Carbon Capture Utilization and Storage (CCUS) as a Regional Development Tool: Planning and Design Considerations

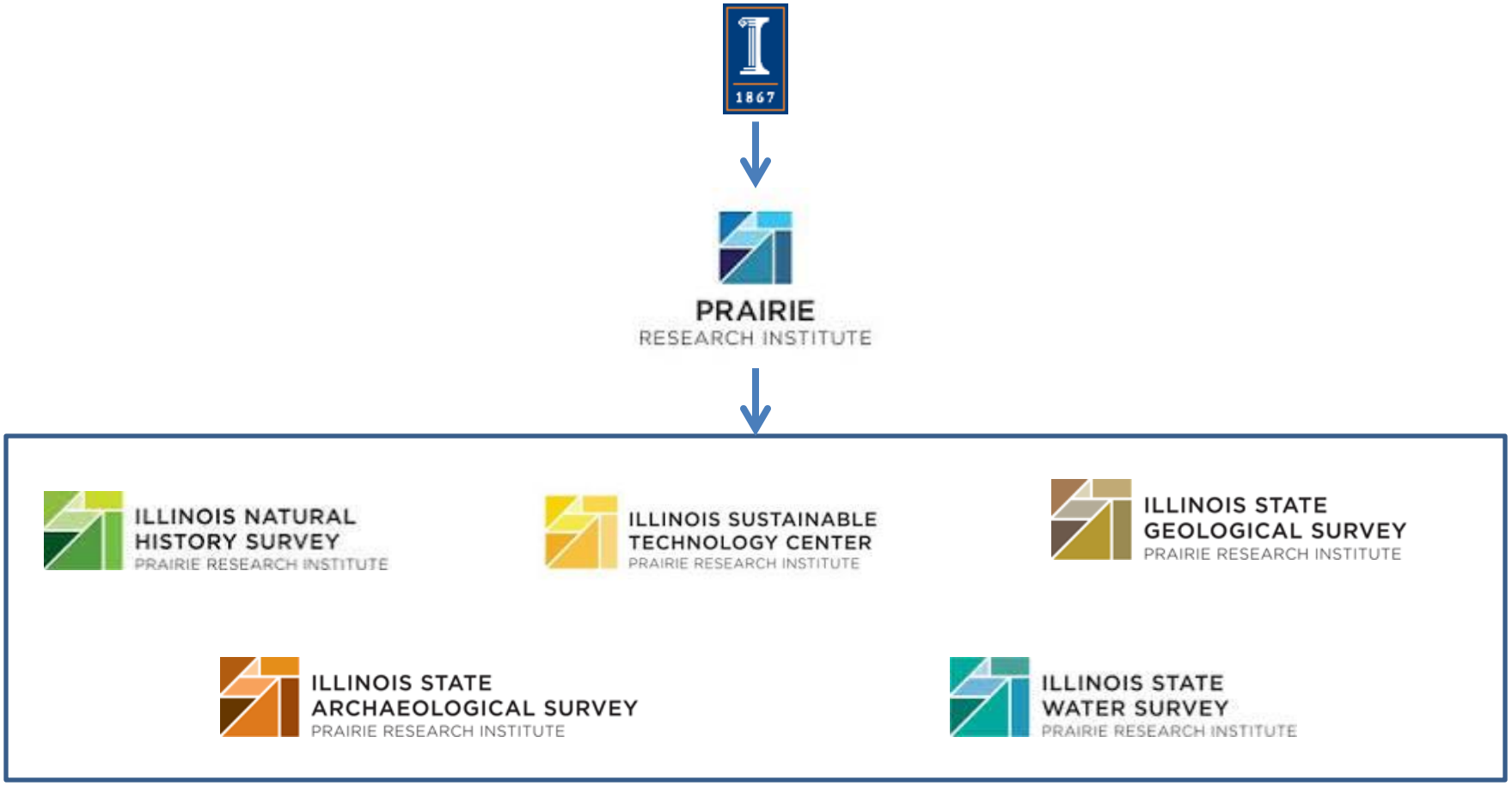
Presenter : Kevin C OBrien, PhD

CMTC 2017
Houston, Texas
July 17-20, 2017

Disclaimer

Prairie Research Institute: Illinois-focused Resource Research and Service

Addressing societal challenges that impact Illinois and the global community



PRAIRIE RESEARCH INSTITUTE · ACS Design · Construction · Integration · Linde · BASF We create chemistry · NETL National Energy Technology Laboratory · AEI Affiliated Engineers · U.S. Department of Energy

