Tenth Annual Conference on Carbon Capture & Sequestration

Session: 2-B Capture Sorbents/Solvents

Solid Sorbents as a Retrofit CO_2 Capture Technology: Viability Review and Pilot Testing

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Discussion Outline

- Technology Development Approach
- Key Technical and Cost Drivers for Full-Scale Implementation
- Experimental Results to Date
  - Laboratory Sorbent Screening
  - 1 kW Pilot Testing at Multiple Sites
- Next Steps
- Questions

Technical Approach to CO_2 Capture

Phase I: Assess Viability

- **Technical**
  - >90% CO_2 capture
  - Produce high purity CO_2
  - Scalablity
- **Economic**
  - < 35% increase in COE
    - CapEX Drivers
      - Size of Equipment
      - Materials of Construction
      - Process Complexity
    - OpEX Drivers
      - Energy to release CO_2
      - Energy to compress CO_2
      - Feedstock

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_2 capture on the existing fleet of coal-fired power plants*

Phase I Project Team

DOE NETL Team Members

- ADA
- NETL
- EPRI
- AEP
- Ameren
- Luminant
- Southern Company
- Xcel Energy

Additional EPRI Member Participation and Support

- TVA
- FirstEnergy
- DTE

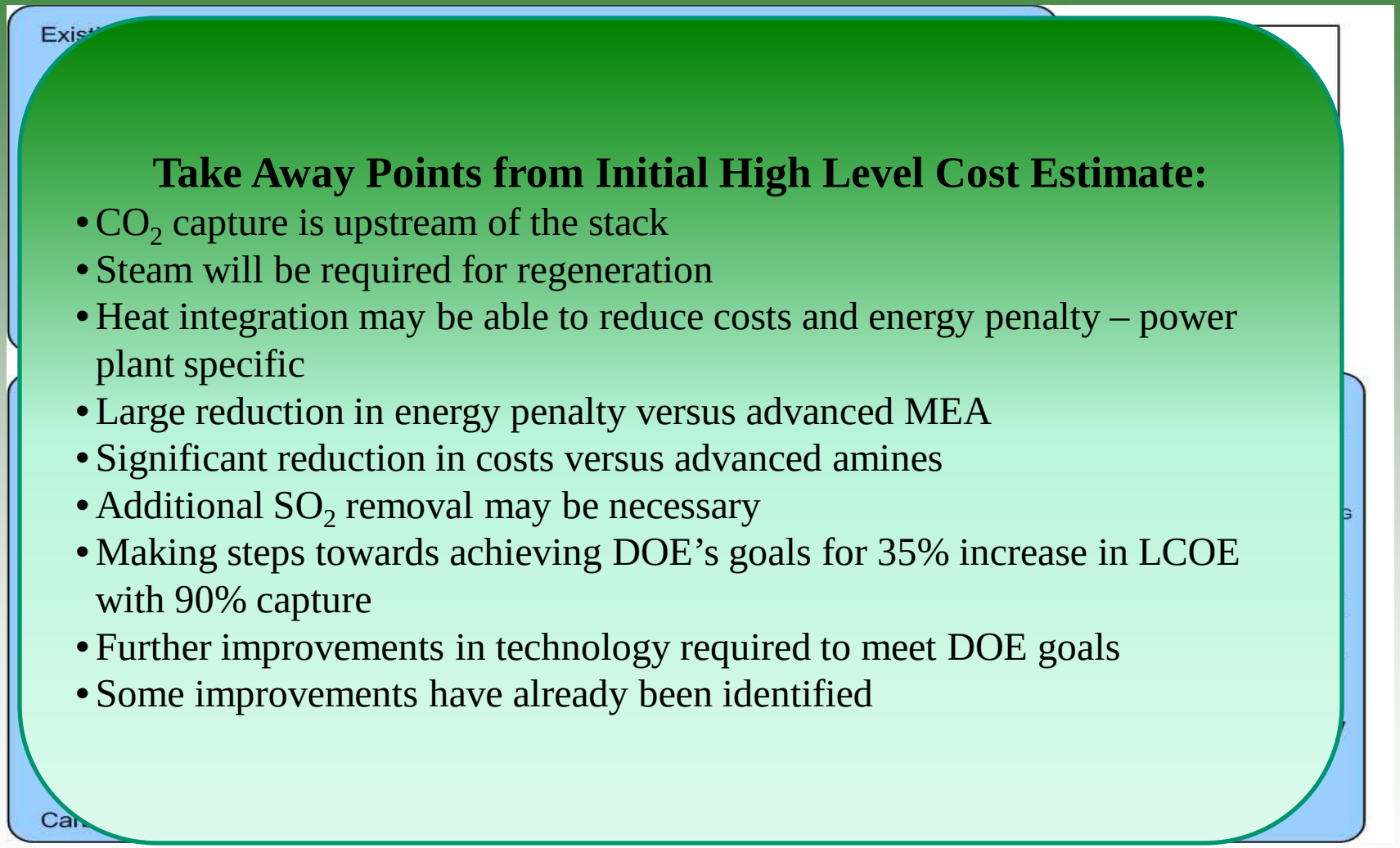
Key Contractors:

