

NATIONAL ENERGY TECHNOLOGY LABORATORY



Carbon Capture for Pulverized-Coal-Based Power Plants: DOE/NETL's R&D Program

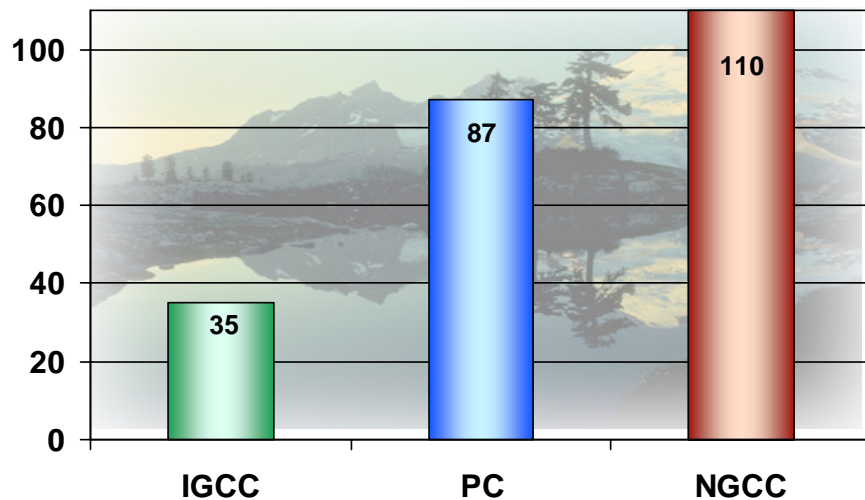
**Mcllvaine Webcast
October 2, 2008**



Cost Estimates for Current CO₂ Capture Technology

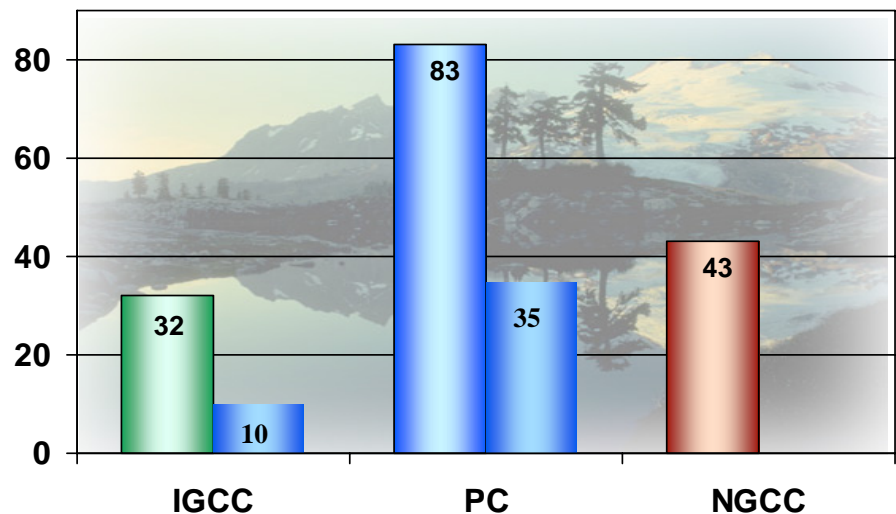
- 5–30% parasitic energy loss
- 35–110% increase in capital cost
- 30–80% increase in cost of electricity

Effect of CO₂ Capture on Capital Cost
(% Increase Resulting From CO₂ Capture)



Note: CO₂ capture costs based on use of Selexol process for IGCC and MEA for PC and NGCC.

