



# A Solid Retrofit Approach for Capturing CO<sub>2</sub>: Pilot Testing and Equipment

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# Phase I Project Team

## DOE NETL Team Members

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- ADA
- NETL
- EPRI
- AEP
- Ameren
- North American Power
- Luminant
- Southern Company
- Xcel Energy

### Additional EPRI Member Participation and Support

- TVA
- FirstEnergy
- DTE

### Key Contractors:

Stantec, Pressure Chemical, Gelest

***DOE Cooperative Agreement: DE-NT0005649***



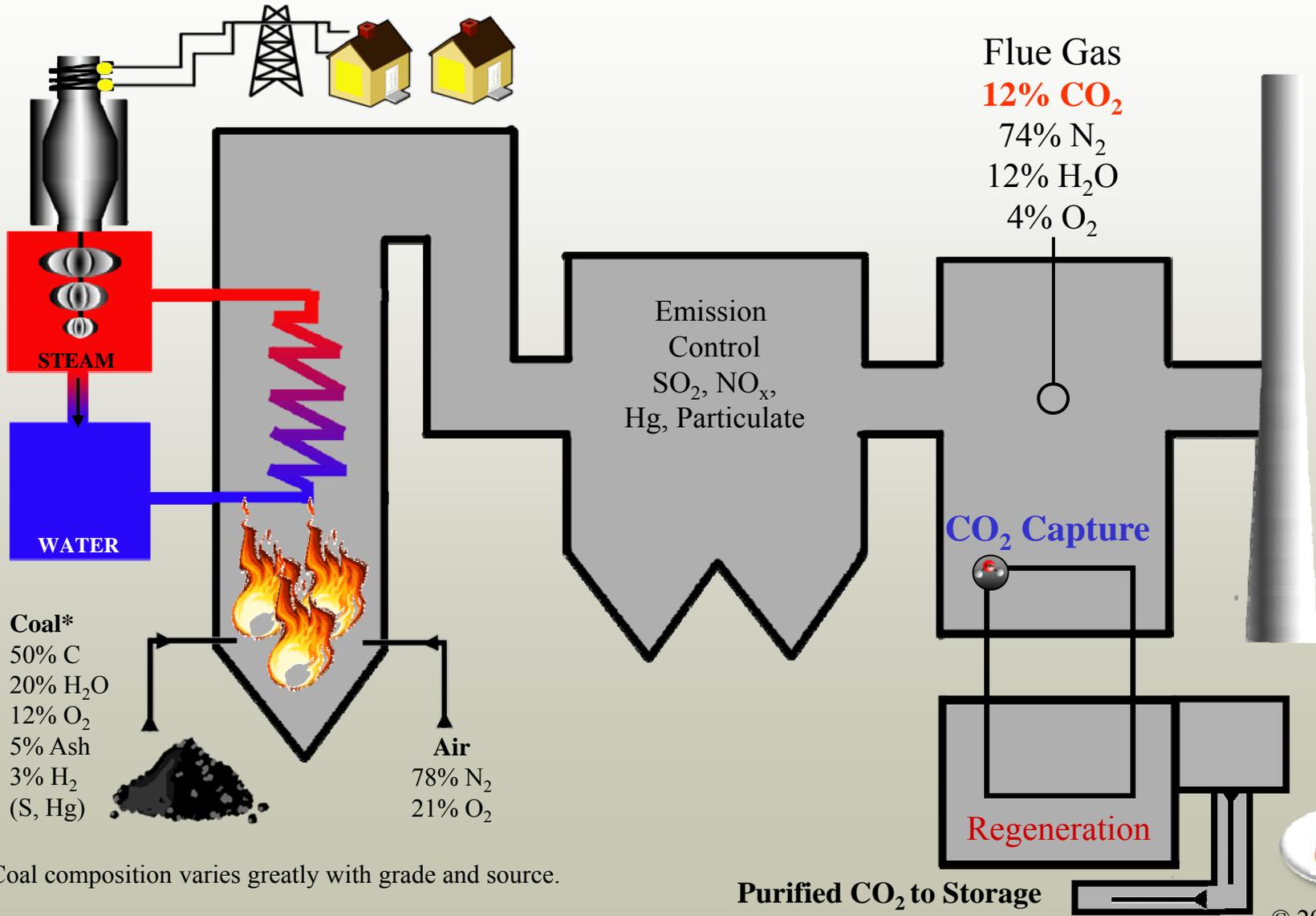
# Presentation Outline

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- Background
  - CO<sub>2</sub> Capture with Solid Sorbents
