Tenth Annual Conference on Carbon Capture & Sequestration

General Capture

National Carbon Capture Center Status

John Wheeldon, EPRI
(on loan to NCCC)

May 2-5, 2011 • David L. Lawrence Convention Center • Pittsburgh, Pennsylvania

National Carbon Capture Center at PSDF

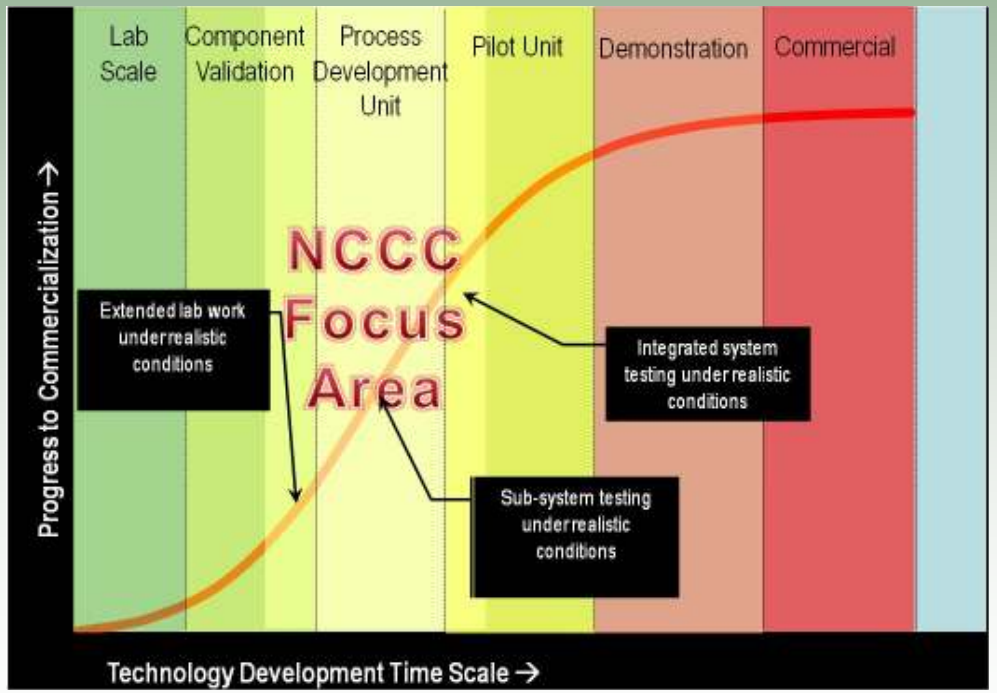
- Power Systems Development Facility set up by US DOE to lead development of coal-based generation technologies with improved efficiency.
- Initiated in1993, started combustion testing June 1996 and gasification Sept. 1999.
- DOE funds 80% with co-funding by industrial partners.
- Project managed by Southern Company.

- May 2009 PSDF transitioned to the NCCC but still funded by DOE with industrial partners.
- Now supporting activities to develop more efficient and cost-effective CO_2 capture technologies for flue gas and syngas applications.

