CO_2 Capture and Storage

AEP's New Generation Perspective

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Climate2050
Technology and Policy Solutions

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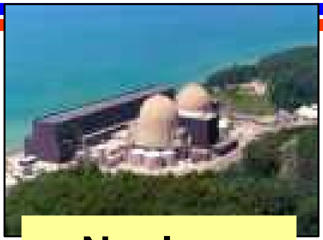
AEP Company Overview

Coal/Lignite

67%

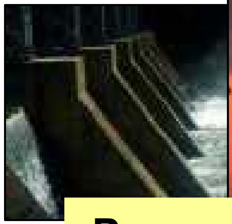
Natural Gas/Oil

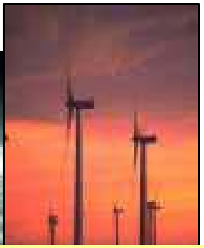
24%



Nuclear

6%





Pumped Storage/ Hydro/Wind

3%

AEP's Generation Fleet

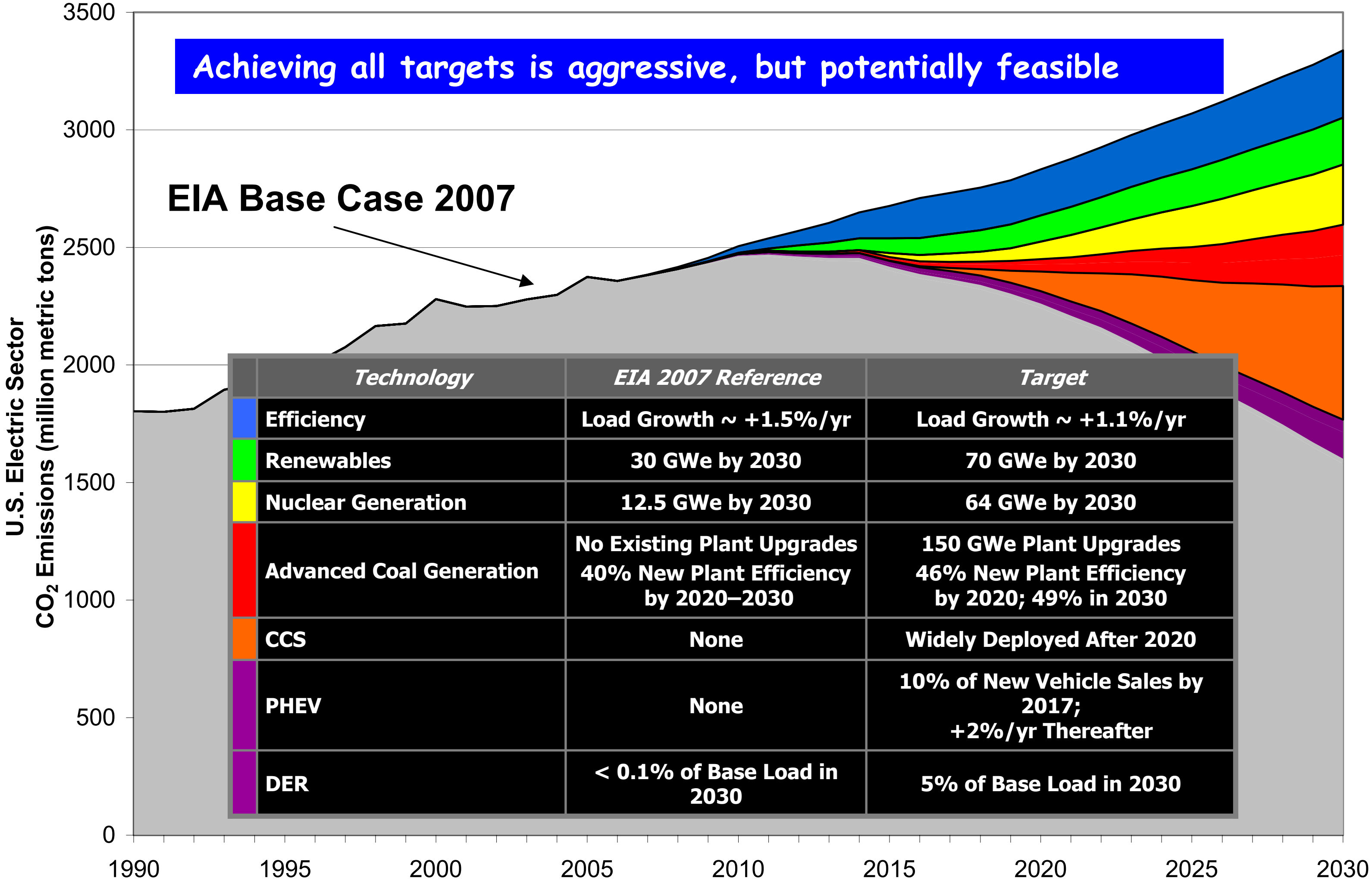
38,388 MW Capacity

5.1 million customers in 11 states

Industry-leading size and scale of assets:

