Evaluation of Solid Sorbents as a Retrofit Technology for CO_2 Capture

DE-FE0004343

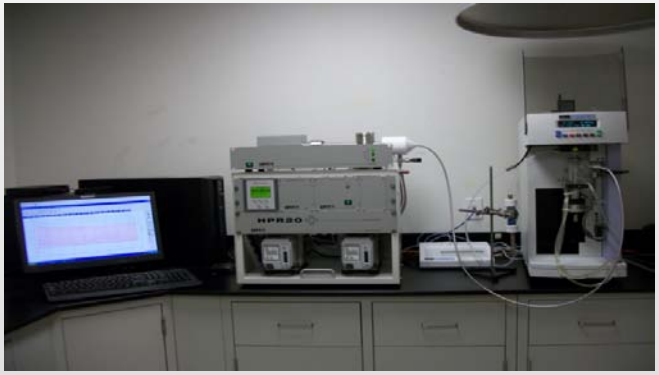
Project Update: July 10, 2012

Presentation Outline

- Background
  - Participants
  - Project Goals
  - Project Overview
- 1 MW Pilot
  - Sorbent Characteristics
  - Contactor Design Selection
  - Host Site Information
  - Project Accomplishments
  - Future Plans

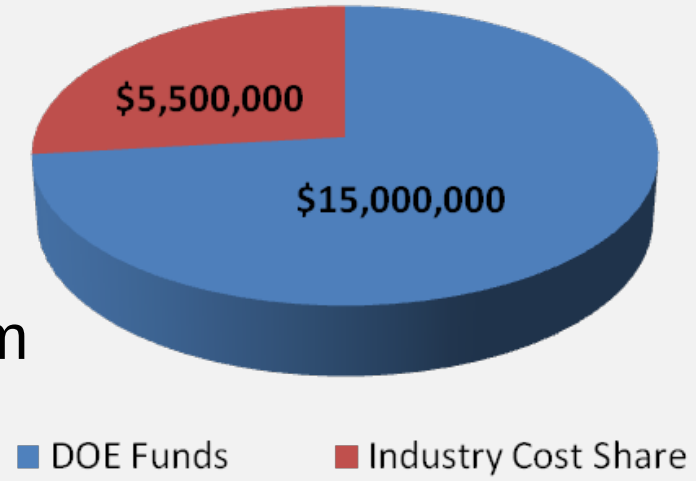
ADA CO_2 Capture Program

- **Phase I – Viability Assessment**
  - Cooperative Agreement: DE-NT0005649
    - Dual Focus: Sorbents & Process
    - 1 kW_e Test Device
- **Phase II – FEED & Pilot Testing**
  - Cooperative Agreement: DE-FE0004343
    - Sorbent Selection & Reactor Design
    - Full-Scale Conceptual Design
    - 1 MW_e Pilot Unit
    - Techno-Economic Assessment
- **Phase III (Demonstration)**
  - Full-Scale Preliminary Design
  - Validate Design (>25 MW_e)



Project Goals

- The overall objective of this funding stage is to validate solid sorbent-based post combustion CO_2 capture through slipstream pilot testing.
- Project Goals:
  - Achieve 90% CO_2 Capture
  - LCOE increase less than <35%
  - Generate a high purity CO_2 stream
  - Successfully scale sorbents



Federal Funding provided by the DOE National Energy Technology Laboratory's Innovations for Existing Plants Program

