

# Climate Change and Carbon Capture and Storage (CCS) Technology



Mountaineer Plant - New Haven, WV



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# Company Overview



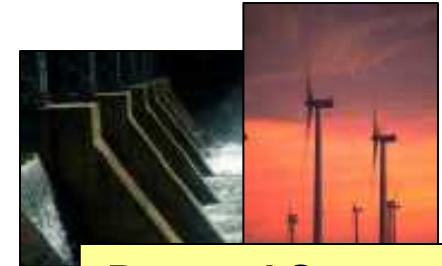
**Coal/Lignite**  
67%



**Nat. Gas/Oil**  
24%

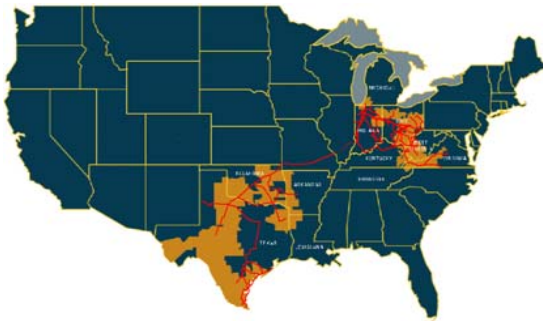


**Nuclear**  
6%



**Pumped Storage/  
Hydro/Wind**  
3%

**AEP's Generation Fleet**  
38,388 MW Capacity



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

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

# AEP's Climate Strategy



Clean Energy for a Secure Future



GLOBAL ROUNDTABLE  
ON CLIMATE CHANGE



- 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

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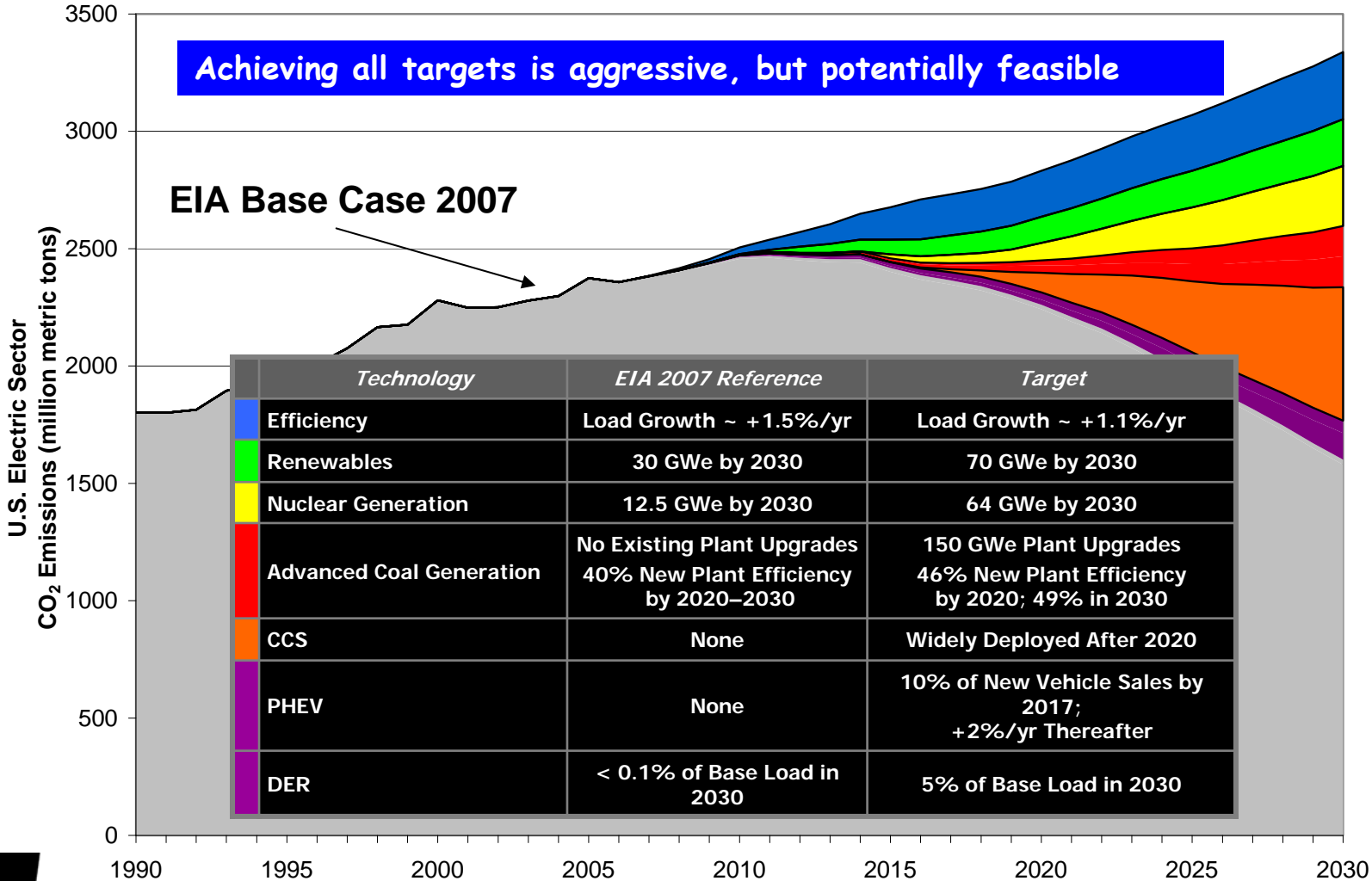
- A certain and consistent national policy for reasonable carbon controls should include the following principles:
  - Comprehensiveness
  - Cost-effectiveness
  - Realistic emission control objectives
  - Monitoring, verification and adjustment mechanisms
  - **Technology development & deployment**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