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

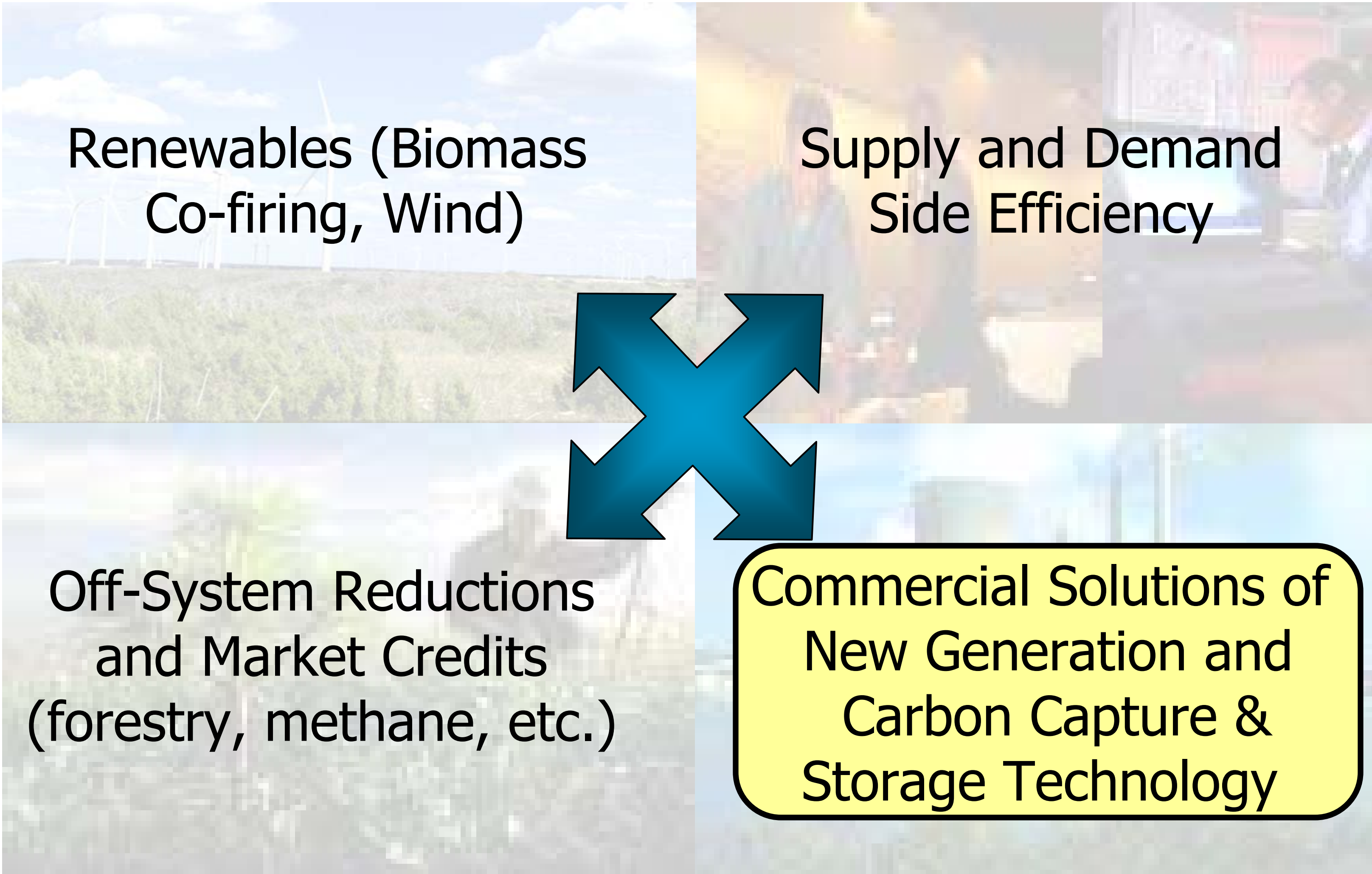
EPRI CO_2 Reduction "Prism"



Technology	EIA 2007 Reference	Target
Efficiency	Load Growth ~ +1.5%/yr	Load Growth ~ +1.1%/yr
Renewables	30 GWe by 2030	70 GWe by 2030
Nuclear Generation	12.5 GWe by 2030	64 GWe by 2030
Advanced Coal Generation	No Existing Plant Upgrades 40% New Plant Efficiency by 2020–2030	150 GWe Plant Upgrades 46% New Plant Efficiency by 2020; 49% in 2030
CCS	None	Widely Deployed After 2020
PHEV	None	10% of New Vehicle Sales by 2017; +2%/yr Thereafter
DER	< 0.1% of Base Load in 2030	5% of Base Load in 2030

ELECTRIC POWER RESEARCH INSTITUTE

AEP's Long-Term GHG Reduction Portfolio



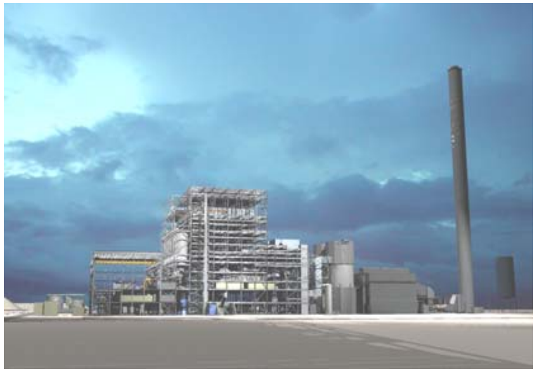
AEP is investing in a portfolio of GHG reduction alternatives

AEP Leadership in Technology: IGCC/USC and Future Gen

NEW ADVANCED GENERATION

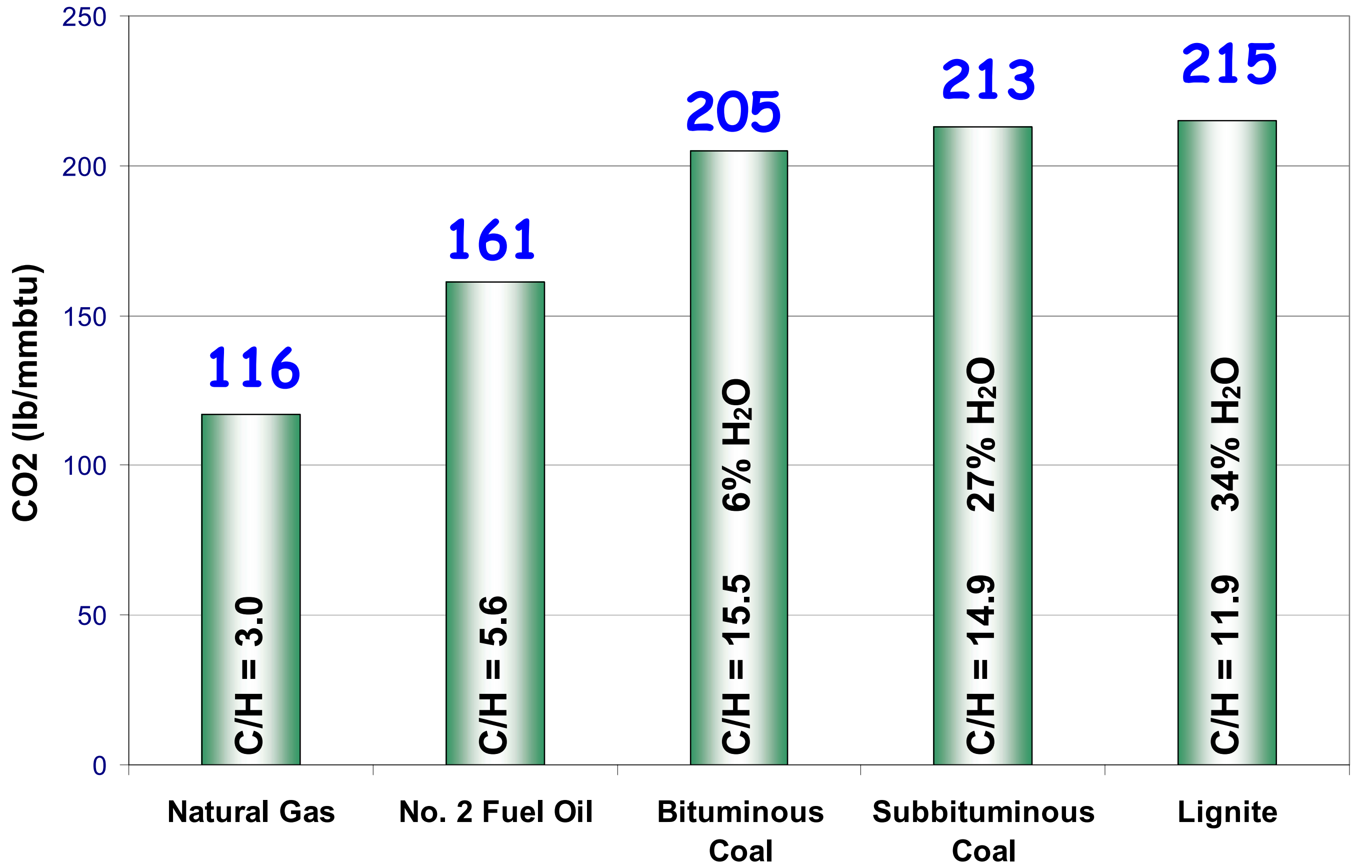
•**IGCC---AEP was the first to announce plans to build two 600+ MW IGCC commercial scale facilities in the US in Ohio and West Virginia by the middle of next decade**