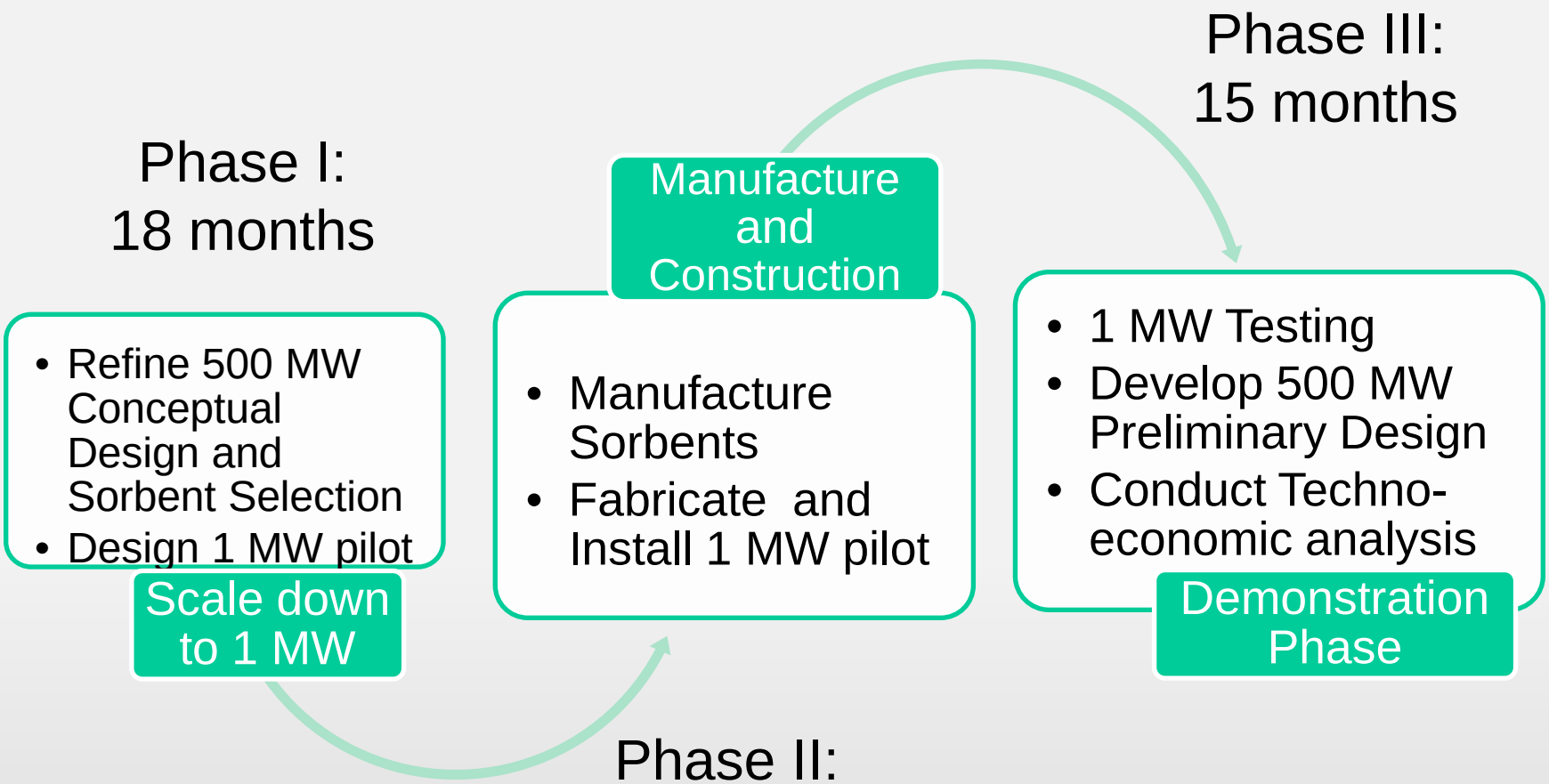
Project Objectives

- Reduction in energy penalty and costs associated with post-combustion CO_2 capture
- Reduction in overall environmental impacts versus other CO_2 capture options
- Reliable operation
- Applicable to retrofit and new builds
- Period of Performance:
  - October 1, 2010 – December 31, 2014

Project Participants

- DOE – NETL
  - Project Sponsor
- ADA-ES, Inc.
  - Project Management
  - Sorbent Evaluation & Selection
  - Conceptual Process Design
  - Techno-Economic Assessment
- Shaw Energy & Chemicals, Inc.
  - Detailed Engineering Services
  - Significant Experience with Fluidized Bed Reactor Design
  - Isothermal and Adiabatic Reactors
  - Single & Multibed Reactors
- Stantec Consulting Ltd.
  - Cost Analysis
  - Plant Integration
  - Owners Engineer Perspective
- EPRI
  - Industry Cost Share
  - Independent Performance Evaluation and Techno-Economic Assessment
- Southern Company
  - Host Site
  - Cost Share
- Luminant
  - Cost Share

