

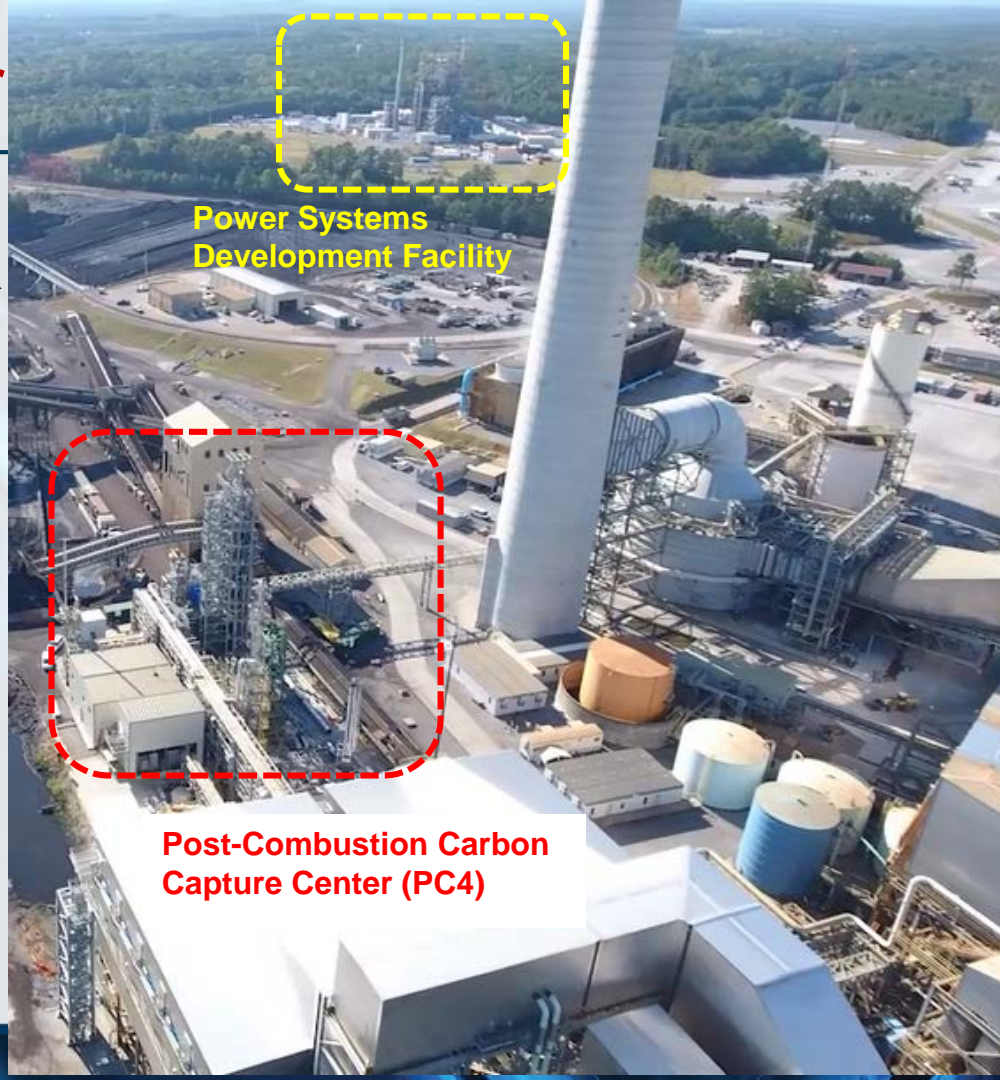
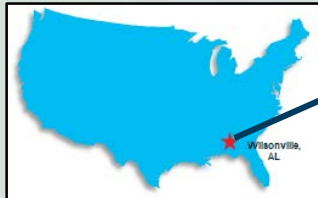
Update on National Carbon Capture Center (FE0022596)

Tony Wu
Southern Company
August 15, 2018

2018 NETL CO₂ Capture Technology Project Review Meeting
Pittsburgh, PA



National Carbon Capture Center



Power Systems Development Facility

Post-Combustion Carbon Capture Center (PC4)