•**USC--AEP will be the first to employ the new generation ultra-supercritical (steam temperatures greater than 1100ºF) coal plants in the U.S.—in Arkansas**



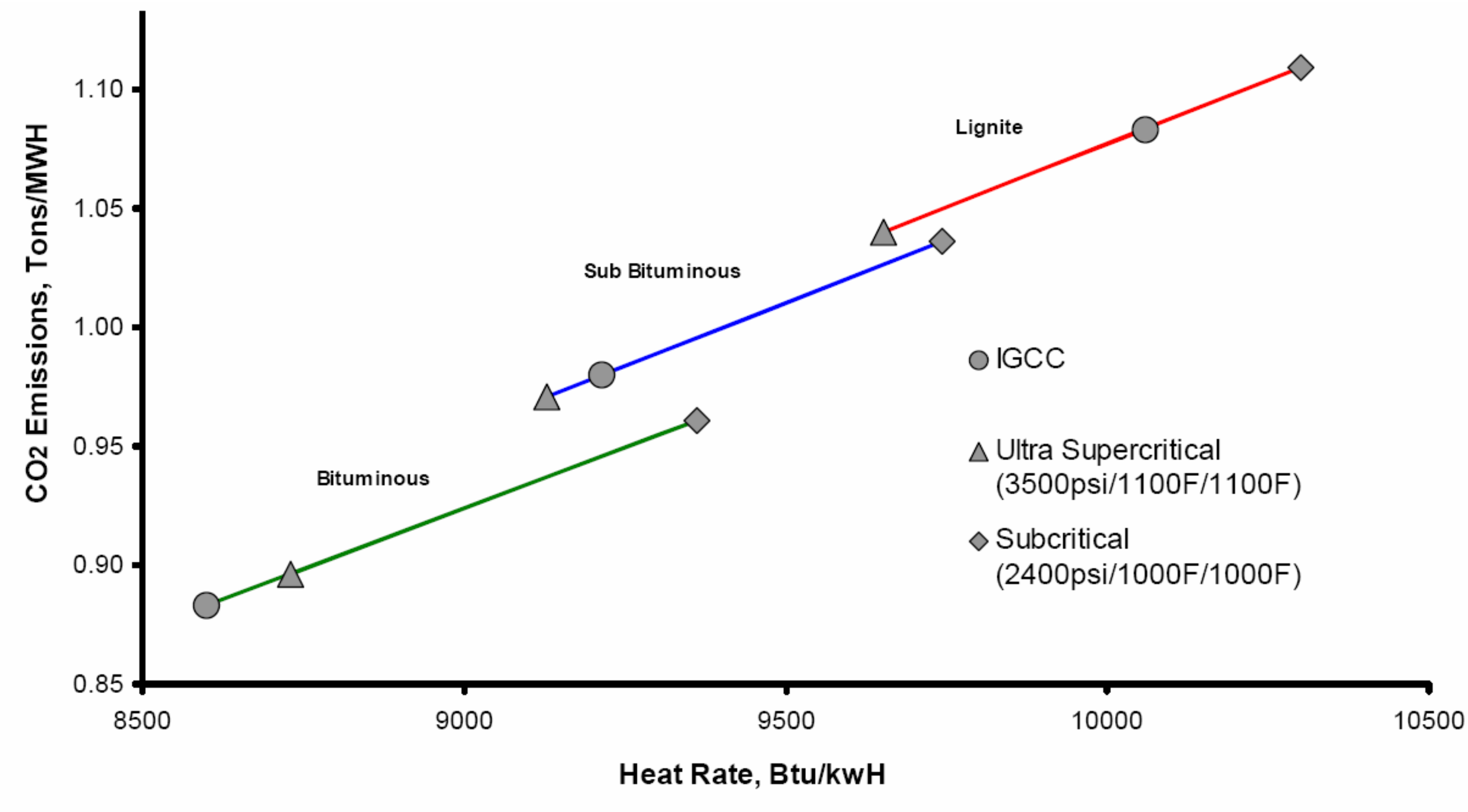
•**FUTUREGEN - First Near Zero Emissions Hydrogen/ Electric (coal-fueled IGCC with CCS)-DOE along with AEP and Alliance members**

Fuels and CO_2 Emission Rates



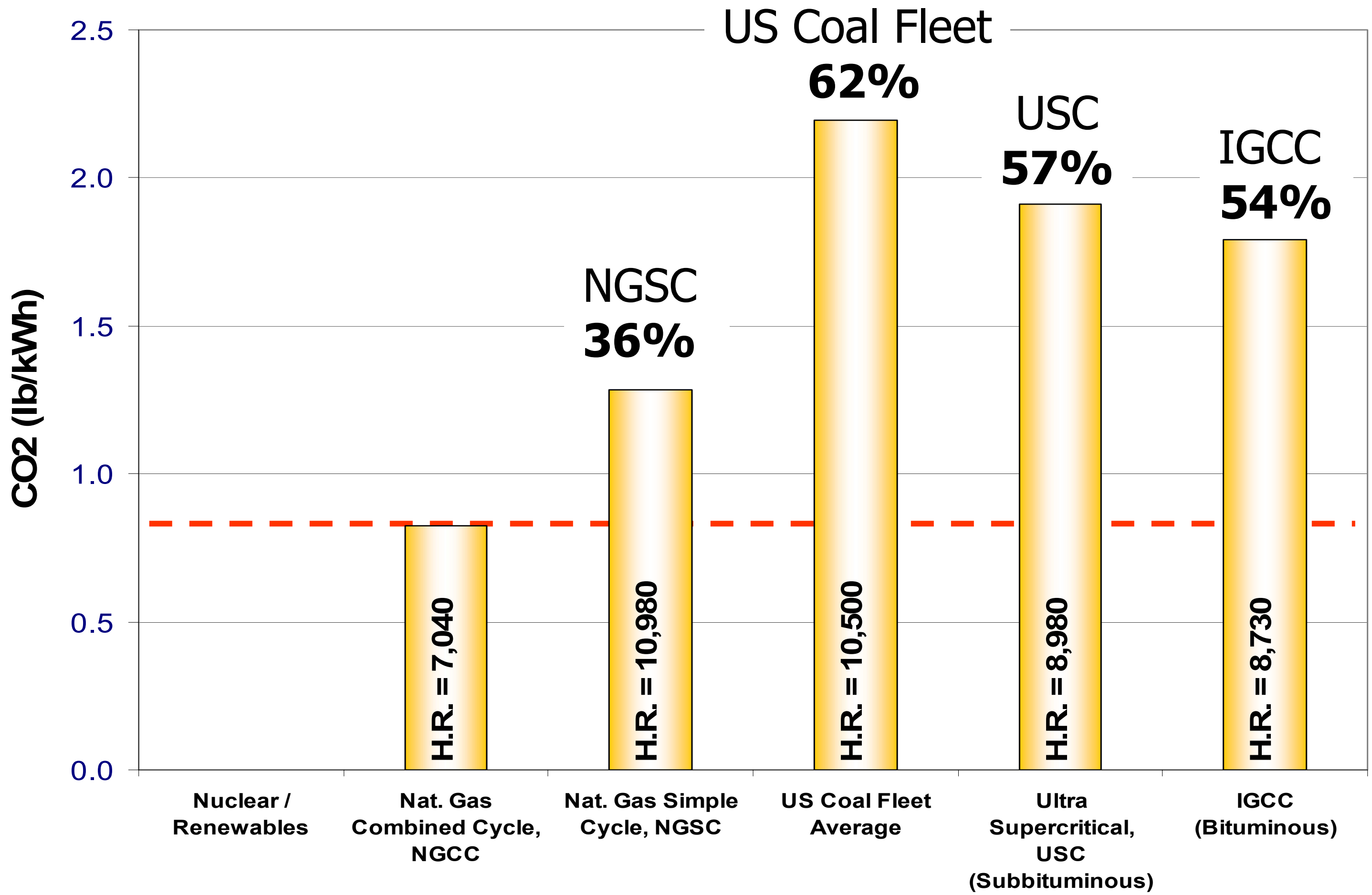
Note: C/H is the mass ratio of carbon to hydrogen

