# *"Validation of Transformational CO<sub>2</sub> Capture Solvent Technology with Revolutionary Stability" (Apollo)*

DE-FE0031727 – 2020 NETL Project Review Meeting

Principal Investigator: Technical Lead: Project Manager: Erik Meuleman, Ph.D. – CTO Nathan Fine, Ph.D. Tyler Silverman

October 5-7, 2020

## **DE-FE0031727: Apollo project**



• Overall Project Objective:

Scaling up a novel amine-based solvent technology with revolutionary stability and excellent  $CO_2$  capture performance from a small-scale (~0.03 MWe) to a ~0.5 MWe scale using real flue gas

- Budget:
  - DOE-NETL: \$2,999,998
  - ION and partners: \$750,000
- Period of Performance:
  - June 1<sup>st</sup>, 2019 to May 31<sup>st</sup>, 2021



Pilot Slipstream Test Unit (0.5 MWe) National Carbon Capture Center (NCCC) Wilsonville, AL (*Courtesy of NCCC*)

## ION's CO<sub>2</sub> Capture Technology Development / ICE-21 Accelerated development path leveraging existing research facilities





## **Technology Background** *ICE-31 – Basis of Performance*

- Low energy consumption (lower than ICE-21)
- Fast kinetics (similar to ICE-21)
- Working capacity (higher than ICE-21)
- Low heat capacity (similar to ICE-21)
- Low corrosion (similar to ICE-21)
- Transformational stability (much better than MEA or ICE-21)



## **Technical Objectives – NCCC/PSTU**



- Parametric testing: determine operating window and validate ProTreat<sup>®</sup> model
- Long-term operation to demonstrate stability of ICE-31
- Dynamic operations to determine maximum ramp-rates, minimize energy consumption and emissions
- Upsets to determine process and solvent stability:
  - Increased O<sub>2</sub> concentration
  - Increased stripper temperature
  - Unplanned FGD outage
  - Unplanned DCC outage

## **COVID-19 Related Project Delays**



- PSTU Testing was slated to begin in Q2 2020; COVID related delays impacted site access for NCCC
- ION and NCCC are in constant communication to determine revised schedule for PSTU modifications and test campaign

## Alabama Covid Map and Case Count





Day with data reporting anomaly. Includes confirmed and probable cases where available. 14-day change trends use 7-day averages.

## Colorado Covid Map and Case Count

#### By The New York Times Updated September 15, 2020, 12:25 P.M. E.T.



Day with data reporting anomaly. Includes confirmed and probable cases where available. 14-day change trends use 7-day averages.



## PRELIMINARY RESULTS

## Lab-based Results: CO<sub>2</sub> Capture Test-rig (Ø=8") Operation CLEAN ENERG --- ICE-31 NGCC 90% CE **Specific Reboiler Duty** -■-MEA Coal 90% CE (GJ/tonne CO<sub>2</sub>) ICE-21 Coal 90% CE (Estimate)



L/G (kg/kg)

## Lab-based Results: Oxidative Loss Bulk at 80°C; 10% CO<sub>2</sub> / 19% O<sub>2</sub>; Analyses: GC, GC-MS, TIC, KF



### **Time of Incubation**



## Lab-based Results: Oxidative Loss Bulk at 80°C; 10%CO<sub>2</sub> / 19% O<sub>2</sub>; Analyses: GC, GC-MS, TIC, KF





## **Other Project Progress / Results**



- β-version of ProTreat<sup>®</sup> developed based on lab-data for ICE-31
- Test plan developed and agreed between ION and NCCC addressing all objectives
- Cold-rich bypass modification currently being installed
- Solvent has been procured
- MLA library developed



## **PSTU Campaign Test Plan**



- Operation
  - Commissioning
  - Parametric testing to determine optimal operating window
  - Long-term testing
  - Upsets testing
- Sampling & analysis plan
- Travel plan remote operations (3 options)

## **Outlook for 2021**



- Execute ION's campaign test plan at NCCC's PSTU with ICE-31
- Analysis and data evaluation
- Decommissioning
- Process model validation
- Techno-Economic Analysis (TEA)

## ION Team: Nathan Fine, René Kupfer, Tyler Silverman, Greg Staab, Jenn Atcheson, Andy Awtry Ned Brown, Kelly Sias, Buz Brown, Erik Meuleman NCCC Team

**Department of Energy:** Katy Daniels, Bethan Young







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## Appendix Organization Chart



## ION Engineering (Lead Institution) Management of scope, schedule and budget of overall project Laboratory work to support solvent property information development Develop test plan for 0.6 MWe demonstration

- Supervise NCCC in daily execution of test plan
- · Analysis of all campaign and laboratory data
- Complete DOE Deliverables: TEA, Technology Gap Analysis, EH&S Risk Assessment, Technology Maturation Plan, and all other required reporting



## **Project Schedule – September 2020 update** *To be updated once campaign starts*



												В	udg	et P	erio	d 1										
Apollo Project Schedule	1	2	3	4	5	6	6	7	8	9	10	11	1	2	13	14	15	16	17	18	3 19	20	21	1 2	2 23	3 24
	Jun-19	Jul-1	Aug-1	9 Sep-	19 Oct-	19 Nov	/-19	Dec-19	Jan-20	Feb-20	Mar-20	) Apr-20	) May	/-20	Oct-20	Nov-20	Dec-20	) Jan-21	Feb-2	.1 Mar-2	21 Apr-2	1 May-2	1 Jun-	21 Jul	21 Aug-	21 Sep-21
Task 1 Project Management	M2				1	M3		M1		M5	5	м	14 M6-1	8, 12											M9-	11 M13-17
Task 2 Laboratory Scale Evaluations																										
2.1 Lab-work for ICE-31 Properties																										
2.2 Develop ICE-31 Process Model in ProTreat®																										
2.3 Thermal and Oxidative Stability Study																										
2.4 Process Development Facility (PDF) Operation																										
Task 3 Host Site Preparation and Test Plan Development																										
3.1 Develop Campaign Test Plan																										
3.2 Campaign related Environment, Health, and Safety (EH&S)																										
3.3 Host Site Preparation																										
Task 4 Field Testing at 0.6 MWe PCC Plant																										
4.1 0.6 MWe PCC Operation Phase I																										
4.2 Analysis and Phase I Data Evaluation																										
4.3 0.6 MWe PCC Operation Phase II																										
4.4 Data Evaluation																										
4.4 Decommissioning																										
Task 5 Analytical Reporting for DOE Metrics																										
5.1 Process Model Validation																										
5.2 Techno-economic Analysis (TEA)																										
5.3 State Point Data Table																										
5.4 Technology Gap Analysis																										
5.5 Environmental Health and Safety Risk Assessment																										
5.6 Technology Maturation Plan																										
5.7 Final Reporting		П									П					П							П			
Overall Task	Ten	tative	Sch	edule	e due	to CO	ov	1D-19	9 Del	ay								•								
Subtask	Sub	task	at Be	ainni	ina &	end o	of F	Proie	ct																	