# EPRI CO<sub>2</sub> Reduction “Prism”

Achieving all targets is aggressive, but potentially feasible

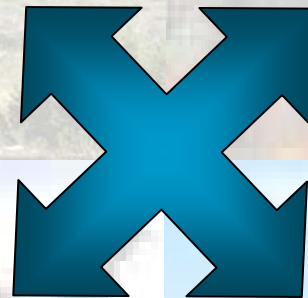
EIA Base Case 2007



# AEP's Long-Term GHG Reduction Portfolio

Renewables (Biomass  
Co-firing, Wind)

Supply and Demand  
Side Efficiency



Off-System Reductions  
and Market Credits  
(forestry, methane, etc.)

Commercial Solutions of  
New Generation and  
Carbon Capture &  
Storage Technology

**AEP is investing in a portfolio of GHG reduction alternatives**

# 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  $>1100^{\circ}\text{F}$ ) coal plant in U.S (AR)



# CO<sub>2</sub> Capture Techniques

## **Post-Combustion Capture** - *Conventional or Advanced Amines, Chilled Ammonia*

- Amine technologies commercially available in other industrial applications
- Relatively low CO<sub>2</sub> 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

## **Modified-Combustion Capture** - *Oxy-Coal*

- Technology not yet proven at commercial scale
- Creates stream of very high CO<sub>2</sub> concentration
- High parasitic demand, >25%

