

A Solid Retrofit Approach for Capturing CO₂: Pilot Testing and Equipment

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Phase I Project Team

DOE NETL Team Members

- 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

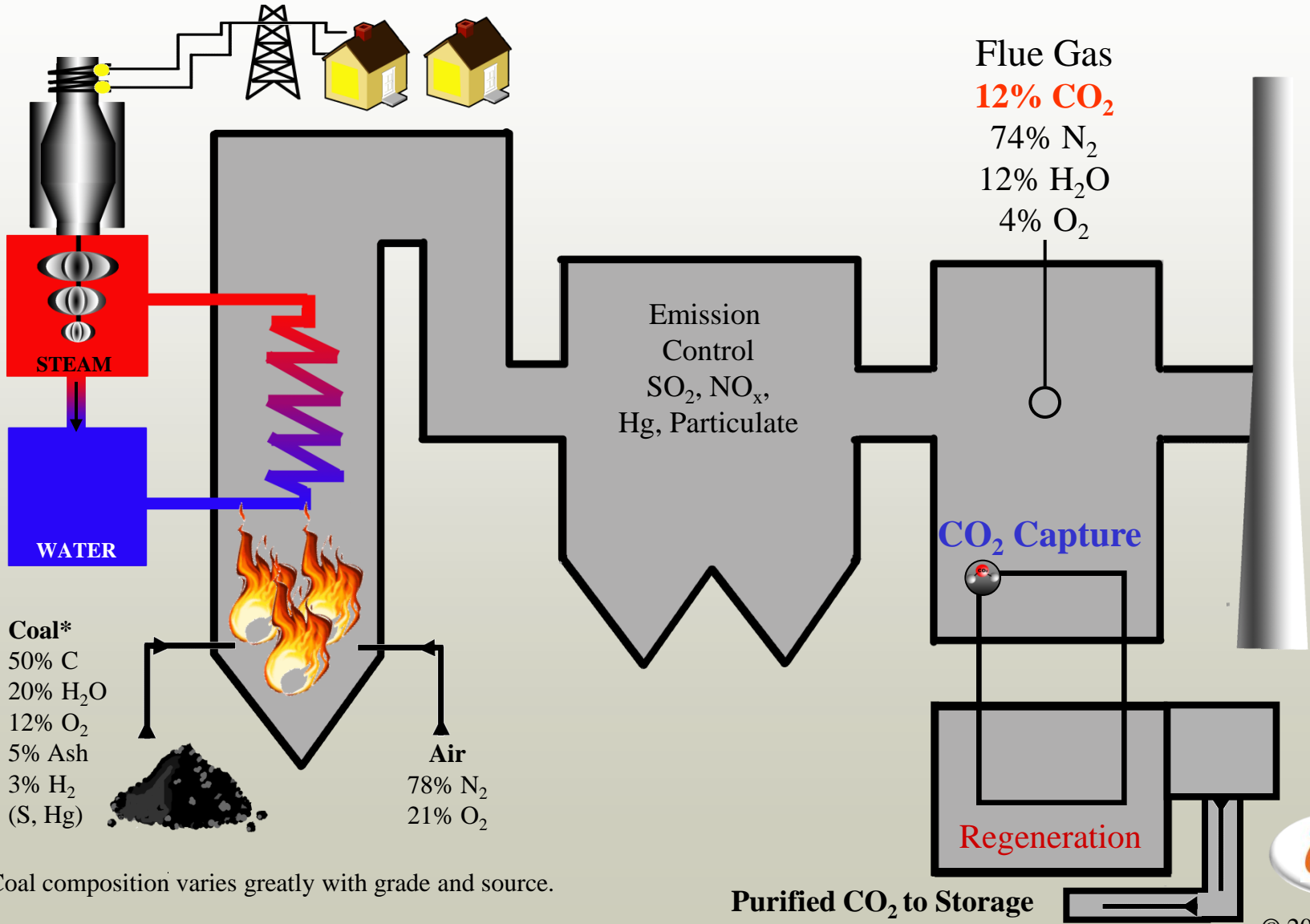


Presentation Outline

- Background
