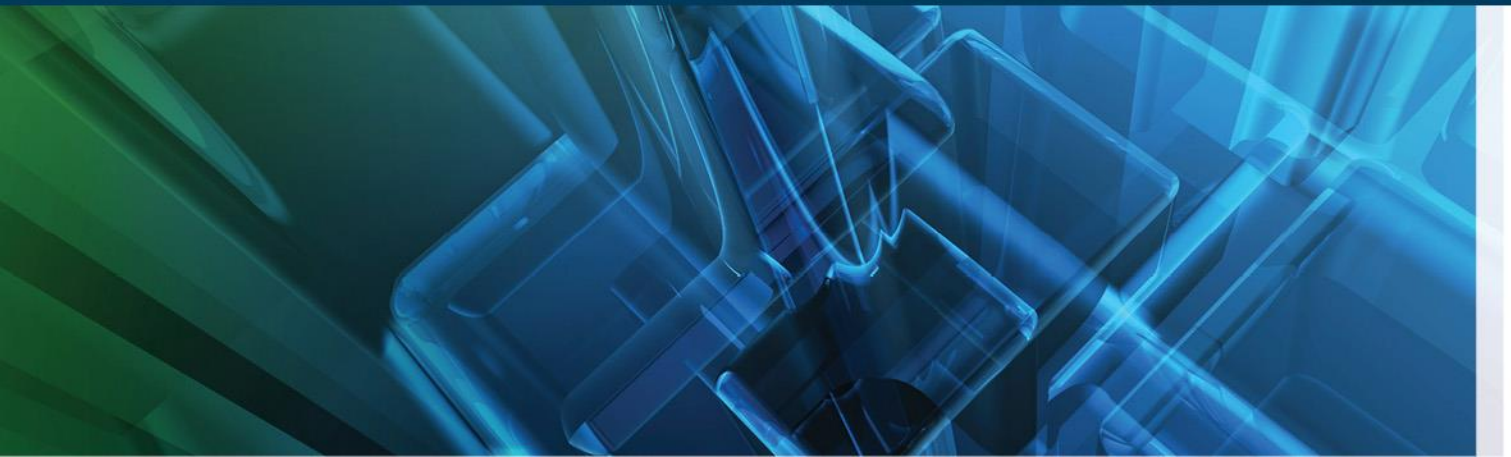
Advancing Fossil Energy Technology Solutions at the National Carbon Capture Center

John Northington – Assistant Director



NATIONAL CARBON CAPTURE CENTER

National Carbon Capture Center (NCCC)

- **Location:** Wilsonville, Alabama
- **Sponsors:** U.S. Department of Energy and its National Energy Technology Laboratory
- **Partners:** Electric Power Research Institute, power and coal industry leaders
- **Managed by:** Southern Company

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Southern Company

AMERICAN ELECTRIC POWER BOUNDLESS ENERGY

CLOUD PEAK ENERGY

DUKE ENERGY

CLEARPATH

Our Mission and Values

Offering a **world-class neutral** test facility and highly specialized staff to **accelerate the commercialization** of advanced technologies and enable coal-based power plants to achieve **near-zero emissions (low-cost CO_2)**.