Efficiency and CO_2 Emission Rates



Carbon Intensity for Different Systems

CO_2 Reduction Necessary to Achieve NGCC Emission Levels



Note: H.R.= Heat Rate (efficiency). Values represent typical heat rates, used here for illustrative purposes only.

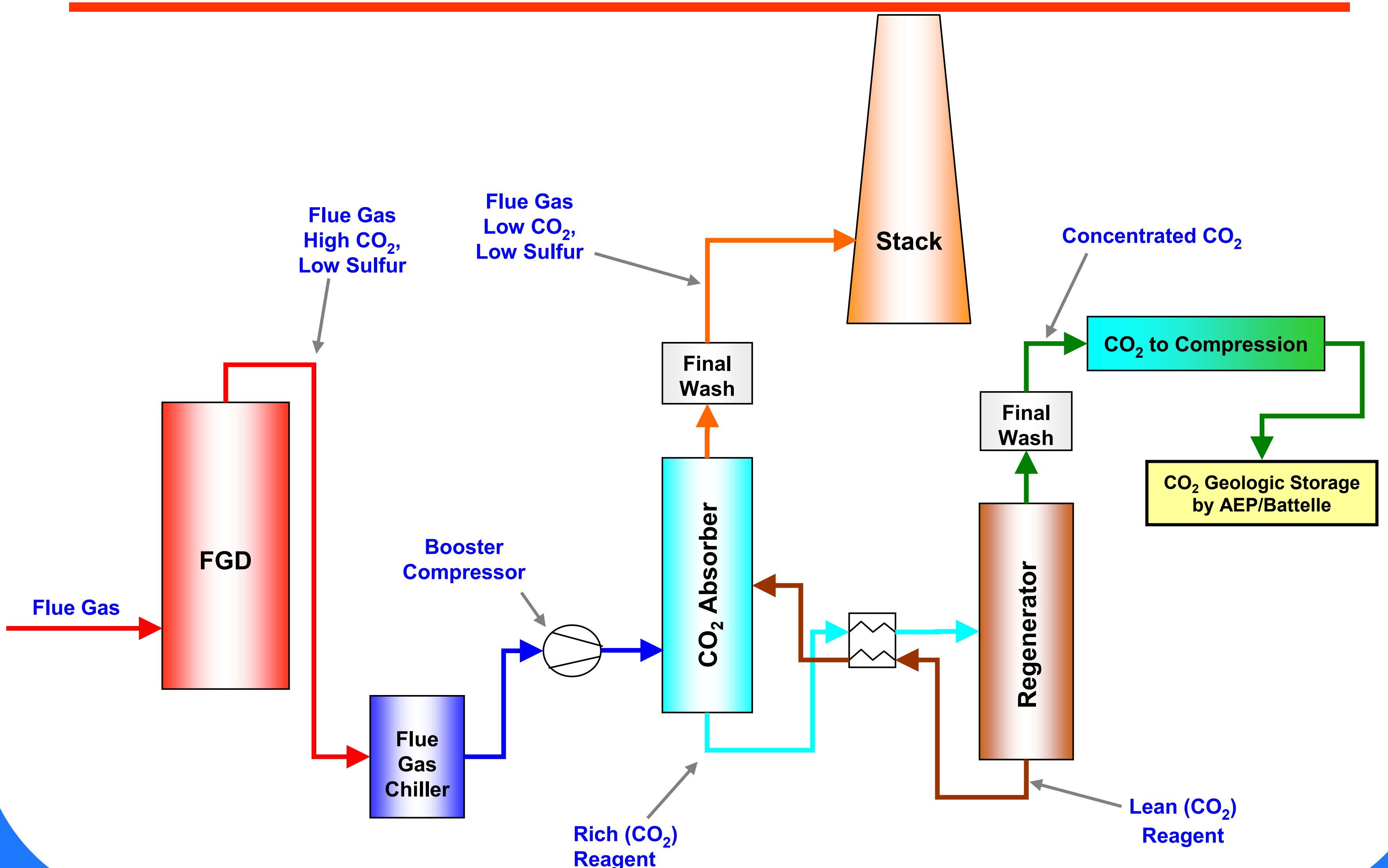
CO_2 Capture Techniques

Post-Combustion Capture

- AEP is committed to bring carbon capture and storage technologies from the research and pilot stages into large scale commercial application
  - Post-Combustion Capture – **Existing Units**
    - Conventional or Advanced Amines, **Chilled Ammonia**
    - *Key Points*
      - Amine technologies commercially available in other industrial applications
      - Relatively low CO_2 concentration in flue gas – Difficult to capture
      - High parasitic demand – reduced unit output
        - Conventional Amine ~25-30%, Chilled Ammonia target ~10-15%
      - Amines require clean flue gas

