NATIONAL ENERGY TECHNOLOGY LABORATORY

DOE/NETL's Existing Plants Program
CO_2 Capture R&D Overview

April 2, 2009

National Energy Technology Laboratory

Where Energy Challenges Converge and Energy Solutions Emerge

- **Only government owned & operated DOE national lab**
- **Dedicated to energy RD&D, domestic energy resources**
- **Fundamental science through technology demonstration**
- **Unique industry–academia–government collaborations**

Oregon

Pennsylvania

West Virginia

Existing Plants—Emissions and Capture Program

Change in Program Focus

2007 R&D Activities

- Water management
- Mercury control
- Coal utilization by-products
- NO_x control

2008 and 2009 R&D Activities

- *CO_2 capture & compression*
- *Water management*

IEP Funding (Fiscal Year)		
2007	**2008**	**2009**
$15 MM	**$36 MM**	**$50 MM**

Carbon Management Technology Options

Reduce Carbon Intensity

- Renewables
- Nuclear
- Fuel switching
- Coal with biomass

Improve Efficiency

- Demand side
- Supply side

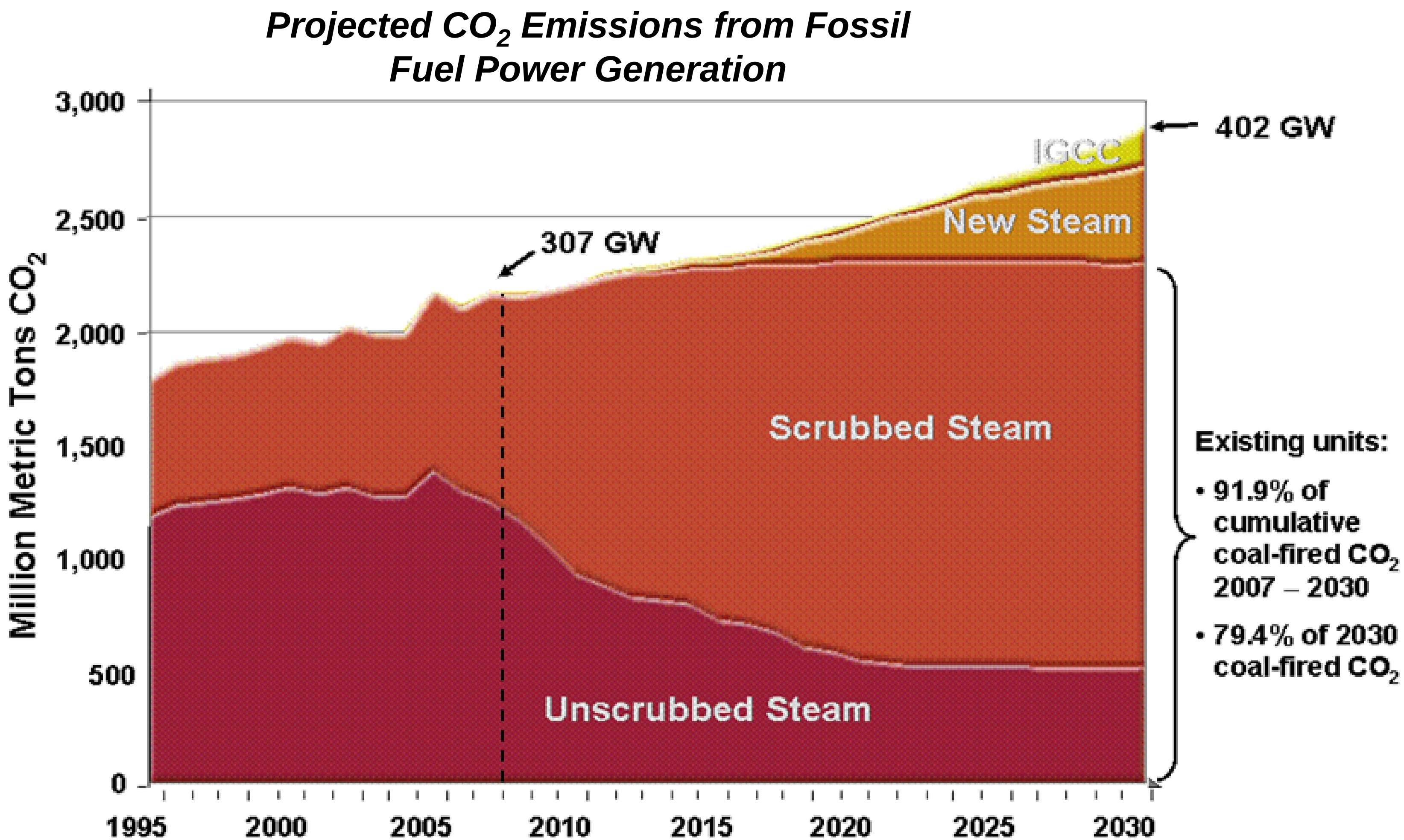
Sequester Carbon

- Capture and store
- Enhance natural sinks

All options needed to:

- Affordably meet energy demand
- Address environmental objectives

U.S. CO_2 Emissions and Existing Coal Plants



Source: EIA, Annual Energy Outlook 2008 Revised Early Release, March 2008

DOE/NETL CCS Program Goals

By 2020, have available for commercial deployment, technologies and best practices for achieving:

90% CO_2 capture

99%+ storage permanence

Pre-combustion Capture (IGCC)

< 10% increase in cost of electricity (COE)*

Post- and Oxy-combustion Capture

< 35% increase in COE*

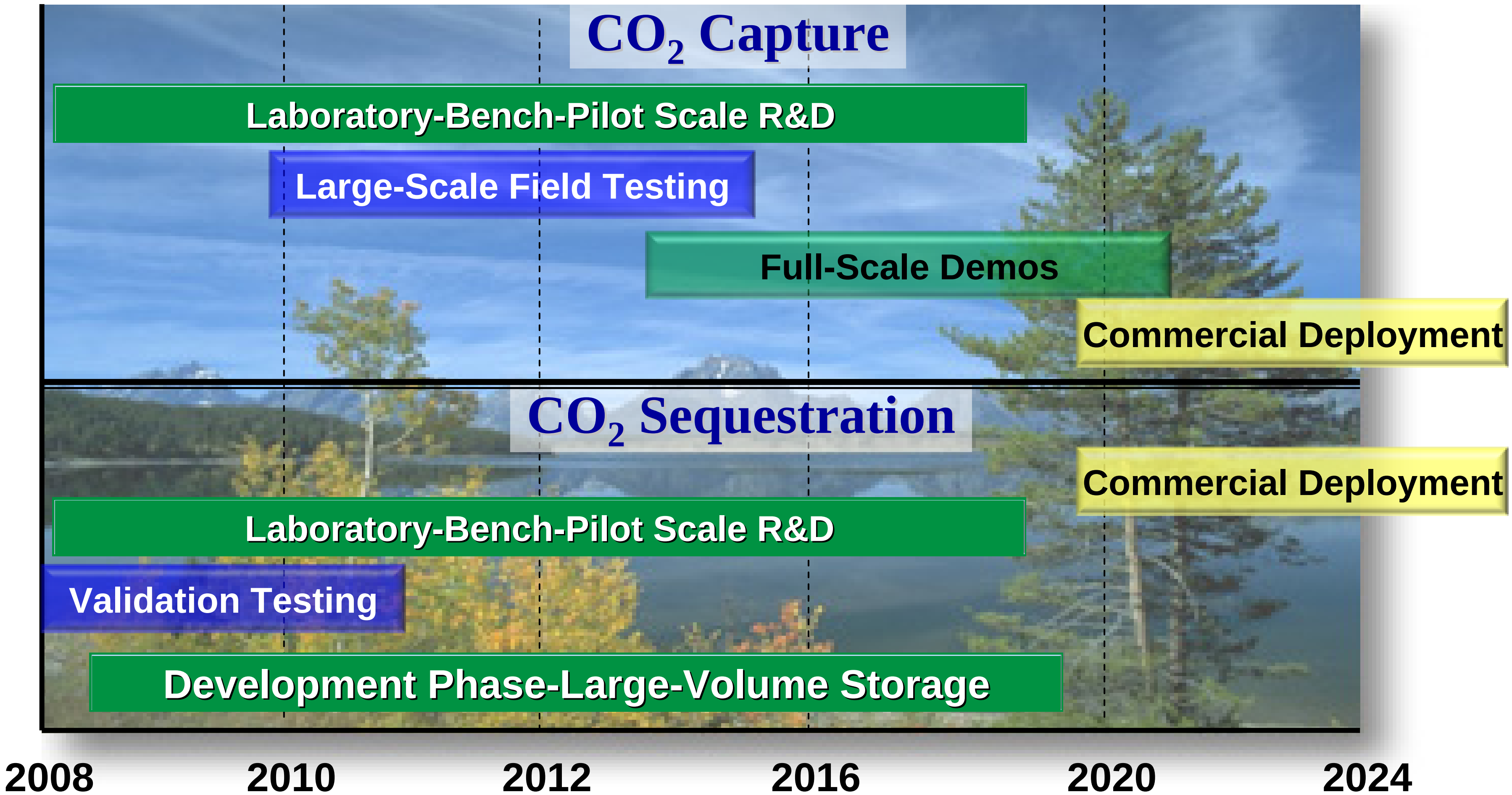
Includes 50 mile pipeline transport and saline formation storage, 100 years of monitoring