Safety First

Unquestionable Trust

Superior Performance

Total Commitment

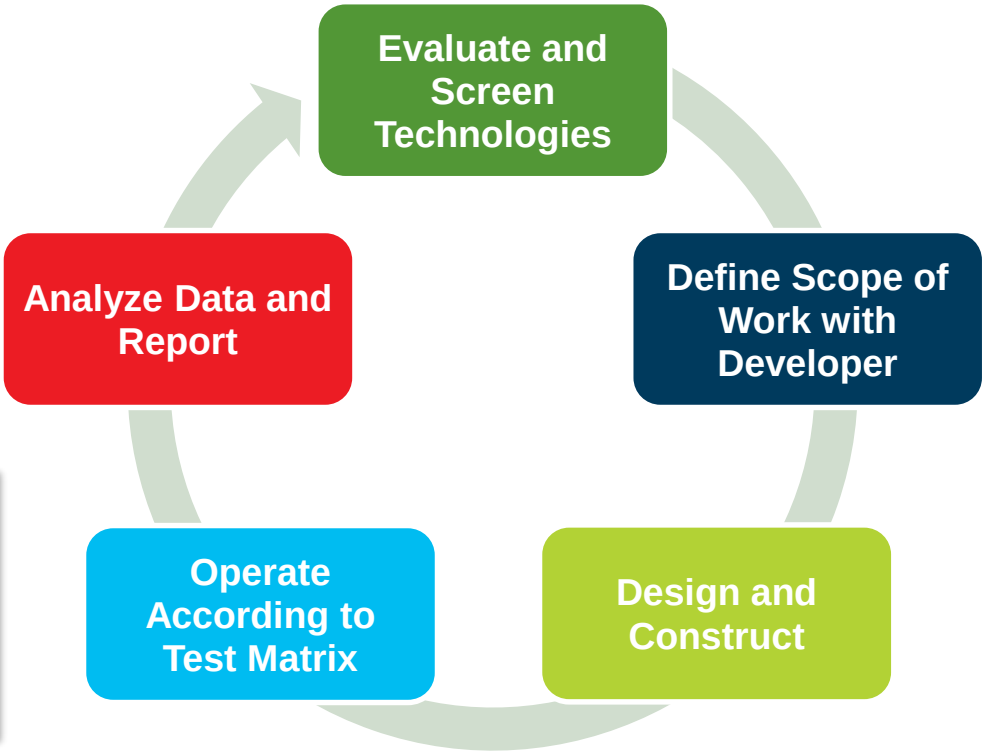
What the Project Provides

- **Cost-efficient test site** with **infrastructure** for numerous technology developers
- **Real-world conditions** with coal-derived flue gas
- Flexible capability for testing at **multiple scales** and **on-site scale-ups**
- Expert **technical staff** for design, installation and testing support
- High-quality **data acquisition** and gas/liquid **sampling and analysis**

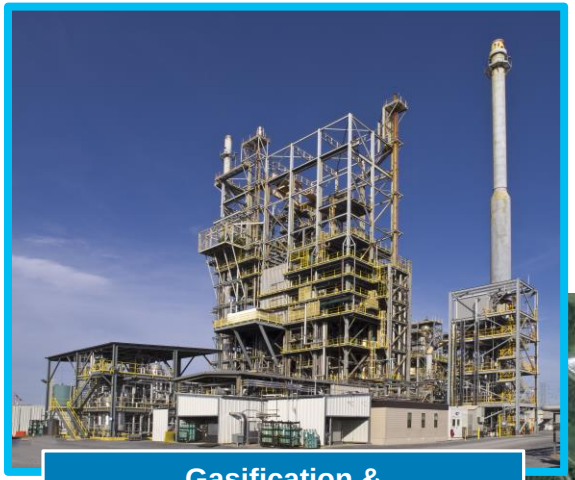
Accomplishments

- Over **98,000 test hours** since founding in 2008
- Technology developers from the **U.S. and six other countries**
- **First coal-derived gas testing** of solid oxide fuel cells and certain solvents, membranes and enzymes
- On-site **scale-ups** and **process enhancements** for 10 technologies
  - Scale-ups for testing at larger sites for five solvents
  - Scale-up to commercial operation for one solvent
- **Full compliance** with all regulations, including on-time submittal and publication of technical reports

Technology Development Process



Test Sites



Gasification &
Pre-Combustion Carbon Capture

Post-Combustion Carbon
Capture Center (PC4)