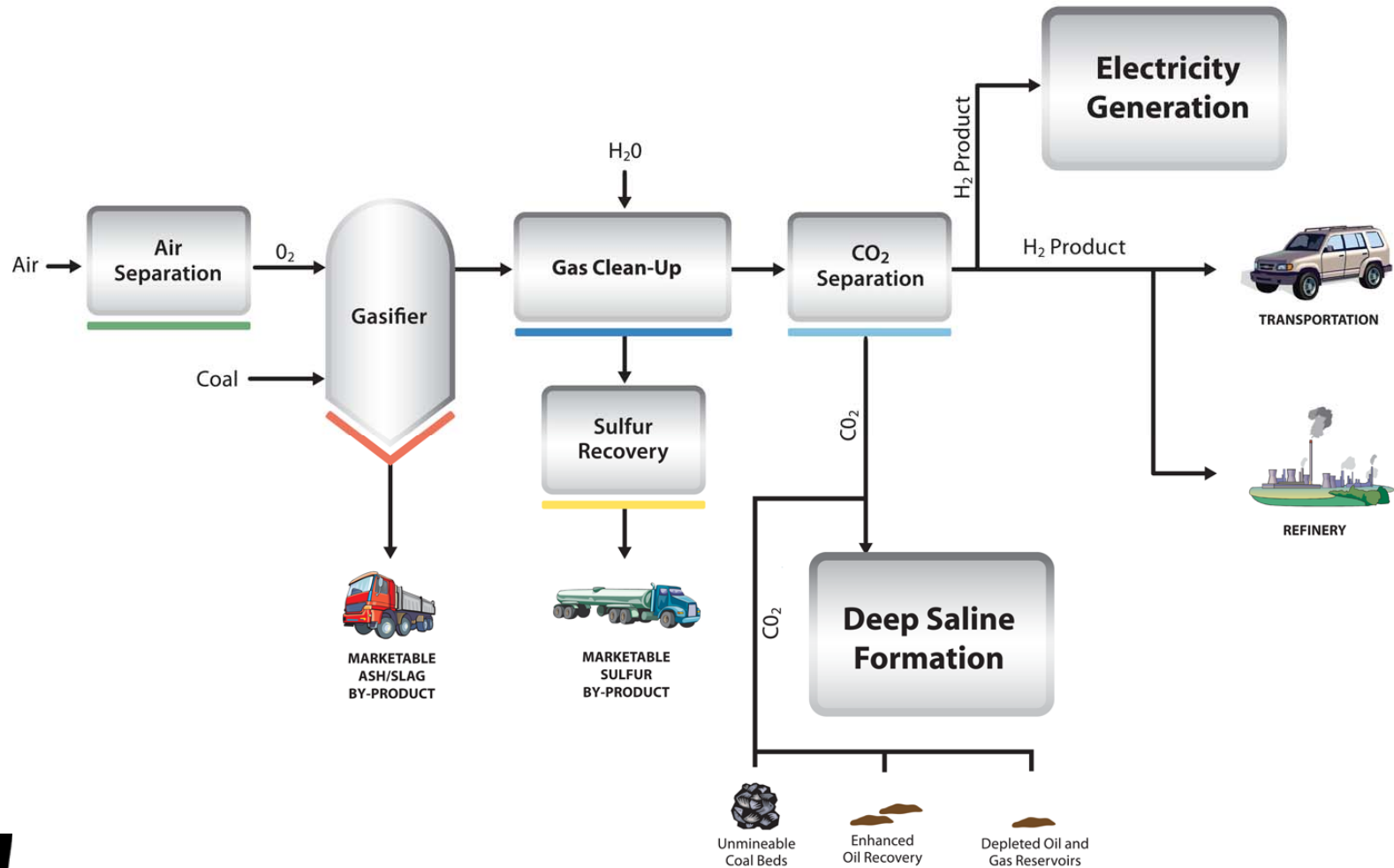
## **Pre-Combustion Capture** - *IGCC with Water-Gas Shift*

- Most of the processes commercially available in other industrial applications
  - Have never been integrated together
- Turbine modified for H<sub>2</sub>-based fuel, which has not yet been proven at commercial scale
- Creates stream of very high CO<sub>2</sub> concentration
- Parasitic demand (~15-20%) for CO<sub>2</sub> capture - lower than amine or oxy-coal