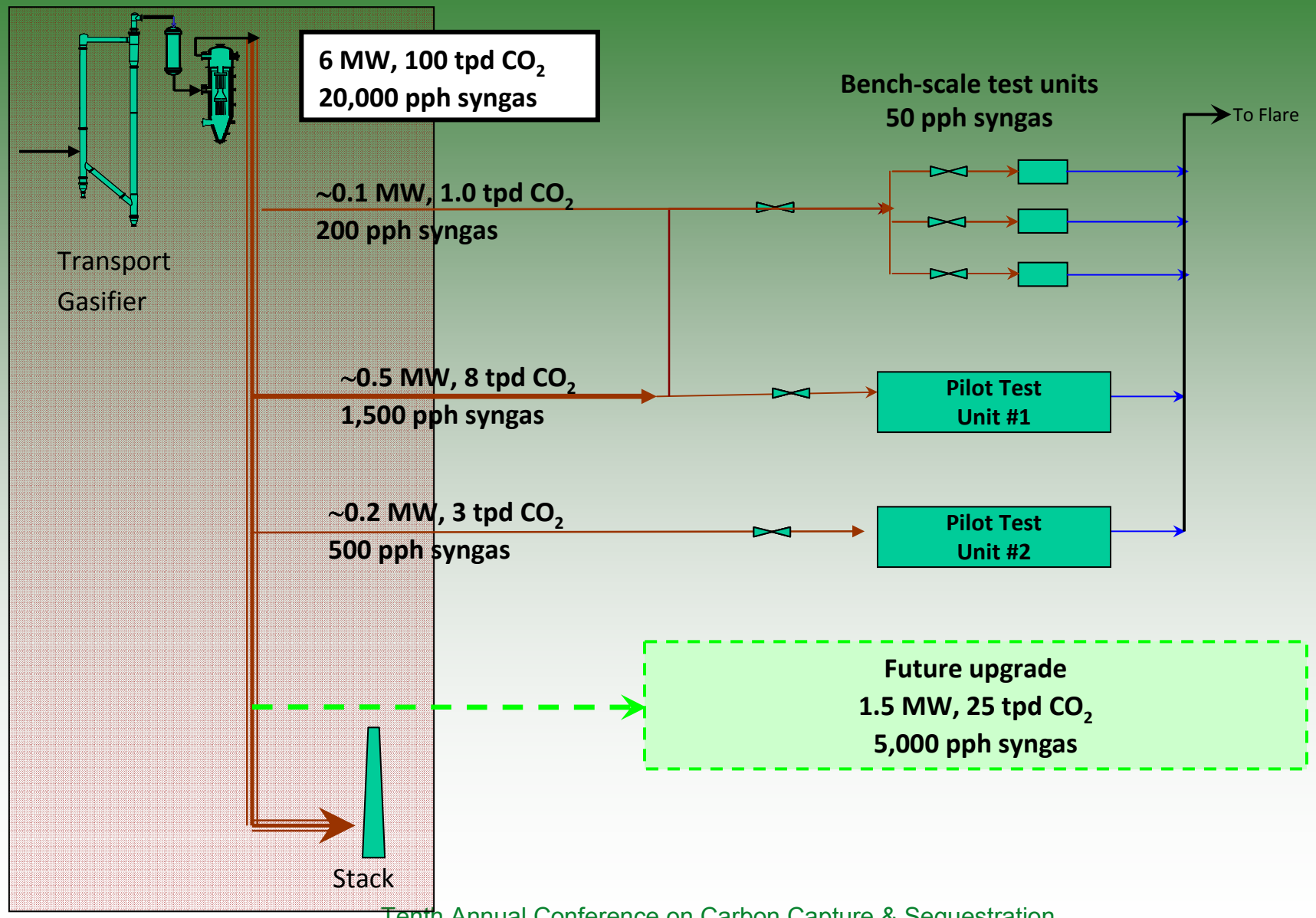
The National Carbon Capture Center

Provides first-class facilities to test developer's technologies for extended periods under commercially representative conditions with coal-derived flue gas and syngas, thereby accelerate development of cost-effective carbon capture technologies.

- All necessary infrastructure to support testing of developer's technology.
- Experienced operators and maintenance staff
- Access to advanced analytical techniques at SRI/UAB Birmingham
- Comprehensive data collection and analysis capability
- Flexible facilities allow for scale-up from bench- to engineering-scale
- Post- and pre-combustion facilities currently available.