Gasification and Pre-Combustion Accomplishments

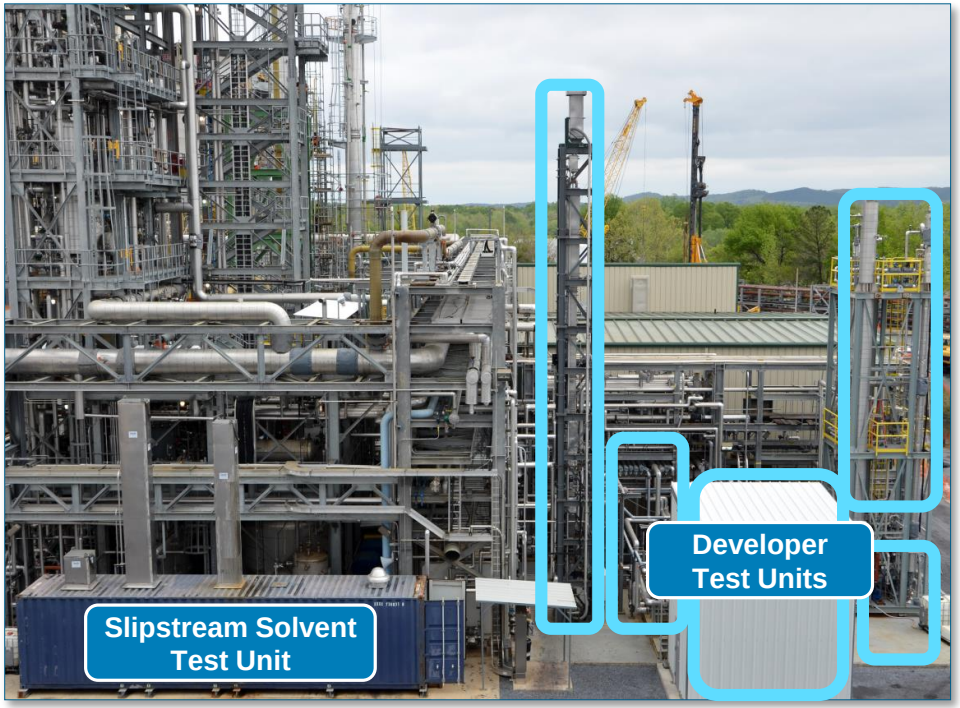
- Gasifier operation supported over 50,000 hours of technology testing
  - Biomass gasification in air- and oxygen-blown operation
  - Sensors: Tunable Diode Laser, particulate monitor, thermowells, coal feeder instrumentation
  - Catalysts: Fischer-Tropsch, water-gas shift, and COS hydrolysis
  - Sorbents: trace metals, CO_2, ammonia
  - Membranes: hydrogen and CO_2
  - Advanced processes: ammonium carbonate/bicarbonate solvent, syngas chemical looping, pressure-swing adsorption, pressure-swing Claus
  - Fuel cells
- Additional operation with CO_2 solvents – on-line and off-line
- Achieved scale-ups and process intensification for several technologies

Recent Developer Testing

Developer	Technology
The Ohio State University	Chemical Looping
MTR Membrane Technology & Research	Hydrogen Membranes
Media and Process Technology	Hydrogen Membranes
SR Southern Research	Coal-To-Liquids
	Syngas Reformer
SRI International	PBI Membrane
TDA Research	0.1 MWe Sorbent System
WGS & COS Developer	WGS
	COS