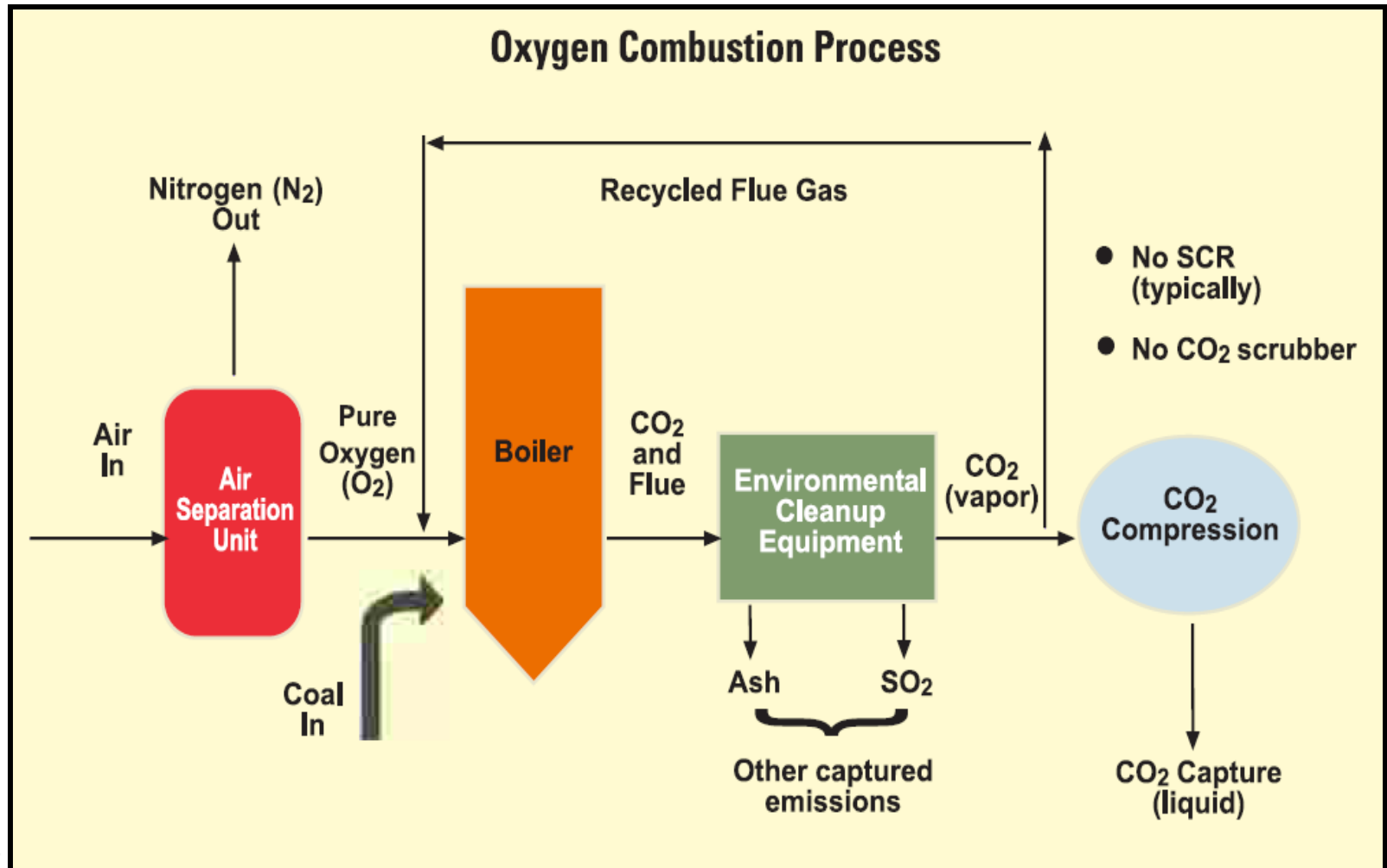
# IGCC Water-Gas Shift Process

## Pre-Combustion Capture



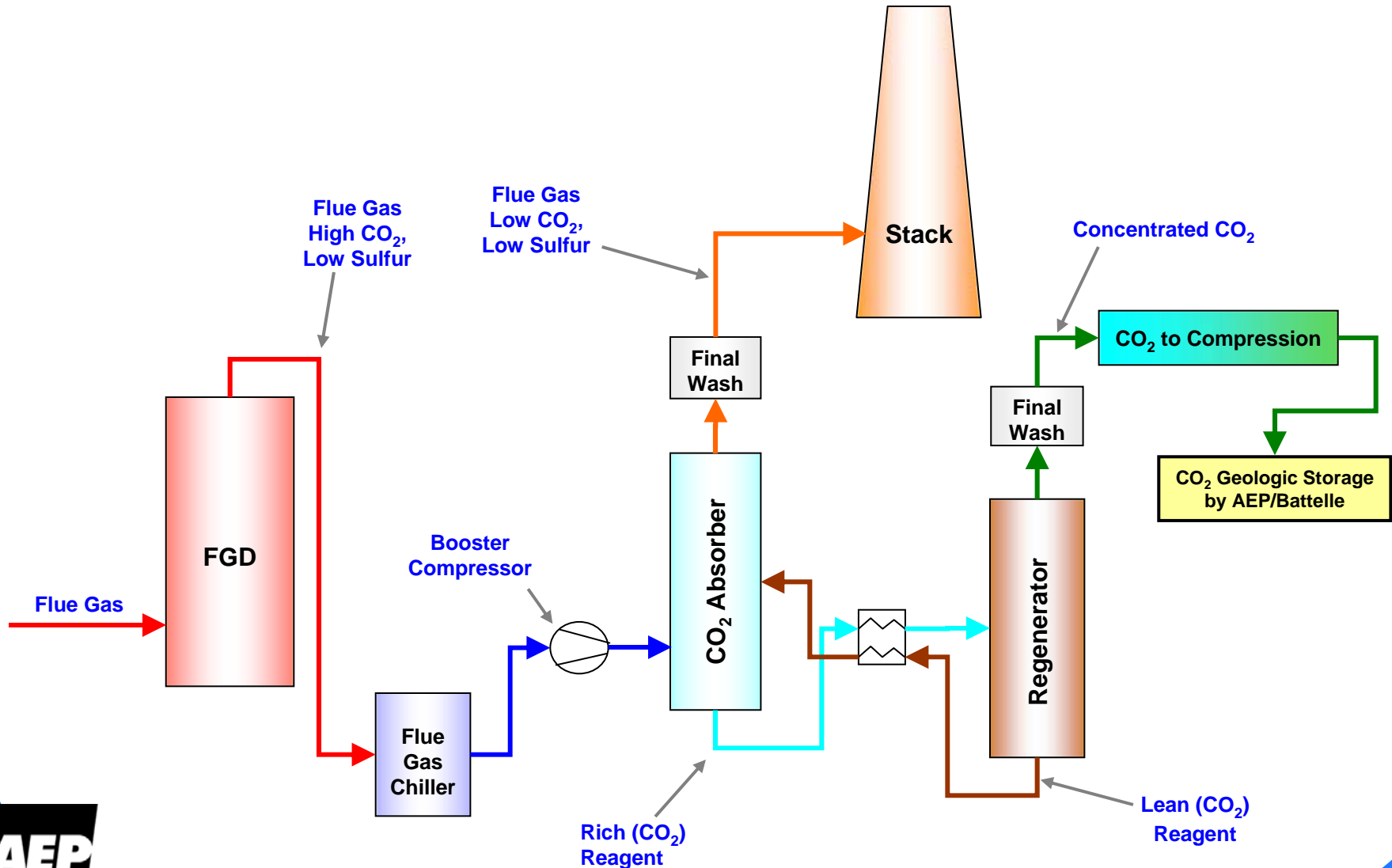
# Babcock & Wilcox Oxy-Coal Process

## Modified Combustion