Overview

Examining from a state-wide perspective

- Status of large scale CO_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_2 value chain
- Develop tools to connect CO_2 utilization with existing economy
  - Tools to examine dispatching of CO_2

Phase 2 proposal (Design, Build, Operate) submitted

STATUS OF LARGE SCALE PILOT

Host Site: Abbott Power Plant

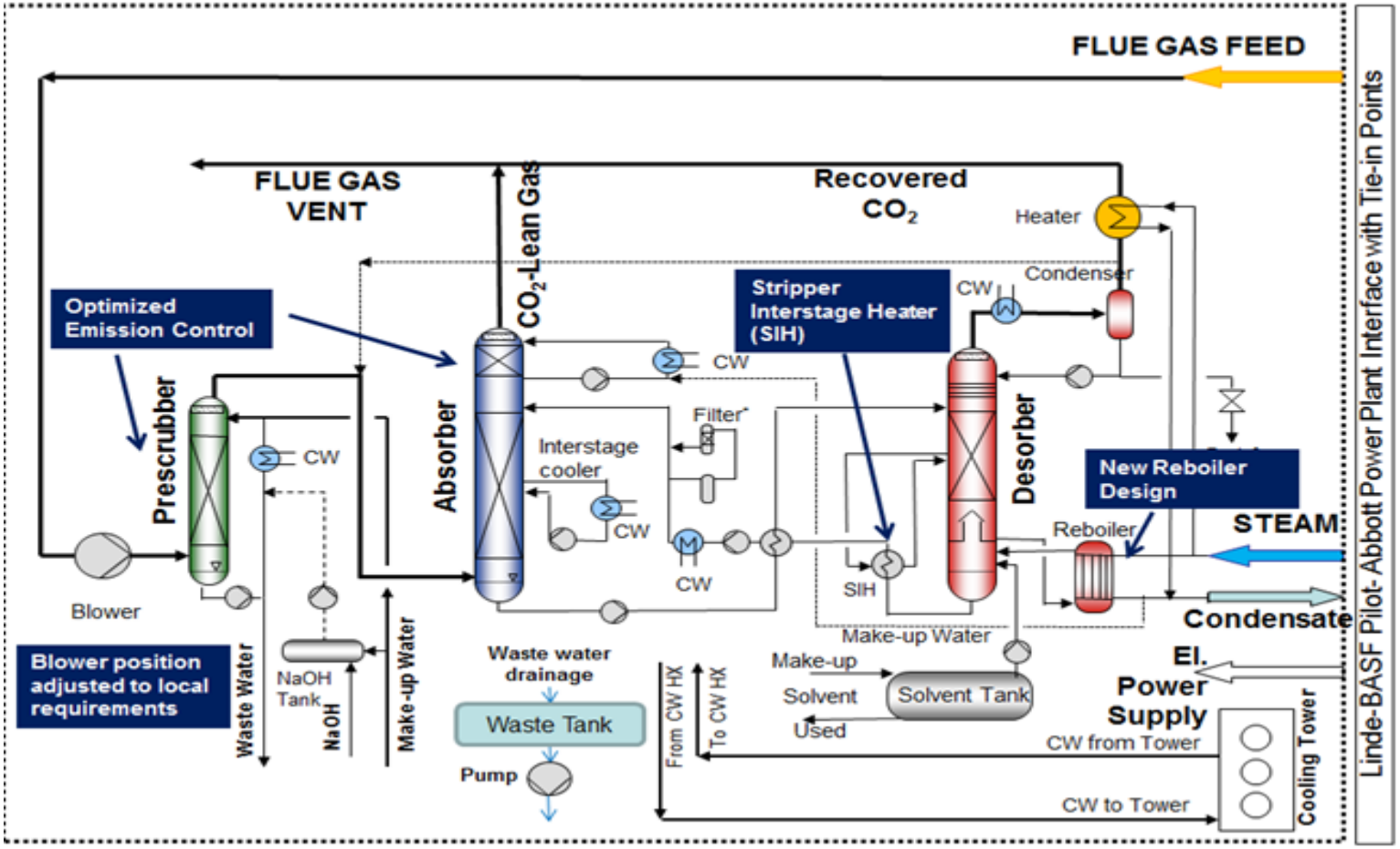
Ideal site for large scale pilot testing of coal and natural gas