Stantec, Pressure Chemical, Gelest

DOE Cooperative Agreement: DE-NT0005649

Technology Development: Review of Initial High Level Process Concept

Temperature Swing Adsorption CO_2 Capture

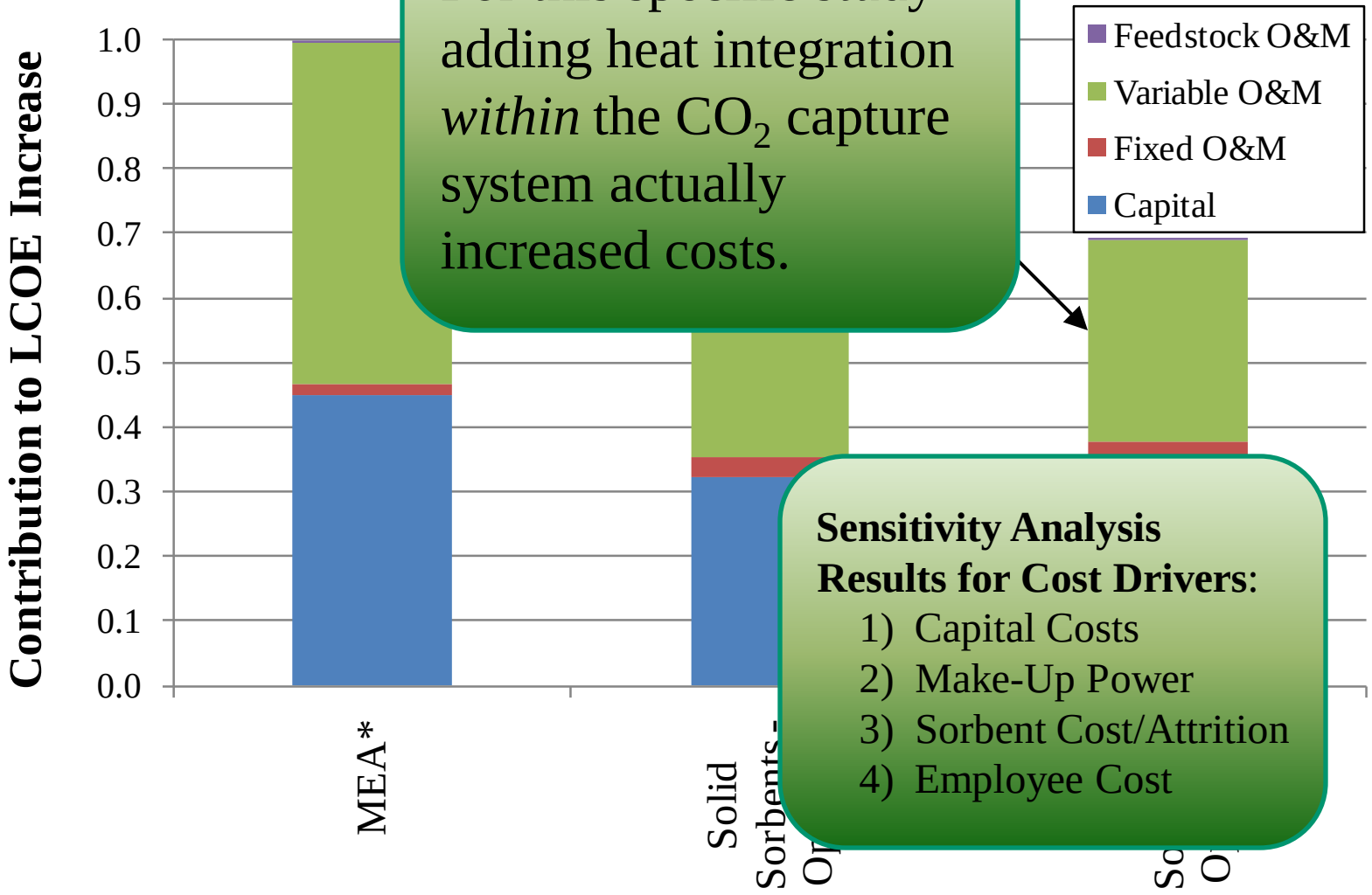


Take Away Points from Initial High Level Cost Estimate:

- CO_2 capture is upstream of the stack
- Steam will be required for regeneration
- Heat integration may be able to reduce costs and energy penalty – power plant specific
- Large reduction in energy penalty versus advanced MEA
- Significant reduction in costs versus advanced amines
- Additional SO_2 removal may be necessary
- Making steps towards achieving DOE's goals for 35% increase in LCOE with 90% capture
- Further improvements in technology required to meet DOE goals
- Some improvements have already been identified

Stantec High Level Cost Comparison

For this specific study – adding heat integration *within* the CO_2 capture system actually increased costs.



Sensitivity Analysis Results for Cost Drivers:

1) Capital Costs
2) Make-Up Power
3) Sorbent Cost/Attrition
4) Employee Cost

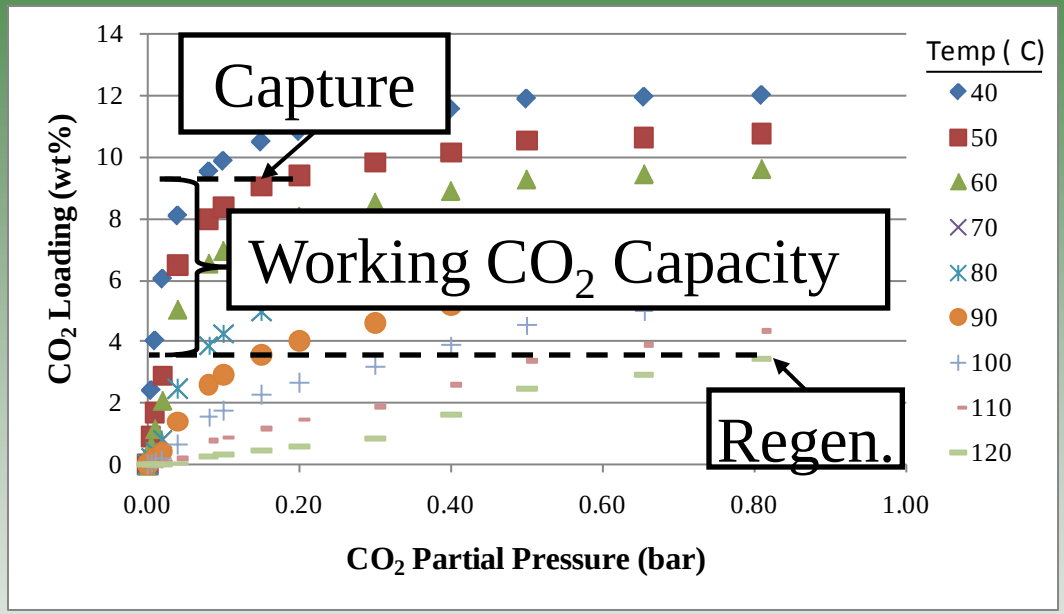
*Ramezan M., Skone T.J., Nsakala N., Liljedahl G.N., "Carbon Dioxide Capture from Existing Coal-Fired Power Plants", Final Report DOE/NETL-401/110907, December, 2007

Sorbent Screening

- Lab-Scale
- 1 kW Pilot

Sorbent Assessment

- Techniques
  - Fixed bed
  - TGA
- Sorbent Families
  - Supported Reactants Chemisorption
  - Non-reacting Adsorbents Physisorption
- Screening Criteria
  - Effect of moisture and flue gas constituents
  - Working capacity
  - Consistent performance
  - Theoretical Regeneration Energy