References:

1. *Existing Plants—Emissions and Capture Program Goals,* U.S. DOE/National Energy Technology Laboratory, Draft Final Report, February 2009
2. Impact of Cost Escalation on Power Systems R&D Goals—Re-baselining APS, CS & FC GPRA R&D Goals, July 2008

RD&D Timeline to Commercial Deployment

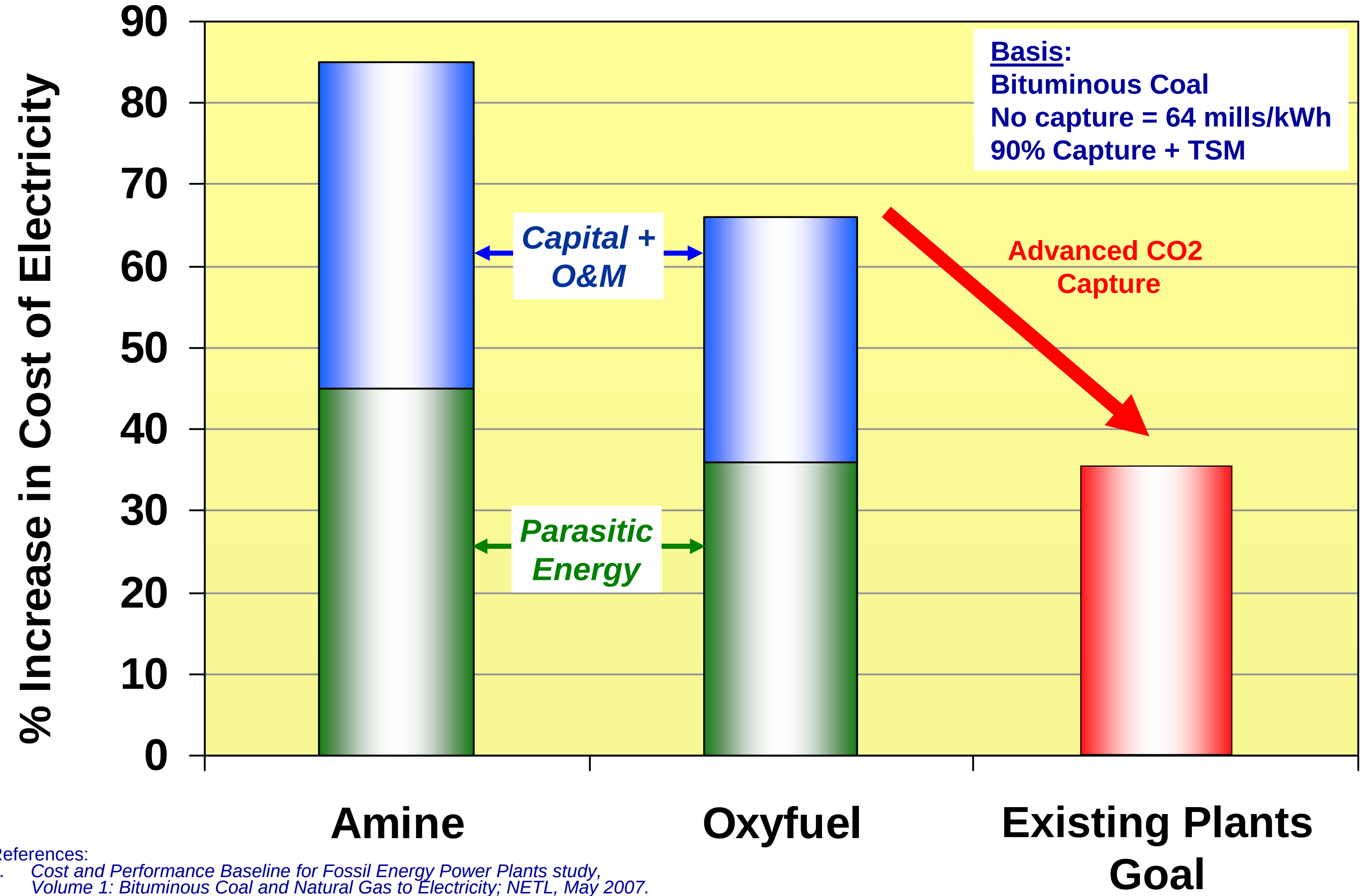
CO_2 Capture and Sequestration Efforts



EPRI, Assessment of Post-Combustion Capture Technology Developments, 2007; Gottlicher (2004)

Post- and Oxy-combustion CO_2 Capture

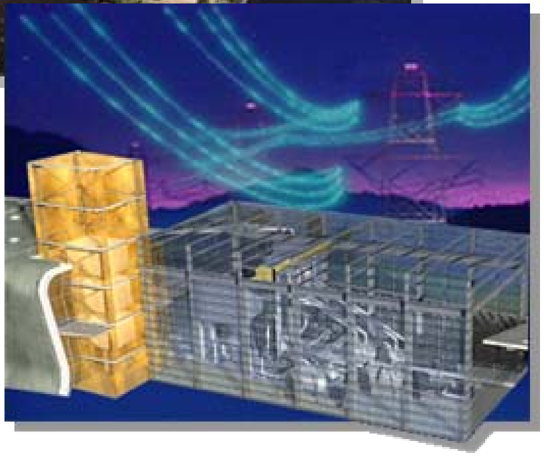
Increase in COE



References:
1. *Cost and Performance Baseline for Fossil Energy Power Plants study, Volume 1: Bituminous Coal and Natural Gas to Electricity; NETL, May 2007.*
2. Pulverized Coal Oxycombustion Power Plants, Volume 1: Bituminous Coal to Electricity, U.S. DOE/NETL, Revised Fiinal Report, August 2008

CO_2 Emissions Control R&D Activities

- **Post-Combustion CO_2 Control**
  - Solvents
  - Sorbents
  - Membranes
- **Oxy-Combustion CO_2 Control**
  - Chemical looping
- **CO_2 Compression**
- **Systems Analyses**