  - Approach and Objectives
- Results to Date
  - Laboratory Sorbent Screening
  - 1 kW Pilot Testing at Multiple Sites
  - High Level Conceptual Cost Estimate
- Next Steps
- Questions



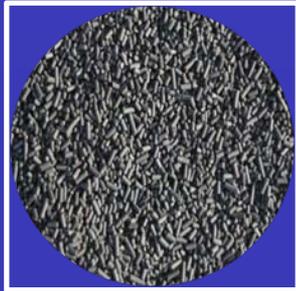
# Post-Combustion Capture



\*Coal composition varies greatly with grade and source.



# Phase I: Dual Focus Viability Assessment



## Sorbents

- Lab Screening
- Lab-Scale Field Screening
- 1 kW Pilot Testing



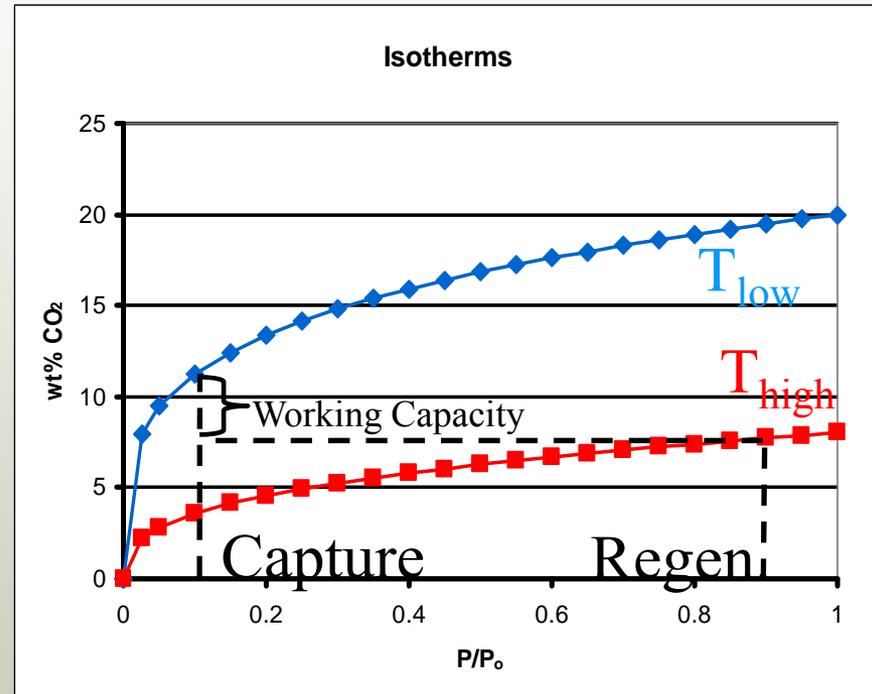
## Equipment

- Survey & Assessment
- Costs & Impacts
- Design
- 500 MW Concept

**Objective:** *Assess the viability and accelerate development of solid-sorbents for CO<sub>2</sub> capture on the existing fleet of coal-fired power plants*