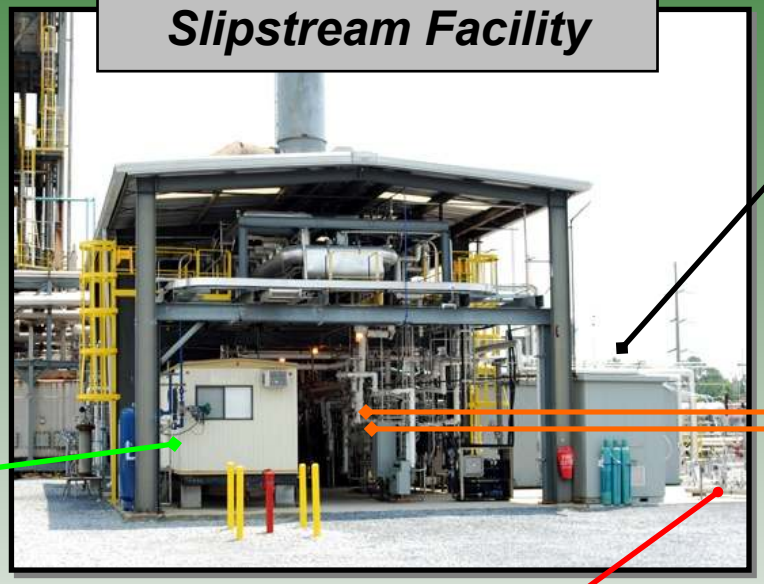
Syngas Slipstream Testing



Pre-Combustion Capture Projects

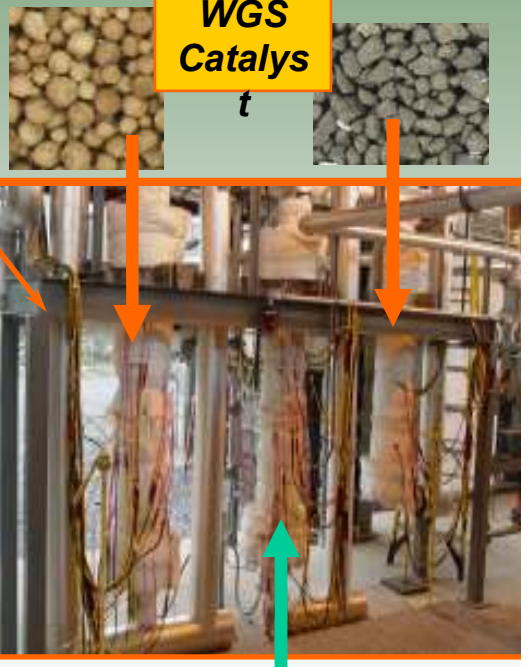
Advanced Solvents

Slipstream Facility

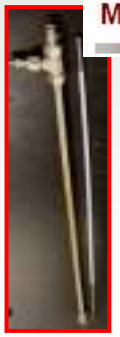


Fuel Cell

WGS Catalyst



MTR



MPT

Mercury Capture Sorbent (500°F)

Membrane Gas Separation (100 to 400°F)

Capture & Seque

Johnson Matthey

CO_2 Capture Solvents Tested

- Chemical solvents
  - Ammonium hydroxide/carbamate/carbonate/bicarbonate.
  - Potassium carbonate/bicarbonate
  - Ammonium, sodium, and potassium prolinate
- Physical solvents
  - Dimethyl ether of polyethylene glycol (DEPG)
  - Polydimethyl siloxane (PDMS)
  - Glycerol triacetate (GTA)
- Additional chemical and physical solvents identified with plans to support ARPA-E program
  - Scoping experiments with bottle gases before testing with syngas
- Discussions held with various enzyme developers
  - Speed up reaction rate of chemical solvents with low heat of reaction

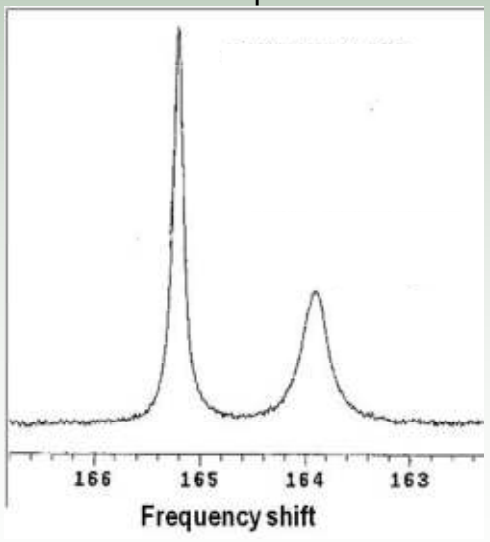
Parr Stirred Reactor

Advanced Analytical Procedures

- Access to sophisticated analytical equipment locally through Southern Research Institute and University of Alabama, Birmingham
  - Nuclear magnetic resonance (NMR) and Raman spectroscopy used to understand solvent chemistry.
- Supporting DOE in developing Gas Chromatograph-Inductively Coupled Plasma/Mass Spectrometry (GC-ICP/MS) for online measurement of trace metals in ppb range.

