneath Mountaineer site

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