Ninth Annual Conference on Carbon Capture & Sequestration

Capture – Solid Sorbents

Post-combustion CO_2 Control Using Solid Sorbents: Results from 1 kW Pilot Tests

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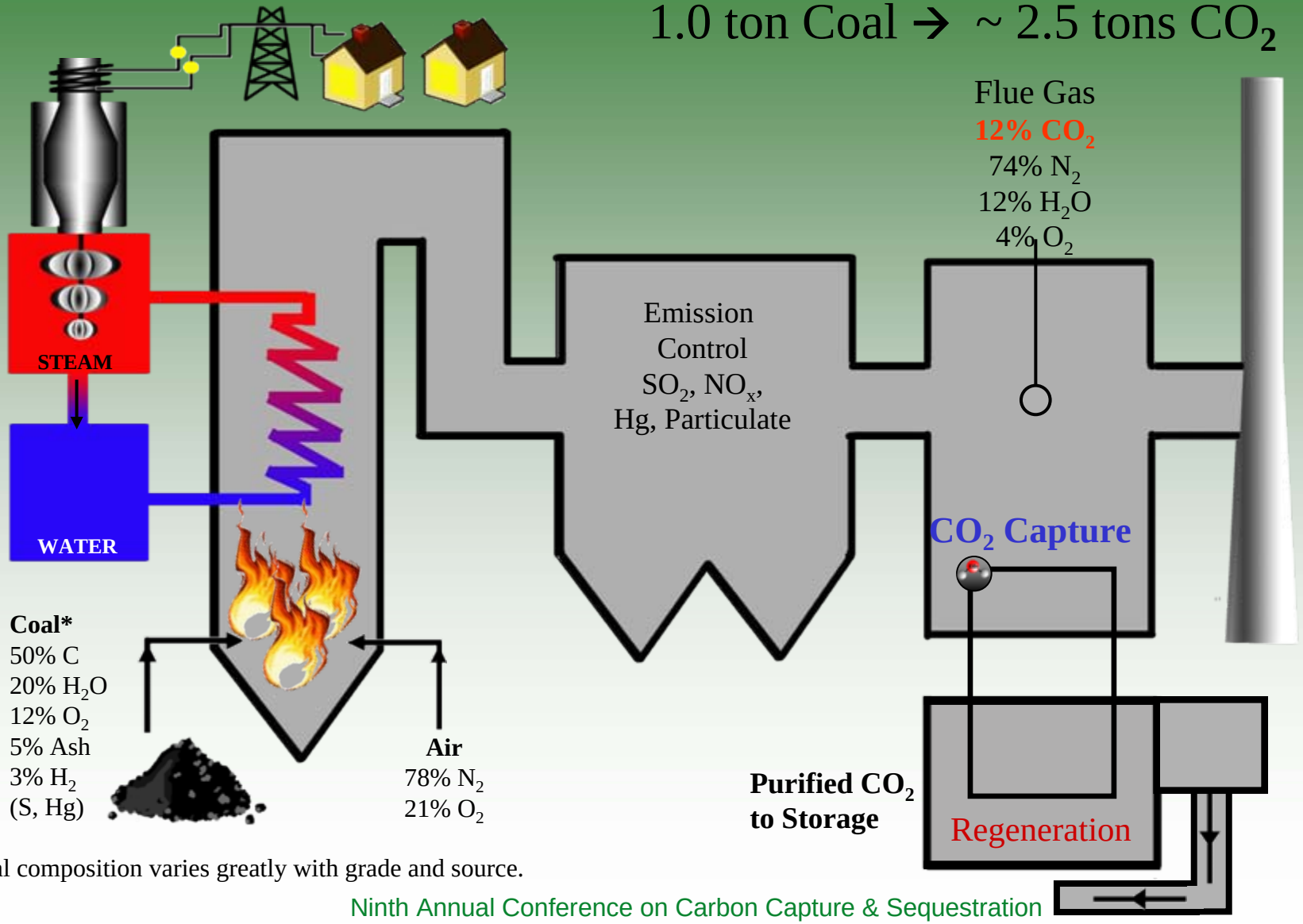
DOE Cooperative Agreement: DE-NT0005649

Post-Combustion CO_2 Capture

1.0 ton Coal → ~ 2.5 tons CO_2



*Coal composition varies greatly with grade and source.

Development Approach

Phase I: Begin with the End in Mind

- Technical
  - >90% CO_2 capture
  - Produce high purity CO_2
  - Scalable Sorbent
  - Scalable Equipment
- 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
      - Sorbent Replacement

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 Conceptual
  - 1MW Detailed

Objective: *Assess the viability and accelerate development of solid-sorbents for CO_2 capture on the existing fleet of coal-fired power plants*

Lab-Scale Focus Areas

- Effect of Moisture
- Effect of Flue Gas Constituents
- Theoretical Regeneration Energy
  - Theoretical RE 700 to 40,000 kJ/kg CO_2
  - Working Capacity: up to 14%
  - $\Delta T_{ads.-regen.}$ 25 to 250°F (15 to195°C)
- Cyclic Stability: up to 260 cycles
- Rate of Reaction (qualitative)

Lab-Scale Status

Goals	Progress to Date
Determine whether solid materials have the desired characteristics	Over 100 materials tested at ADA from 22 different sources
Work iteratively with sorbent developers to improve sorbent properties	Currently evaluating several 2nd and 3rd generation materials with significantly improved properties
Use lab-scale results to select materials for scale-up	Three materials produced in 600 lb quantities based on lab-results. Initial 1kW slipstream tests underway.