Alstom's Chilled Ammonia Process

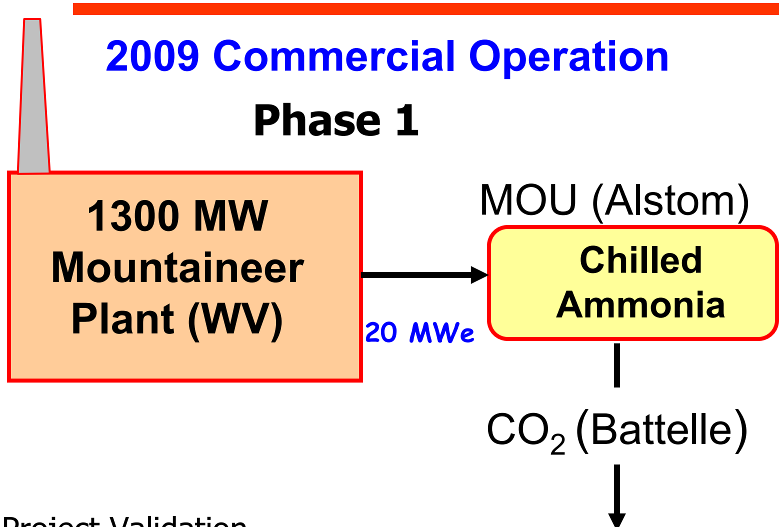
Post-Combustion Capture



Chilled Ammonia Technology Program

2009 Commercial Operation

Phase 1



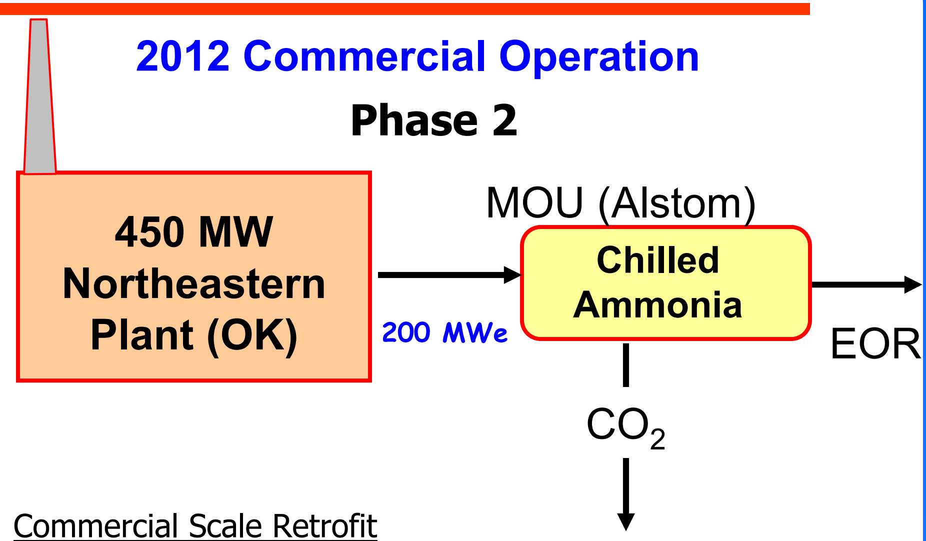
<u>Project Validation</u>

- 20 MW$_e$ (megawatts electric) scale (a scale up of Alstom/EPRI 5 MW$_t$ (megawatts thermal) field pilot, under construction at WE Energies)
- ~100,000 tonnes CO_2 per year
- In operation 2Q 2009
- Approximate total cost \$80 – \$100M
- Using Alstom "Chilled Ammonia" Technology
- Located at the AEP Mountaineer Plant in WV
- CO_2 for geologic storage

