Carbon Utilization and the National Carbon Capture Center

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Southern Company

October 22, 2020
National Carbon Capture Center

- **Sponsors**: U.S. Department of Energy and its National Energy Technology Laboratory
  - DOE’s primary carbon capture research facility since 2009
- **Partners**: Electric Power Research Institute, power/energy industry leaders
- **Managed/operated by**: Southern Company
- **Location**: Wilsonville, Alabama
- **Infrastructure**: Real-world power plant operating conditions – coal and natural gas
- **Expertise**: Technical staff for design, installation, testing support and analysis
- **International collaboration**: Co-founder of International Test Center Network
Major Accomplishments and Future Scope

- 110,000+ test hours of testing over last decade
- 60+ technologies tested / developers from 7 countries
- Post-combustion accomplishments:
  - Continuous expansion – alternative regeneration, gas injection, analytical support
  - Advanced solvents, membranes, solid sorbents
    - 16 technologies in queue to test / 7 technologies scaled up (or ready) to 10+ MW

Reduced cost of CO₂ capture from fossil generation by 1/3

Oct. 1, 2020 – 5-Year Agreement Renewal / $140 Million
Expanding scope to CO₂ capture for natural gas power, CO₂ utilization, direct air capture
Utilization Capabilities

Test Bay Configuration

Flue Gas from Gaston Unit 5 FGD Outlet
Flue Gas from Natural Gas Boiler

Pre-Scrubber
Air Dilution System
Blower

To FGD Inlet

Bench-Scale Units
0.4 MWe; 4,000 lb/hr
Bay 1
Bay 2
Bay 3
Bay 4

PSTU
0.5 MWe; 5,000 lb/hr

SSTU
0.05 MWe; 500 lb/hr

Pilot Bay 2
1 MWe, 10,000 lb/hr
Pilot Bay 3
1 MWe, 10,000 lb/hr
LSTU
0.005 MWe; 50 lb/hr

To NG Flue Gas Stack

Test Bays

Lab-Scale
Indoor, tabletop-size units

Bench-Scale
Outdoor units up to ~15’ x 25’

Pilot-Scale
Outdoor units up to 50’ x 75’
Exploring CO₂ Utilization Technologies at NCCC

- NCCC is a preferred host site for DOE utilization research funding opportunities
- NCCC is engaging developers in a variety of utilization technology areas
  - CO₂ conversion to biomass via agriculture/aquaculture
  - Synthesis of fuels and organic chemicals
  - Conversion of CO₂ to inorganic products, i.e., construction materials
  - Synthesis of inorganic materials and chemicals
  - CO₂ as working fluid for EOR and as solvents and refrigerants
Potential CO$_2$ Utilization Infrastructure Additions

• Three possible scopes:
  1. Captured CO$_2$ header
  2. Captured CO$_2$ header with CO$_2$ gas storage
  3. Captured CO$_2$ header with CO$_2$ liquid storage

• Scopes 1-3 increase flexibility of CO$_2$ supply for utilization projects, but obviously increase cost as well

• Also evaluating possibilities of pairing capture and utilization projects that have synergies
## Current CO₂ Utilization Demonstration Projects at NCCC

<table>
<thead>
<tr>
<th>Southern Research</th>
<th>Carbon Upcycling UCLA</th>
<th>Helios-NRG</th>
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<tbody>
<tr>
<td>Ethylene production using coal-fired flue gas</td>
<td>CO₂ mineralization to produce concrete</td>
<td>Algae technology to utilize CO₂ for value-added products</td>
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<tr>
<td>• Thermo-catalytic process</td>
<td>• Convert waste gas into pre-cast concrete building components</td>
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<td>• Uses nanoengineered low-cost catalyst</td>
<td>• Potential for utilization of off-spec fly ashes</td>
<td>• Grow dense populations of algae quickly while capturing 70%+ of CO₂</td>
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<td>• Advantages over commercial steam</td>
<td>• CO₂ utilization into concrete without CO₂ capture step</td>
<td>• Utilize algae products to reduce overall CO₂ capture cost</td>
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<tr>
<td>• Co-production of CO-rich syngas</td>
<td>• Carbon XPRIZE finalist</td>
<td>• Advance DeAqua technology for dewatering</td>
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<td>• Validate capture efficiency</td>
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SR SOUTHERN RESEARCH  
UCLA  
Helios-NRG, LLC
Potential Benefits of Testing DAC Technologies at NCCC

- Existing balance of plant infrastructure, i.e., steam/heat, cooling water, electricity, etc.
- Existing analytical support and equipment
- Existing permitting in place
- Capability to test both DAC and capture from concentrated sources (or hybrid concepts)
- Experienced design, engineering, O&M and support personnel to assist in technology scale-up, process and infrastructure modifications, test operations, troubleshooting, and evaluation.
Thank You