- 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

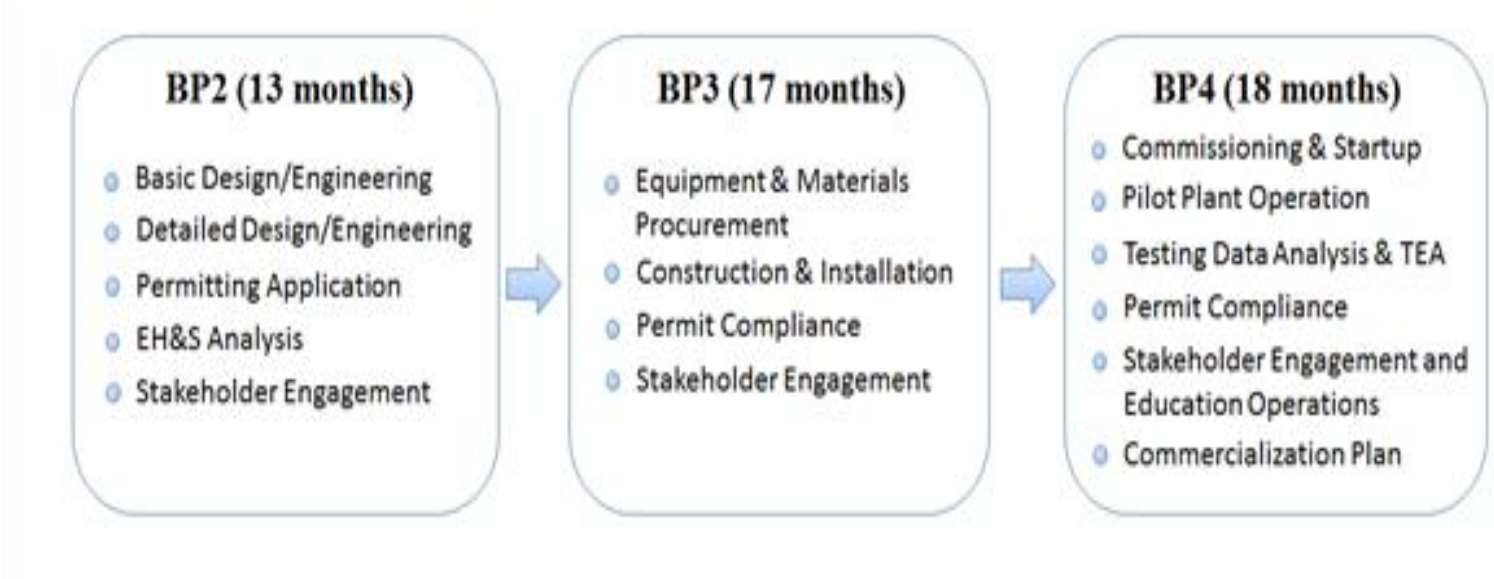
Overview of Capture System for Large Pilot Plant