Phase 1 will capture and sequester 100,000 metric tons of CO_2/year

2012 Commercial Operation

Phase 2

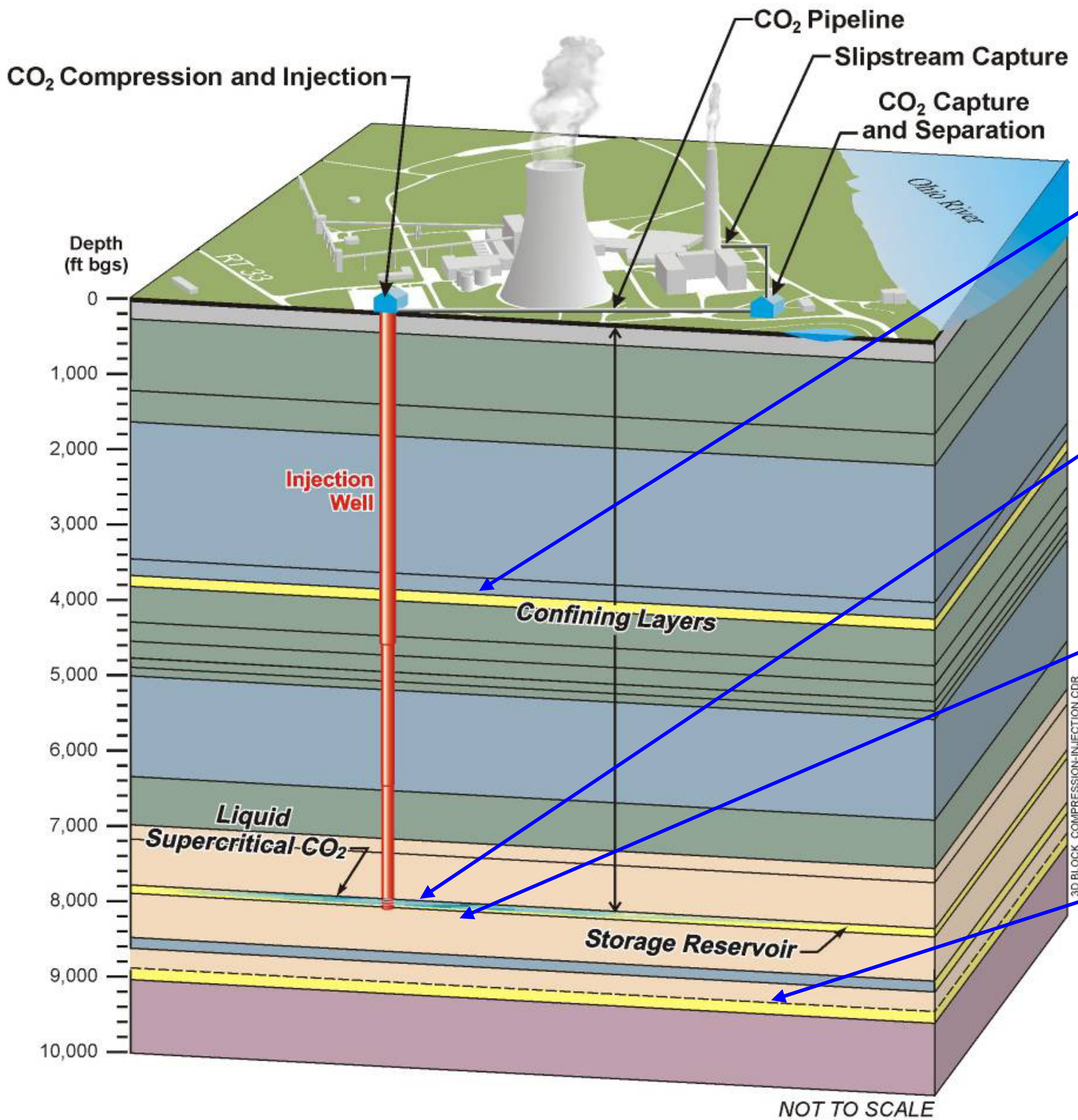


<u>Commercial Scale Retrofit</u>

- ~ 200 MW$_e$ scale (megawatt electric)
- ~1.5MM tonnes CO_2 per year
- In operation 2012
- Approx. capital \$250 – \$300M (CO_2 capture & compression)
- Approx. O&M cost \$12M per year
- Energy penalty ~ 35 – 50 MW steam, 25 – 30 MW for CO_2 compression
- Retrofit NOx Controls and FGD Required: ~\$225 – \$300M (required for CO_2 capture equipment)
- Located at AEP's Northeastern Plant Unit 3 or 4 in Oklahoma
- CO_2 for Enhanced Oil Recovery (EOR) or geologic storage

Phase 2 will capture and sequester 1.5 Million metric tons CO_2/year

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

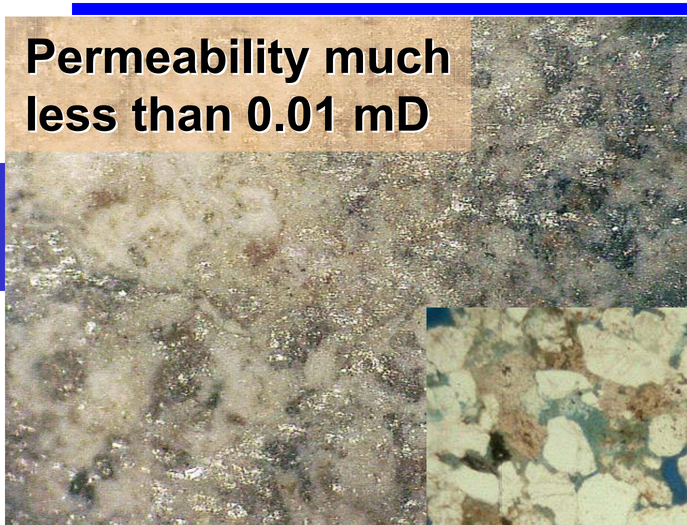
A high permeability zone called the "B zone" within Copper Ridge Dolomite has been identified as a new injection zone in the region