Project Budget Period Overview



Potential Benefits of Solid Sorbents

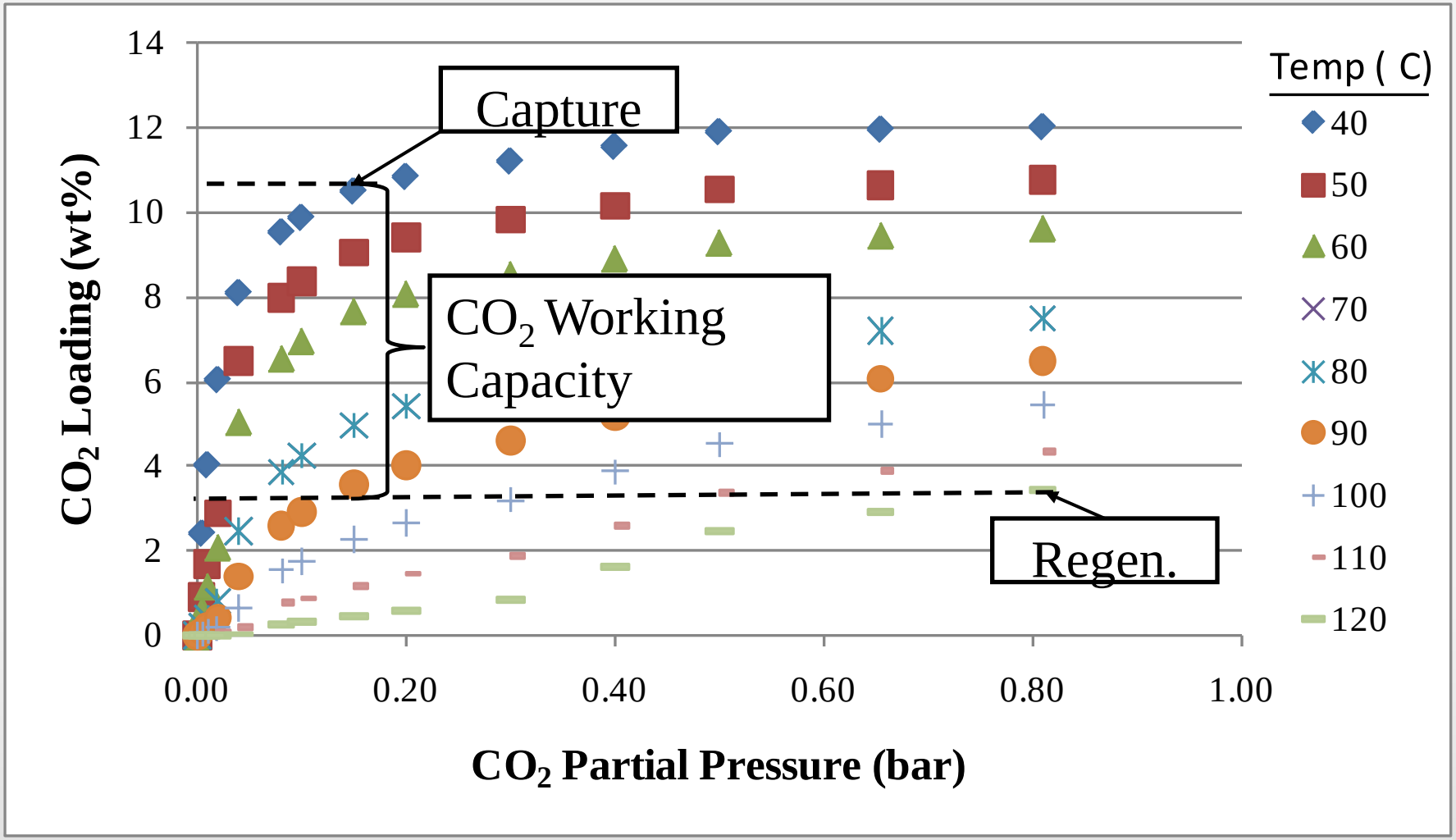
- Energy Penalty
  - Sensible heat requirement is less – although heat recovery should be considered
  - Latent heat of evaporation
- Corrosion
  - Less expensive materials of construction
  - No corrosion inhibitors required
- Air
  - Reduced emissions of amines
- Water
  - Less cooling water required
  - Minimal liquid waste
- Process Flexibility and Operability
  - Can be applied to cycling plant “load following”
  - No risk of foaming or other solvent-related challenges