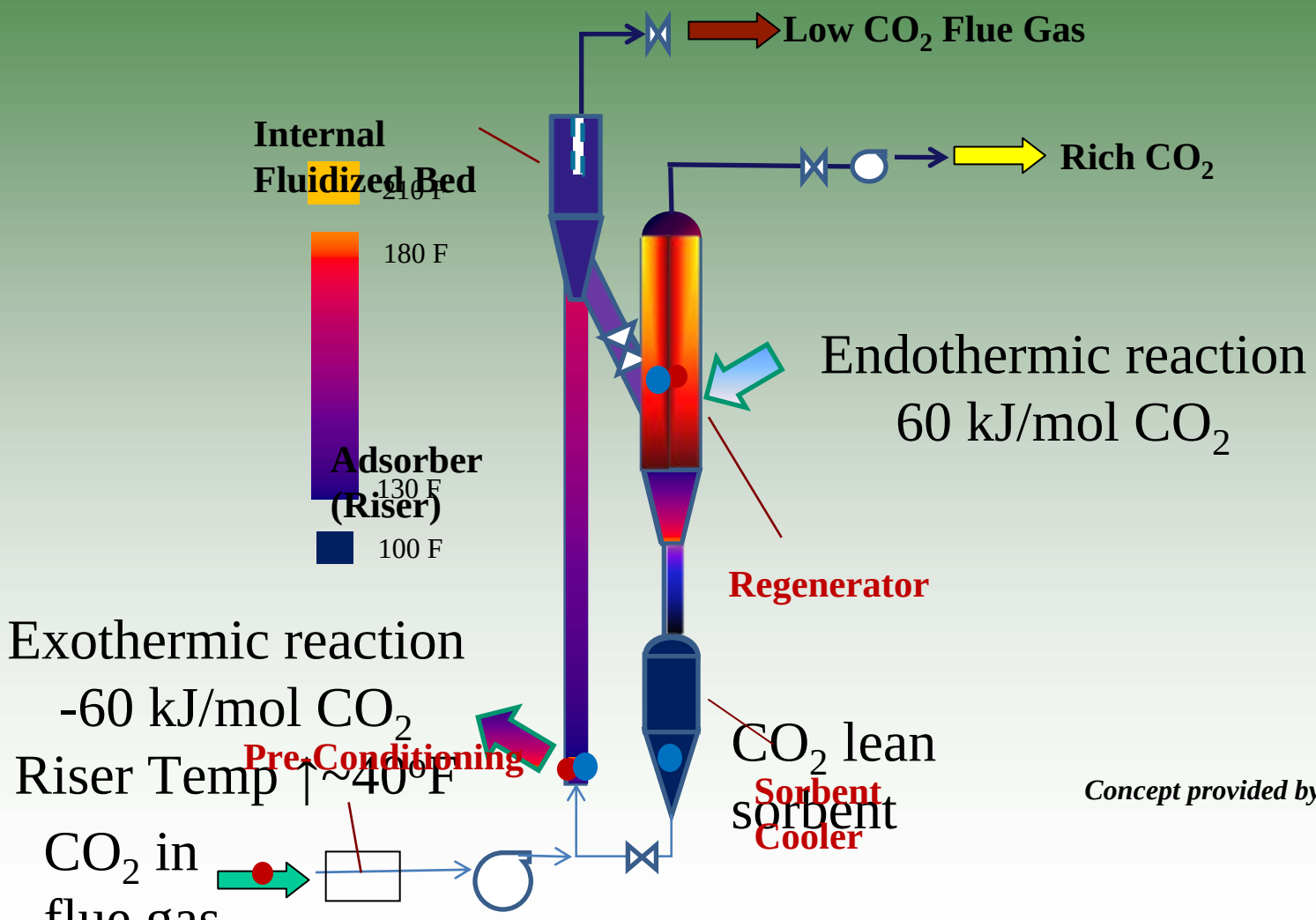
Lab-Scale Screening Results: Summary

	Supported Amines	Carbon	Zeolites	Carbonates
Working Capacity	High	Low	Low	High
TRE* *(vs aq. MEA)*	Lower	Similar	Higher	Similar
Thermal Stability	Low	High	High	High
Thermal Management				Challenging
Issues	SO_2	Capacity	Moisture	SO_2 High HR*

** TRE = Theoretical Regeneration Energy, HR = Heat of Reaction*

1kW Slipstream Evaluations

1 kW Pilot



Concept provided by Southern Company

1 kW Results

- ✓ > 90% capture achieved
- ✓ ~ 6% working capacity achieved without removing heat of reaction
  - ➢ 10 to 12% capacity expected at lower temperatures
- ✓ Fast Reaction
  - ➢ Maximum temperature measured at < 1 sec. residence time