Technology features



Overview of Phase 2 Project Schedule

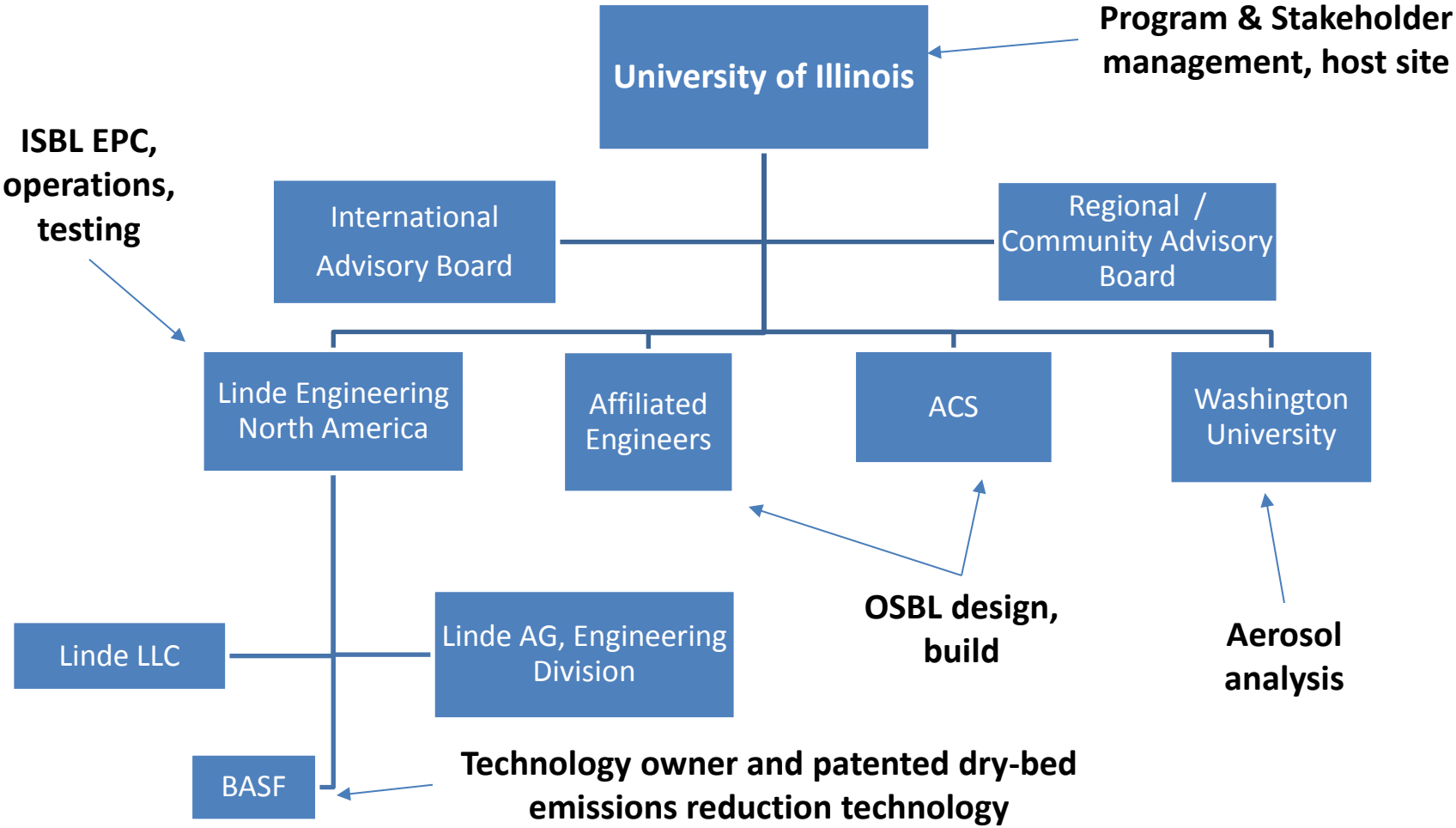
More than just a design, build, operate project