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

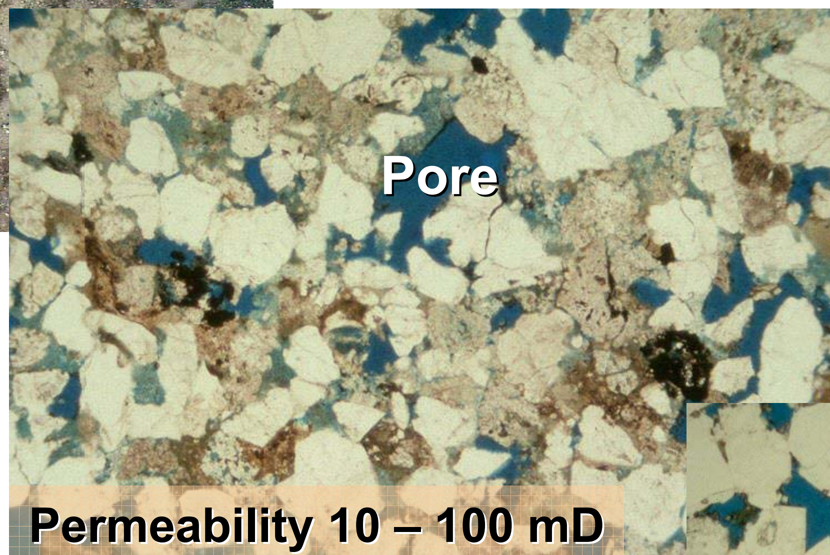
Battelle
The Business of Innovation

Sedimentary Rocks

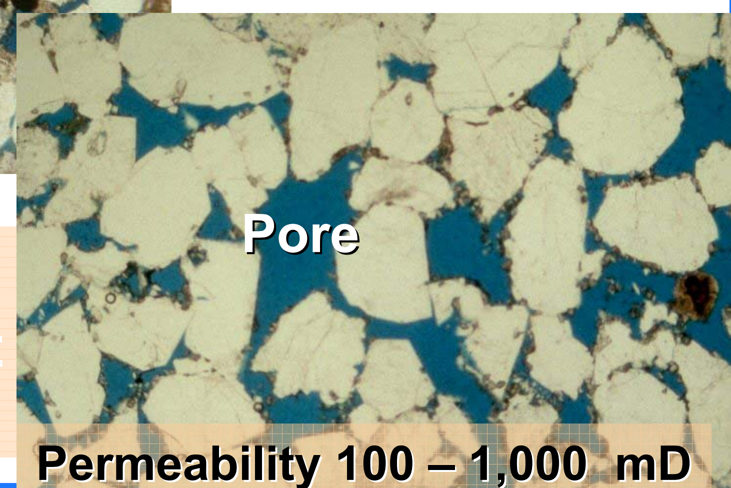
A Microscopic View



Shale with Extremely Low Permeability Forms Good Caprock

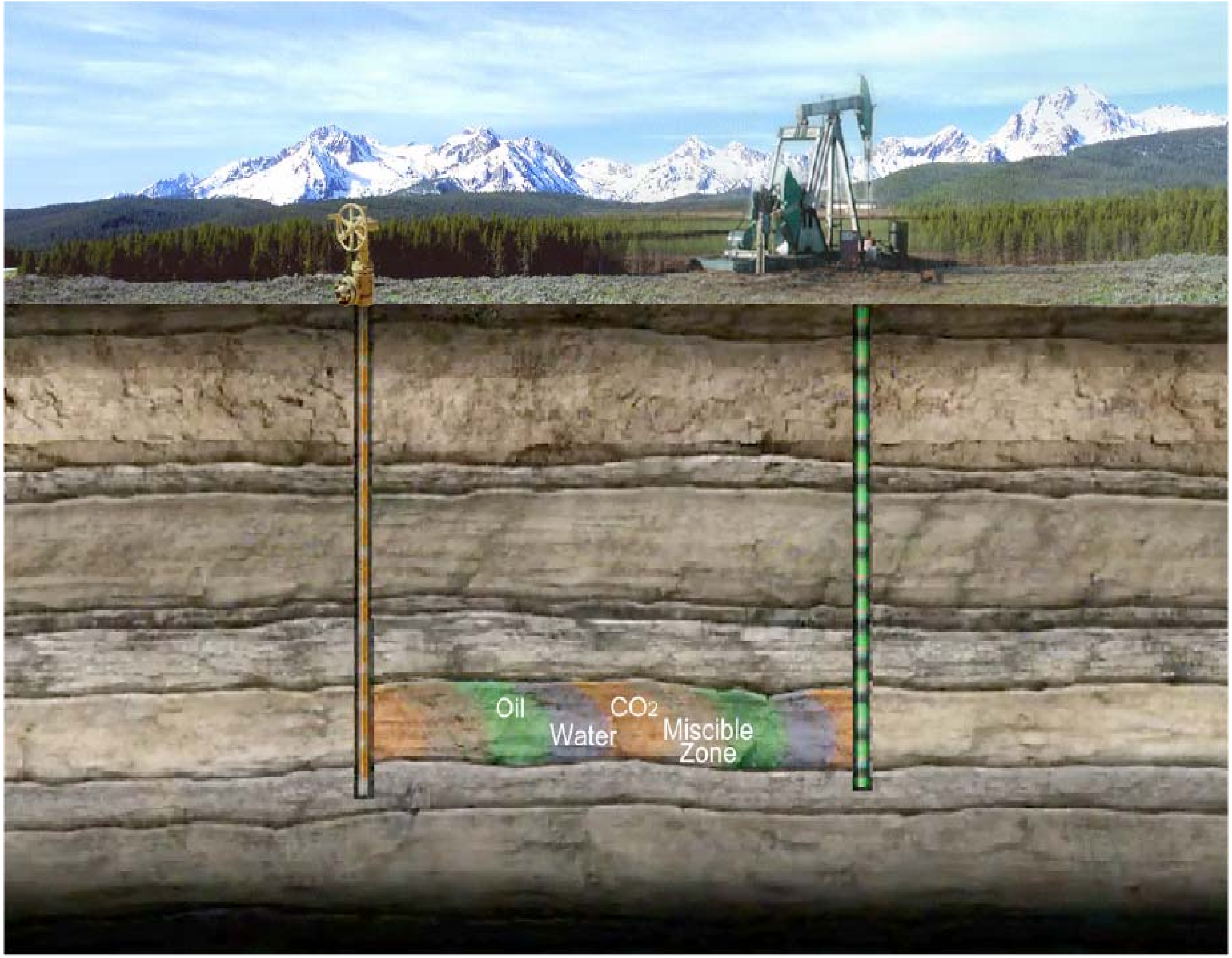


Sandstone with Medium Permeability Forms Good Host Reservoir Medium Cost



Sandstone with High Permeability Forms Excellent Host Reservoir at Low Cost

Enhanced Oil Recover (EOR)



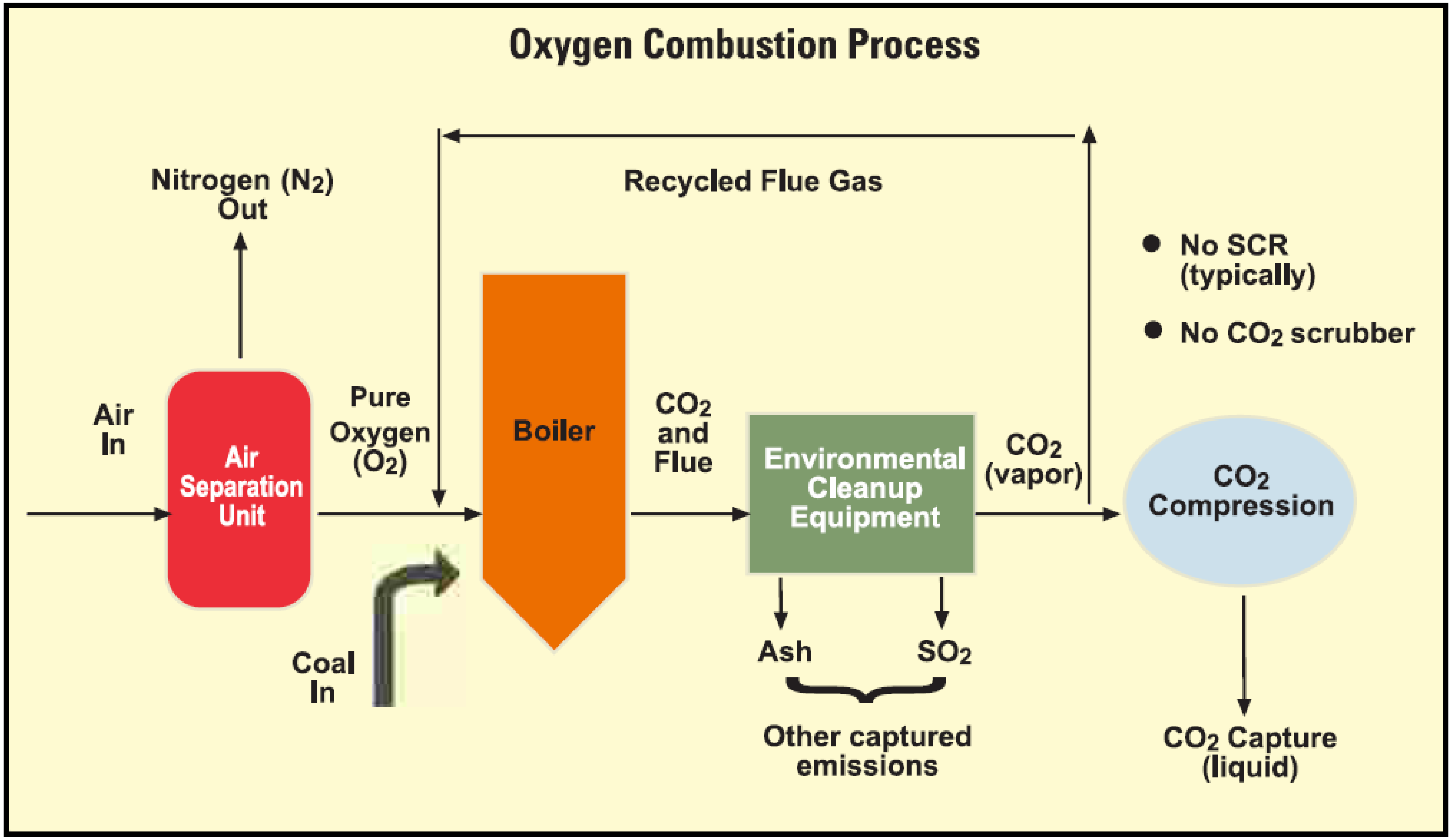
Graphic courtesy of USDOE National Energy Technology Laboratory

CO_2 Capture Techniques

Oxy Coal Firing

- Modified-Combustion Capture – Oxy Coal Firing
  - *Key Points*
    - Technology not yet proven at commercial scale
    - Creates stream of high CO_2 concentration
    - High parasitic demand, >25%
  - Demonstration Scale
    - 10 MWe scale
    - Teamed with B&W at its Alliance Research Center and several other utilities
    - Demo completion 4Q 2007
  - Commercial Scale
    - Retrofit on existing AEP sub-critical unit (several available)
    - 150 – 230 MWe scale retrofit
    - 4,000 – 5,000 tons CO_2 per day
    - Feasibility study in progress