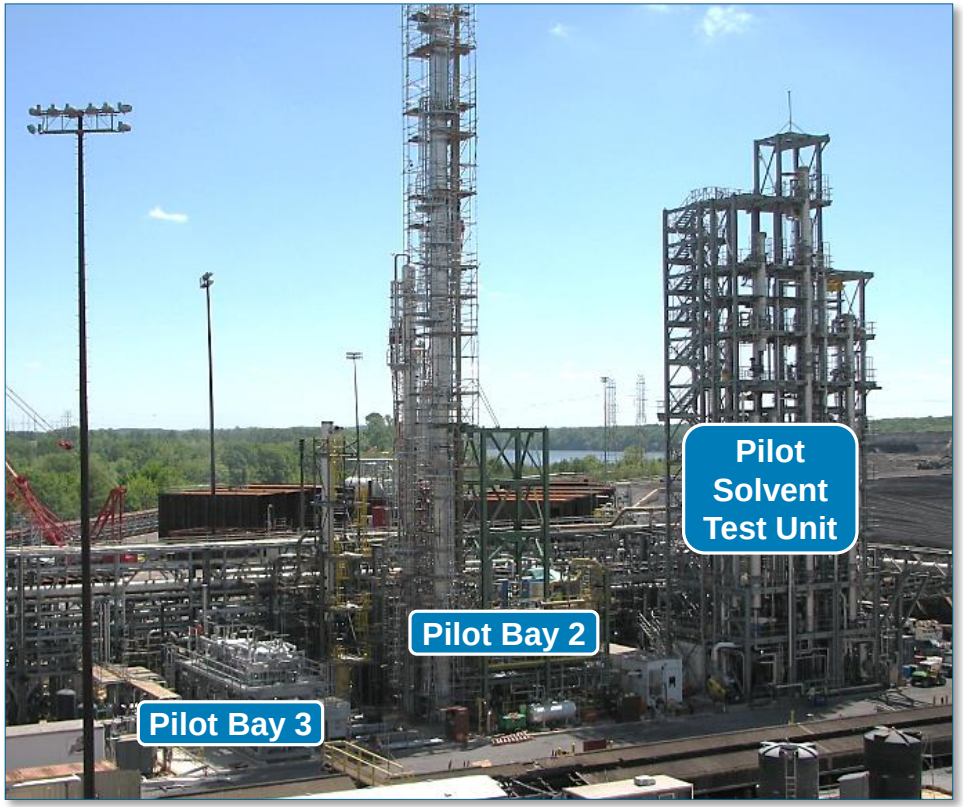
PC4 Bench-Scale

- Simultaneous operation of up to five developer test units
- Slipstream Solvent Test Unit (SSTU) for solvents in early development
- SSTU also used for solvent emissions studies, emission mitigation processes
- Flue gas/utilities and gas analysis systems operating independently of PC4 pilot-scale area



PC4 Pilot-Scale

- Simultaneous operation of developer test units and Pilot Solvent Test Unit (PSTU)
- PSTU offers flexible operation to match developers' planned commercial configuration
- PSTU also supports solvent emissions and degradation studies



Post-Combustion Accomplishments

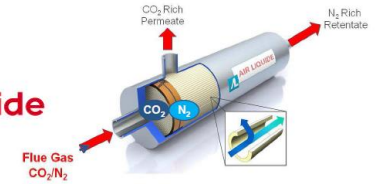
- **PC4 operation supported over 49,000 hours of technology testing**
  - Over 6,000 hours under natural gas conditions
  - More than 20 developer projects completed
  - Tested enzymes, membranes, sorbents, solvents, and associated systems
  - Continued relationship with technology developers to achieve scale-ups and process enhancements
- **PSTU operation for over 15,000 hours**
  - Demonstrated near 100% mass and energy balance closures
  - Supported commercial developers and DOE Carbon Capture Simulation Initiative
  - Several solvents progressed to further testing at other facilities
- **Facility construction and upgrades**
  - Plant capacity more than doubled from 12,000 to 30,000 lb/hr flue gas
  - Added systems (SSTU, air dilution, etc.) and enhanced instrumentation, sampling methods, and analysis systems

Recent/Upcoming Tests

- PSTU MEA Baseline
  - Supported DOE-NETL's Carbon Capture Simulation for Industry Impact
- Air Liquide
  - Hollow fiber membrane
  - Cold operation
  - Improved separation (minimum sacrifice to CO_2 permeance)
- GTI Hollow Fiber Membrane Contactor
  - Abs: aMDEA/membrane contactor
  - Regen: Steam/flashing
- Trimeric/UT NOx Reduction
  - Chemical additives to pre-scrubber
- AECOM PZ/AFS
  - 5M PZ in PSTU
  - AFS-Adv. flash stripper & PSTU simple stripper
- TDA Sorbent
  - Alkalized alumina sorbent
  - Fixed-bed, isothermal
  - Regen: steam

CCSI²

Air Liquide



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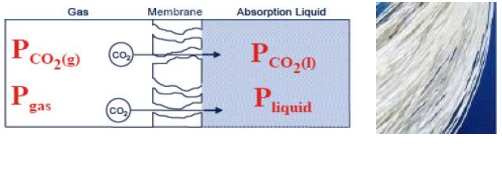
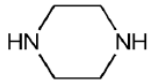
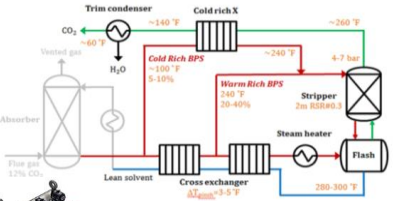


TEXAS
The University of Texas at Austin



PZ (Piperazine)