Sorbent Properties

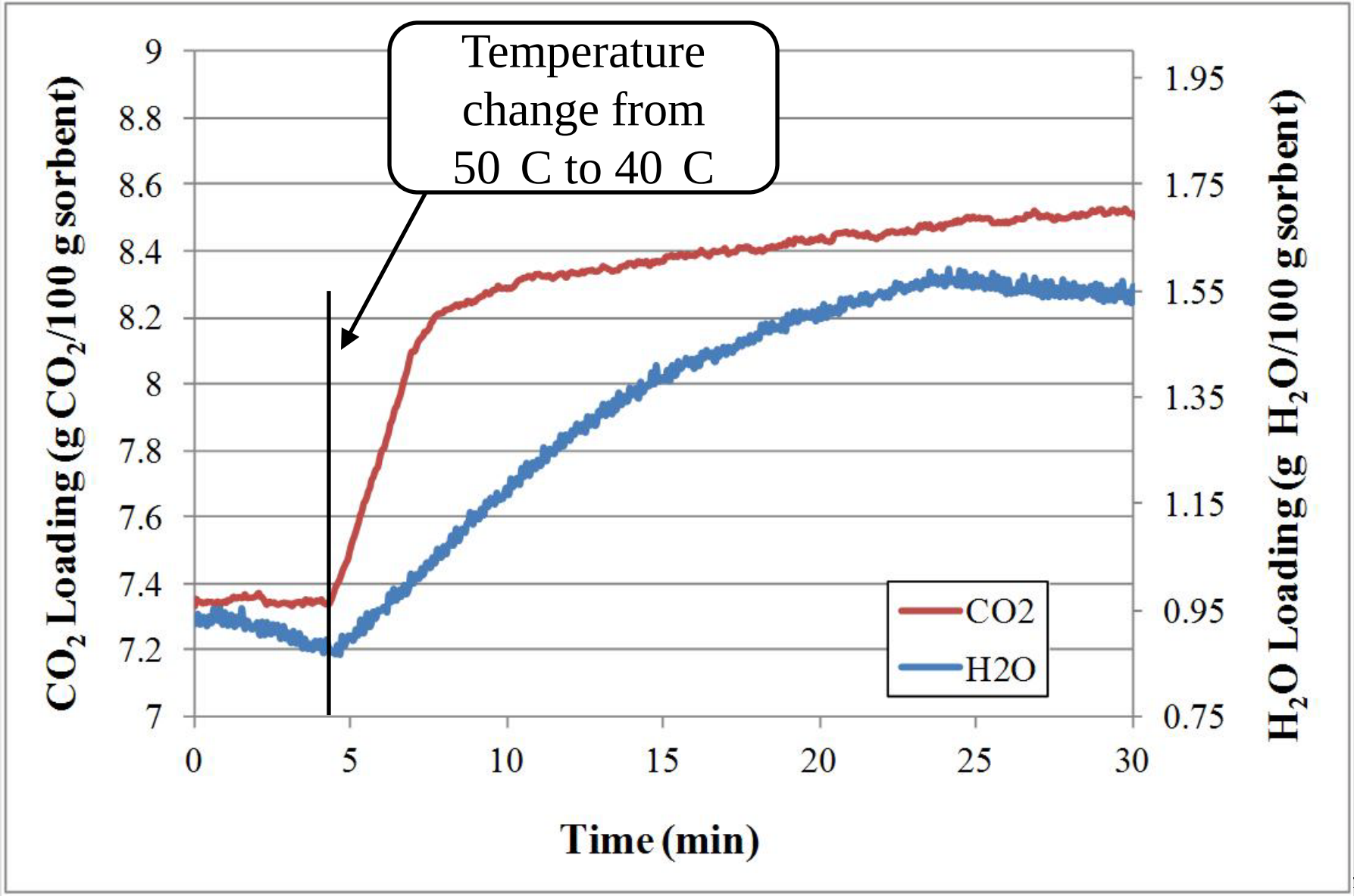
Sorbent Selection

- Selection Criteria
  - Kinetics
  - Higher working CO_2 delta loading
  - Stability
  - Part of a commercial process
  - Experience with changing particle size
  - Potential regeneration after the formation of heat stable salts
- 1MW Pilot Capacity
  - Approximately 5 tons (dry basis) required for operation
  - Batches will have same specifications
  - QC checks through lab scale testing

Sorbent Isotherms



Sorbent Kinetics



1 MW Pilot Design

Design Considerations

- Capital costs
- Gas/solids contacting
- Heat transfer
- Sorbent attrition
- Pressure drop
- Maintenance requirements
- Footprint