 - CO₂ 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



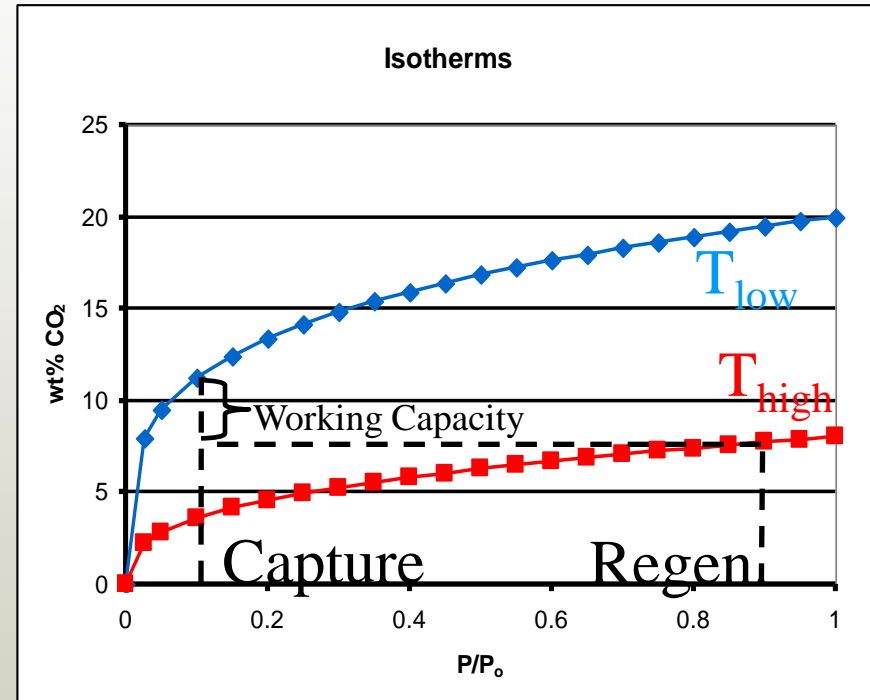
Equipment

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

Objective: *Assess the viability and accelerate development of solid-sorbents for CO₂ 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