TDA Research

NCCC Active Internationally

International Collaboration

- Support DOE goal of international cooperation
- Multiple paths for involvement; partners, developers, network members and workshops
- Ease of collaboration since intellectual property is not being shared
- Broad effort China, India, Middle East, Korea, Japan, EU, Australia, Canada, Norway

ITCN

- Share pubic knowledge with 13 carbon capture test facilities
  - Facility operations
  - Facility funding
  - Safety
  - Analytical techniques
- Collaborate on one technical item per year

Carbon Capture is an international issue that requires international solutions

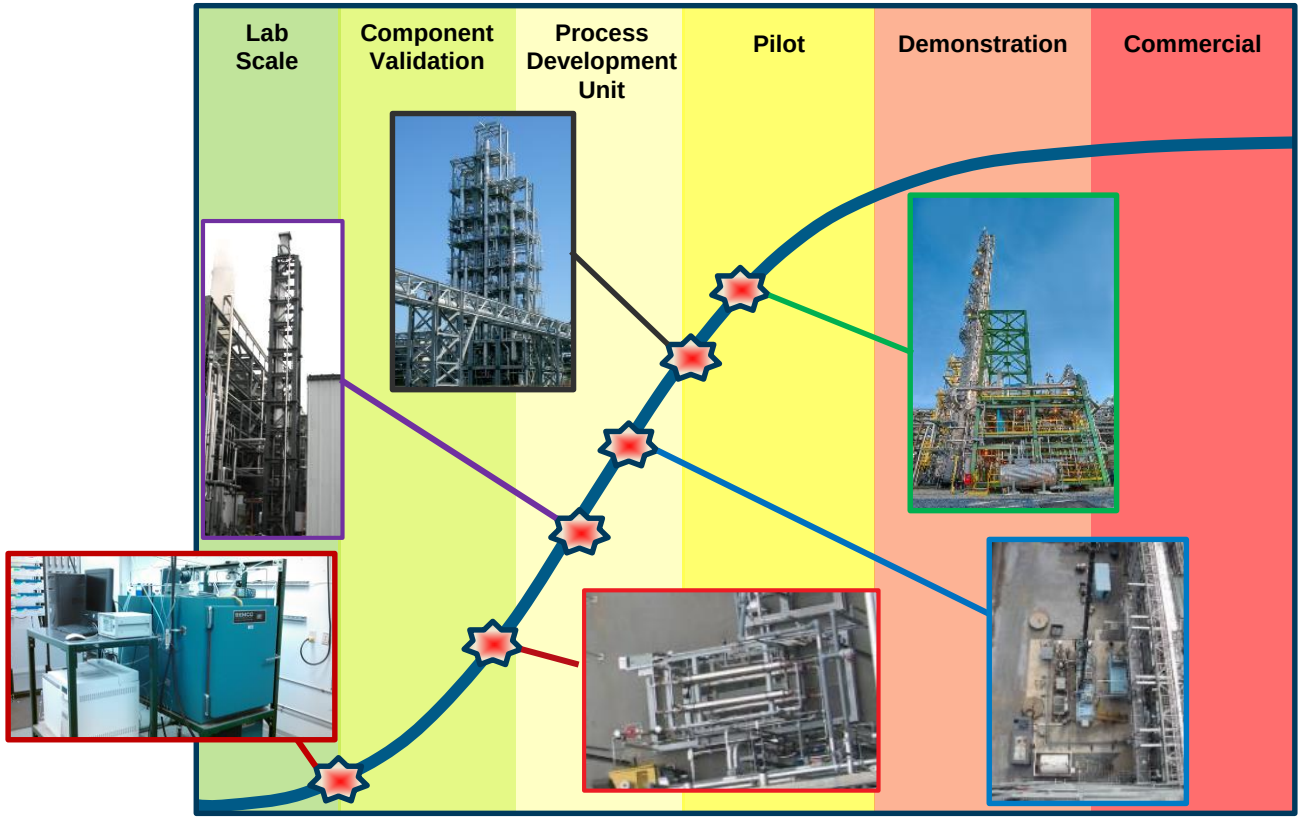






International Test Center Network Members

Successful Testing and Partnerships



More information

www.nationalcarboncapturecenter.com

https://twitter.com/NCarbonCaptureC