Designs Considered

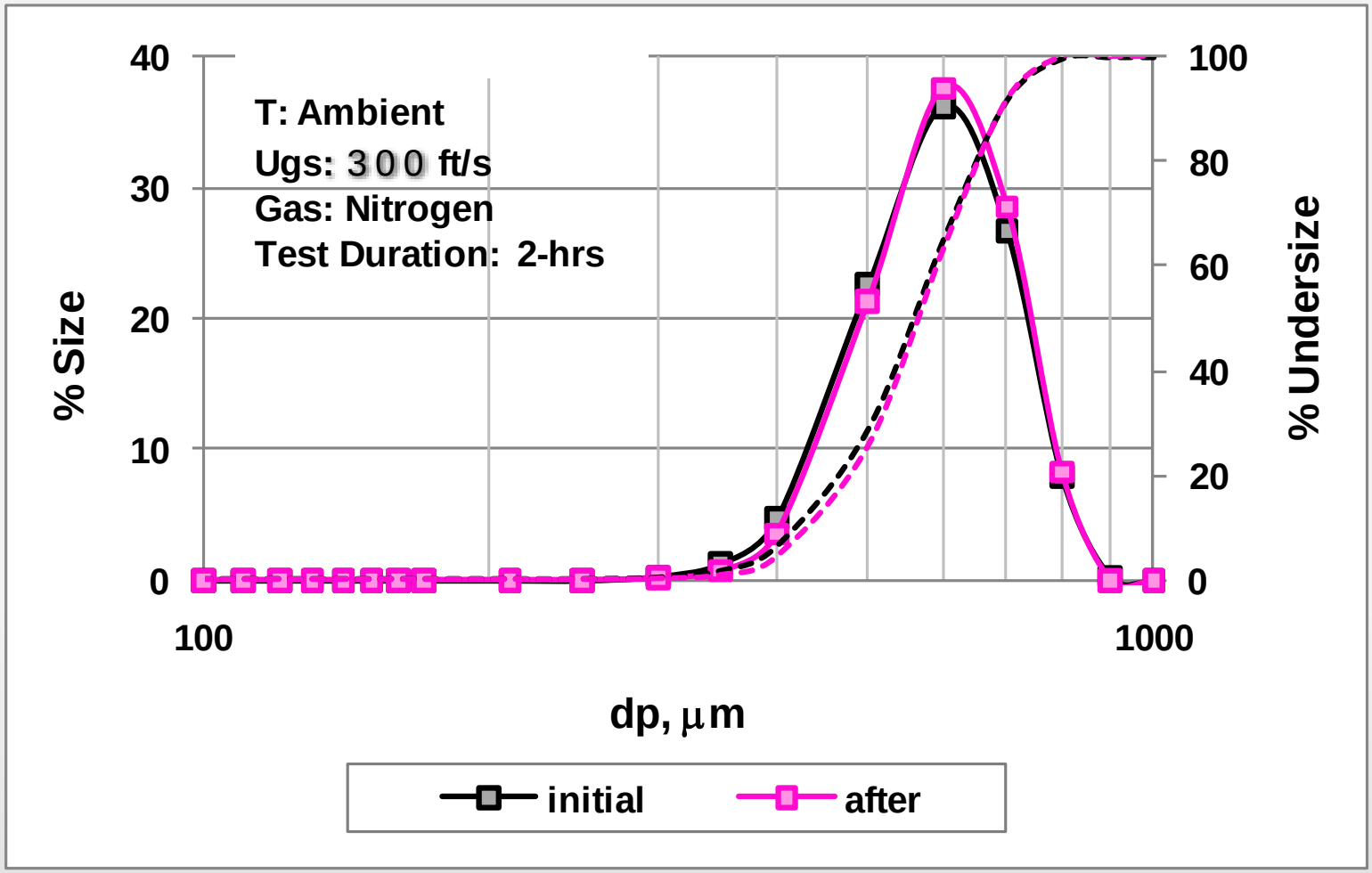
Comparison

- Similar
  - Capital costs
  - Footprint
- Advantage TDR
  - Pressure drop
  - Attrition
- Advantage SFB
  - Gas/solids contacting
  - Heat transfer
  - Commercial design

Fluidization Characterization

- Variables
  - Sorbent particle size
  - Gas velocity: (1-5 ft/s)
- Measurements
  - Fluidization regime
  - Pressure drop (average and fluctuations)
  - Heat transfer coefficient
  - Entrainment rate
- Results
  - Optimized particle size distribution
  - Bed density: 15-30 lb/ft^3
  - Heat transfer coefficient: 65-105 $Btu/hr \cdot ft^2$ F
  - Entrainment flux: provided operation limits