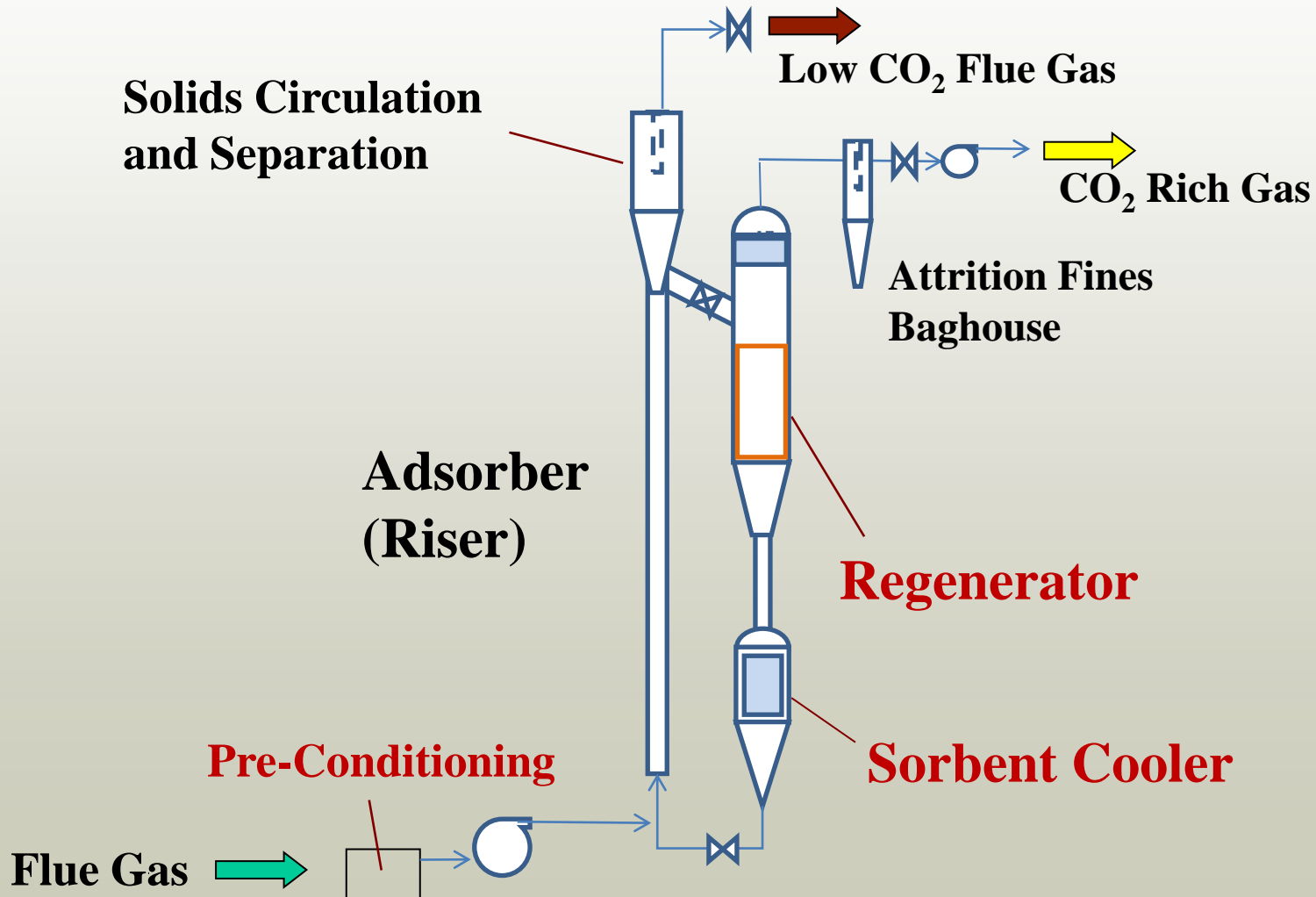
Luminant's Martin Lake Power Plant



Xcel's Sherco Station