Capture



# Alstom's Chilled Ammonia Process

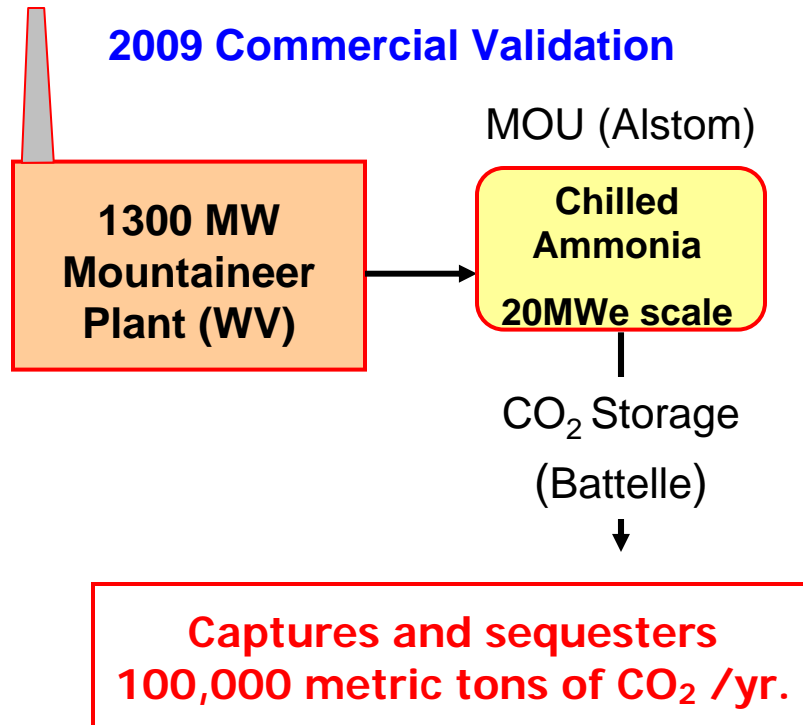
## Post-Combustion Capture



# AEP Leadership in New Technology: Chilled Ammonia CCS

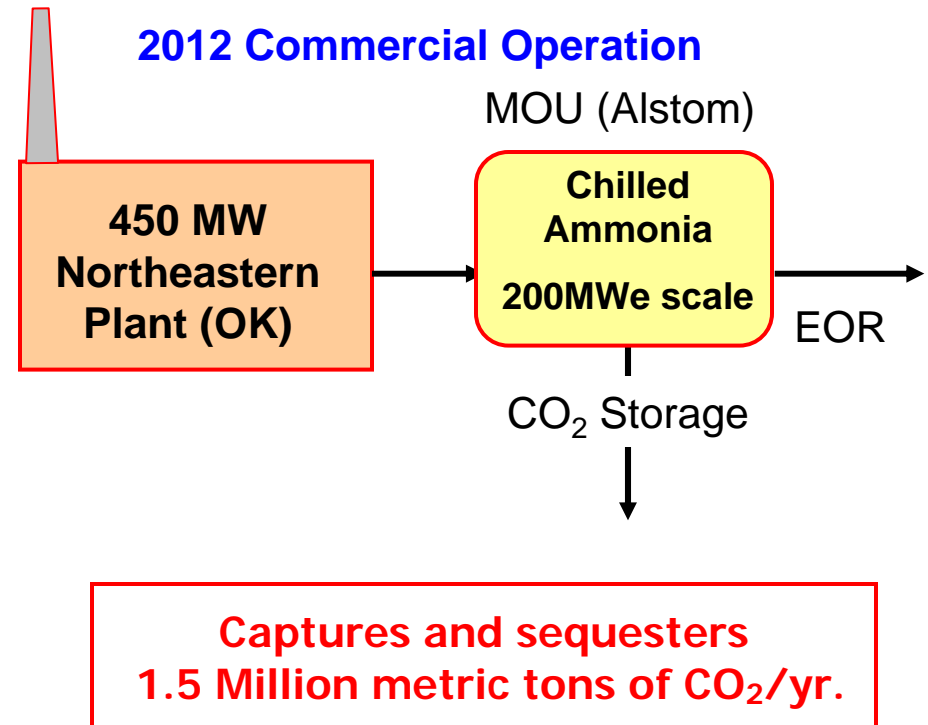