Mechanical Attrition Test Results

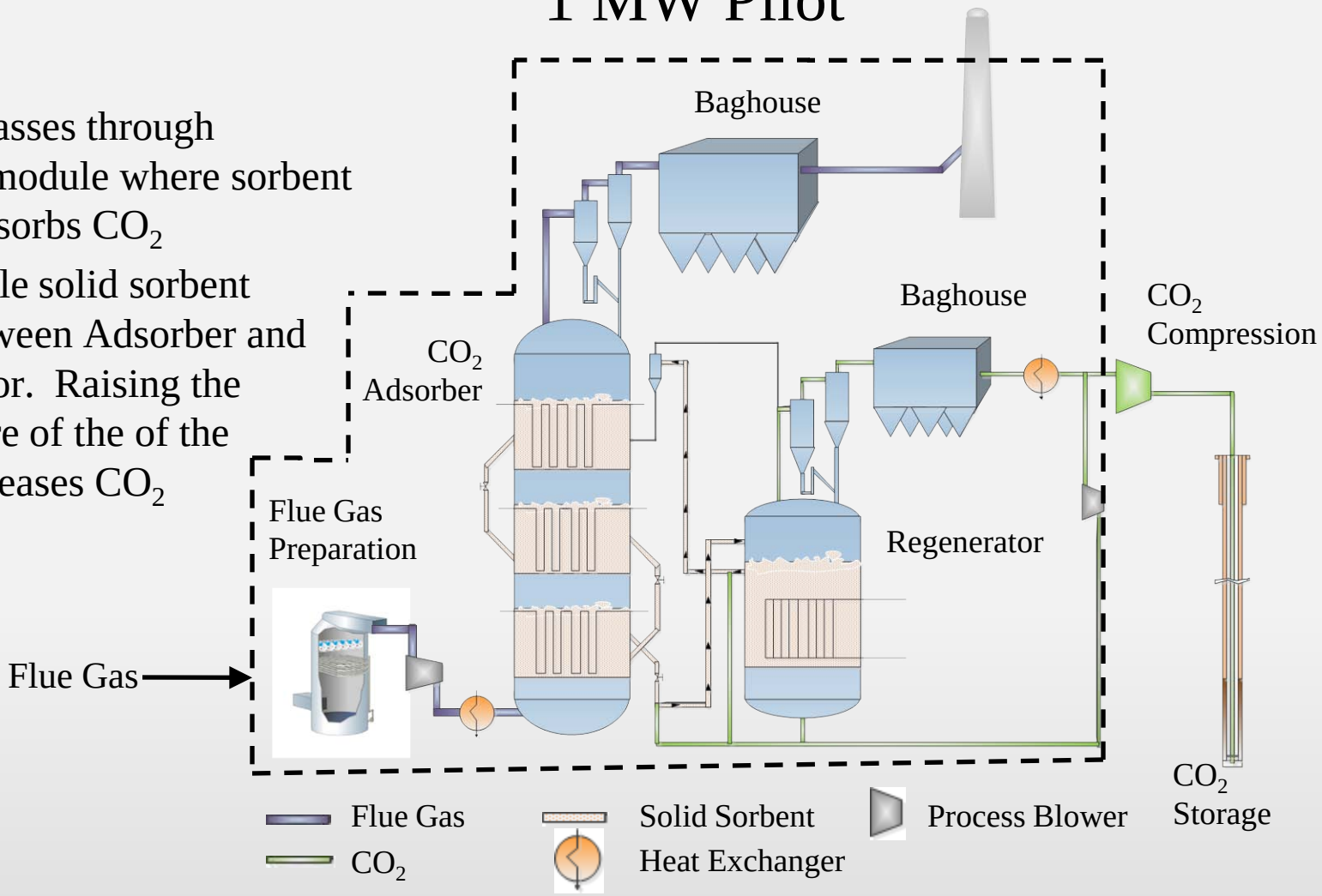


Process Conceptual Design

1 MW Pilot

Principal

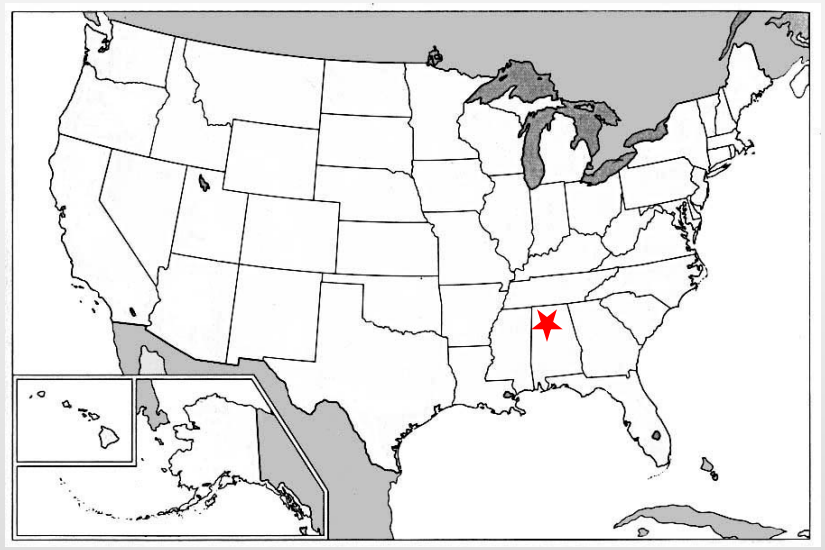
- Flue gas passes through Adsorber module where sorbent particle adsorbs CO_2