# Sorbent Assessment

- Sorbent Families
  - Supported Reactants  
Chemisorption
    - Amines and Carbonates
  - Non-reacting Adsorbents  
Physisorption
    - Zeolites and Activated Carbon
- Screening Criteria
  - Effect of moisture and flue gas constituents
  - Working capacity
  - Consistent performance
  - Theoretical Regeneration Energy



$$\text{TRE} = \text{Sensible Heat} + \text{Heat of Reaction}$$

$$\text{TRE} = mC_p\Delta T + \Delta H_{\text{rxn}}$$



# Sorbent Selection

- Effect of Moisture
- Effect of Flue Gas Constituents
- Theoretical Regeneration Energy
  - Theoretical RE
  - Working Capacity
- Cyclic Stability
- Rate of Reaction (qualitative)

	Amines	Carbon	Zeolites	Carbonates
Effect of Moisture			X	
Effect of Flue Gas Constituents	X	X		X
Theoretical Regeneration Energy				
– Theoretical RE			X	X
– Working Capacity	X	X		X
Cyclic Stability	X	X		
Rate of Reaction (qualitative)				

**Promising Materials:** Supported Amines and Activated Carbon

*Five supported amine materials indicate initial promise.  
Four produced in 600 lb quantities for 1 kW pilot testing.*



# 1kW Pilot Installed

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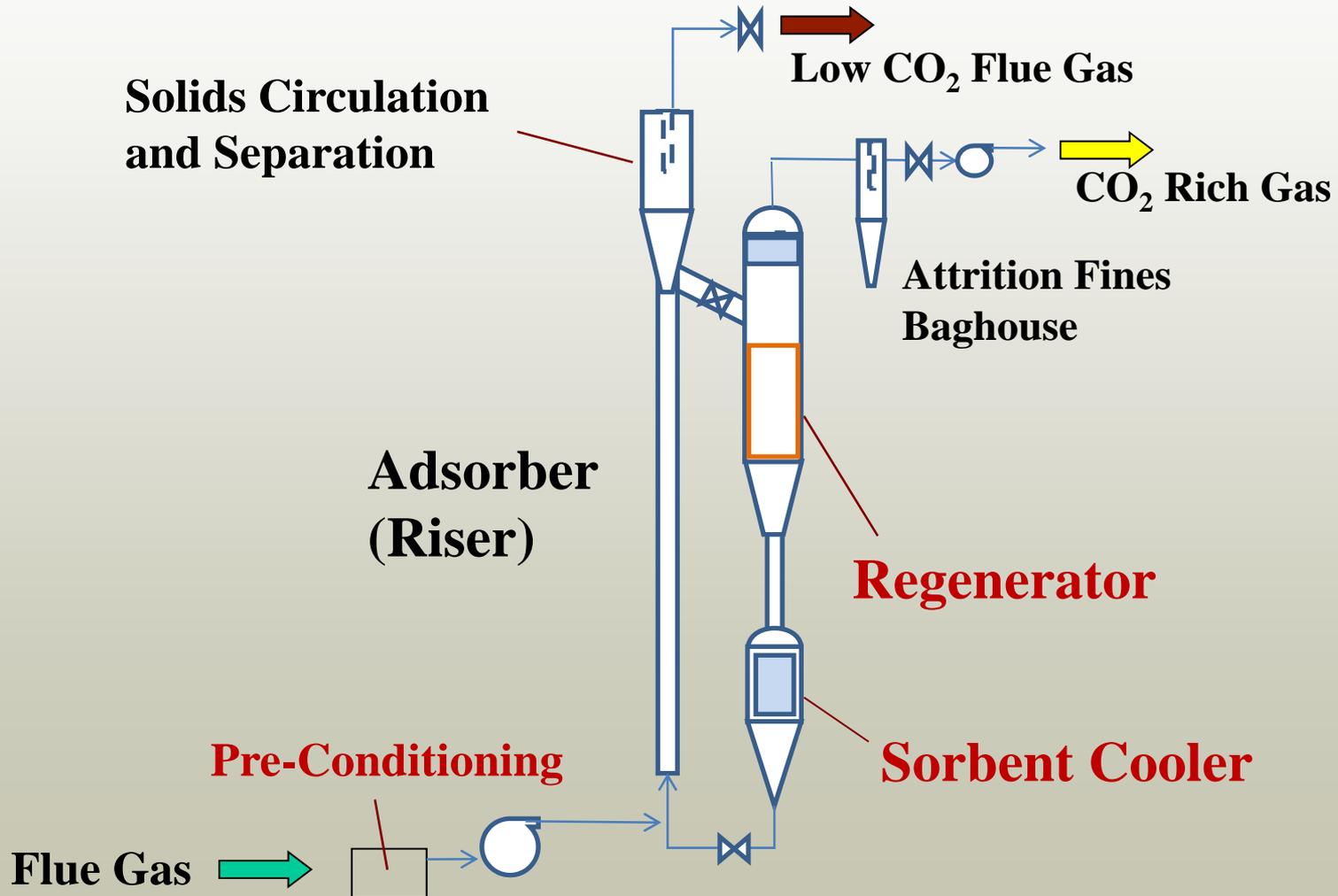
Luminant's Martin Lake Power Plant