Alabama Power Plant E.C. Gaston



CLEARPATH



ExxonMobil



Peabody



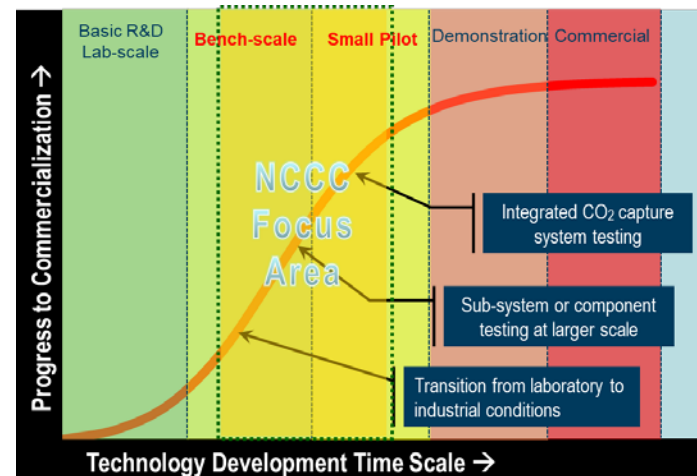
2014 - 2020

DOE & Industrial Sponsors
80/20 \$187.5 million -
Continue CO₂ Capture R&D
for Cost Reduction



Benefits of NCCC

- Serve as centralized R&D facility
 - Reduce redundancy
 - Conduct multiple testing simultaneously
 - Make available realistic flue gas for performance verification
 - Flexible in capacity and process conditions
 - Effective performance comparison between technologies tested
 - Leverage existing infrastructure and onsite expertise
 - Power plant, process engineering and integration, design, construction, and O&M areas
 - Provide independent data acquisition and analysis for developers as needed
- Accelerating CO₂ capture technology development and commercialization

