CCUS as a Regional Economic Development Tool: Planning and Design Considerations

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Overview

*Examining from a state-wide perspective*

- **Status of large scale CO\textsubscript{2} capture pilot**
  - Phase 2 proposal submitted to DOE for 15 MW large scale capture pilot
- **Select utilization options synergistic with regional economy**
  - Preferred options can vary throughout one state or region
- **Identify relevant workforce development partners**
  - Related to utilization options and part of CO\textsubscript{2} value chain
- **Develop tools to connect CO\textsubscript{2} utilization with existing economy**
  - Tools to examine dispatching of CO\textsubscript{2}
STATUS OF LARGE SCALE PILOT

Phase 2 proposal (Design, Build, Operate) submitted
Host Site: Abbott Power Plant

Ideal site for large scale pilot testing of coal and natural gas

- Seven boilers total: three are coal based (Chain-grate stoker design) others natural gas
- **Coal side has completely separate treatment system from natural gas side**
- For testing will run two coal boilers
- Illinois high sulfur coal is burned
- Electrostatic precipitators and a wet Flue Gas Desulfurizer (FGD) in place
- **Tradition of evaluating new emission technologies**
- **Tradition of showcasing technologies to other power plants and education groups**

Major advantage that University owns and operates Host Site
Overview of Capture System for Large Pilot Plant

Technology features
Overview of Phase 2 Project Schedule

More than just a design, build, operate project

- Stakeholder Engagement helps educate, understand market needs, and propagate technology
- Education: workforce development for existing and future operators and engineers
- Demonstrating not only the technology but how to create jobs and drive regional economies
Phase 2: Project Organization Chart

Added expertise in aerosols, OSBL procurement / construction, and dry-bed emissions reduction

- University of Illinois
- International Advisory Board
- Linde Engineering North America
- Affiliated Engineers
- Linde AG, Engineering Division
- Linde LLC
- ACS
- Washington University
- Regional / Community Advisory Board
- Program & Stakeholder management, host site
- OSBL design, build
- Aerosol analysis
- Technology owner and patented dry-bed emissions reduction technology
Site for Carbon Capture Plant Established and Evaluated

Located close to Abbott Power Plant

Extract flue gas POST CEMS Unit
Plot Plan for Capture Plant

49 m x 46 m (160 ft. x 150 ft.) footprint

No modifications to existing plant combustion system (i.e. boilers) considered a major risk reduction by Abbott Power Plant.
Regional & Global Test Bed for CCUS

Concentration of natural resources and intellectual capital

- Capture of CO₂: Abbott Power Plant UIUC
- Storage of CO₂: ADM Project
- Utilization of CO₂: Enhanced Oil Recovery (EOR)
- Operator Training
- Coal combustion
Important to consider regional economy

SYNERGISTIC UTILIZATION OPTIONS
Illinois Legislation Relevant to CCUS

Commitment to CCUS and potential impact on regional economic development

HR 1501

"Carbon capture, utilization, and storage (CCUS) technologies provide a key pathway to address the urgent U.S. and global need for affordable, secure, resilient, and reliable sources of clean energy"

SR 2462

“A central element of a clean energy strategy for Illinois is continued research and development of carbon reduction strategies, such as carbon dioxide (CO2) capture, utilization, and storage through emerging technologies such as geological sequestration, mineral carbonation, and the beneficial use of captured CO2, in order to maximize environmental benefits and economic opportunities…”

“Illinois institutions such as the Prairie Research Institute at the University of Illinois, Southern Illinois University, Illinois Eastern Community Colleges, Richland Community College, and others strive to address climate, health, education, and economic impacts, through collaborations on applied CO2 research, practical applications, workforce development and public education..”
COAL: A SIGNIFICANT RESOURCE FOR ILLINOIS

Underlies 95,830 m² (37,000 mi²) or 68% of Illinois

- More than 211 billion tons of identified resources are currently estimated to lie beneath the state
- Demonstrated reserve base is 112 billion tons, as defined in terms of minimum thickness and some geologic assurance of coal's presence
- Demonstrated coal reserve base is the second largest in the United States and, for bituminous coal, is the largest in the nation
- Over $2.5 billion in annual economic activity within the State,
- Employing approximately 5,000 miners with an average annual salary of $85,000
- Higher than both the United States and Illinois median household incomes
Other Relevant Illinois Metrics

Factors considered when evaluating CO₂ Utilization options

• Leads the Midwest in crude oil refining capacity and ranked fourth in the nation (January 2015)

• Second in the nation in recoverable coal reserves at producing mines (2013)

• Third largest producer of ethanol (production capacity of 1.5 billion gallons per year)

Source: [http://www.eia.gov/state/analysis.cfm?sid=IL](http://www.eia.gov/state/analysis.cfm?sid=IL)
Connection Between Coal-Fired Plants and Agriculture

*Long standing relationship in Illinois*

Coal fired Power Plants
Coal-Fired Power Plants and Refineries / Chemicals

Focus on more urban areas

Coal fired Power Plants

Refineries

Source: http://www.eia.gov/state/analysis.cfm?sid=IL
CarbonSAFE ILLINOIS

Funded to match carbon “sources” with carbon “sinks”

$12M funding - Commercial-scale CCS opportunities for 50+ million tonnes CO₂ capture and storage in the Illinois Basin

• Geological characterization and utilization options such as EOR
  • drilling, core, modeling

• Source suitability, options, and proximity to storage

• Transportation needs

• Business case scenarios

• Pre-Feasibility and Feasibility studies
CO₂ Utilization with Algae

Synergistic with agricultural economy in Illinois

**Diagram:**
- **Sunlight** → Algae Culture
- **Flue gas or captured CO₂** → Algae Culture
  - Make-up water & nutrients
- **Water + nutrient recycled**
- **High value co-product** → Hydro-thermal liquefaction (HTL)
- **Solid Residue**
- **Liquid Bio-fuel**
- **CO₂, Water, Nutrients recycled**
Nutrient Loss Reduction: Critical to Illinois Agriculture

Plan required to reduce nutrients (N and P) carried in rivers and to the Gulf of Mexico

Nutrient sources in Illinois contributing to riverine nutrient export from the state

Annual nitrate-nitrogen and total phosphorus loads from Illinois
SoyFACE: Evaluating Elevated CO$_2$ Levels on Crop Growth

Free Air Concentration Enrichment (FACE) approach requires no enclosure

FACE ring. Wind Direction and velocity are measured in the center, then a computer controls the release of gases to simulate future possible conditions.

Fumigation ring is 30 m in diameter. At the center of the ring, wind speed and direction is monitored in real time.

http://soyface.illinois.edu/
Manufacturing Di-Methyl Carbonate (DMC) with co-production of Mono Ethylene Glycol
Partners connected into relevant supply chains

WORKFORCE DEVELOPMENT
Training Operators and Engineers

*Partners already connected into existing supply chains*
Enable connection of utilization with existing infrastructure

APPLYING EXISTING TOOLS
Weather and Atmospheric Monitoring Program (WARM)

Weather, soil, groundwater, streamflow, and reservoir data relevant for agriculture

- Data collected at 19 stations
- Five (5) minute, hourly, and daily data available
- Daily maps, weekly trends, and historical daily data at [http://www.isws.illinois.edu/warm/weather/](http://www.isws.illinois.edu/warm/weather/)
- Towards a model of “dispatching” CO₂
## ACKNOWLEDGEMENTS

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