GC-ICP/MS at DOE-NETL

NMR Spectra

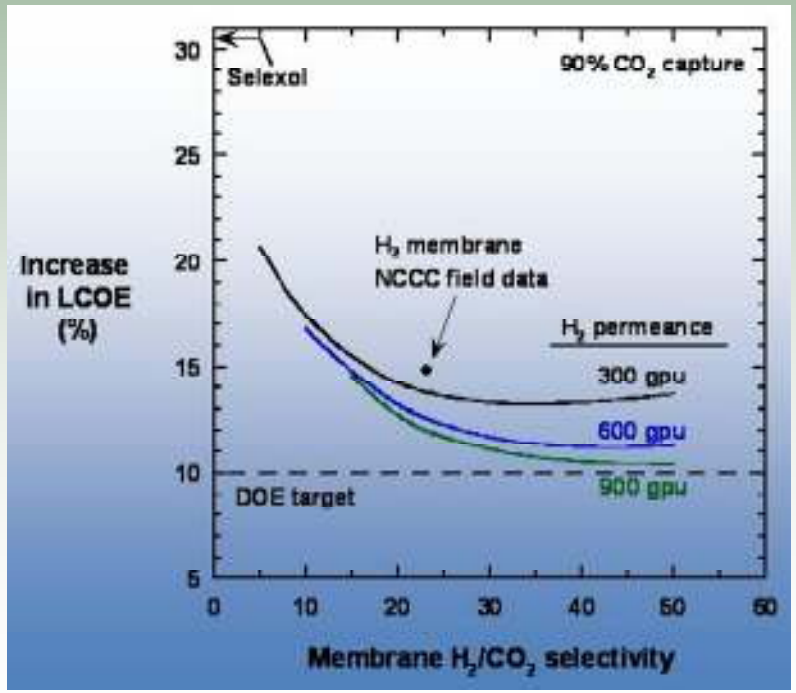


Membrane Testing

- Membrane Technology & Research (MTR) polymeric membranes for CO_2 (50 lb/hr syngas at ~100°F) and H_2 (1 lb/hr syngas at 250°F) tested using unshifted sweet syngas and shifted sour syngas
  - Over 1500 hours of testing using three different membranes materials.

- Media & Process Technology (MPT) carbon molecular sieve H_2 membrane processing up to 10 lb/hr syngas at 480°F augmented with bottled H_2
  - Over 200 hours of testing using three different membrane assemblies
  - Single stage achieved over 95% purity H_2 with ~ 40 percent yield.