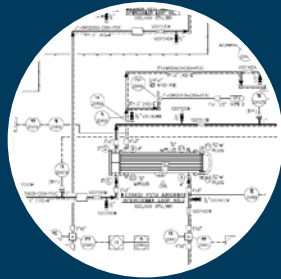


Project Development and Implementation

Safety
First

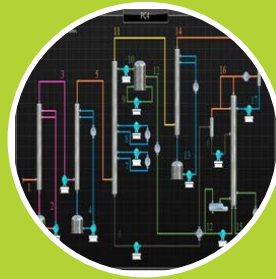
Contract

- Screening
- NDA/TCA
- Onboarding



Project Scope

- Process
- Modification
- Integration



Design

- Mechanical
- Instrument
- Control
- Electrical
- Civil



Construction

- Foundation
- Flue Gas
- Utilities
- Installation
- Interconnection

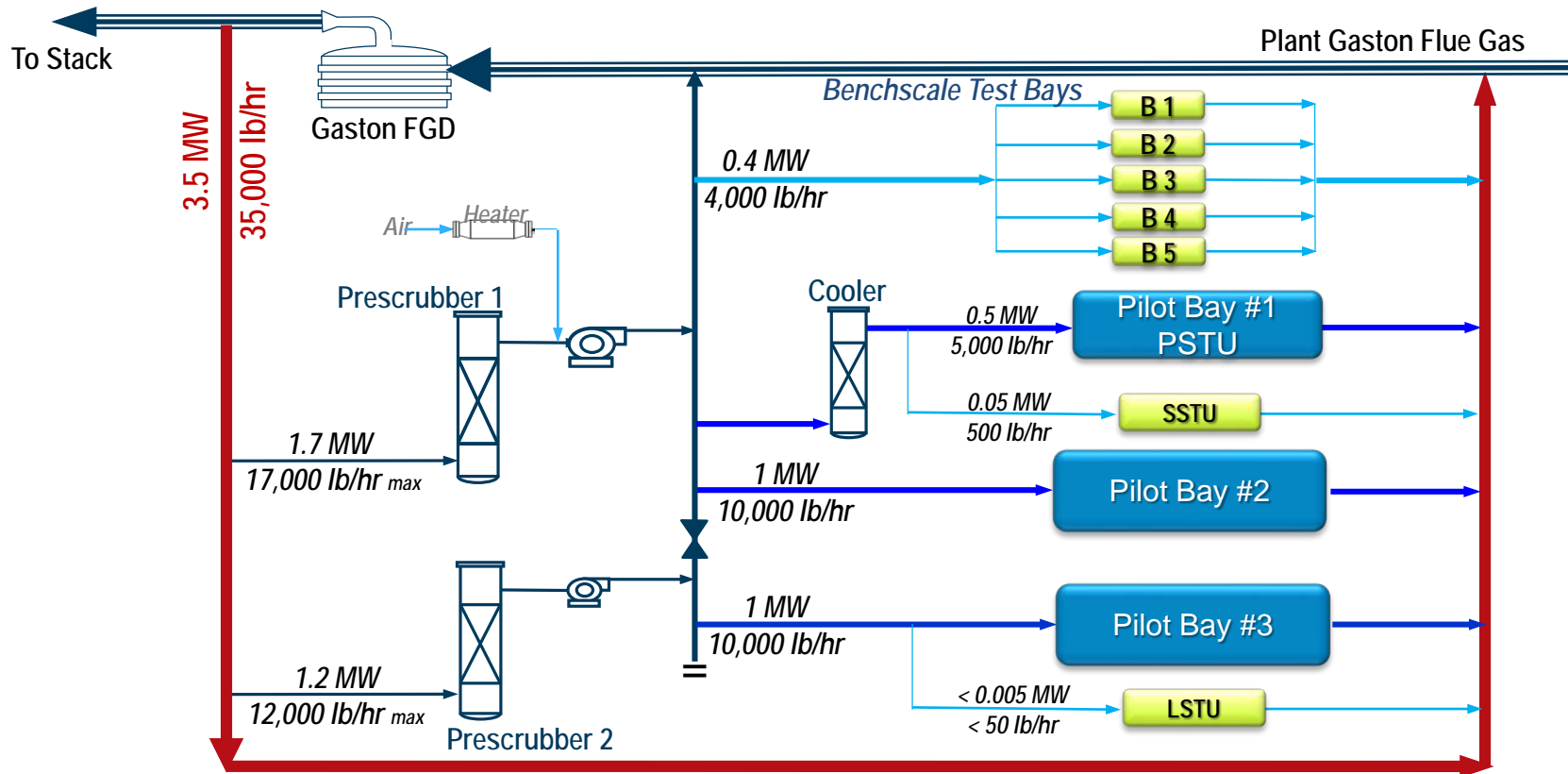


O & M

- Operate
- Test Support
- Analysis
- Troubleshoot
- Repair

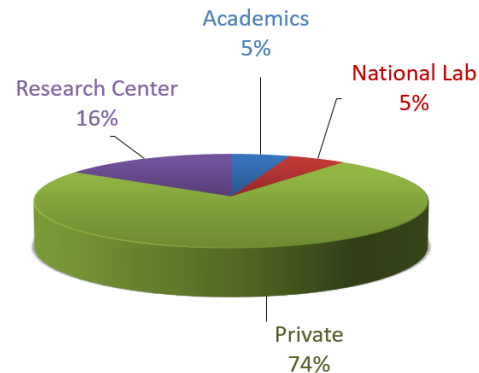
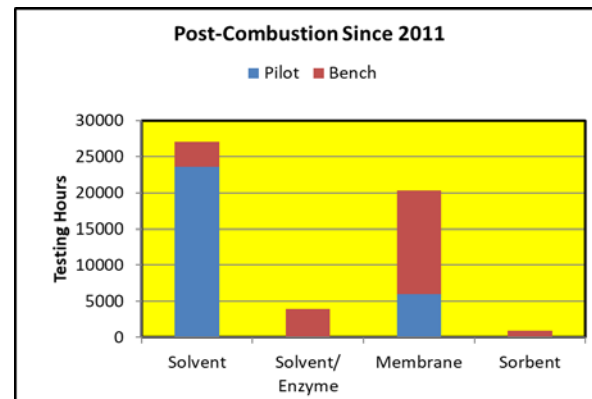
Project Initiation to Completion