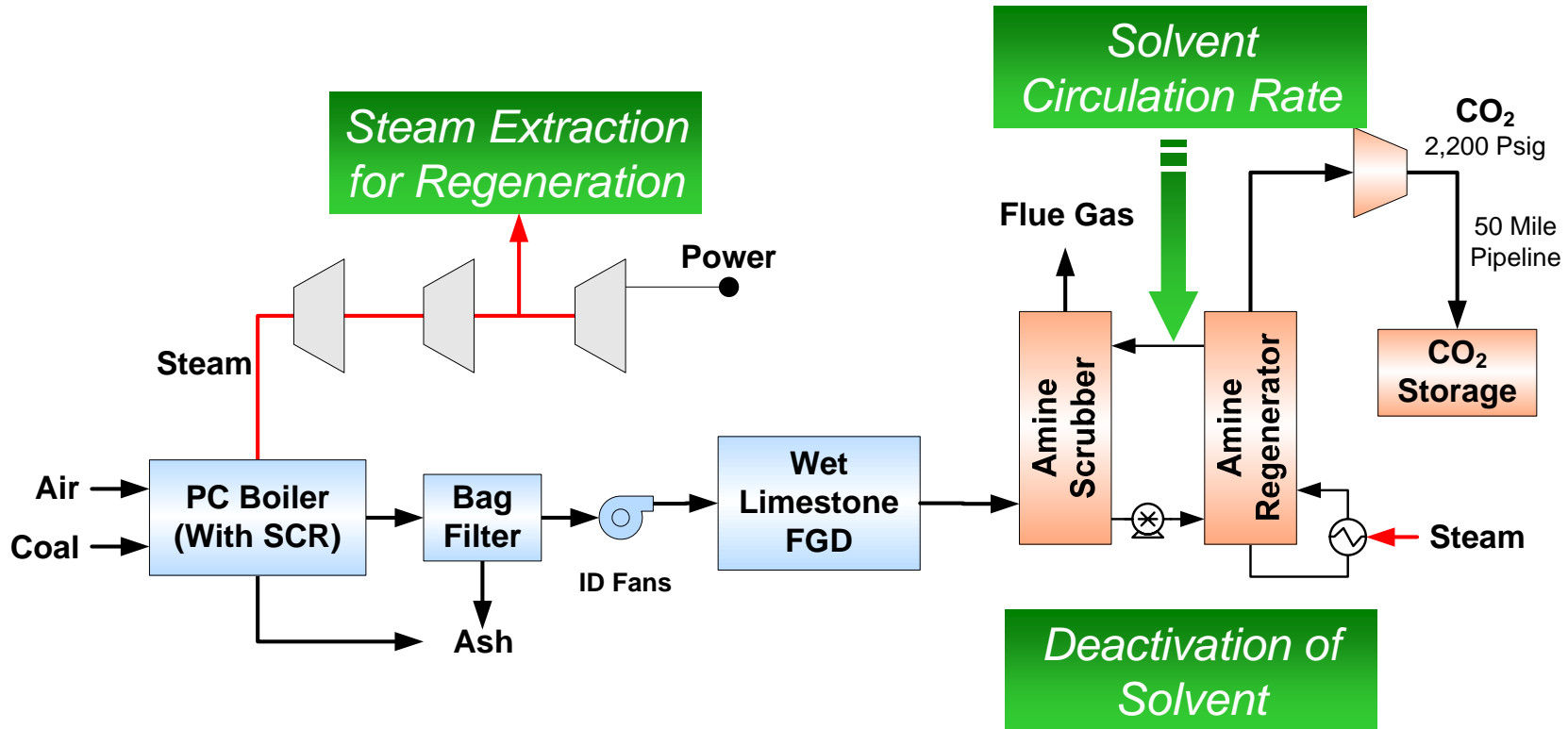
Effect of CO₂ Capture on Cost of Electricity
(% Increase Resulting From CO₂ Capture)