- Regenerable solid sorbent cycles between Adsorber and Regenerator. Raising the temperature of the of the sorbent releases CO_2



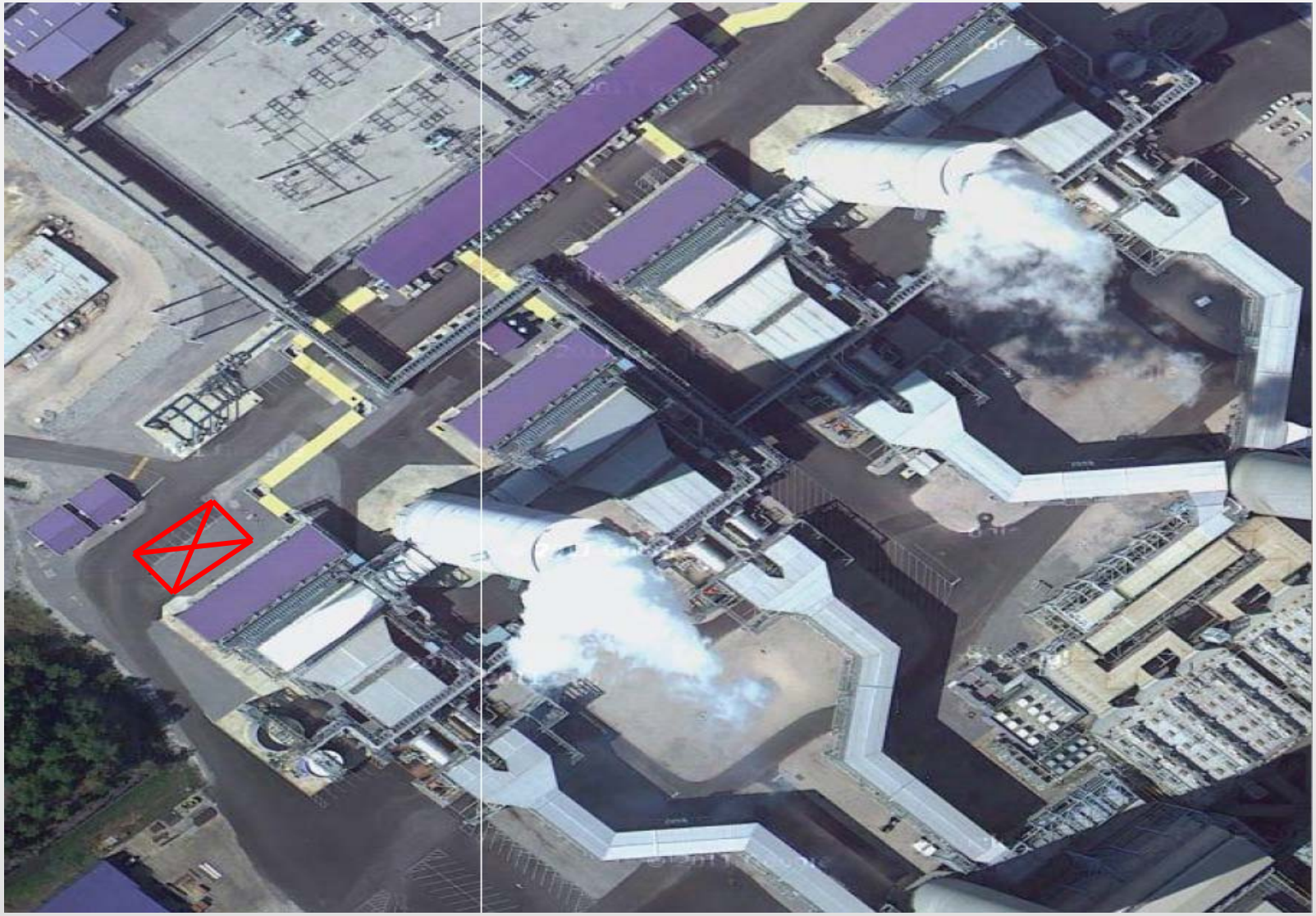
Next Steps: Heat Integration & Optimization