1kW Pilot System



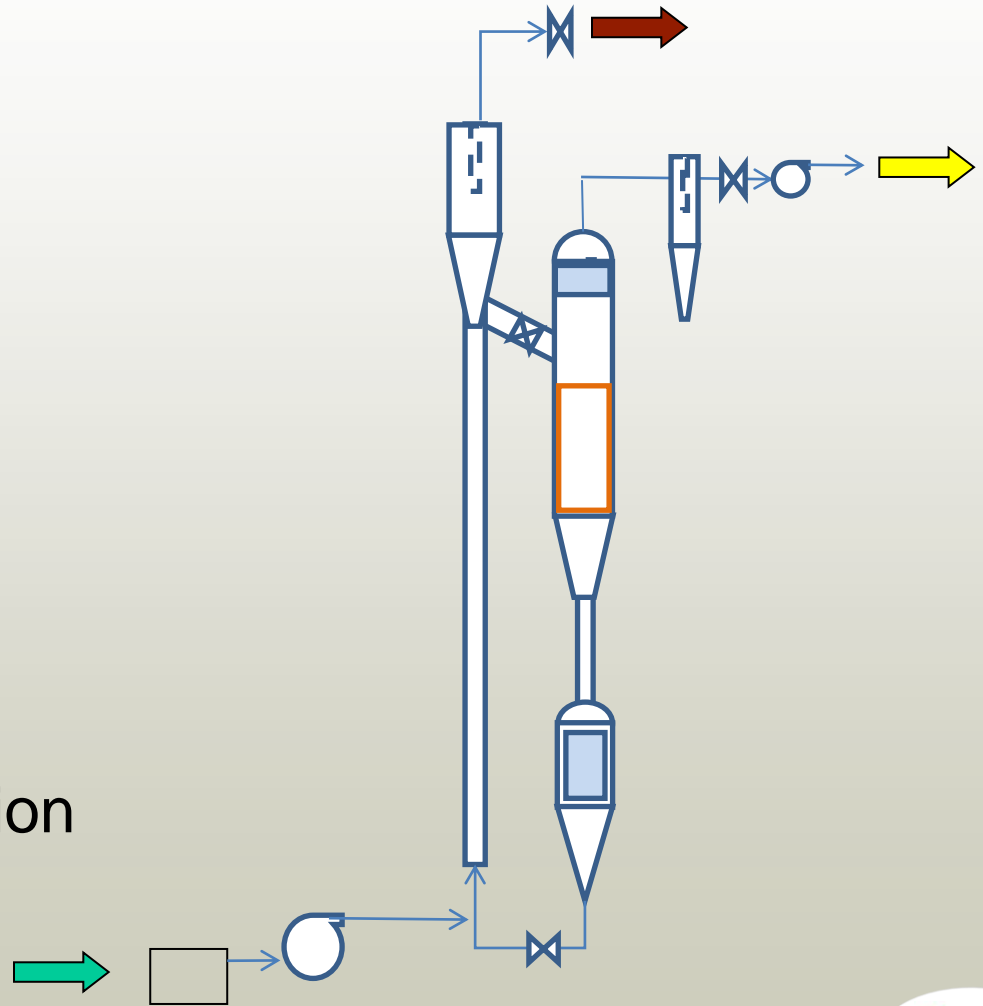
Process concept provided by Southern Company