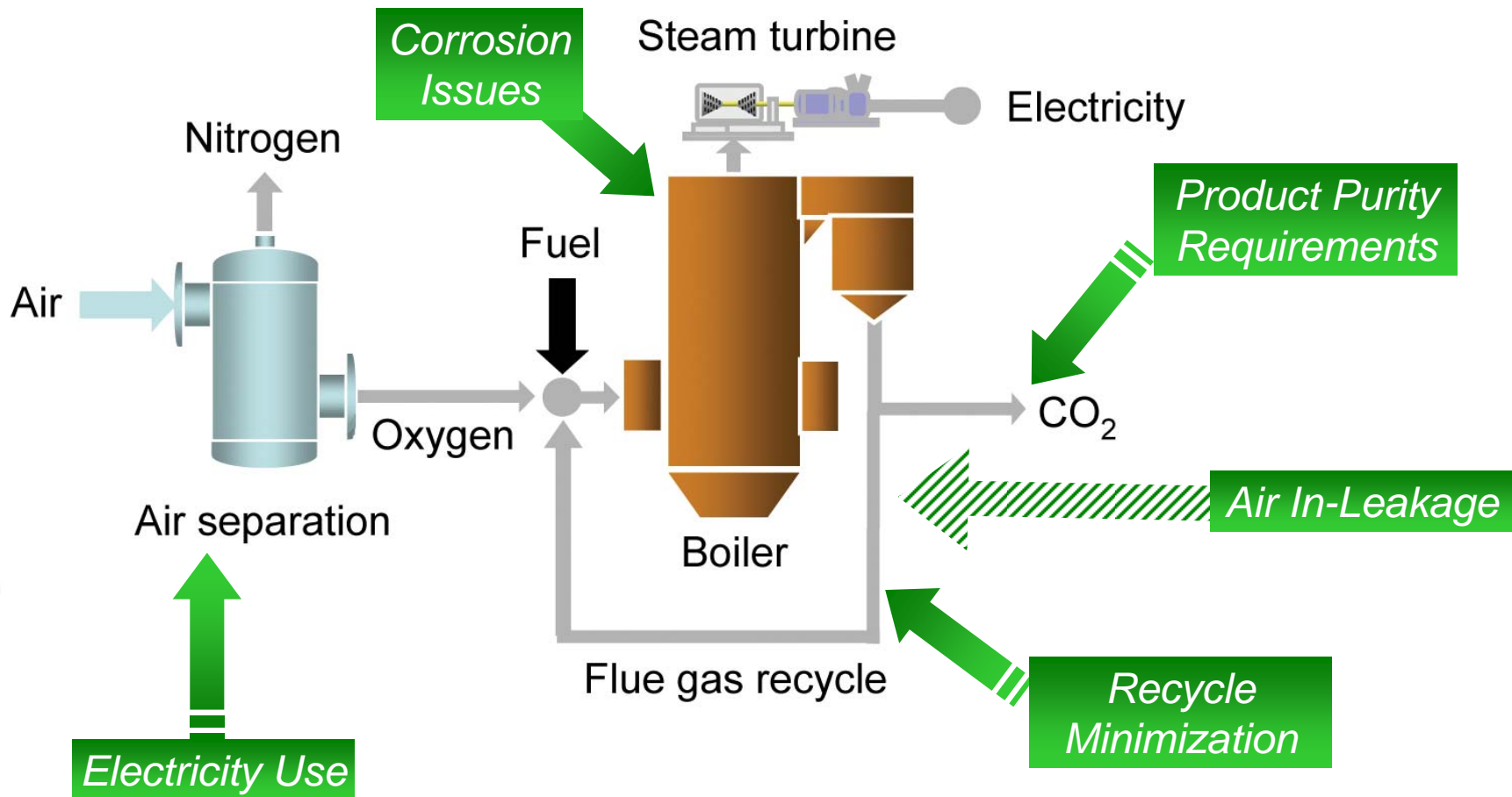
Source: *Cost and Performance Baseline for Fossil Energy Power Plants study, Volume 1: Bituminous Coal and Natural Gas to Electricity*; NETL, May 2007.

Post-Combustion Current Technology

Pulverized Coal Power Plant with CO₂ Scrubbing

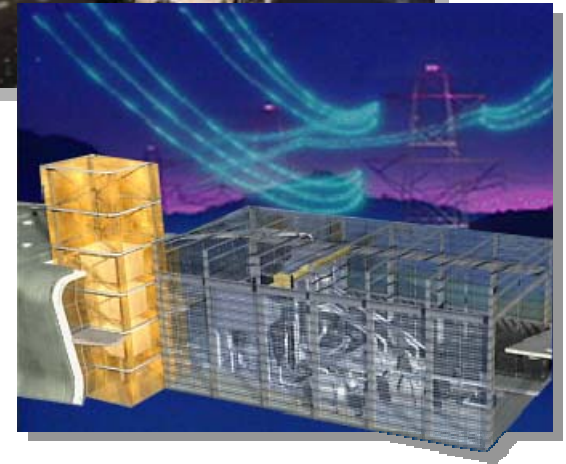


Pulverized Coal Oxycombustion



CO₂ Emissions Control R&D Activities

- Post-Combustion CO₂ Control
- Oxy-Combustion CO₂ Control
 - Chemical looping
- CO₂ Compression
- CO₂ Beneficial Use
- In-house R&D
- Systems Analysis