PC4 Configuration



PC4 Testing Accomplishments since Inception

- **52,000+** hours of performance data collected
- **33 technologies** from **24 developers** tested
 - 74% are private companies
- **7 technologies** scaled up (or ready to) to 10+ MW
 - Aker, Carbon Clean Solutions, ION Engineering, Linde, MTR, RTI and Shell Cansolv
- **International collaboration: 6 countries**
 - Canada, Germany, India, Japan, Norway, UK



NCCC International Collaboration

- Support DOE goal of international cooperation
- Broad effort China, India, Middle East, Korea, Japan, EU, Australia, Canada, Norway
- Multiple paths for involvement
 - Partners, developers, network members, consulting services and workshops
- Ease of collaboration since intellectual property is not being shared – Extensive support from the NCCC
- Co-founded ITCN (International Test Center Network)
 - Share knowledges (construction, operation, safety, funding, analytical techniques) among test facilities around the world
 - Collaborate on one technical item per year



Advanced Solvents and Processes @ NCCC

- **Advanced Solvents**

- Adv. aqueous amines/blends
- Enzyme-catalyzed
- Water-lean
- Non-aqueous

- **Absorber**

- Intercooling configuration
- Use of gravity force
- Rich recirculation
- Advanced contactors (e.g. packing, membrane)

- **Regenerator**

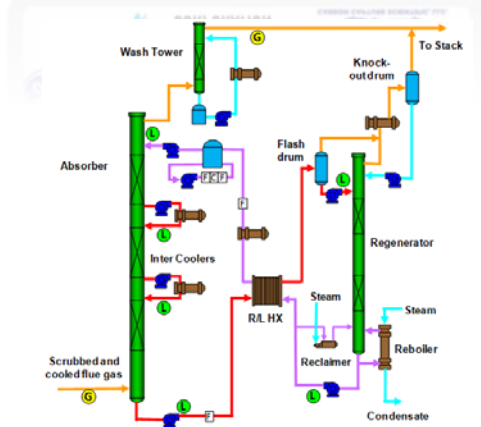
- Flash regeneration
- CSTR configuration
- Gas stripping w/column heaters

- **Advanced Process**

- Improved heat utilization
- Adv. R/L HX, reboiler
- High pressure regeneration
- Flue gas blower location
- Adv. process controls
- Realtime solvent physical properties for control

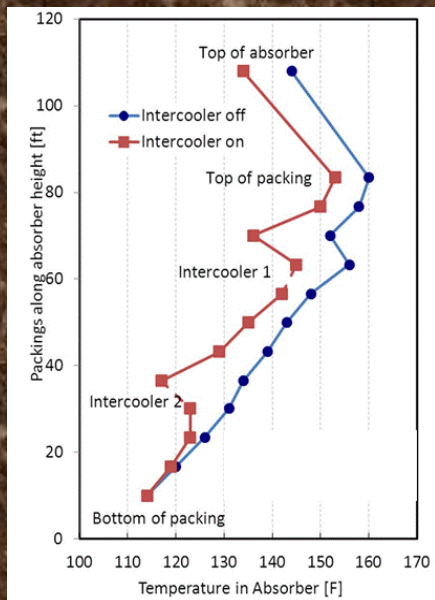
- **Emission/Degradation Reduction**

- High efficient packing
- Proprietary Anti-Mist
- Patented dry-bed wash
- Induced aerosol growth
- Advanced filters
- Additives for NO₂ reduction
- N₂ sparging for O₂ reduction
- Low stripper sump hold-up



Solvent Performance Evaluation in PSTU/SSTU (Examples)