CO_2 Capture Techniques



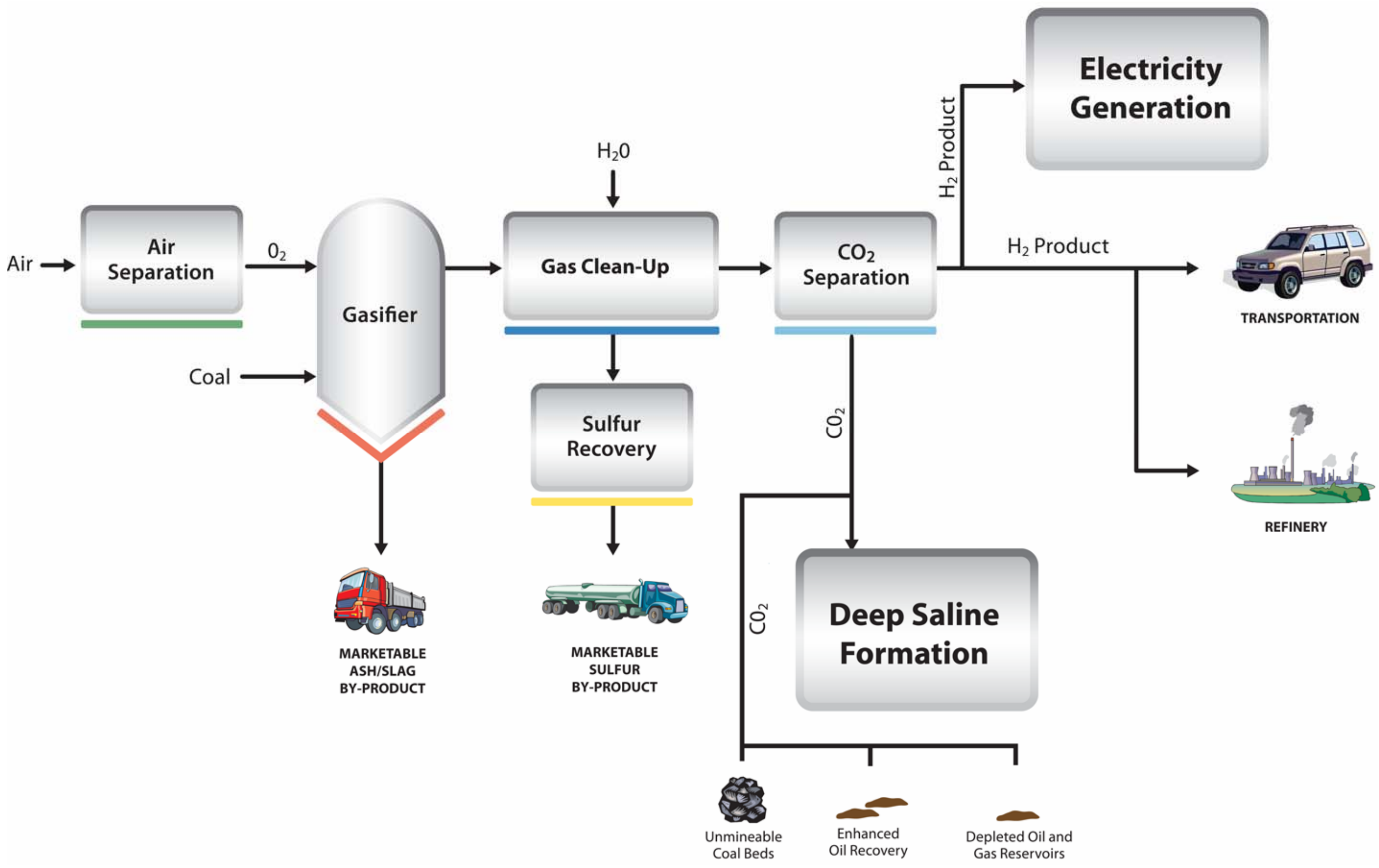
CO_2 Capture Techniques

Pre-Combustion Capture

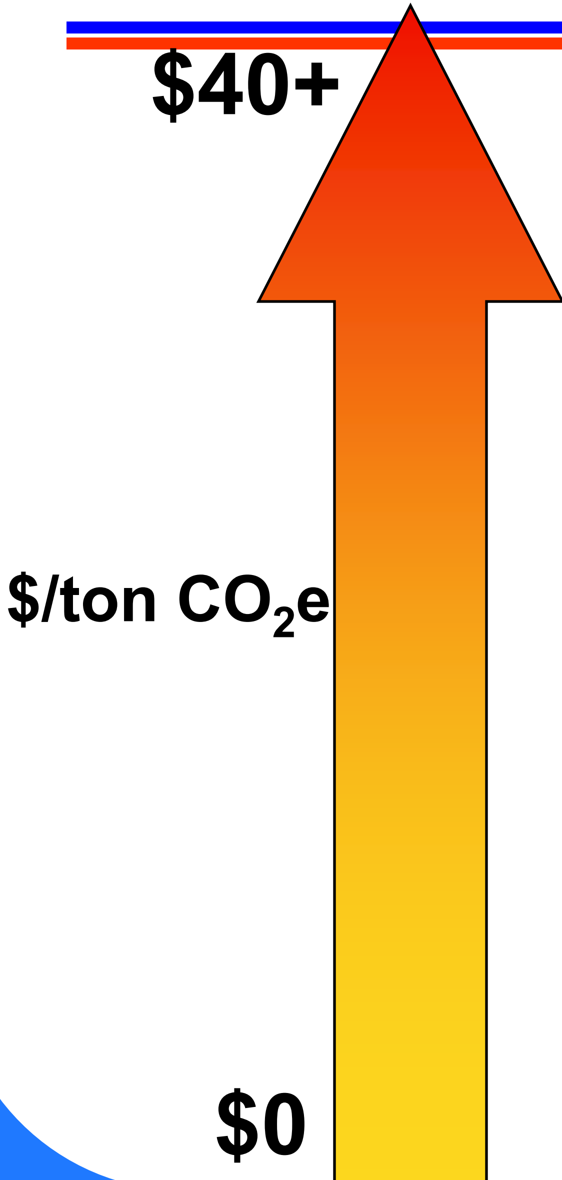
- Pre-Combustion Capture
  - IGCC with Water-Gas Shift – FutureGen Design
  - *Key Points*
    - Most of the processes commercially available in other industrial applications
      - Have never been integrated
    - Turbine modified for H_2-based fuel, which has not yet been proven at commercial scale
    - Creates stream of very high CO_2 concentration
    - Parasitic demand (~20%) for CO_2 capture - lower than amine or oxy-coal options

FutureGen's Water-Gas Shift Process

Pre-Combustion Capture



Examples of Relative GHG Mitigation Costs for Power Sector



- 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

Nuclear?

Questions ?

Thank you for listening