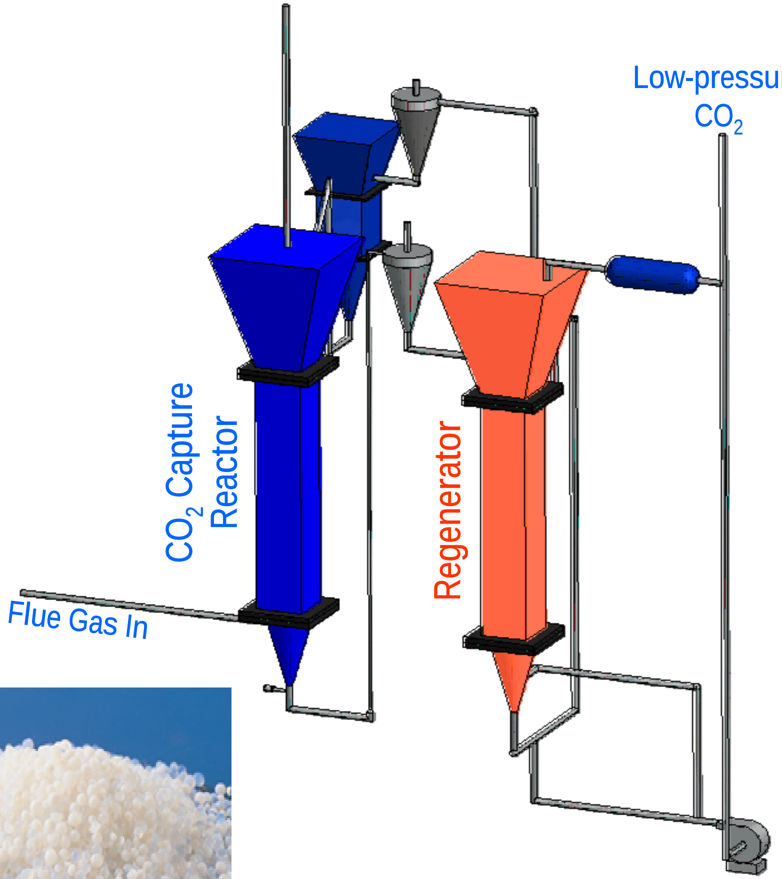
Carbon Capture Research Pathways
Solvents

Research Objectives

- High CO_2 loading capacity
  - Efficient, compact system
- Minimize regeneration energy
- Fast reaction kinetics
- Non-corrosive
  - Low cost materials of construction
- No solvent degradation
  - Thermally & chemically stable
- Low cost

Carbon Capture Research Pathways

Solid Sorbents



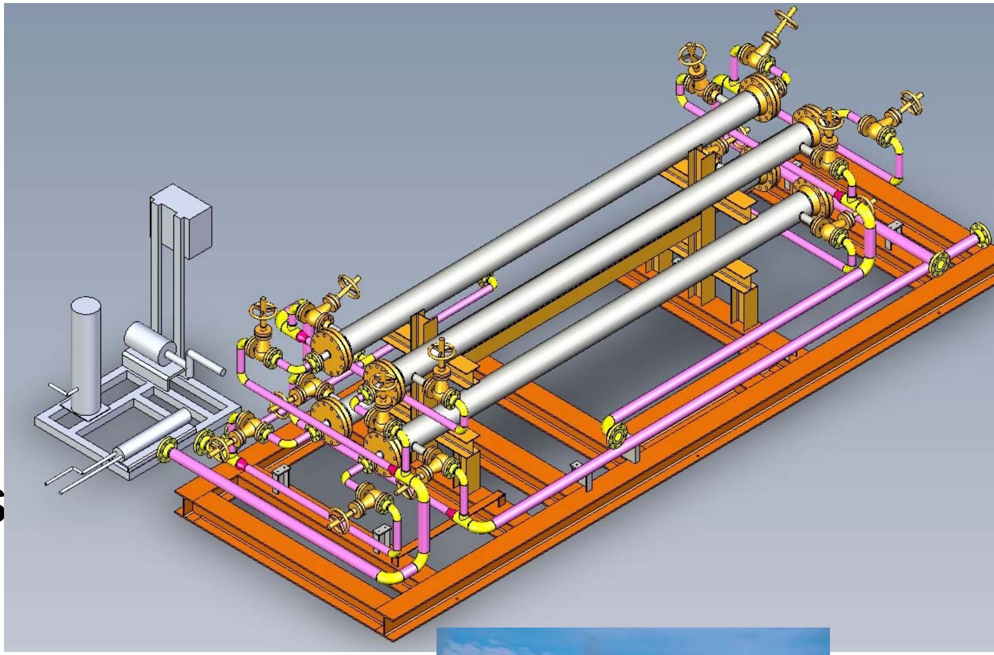
Research Objectives

- High CO_2 loading capacity
- Minimize regeneration energy
- Fast reaction kinetics
- Durable
  - Thermally & chemically stable
  - No attrition
- Advanced sorbent systems
  - Low pressure drop critical
  - Heat management
- Low cost