Host Site

- **Host Site:** Southern Company – Alabama Power Co. Plant Miller
  - 4 EGUs (~2,640 MW_e)
  - Flagship Plant
  - PRB Coal
  - WFGD
  - Pilot Located near WFGD on Unit 1

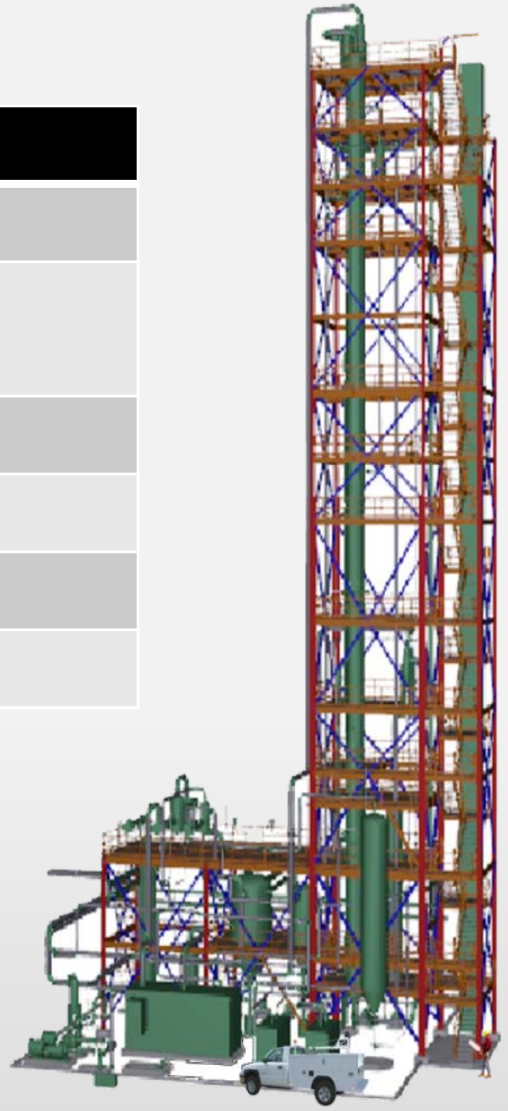


1 MW Pilot Location



1 MW Pilot Project Schedule

Milestone Description	Date
Start site work for 1 MW pilot	4Q12
Substantial completion of mechanical installation SOW	3Q13
Substantial completion of electrical SOW	4Q13
Demonstrate pilot operation	1Q14
Begin continuous performance testing	1Q14
Complete field testing	2Q14



Budget Period 2 Scope

- Procure and Manufacture Sorbents
- Procure and Fabricate Pilot-Scale Equipment
  - Procure Pilot Scale Equipment
  - Finalize Fabrication and Construction Work Packages
  - Equipment and Module Fabrication
- Installation and Startup
  - Host-site Preparation
  - Mechanical Installation
  - Electrical Installation
  - Commissioning/Startup Activities

Budget Period 3 Scope

- Pilot Scale Operation and Evaluation
  - Parametric Testing
  - 60 Day Continuous Performance Test
- Define and Collect Compression and Sequestration Information
- Prepare Commercial Design Specifications
  - Refine Full-Scale Design Specifications
  - Full-Scale Conceptual Engineering Design
  - Conduct Full-Scale System Economic Evaluation
  - Heat Recovery Information

Creating a Future with Cleaner Coal

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