Xcel's Sherco Station



# 1kW Pilot System

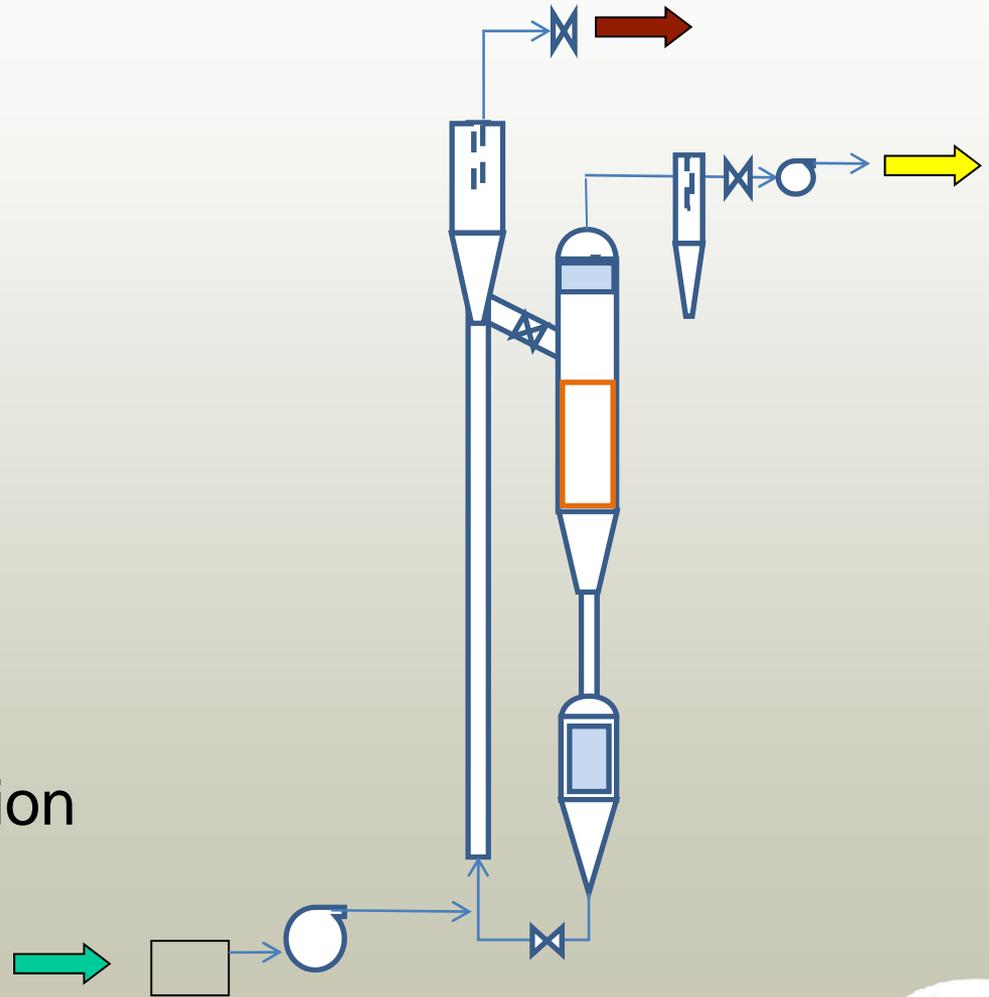


Process concept provided by Southern Company

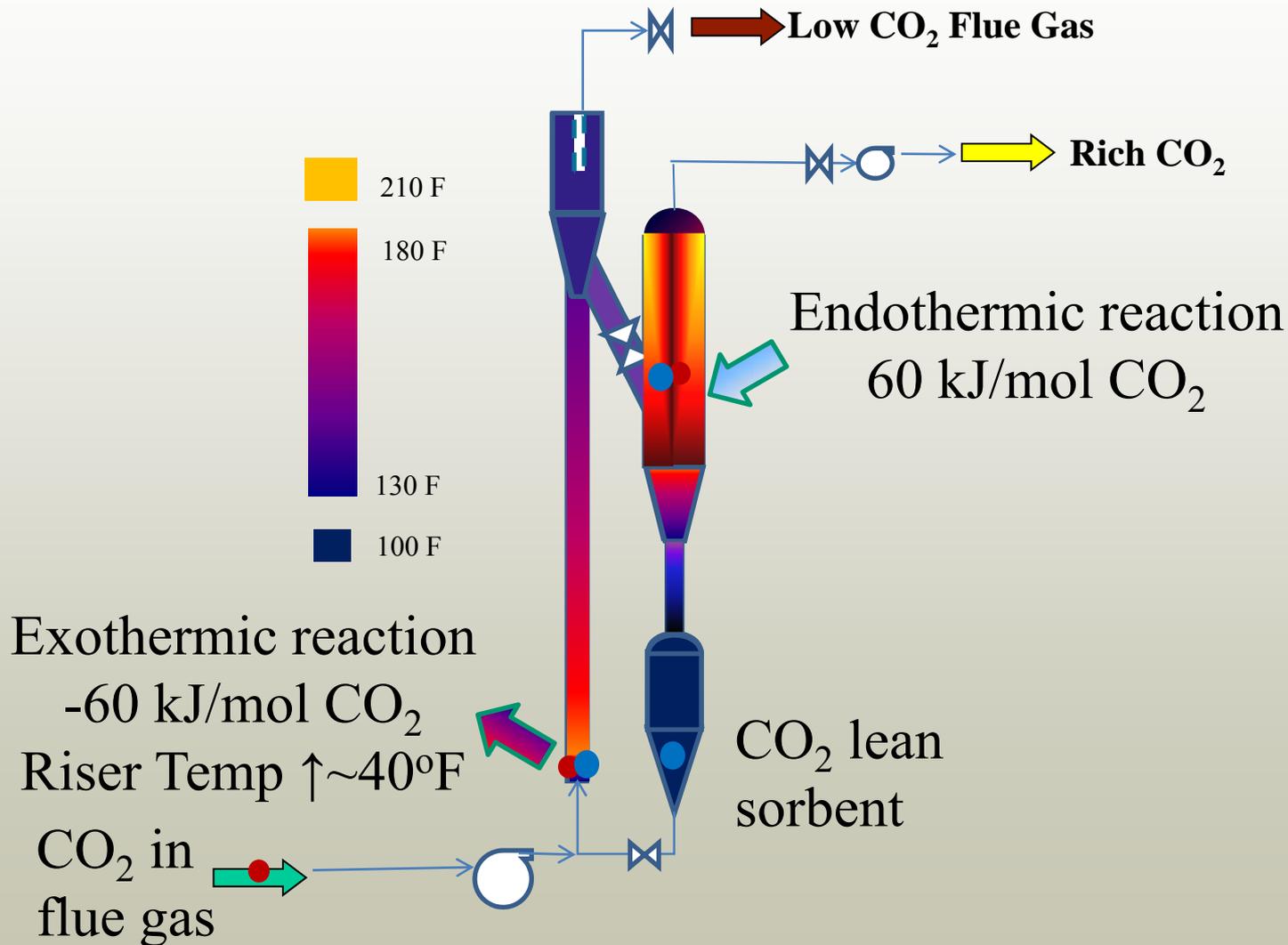


# System Operation

- Continuous
  - Adsorption and regeneration simultaneously
- Batch
  - Adsorption and regeneration are separate
  - Increase regeneration time