## Phase 1

### 2009 Commercial Validation

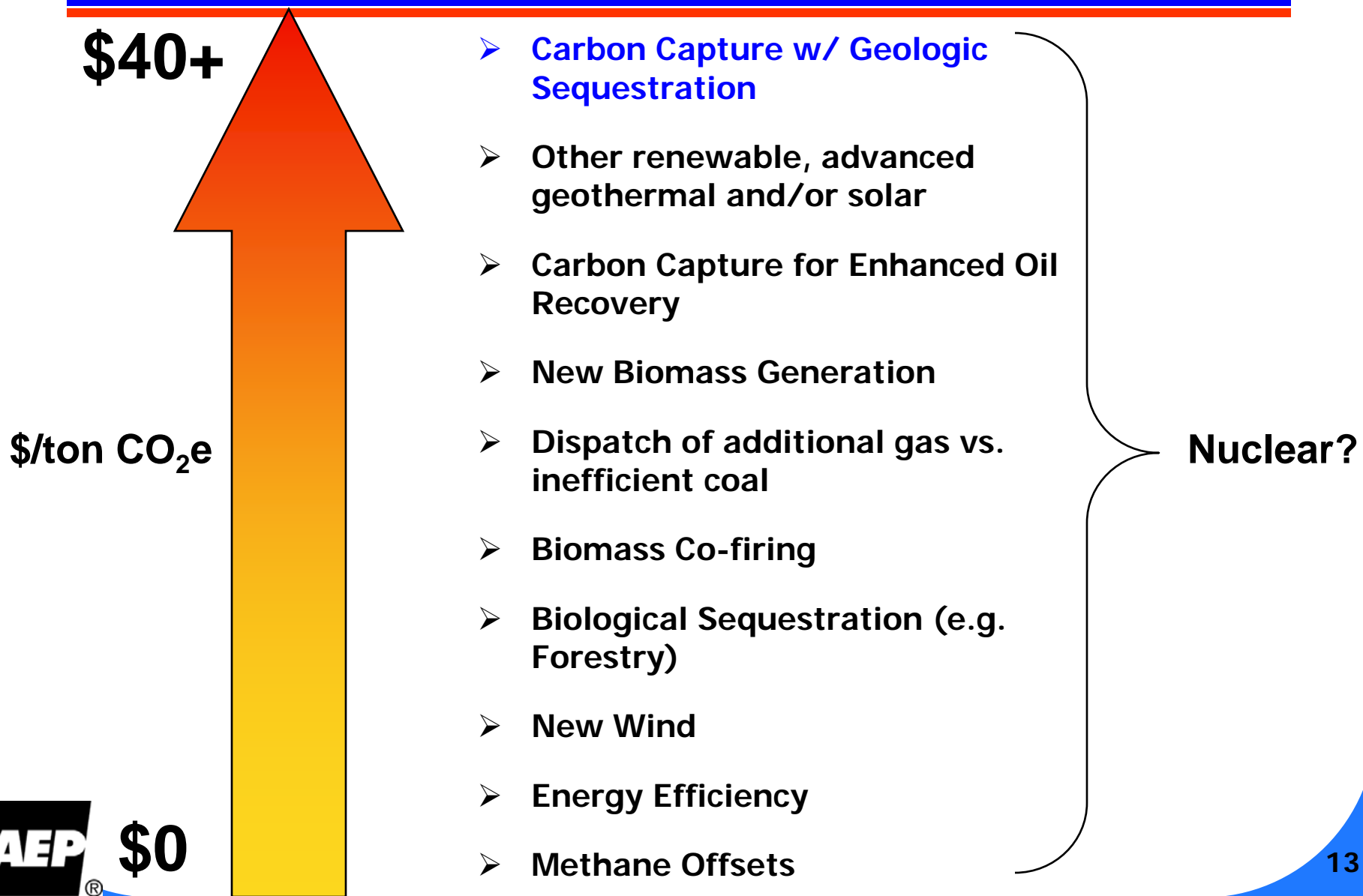


## Phase 2

### 2012 Commercial Operation



# The Challenge: CCS is Expensive



# CCS: The Business Case

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- 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

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- 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