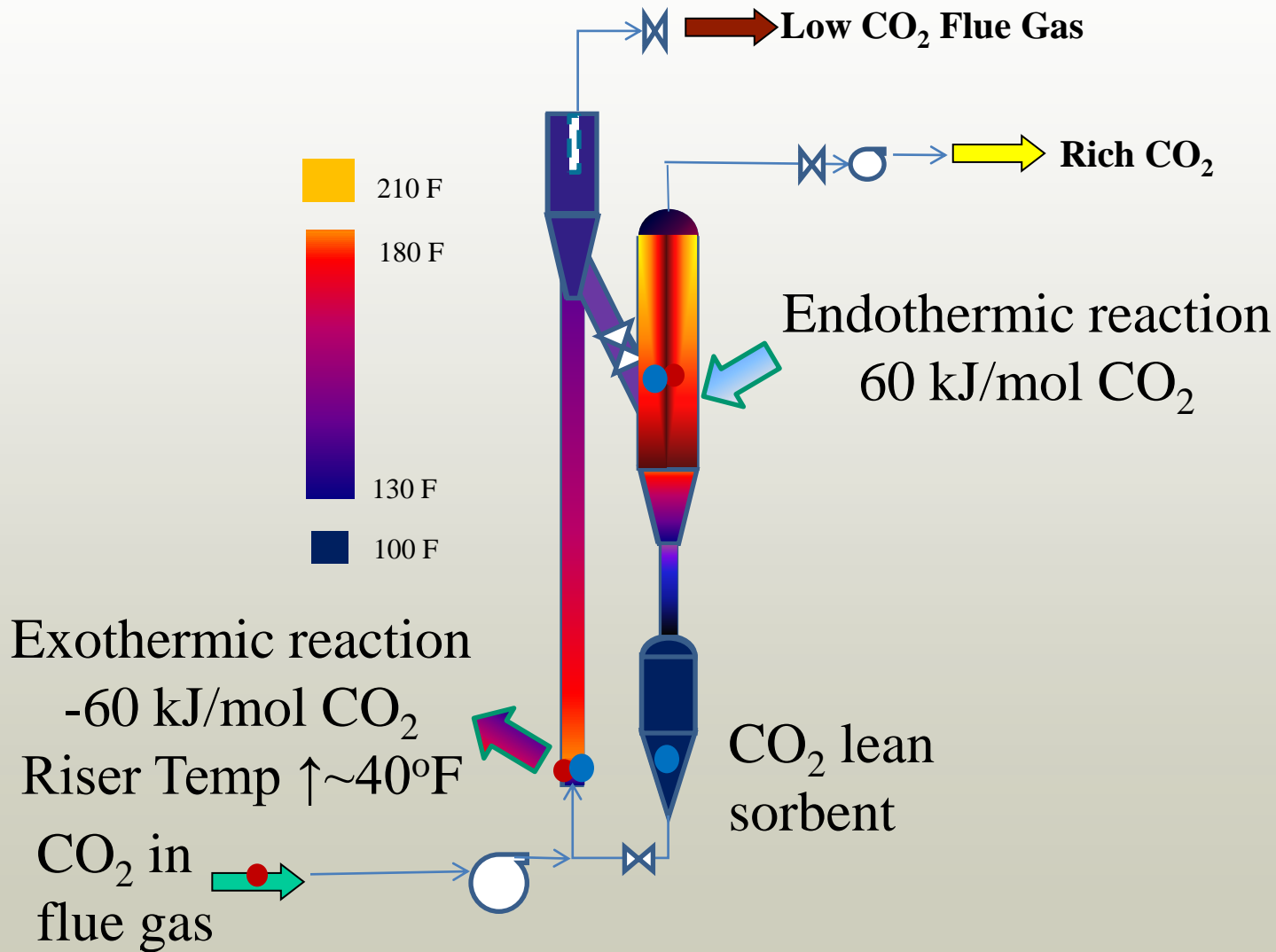
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System Operation