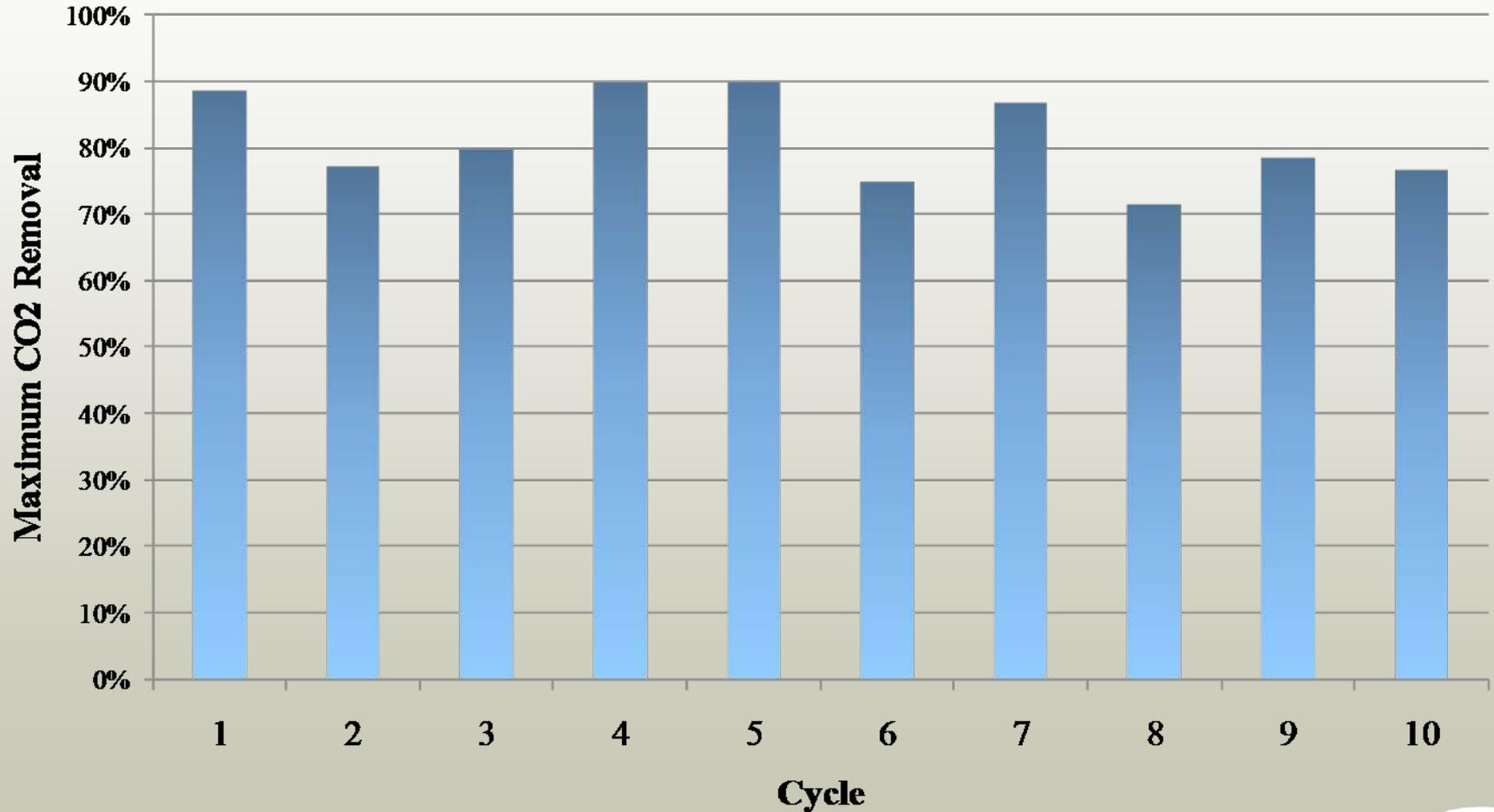


# 1 kW Pilot with Sorbent R



# Batch Test Summary

## Sorbent R



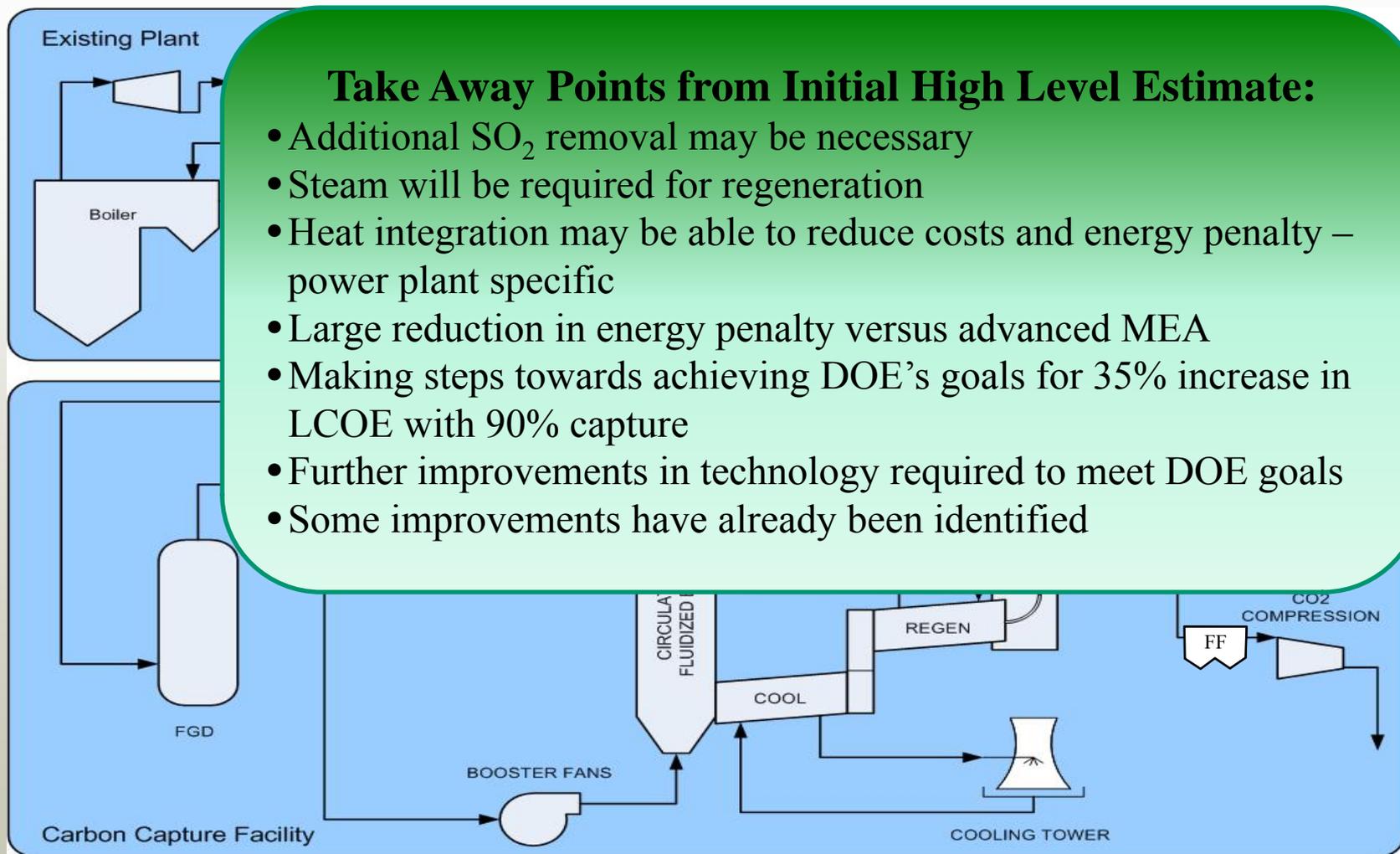
# 1 kW Summary of Results

- ✓ > 90% capture achieved
- ✓ Fast adsorption reaction
  - Significant removal at < 1 sec. residence time
- ✓ Pressure drop: 2.5 – 3 in H<sub>2</sub>O (includes ICFB) at 40 lb/hr circulation
- ☒ Slow regeneration with test sorbent (R)