Detail Performance



Absorber Temp Profiles

Corrosion

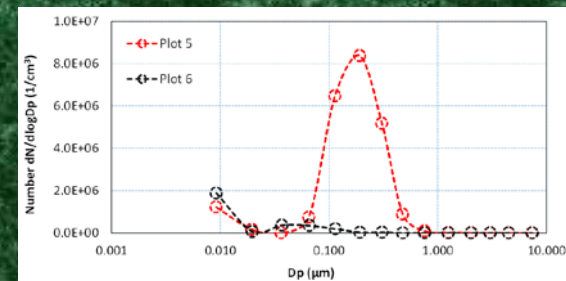


Coupon Materials



ER Probe & Coupon Holder

Emission & Degradation













Aerosols Size and Counts




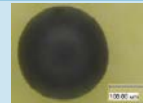

Solvent Samples Over Testing

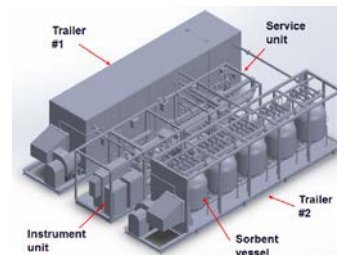
CO₂ Membrane Test @ NCCC

Scale	Pilot	Lab/Bench			
Company	MTR	Air Liquide	MTR	OSU	NETL
Material	Polymer	Polymer	Polymer	Polymer/ Hybrid	Hybrid
Design	S-W / Flat	HF	S-W	S-W	HF/ Flat
					
OP Temp (°C)	30	- 40	30	57	40
Size	1 MW	0.3 MW	50 KW	< 1 KW	< 1 kW
Field Unit					

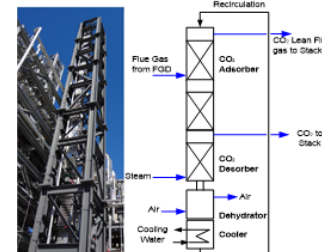
S-W: Spiral-Wound; HF: Hollow Fiber

Sorbents Test @ NCCC

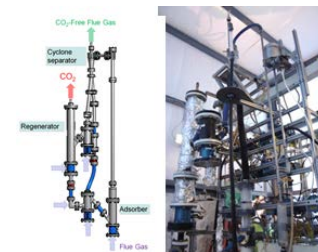
Scale	Pilot	Lab/Bench	
Company	TDA	SRI Int.	NETL
Material	Alkalized Alumina	Carbon	Supported Amine
			
Design	Fixed-bed	Circulating	Circulating
T (°C) Abs/Reg	140/140	50/120	60/100
Size	0.5 MW	40 KW	< 5 kW



TDA Skid



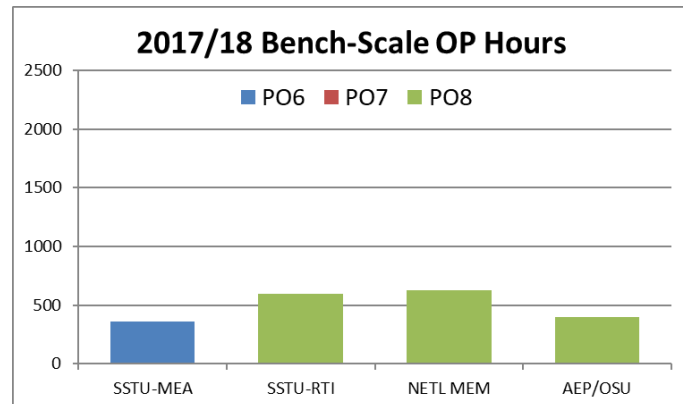
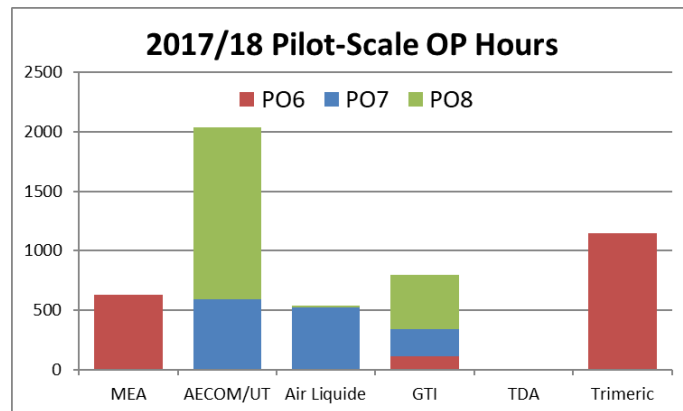
SRI Int Skid