1kW Next Steps

- Characterize improvements to sorbent capacity while removing heat from reaction
- Improve operation of regenerator
- Complete evaluations of 3 materials at Site 1
  - Lignite/PRB Blend, Wet Scrubber
- Move system to Site 2 (Target July)
  - PRB fuel, Dry Scrubber

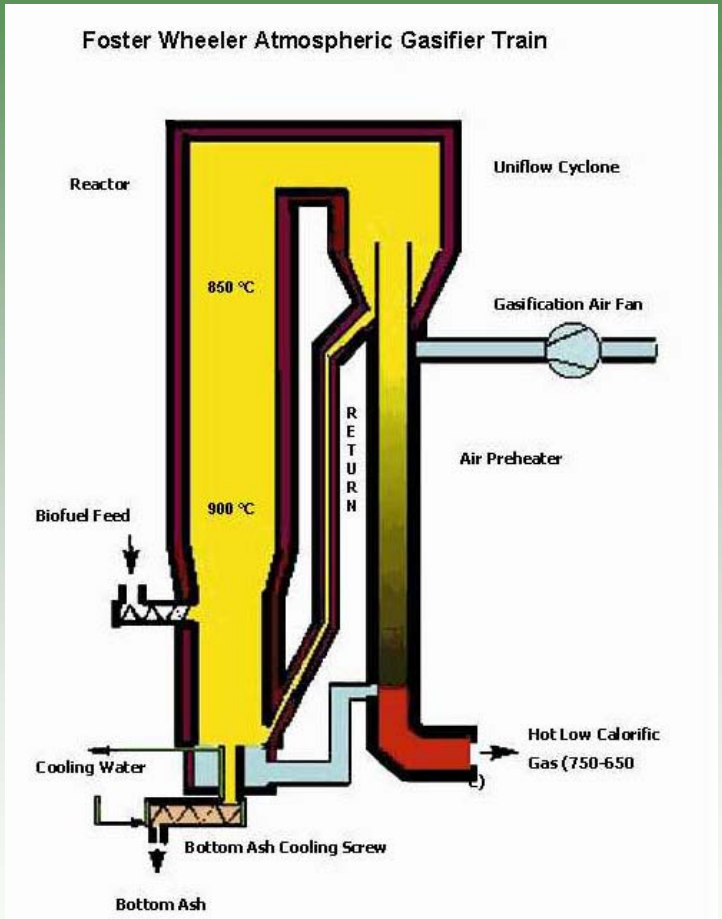
Full-Scale Concept Development: Status

- Technology Survey and Selection Completed
  - Adsorption Technologies
  - Heat Transfer Technologies
  - Materials Handling Technologies
  - Desorption Technologies
- Preparing Concept Design with Economics for 500 MW Retrofit

Supported by Stantec

Adsorption Option: Transport Reactor
Example: Riser design similar to CFB Boiler

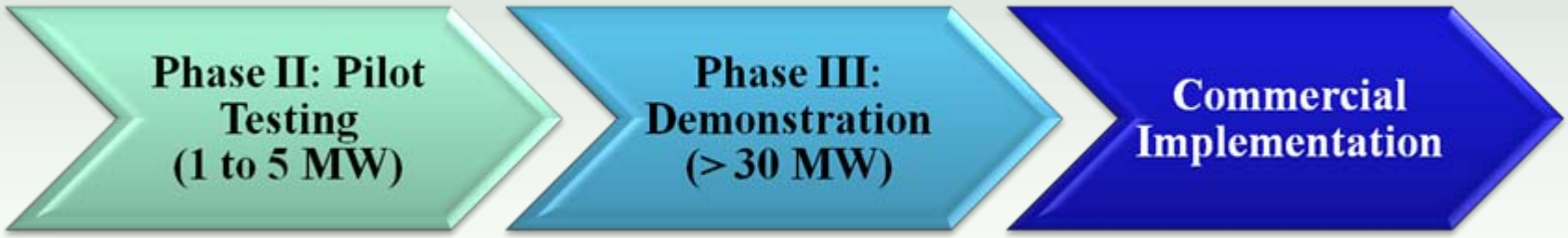
- 460 MW
  - Lagiza Power Plant , Poland
    In Service July 2009
  - Foster Wheeler Design
  - 35’ x 90’ fluidized bed
  - Boiler Feed: 360 kg/s
    (1,700 ton/hr)
- 600 MW design offered today
- 800 MW expected by 2010
- **Estimate for 300 MW CO_2**
  Riser: 17’ x 50’ x 45’ tall



http://www.power-technology.com/projects/lagisza/

Summary

- Solid sorbents are a promising option for post-combustion CO_2 capture
  - Lower energy requirements than aqueous MEA
  - Higher CO_2 capacity than MEA
  - Scalable Sorbent
  - Scalable Process



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

DOE Cooperative Agreement: DE-NT0005649

Creating a Future with Cleaner Coal

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