  - Batch operation required to characterize performance in this pilot

*Successful sorbents must regenerate quickly and/or in the presence of increased CO<sub>2</sub> concentrations.*



# Proposed Integration into Power Plant



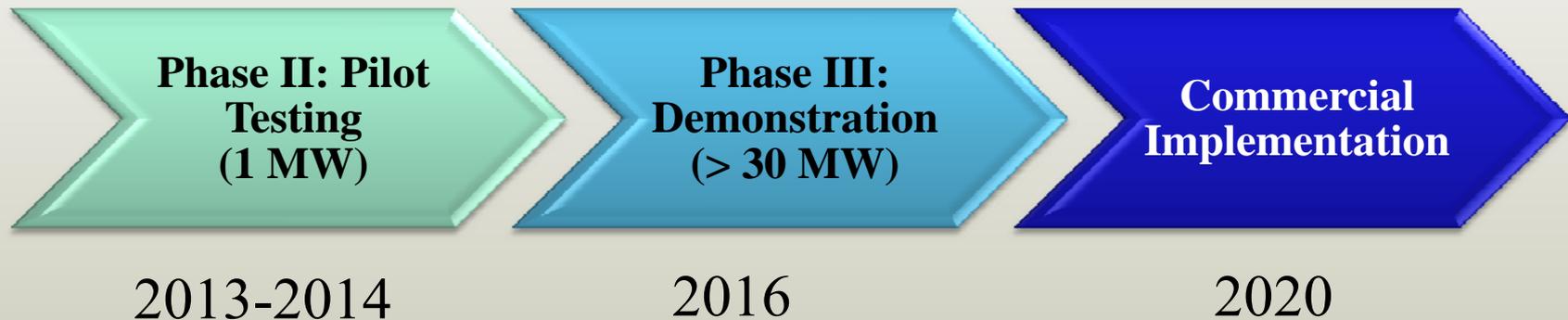
# Project Next Steps

- Complete testing of two alternative supported amine materials and one activated carbon sorbent in 1 kW system at Xcel Energy Sherco Station
- Install 1kW pilot at NCCC for additional testing
- Complete concept design and economics for 430 MW



# Next Steps for Solid Sorbents

New NETL project funded for additional development of 500 MW design supported through 1 MW pilot testing



*Seeking additional project partners*





# Creating a Future with Cleaner Coal

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