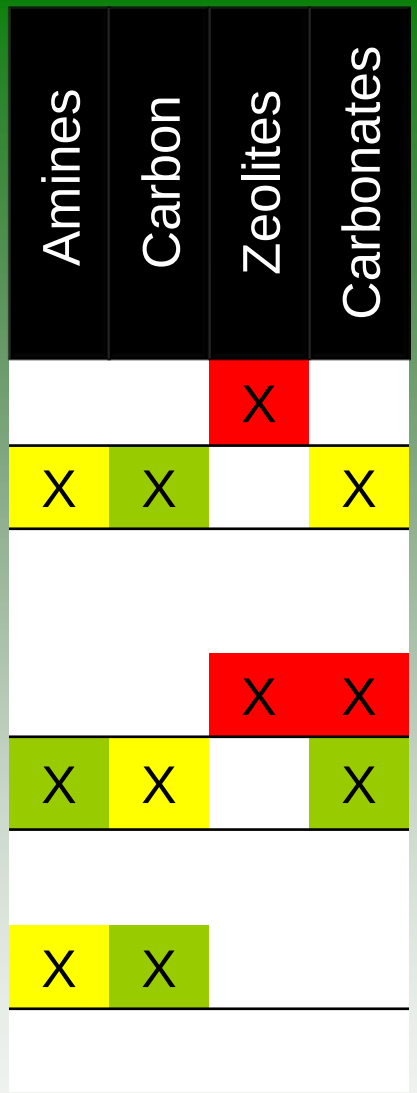


TRE = Sensible Heat + Heat of Reaction

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

Sorbent Selection

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

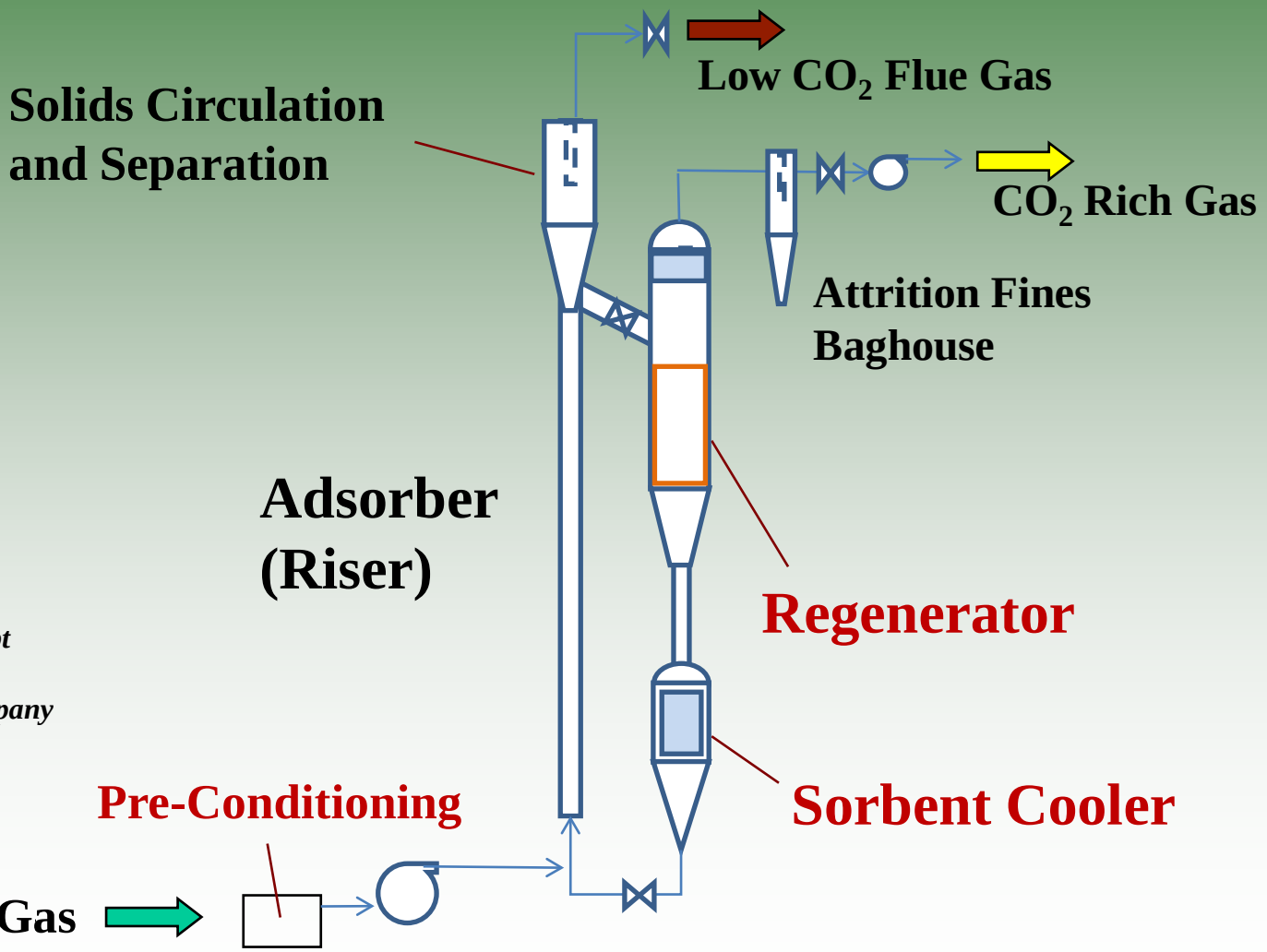


Promising Materials: Supported Amines

Four supported amine sorbents produced in 600 lb quantities for 1 kW pilot testing.