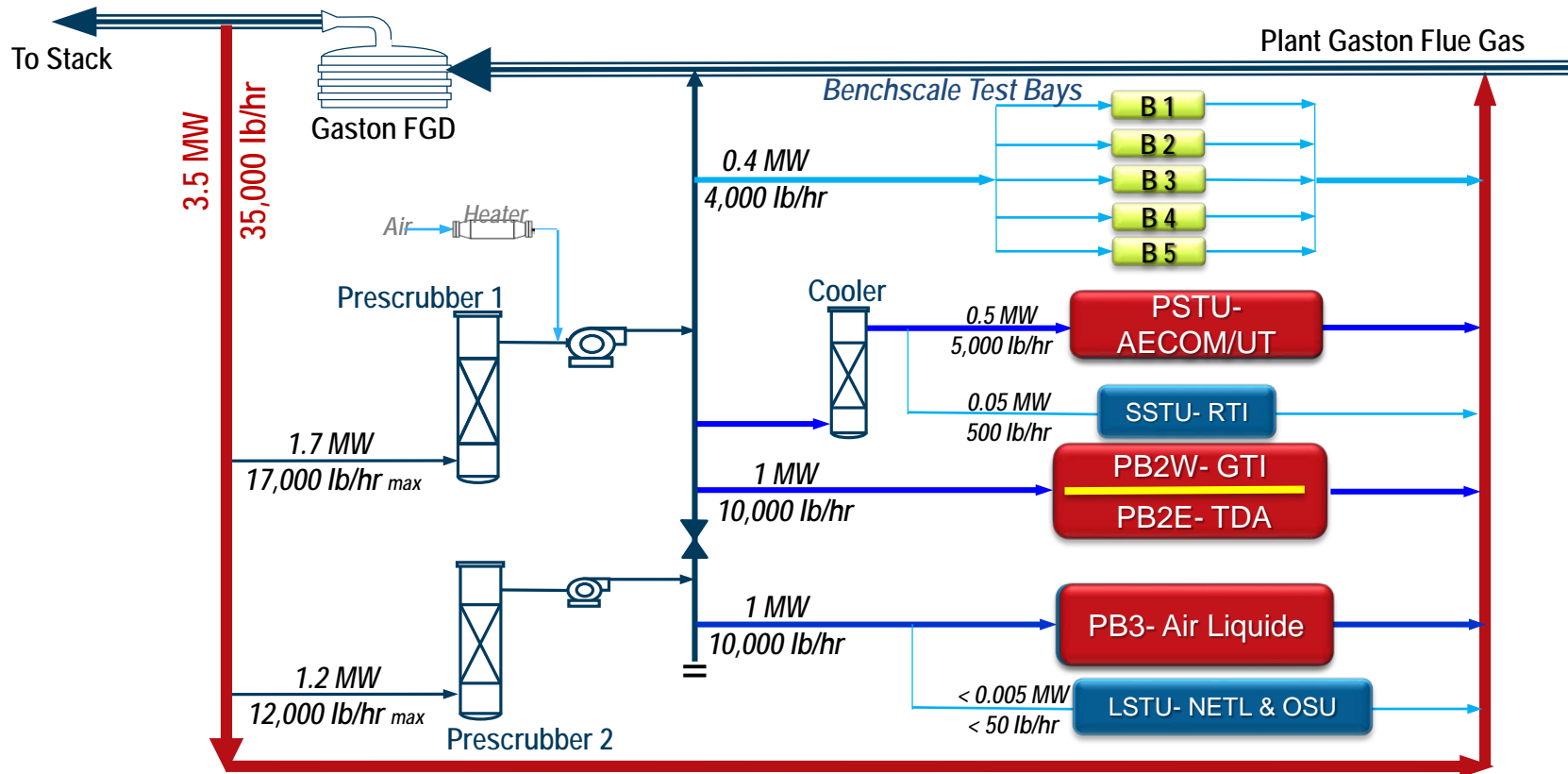
NETL Skid

Recent Test Campaign

- **PO-6 to PO-8 (June '17 – Aug '18)**
 - Pilot-Scale **5,136** hours
 - ▶ PSTU MEA DOE CCSI² (Carbon Capture Simulation for Industrial Impact)
 - ▶ PSTU AECOM/UT Piperazine (PZ) /AFS (Advanced Flash Stripper)
 - ▶ PB2W GTI aMDEA/membrane contactor
 - ▶ PB2E TDA sorbent
 - ▶ PB3 Trimeric/UT chemical additives for NO₂ reduction
 - ▶ PB3 Air Liquide cold membrane
 - Bench-Scale **1,973** hours
 - ▶ SSTU MEA baseline
 - ▶ SSTU RTI NAS (Non-Aqueous Solvent)
 - ▶ NETL membrane
 - ▶ AEP/OSU membrane