MTR's Self-Evaluation Results



MPT Membrane Scale-Up Support

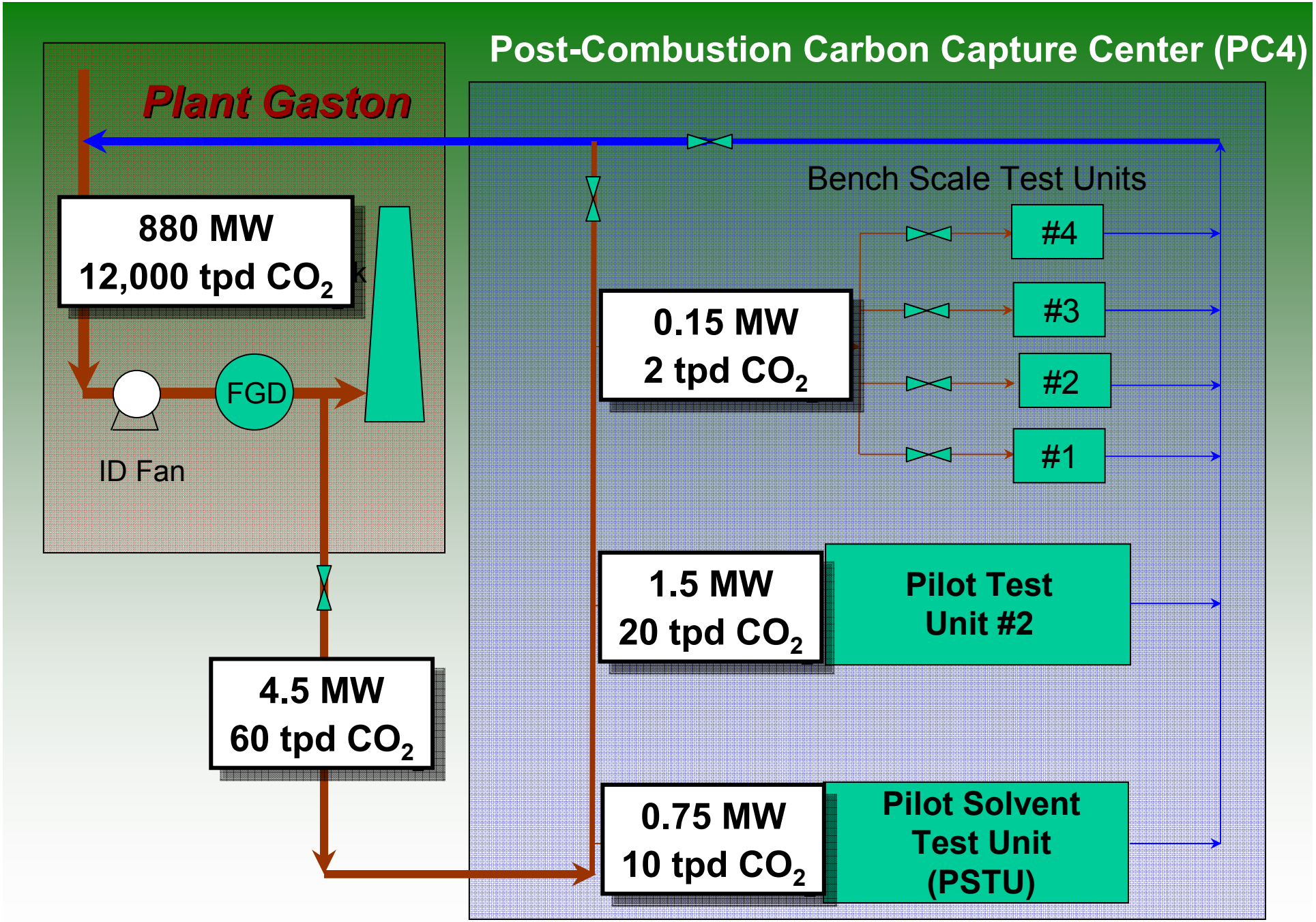
Initial single-tube design

Ten-tube design in SS vessel with fittings

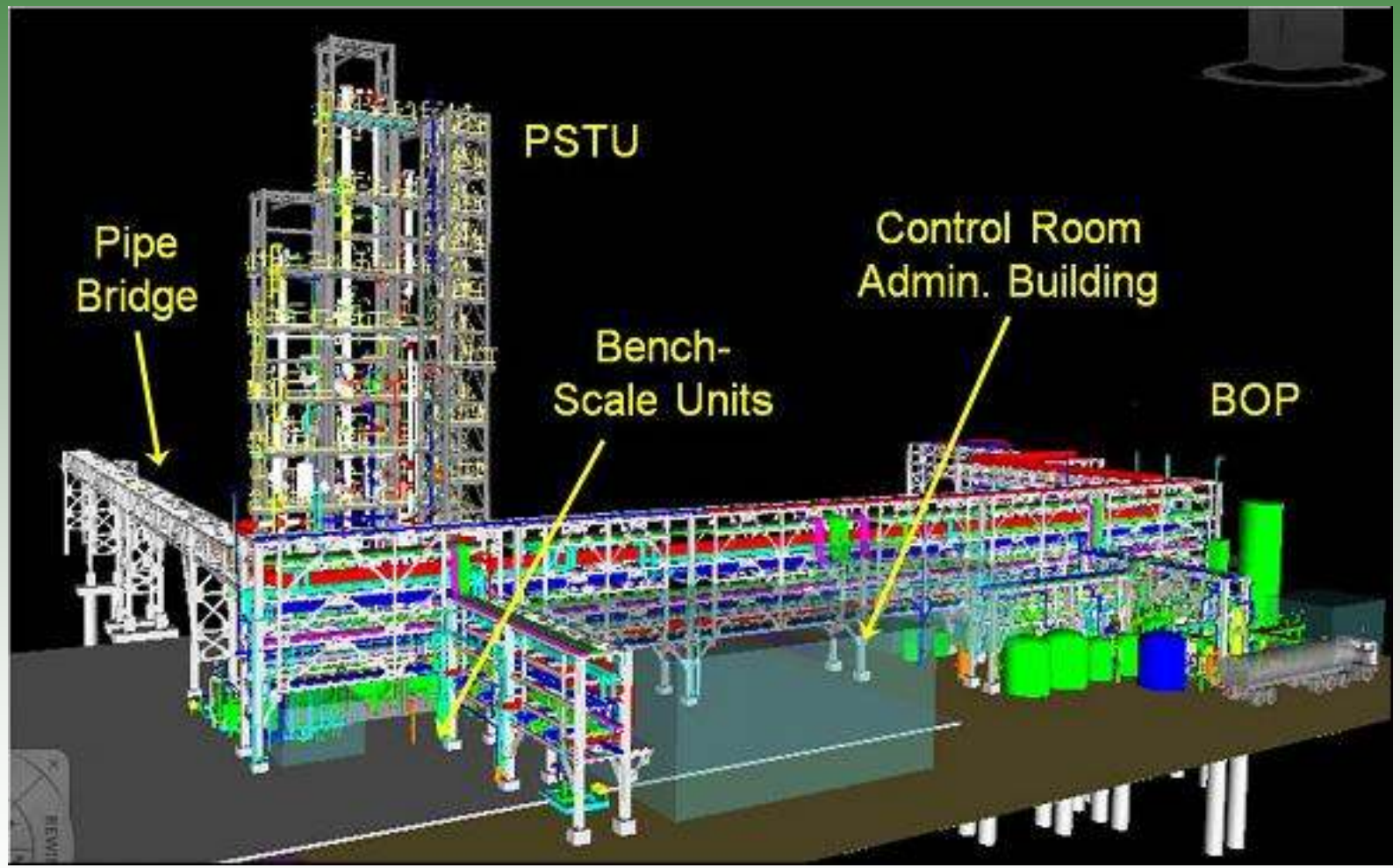
14-tube design with glass collar

20-tube design to be tested in near future

Alabama Power Plant E.C. Gaston


Post-Combustion Carbon Capture Center (PC4)
Plant Gaston
880 MW
12,000 tpd CO_2
FGD
ID Fan
4.5 MW
60 tpd CO_2
Bench Scale Test Units
0.15 MW
2 tpd CO_2
#4
#3
#2
#1
1.5 MW
20 tpd CO_2
Pilot Test Unit #2
0.75 MW
10 tpd CO_2
Pilot Solvent Test Unit (PSTU)