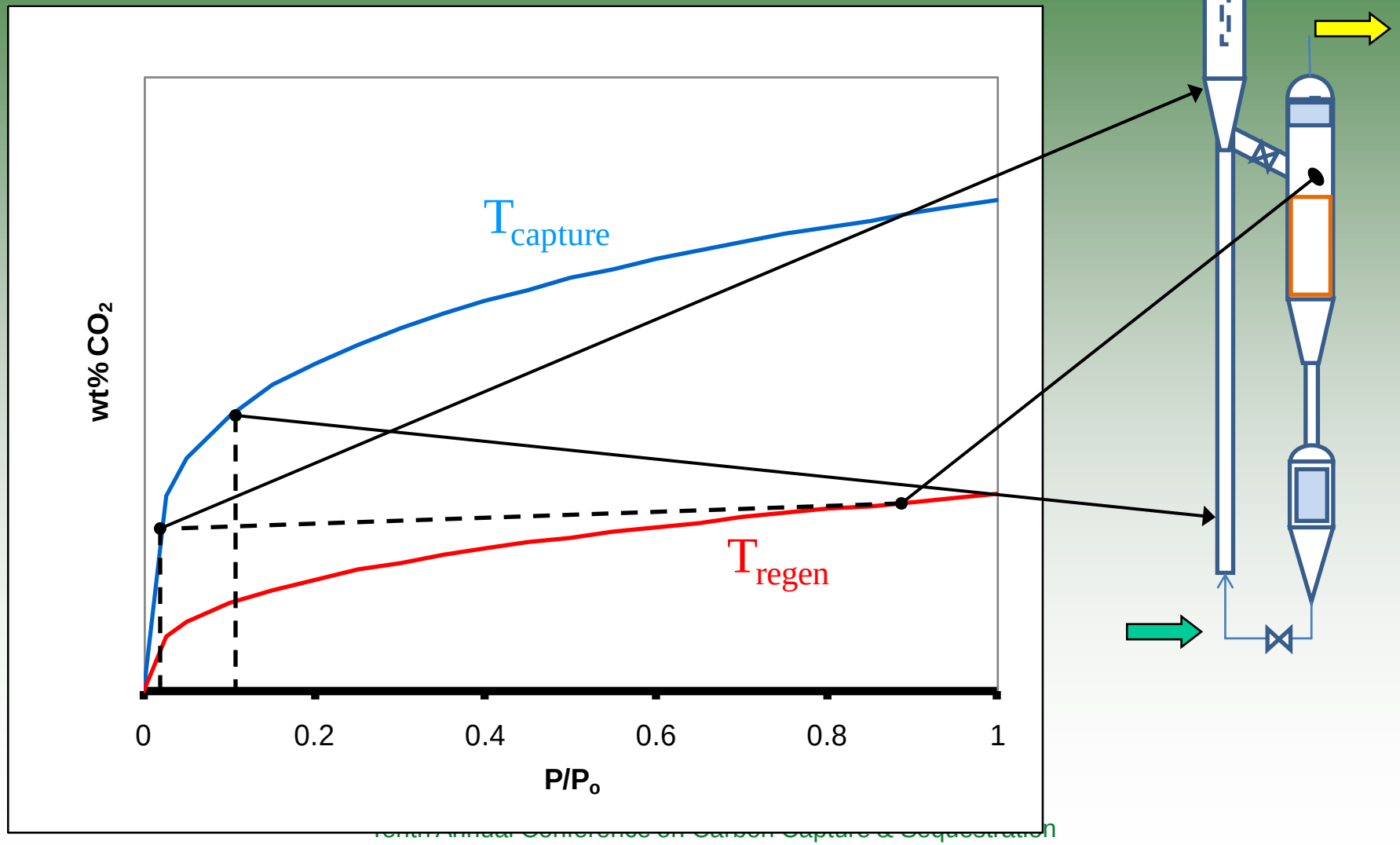
1kW Pilot Installed

1 kW Pilot System

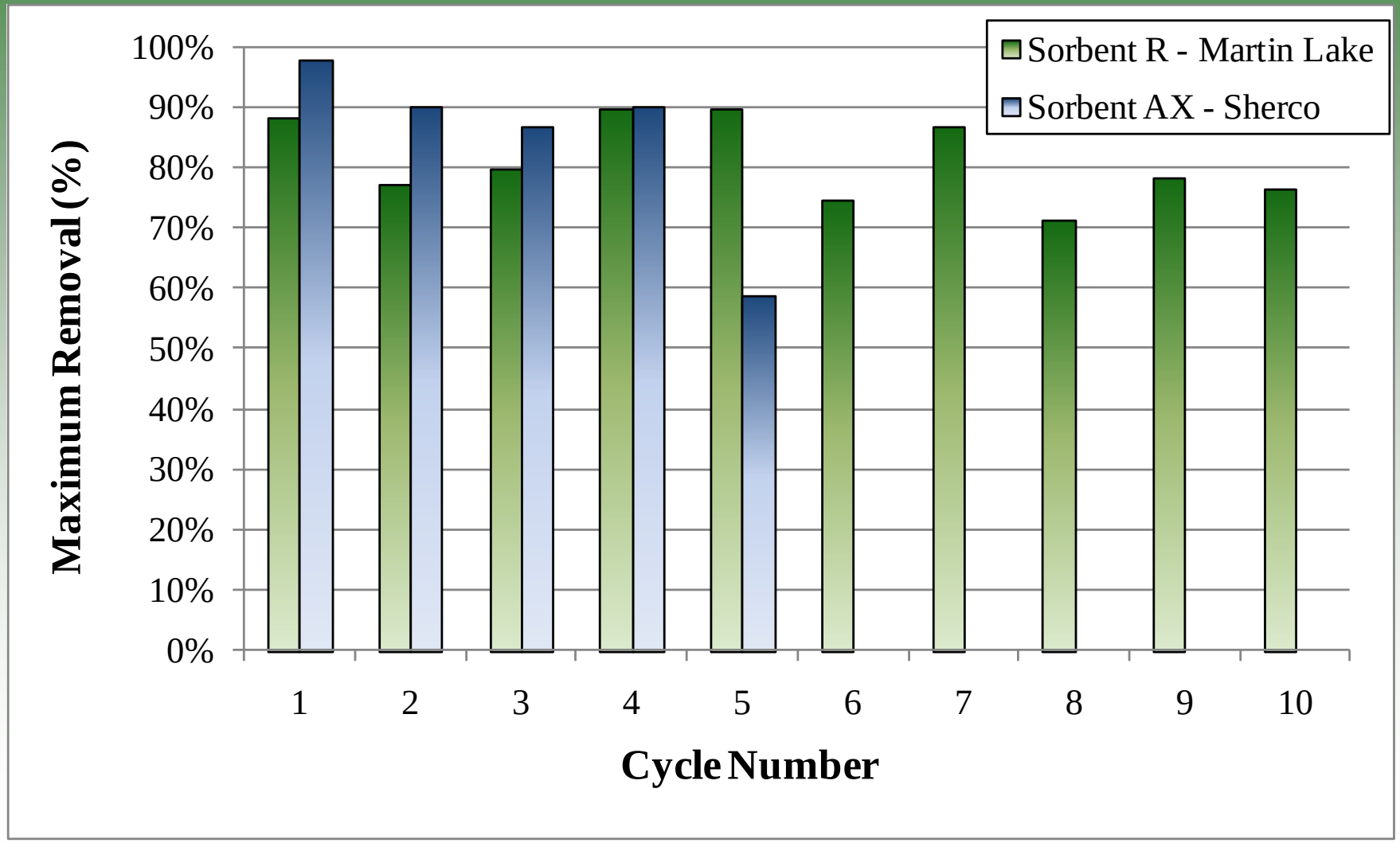


Process concept provided by Southern Company

Challenge with Current Process Design



Performance Comparison



Next Steps

Pilot Phase Project

- Refine 500 MW concept design
- Validate design elements through 1 MW pilot testing
- Focus development to advance towards technical goals while limiting impacts on LCOE
  - Refine process design to exploit key sorbent characteristics
  - Define and characterize the impacts of sorbent physical characteristics
  - Evaluate heat integration and optimization

Next Steps for Solid Sorbents

NETL project DE-FE0004343:

Seeking additional project partners

Creating a Future with Cleaner Coal

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