Carbon Capture Research Pathways

Solvents

Process Description

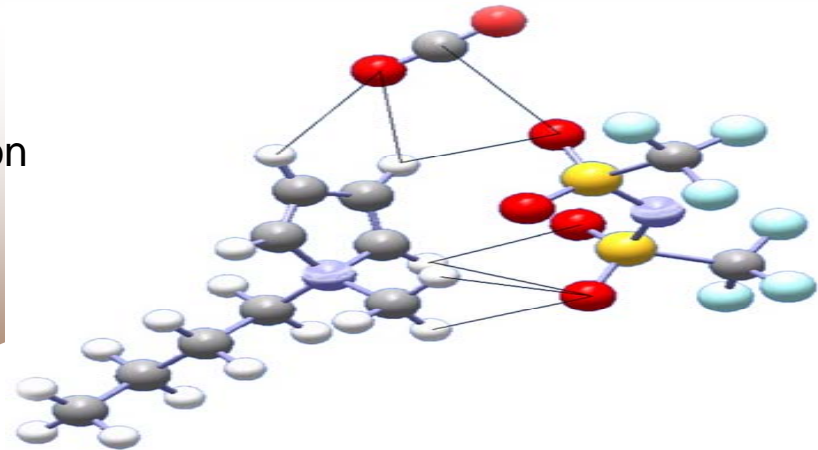
- Chemical - Reversible chemical reaction (s) between CO₂ and aqueous absorbent solution
- Physical - Bulk phenomenon where liquids absorb a gaseous species from a gas mixture
- Mature technology (MEA) at smaller scale

External Research Projects

- ✓ Ionic Liquids – Notre Dame
- ✓ Novel Oligomers – GE Global Research
- ✓ Reversible Ionic Liquids – Ga Tech
- ✓ Novel Integrated Vacuum Carbonate Absorption Process - ISGS

Key Technology Challenges

- ❖ CO₂ Loading
- ❖ Regeneration Energy
- ❖ Solvent Deactivation



Carbon Capture Research Pathways

Sorbents

Process Description

- Chemical adsorption involves bonding with a solid sorbent
- Physical adsorption of CO₂ on solid adsorbents by weak surface forces
 - Adsorption capacity increases with CO₂ partial pressure
- Low moisture content reduces regeneration steam requirements
- Regeneration via TSA or PSA

External Research Projects

- ✓ Dry Regenerable Sorbents – RTI
- ✓ Metal Organic Frameworks - UOP
- ✓ Solid Sorbents – ADA-ES
- ✓ Novel Carbon Sorbents – SRI International
- ✓ Low-cost Solid Sorbents - ISGS

Key Technology Challenges

- ❖ CO₂ Loading
- ❖ Heat Management
- ❖ Attrition/Blinding
- ❖ Solids Handling



Carbon Capture Research Pathways

Membranes

Process Description

- Diffusion via a physical or chemical interaction between the membrane and CO₂
- Selectivity and permeability are key

External Research Projects

- ✓ Enzymatic membranes – Carbozyme
- ✓ Novel fluorinated polymer membranes - RTI
- ✓ Polymer membranes with integrated application
- MTR

Research Focus

- ❖ Area Requirements
 - Permeability/Selectivity
- ❖ Energy for Driving Force
- ❖ Flue Gas Contaminants

Carbon Capture Research Pathways

Advanced Oxycombustion Technologies

Process Description

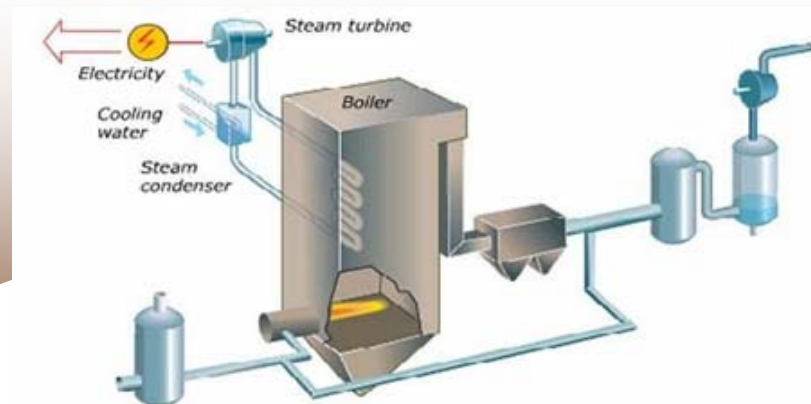
- Combustion in pure O₂ to produce flue gas that is comprised of H₂O and CO₂
- CO₂ separation via H₂O condensation

External Research Projects

- ✓ Oxycombustion Retrofit – B&W, Southern Research, Jupiter
- ✓ Oxygen Transport Membranes – Praxair
- ✓ Flue gas purification – Air Products, Praxair
- ✓ Tangentially Fired – Alstom
- ✓ Oxycombustion corrosion issues – Foster Wheeler
- ✓ Multi-scale oxycombustion with model development – REI
- ✓ Chemical Looping – Ohio State, Alstom

Potential Technology Solutions

- ❖ Oxygen Production Cost
- ❖ Product CO₂ Purity
- ❖ Retrofit Assurance



CO₂ Capture Technology RD&D Timeline