Computer Generated View of PC4

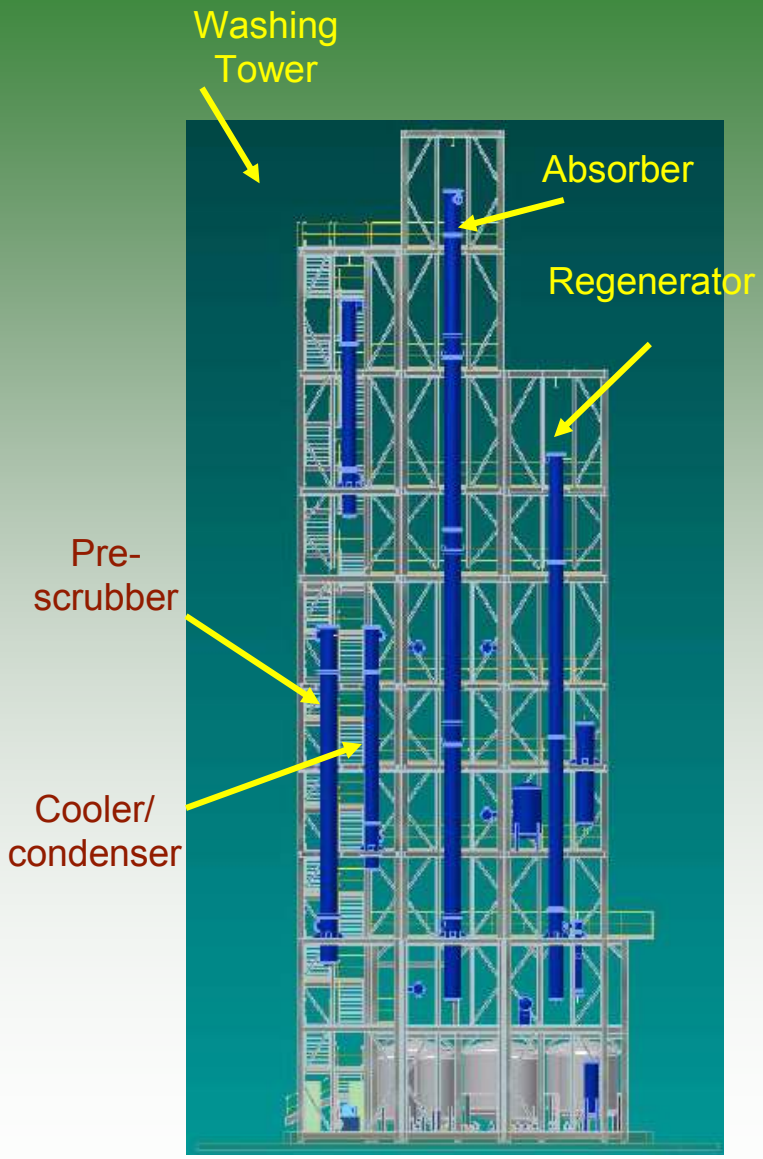


- Modular construction as no space for lay-down area

Modules Fabricated Off-Site

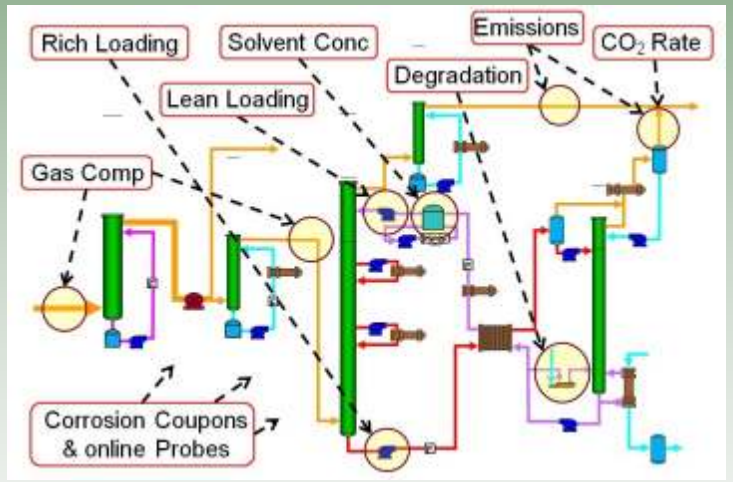
- Modules assembled in structure by fabricator to ensure fittings align and no interferences.
- Dissembled in twelve modules to be transported to NCCC.