Carbon Capture Research Pathways
Membranes

Research Objectives

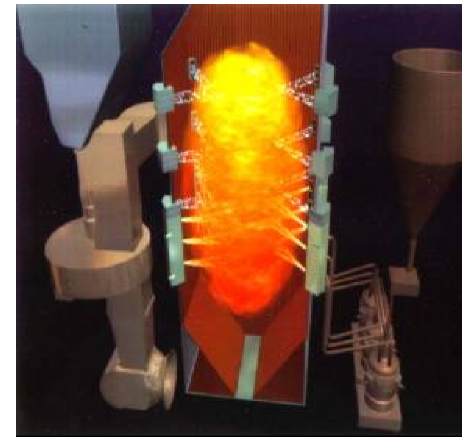
- High CO_2/N_2 selectivity
- Durable
  - Chemically (SO_2), thermally
  - Physically
- Membrane systems
  - Process design critical
- Membrane/solvent systems
  - Enhance chemical potential
- Low cost
  - Capital and energy penalty



Carbon Capture Research Pathways
Oxy-combustion Technologies

Research Objectives

- New oxyfuel boilers
  - Advanced materials and burners
  - Compact designs (FG recycle)
  - Corrosion
- Retrofit existing air boilers
  - Air leakage
  - Heat transfer
  - Corrosion
  - FG recycle
  - Process control/sensors
- Low-cost oxygen
- CO_2 purification
- Co-capture (CO_2 + SOx, NOx, O_2)

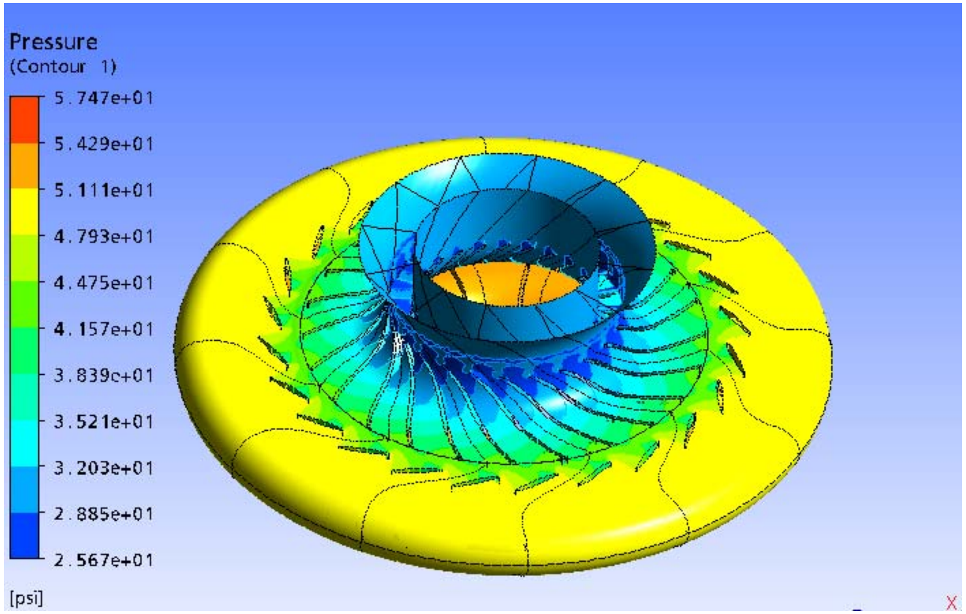


Carbon Capture Research Pathways

Advanced Compression

Research Objectives

- Reduce Capital Costs
- Increase efficiency
- Integration with CO_2 capture process
- Heat recovery
- Modeling



For Additional Information

Office of Fossil Energy
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NETL
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