Current PC4 Configuration



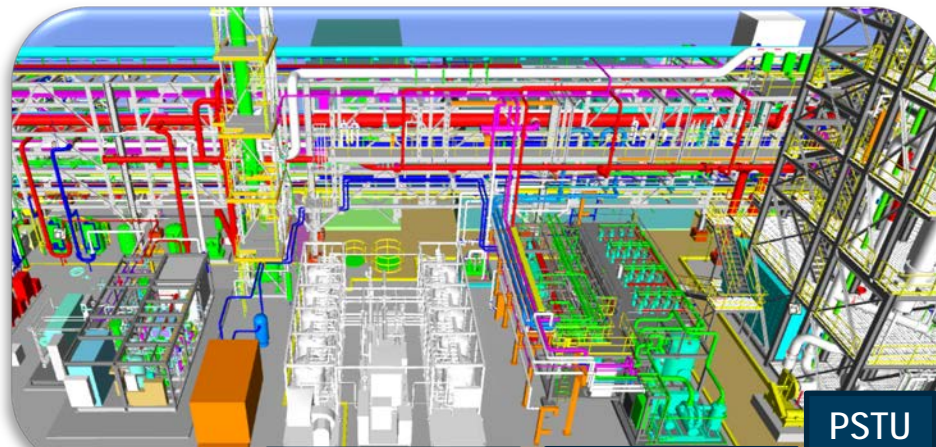
Current Pilot-Scale Layout



PSTU



AECOM/UT Skid



PB3-AL Skid

PB2-TDA Skid

PB2-GTI Skid

PSTU

Current Lab/Bench-Scale Layout

SSTU



LSTU

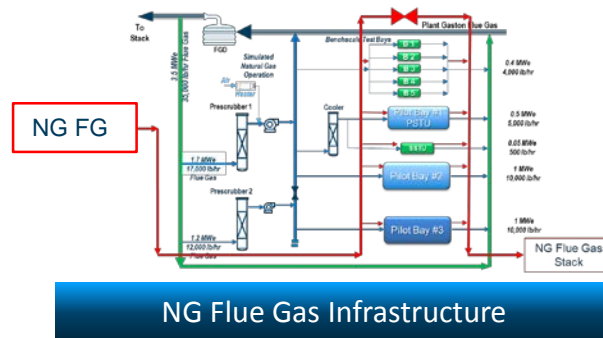
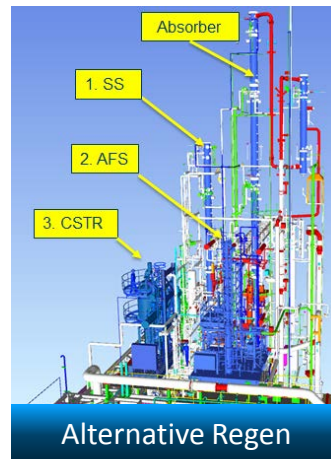


Bench-scale



Continuous Expansion on NCCC Capabilities

- Alternative Regeneration
 1. Simple Stripper (SS): Conventional
 2. Advanced Flash Stripper (AFS): UT
 3. Continuous Stirred-Tank Reactor (CSTR): GE
- Gas Injection System
 - NO/NO₂
 - SO₂/SO₃
- Natural Gas (NG) Flue Gas Source
 - NG boiler
 - Increase flue gas availability
 - Offer realistic flue gas from NG
- Analytical Support
 - Gas Chromatography (GC) for gas
 - Low NO₂. (ppb) analyzer
 - ELPI®+(Electrical Low Pressure Impactor)
 - Amine/degradation products sampling



Prepare for Unexpected



PSDF
(12/8/2017)



PC4
(1/17/2018)

Acknowledgements



Nationalcarboncapturecenter.com

Special
Thanks

Andy O'Palko
Lynn Brickett
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