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

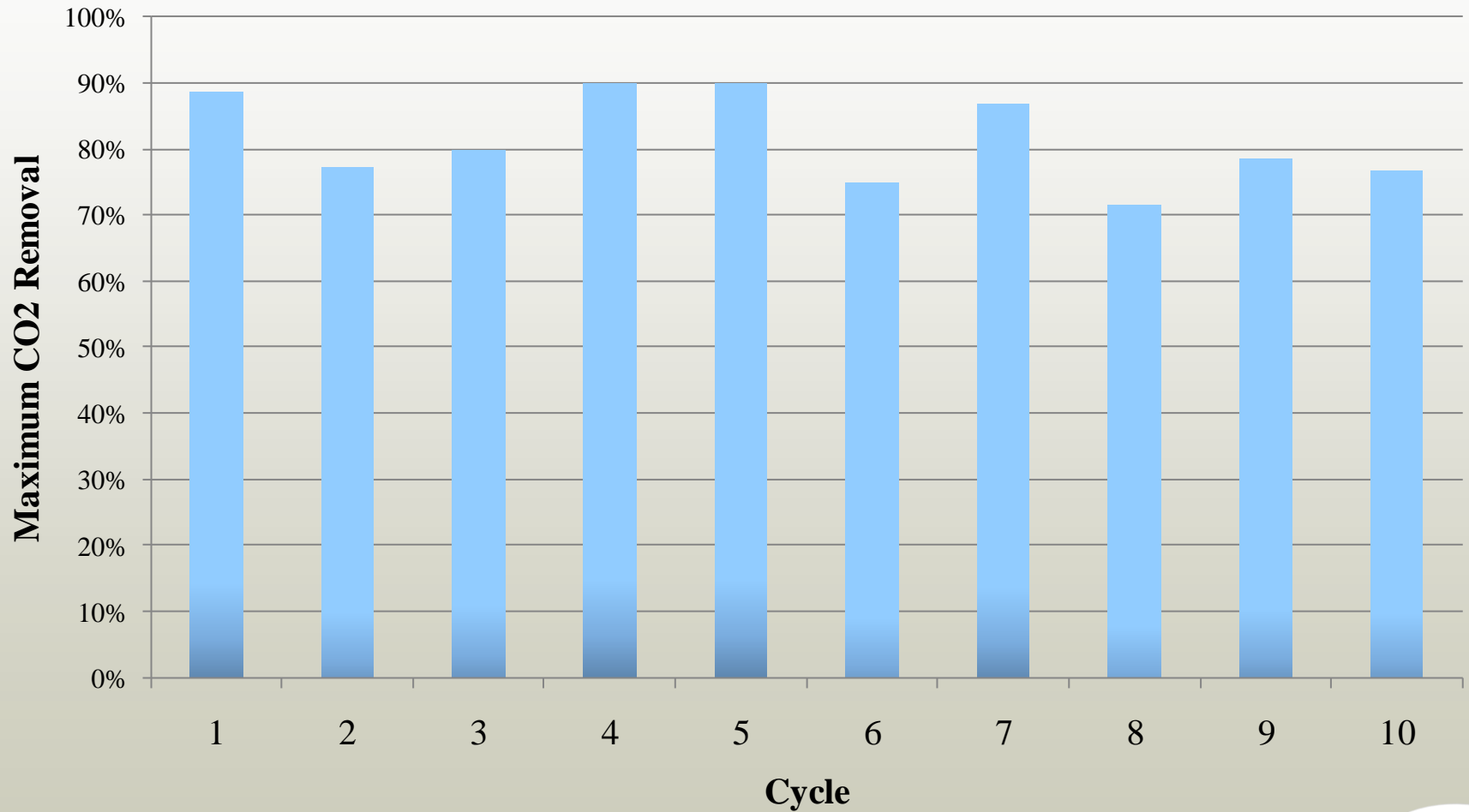


1 kW Pilot with Sorbent R



Batch Test Summary

Sorbent R



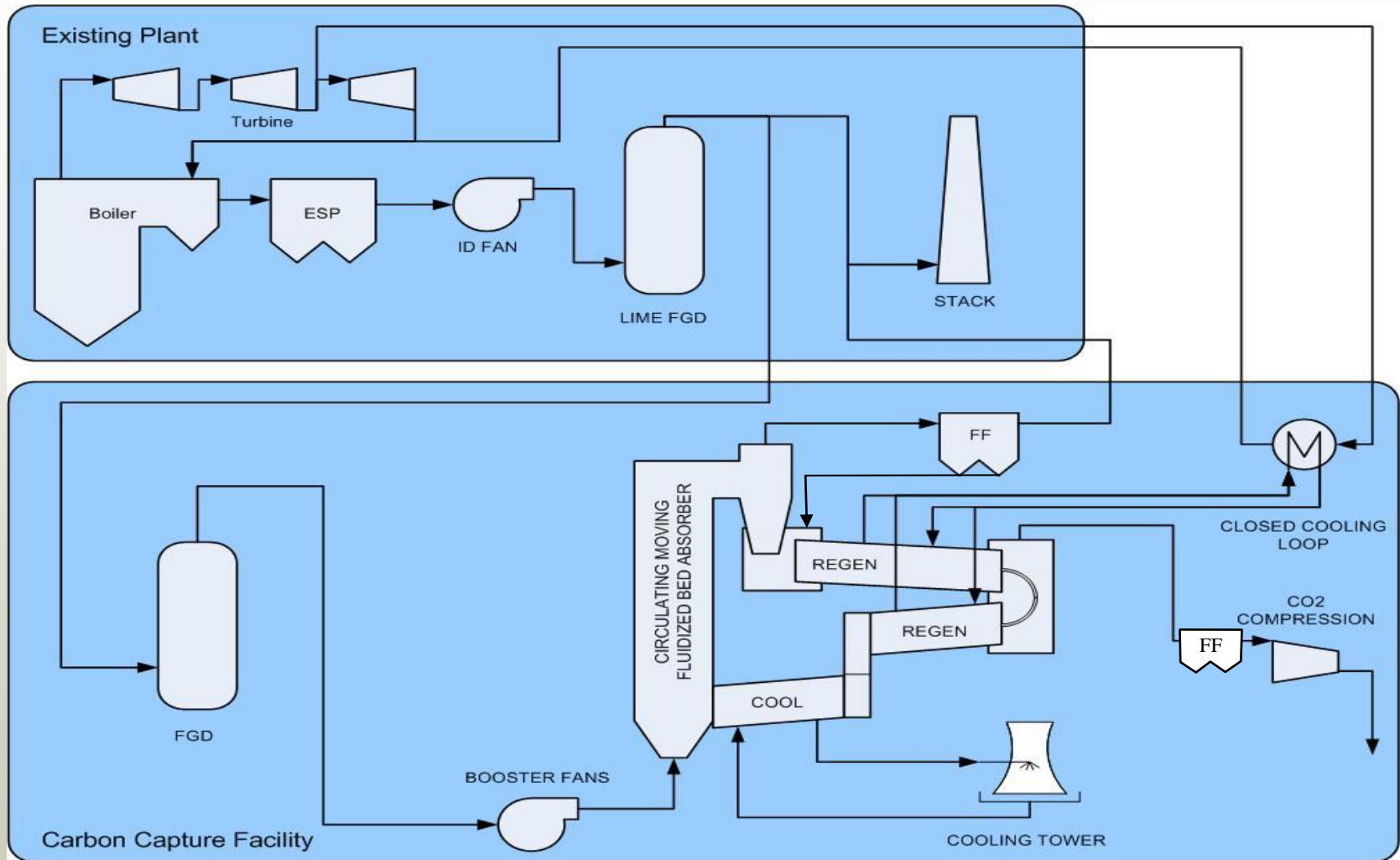
1 kW Summary of Results

- ✓ > 90% capture achieved
- ✓ Fast adsorption reaction
 - Significant removal at < 1 sec. residence time
- ✓ Pressure drop: 2.5 – 3 in H₂O (includes ICFB) at 40 lb/hr circulation
- ☒ Slow regeneration with test sorbent (R)
 - Batch operation required to characterize performance in this pilot