PSTU Design and Final Installation



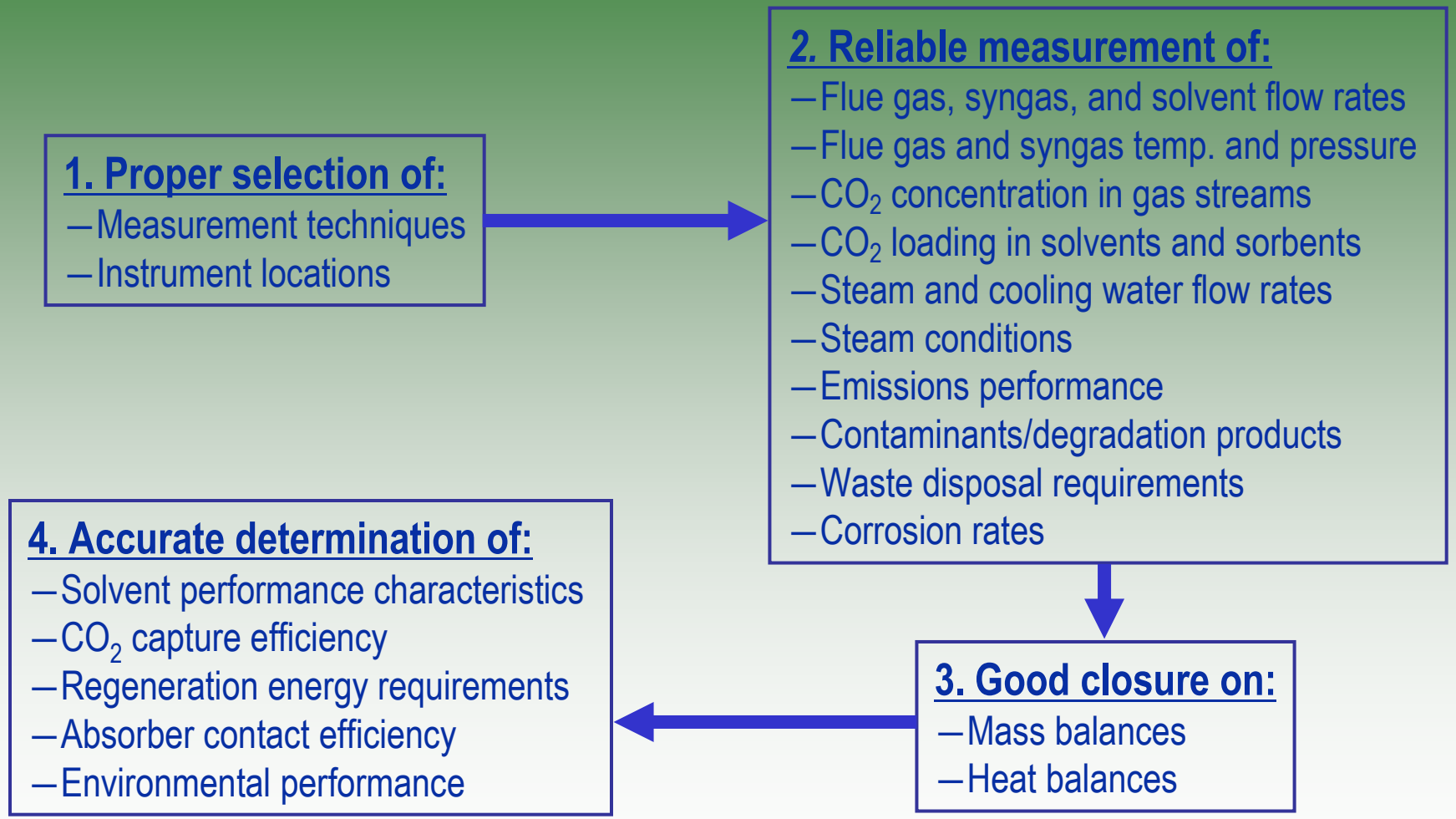
Test Program Developed

- Major control variables
  - 15 test conditions to characterize solvent, plus 250 hour run at design conditions: ~ 1000 hour program
  - Inlet flue gas flow; lean amine to absorber gas flow (L/G); absorber temperature profile; steam to rich-amine flow in regenerator (S/G).
- Major parameters monitored
  - Inlet flue gas composition
  - Rich and lean amine CO_2 loading
  - Solvent concentration in water
  - Water balance
  - CO_2 exiting regenerator
  - Amine degradation and corrosion
  - Amine and degradation products in flue gas discharge.



- Commissioning with test program 20-, 30-, and 40-percent MEA
  - Results will be used in developing post-combustion capture model in DOE's Carbon Capture and Storage Simulation Initiative.

QA/QC Approach: Essential for Developer Confidence



Developers Negotiating to Test at NCCC

- Post- and pre-combustion solvents and enzymes.
- Developer's post-combustion capture modules and design modifications.
- Post-combustion CO_2 separation membranes and CO_2 and H_2 pre-combustion membranes.
- Post- and pre-combustion adsorbents.
- Working with B&W and Ohio State to install a chemical looping pilot plant (1000 lb/hr syngas).
- Technology assessment process developed to determine status of technology and help with prioritizing and sequencing of tests
  - Over 100 developers in data base.

Closing Comments

- CO_2 capture and storage essential to allowing continued use of coal and maintaining electricity prices affordable in a low-carbon economy
  - Electricity must bear the additional cost so improved technology options are required.
- The NCCC is prepared to work with all CO_2 capture technology developers to improve their products and accelerate development.
- Also preparing to support development of the novel approaches being funded by DOE.