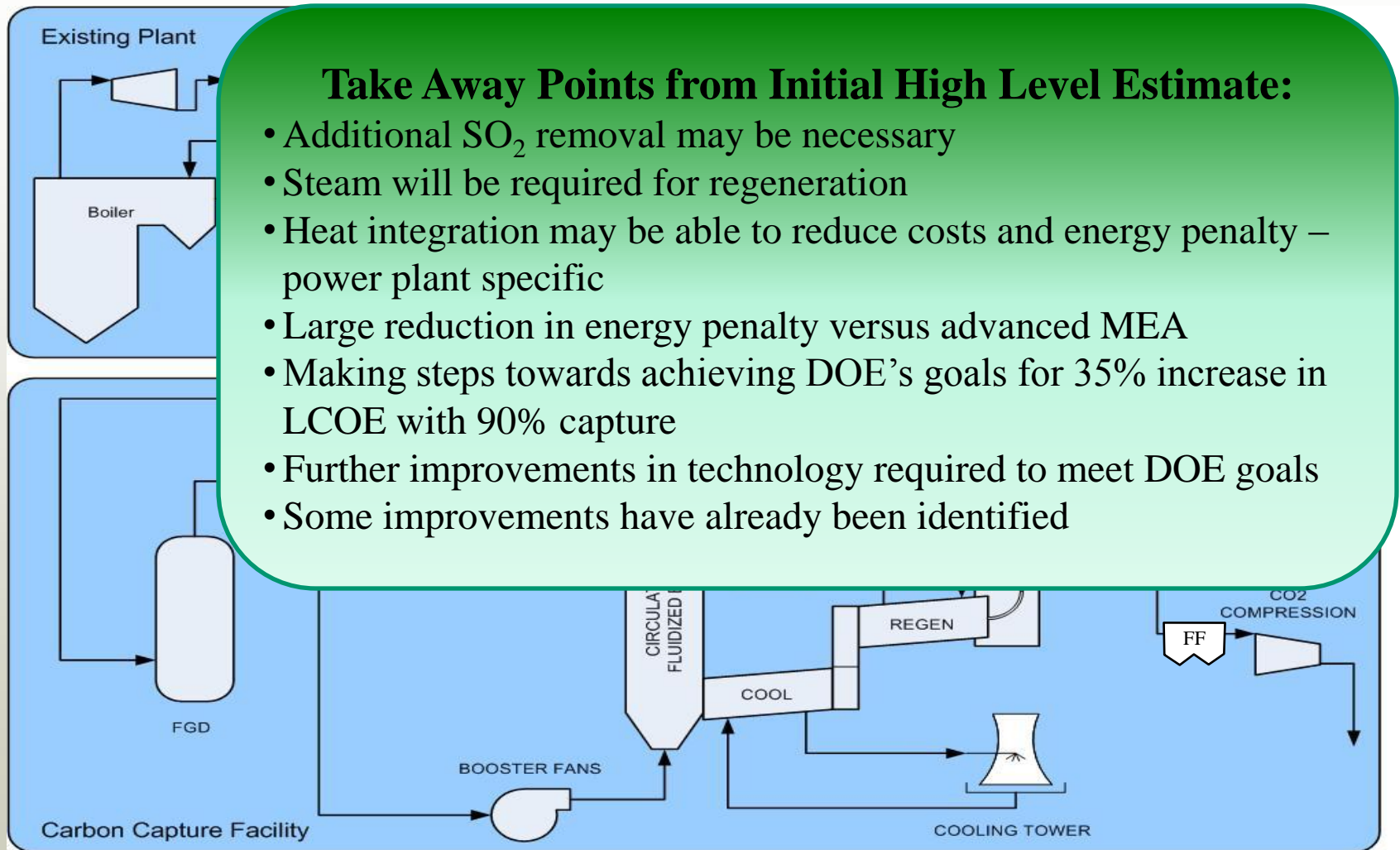
Successful sorbents must regenerate quickly and/or in the presence of increased CO₂ concentrations.



Proposed Integration into Power Plant



Proposed Integration into Power Plant



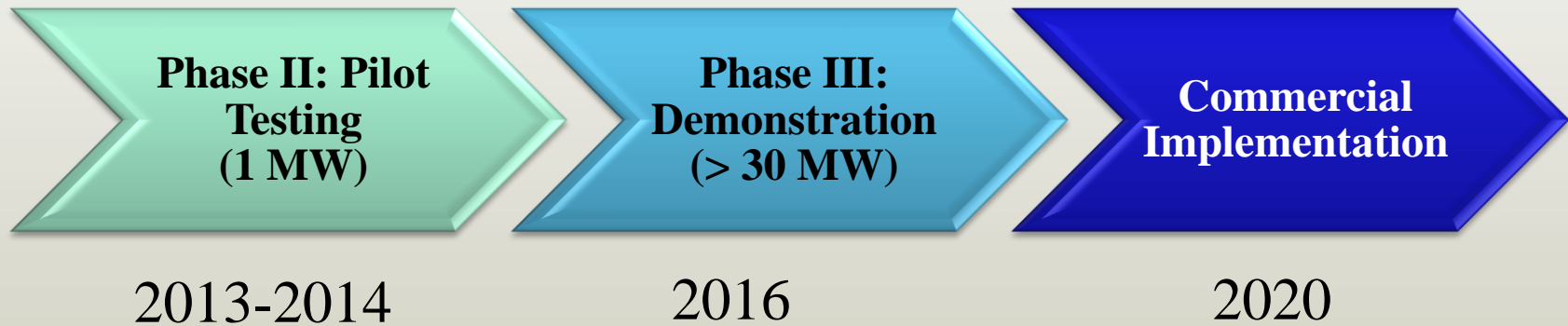
Project Next Steps

- 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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