- ***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***

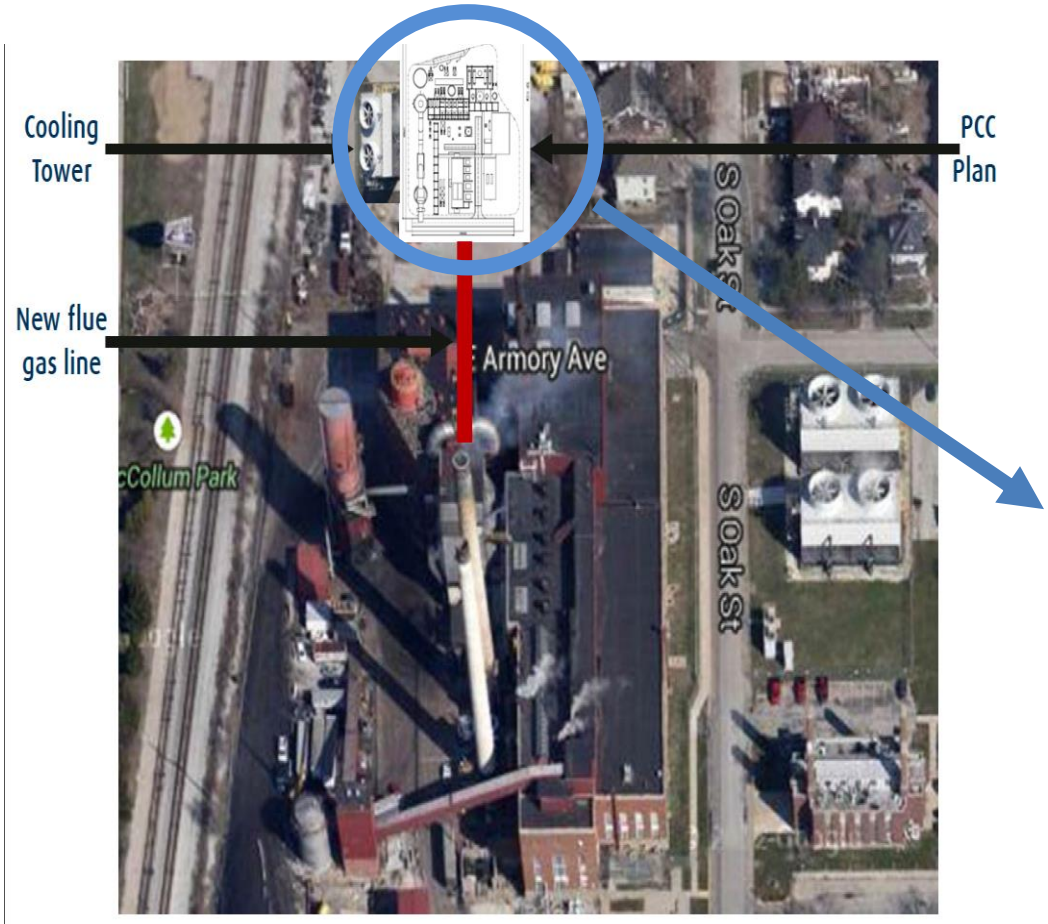
Phase 2: Project Organization Chart

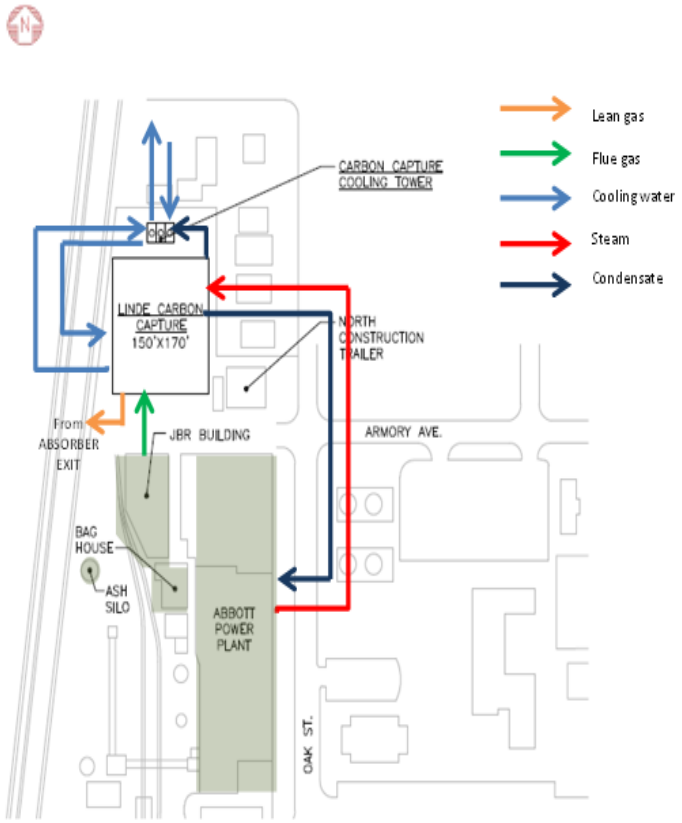
Added expertise in aerosols, OSBL procurement / construction, and dry-bed emissions reduction



Site for Carbon Capture Plant Established and Evaluated

Located close to Abbott Power Plant





Extract flue gas POST CEMS Unit

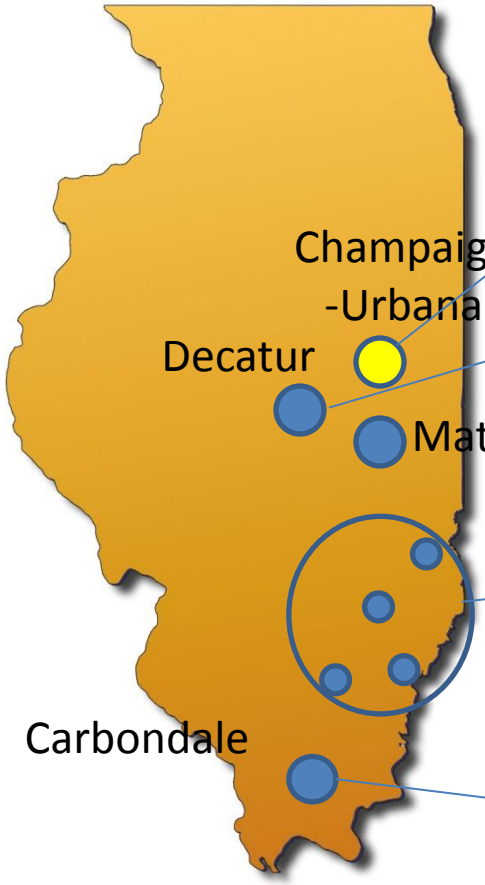
Regional & Global Test Bed for CCUS

Concentration of natural resources and intellectual capital

- Capture of CO_2 : Abbott Power Plant UIUC

ADM MGSC Richland Community College

- Storage of CO_2 : ADM Project



MATTOON
Mattoon, Illinois: *Working Together to Build the Future*

- Utilization of CO_2 : Enhanced Oil Recovery (EOR)

Illinois Eastern Community Colleges

- Operator Training

Southern Illinois University Carbondale

- Coal combustion

PRAIRIE RESEARCH INSTITUTE · ACS Design · Construction · Integration · Linde · BASF We create chemistry · NETL National Energy Technology Laboratory · AEI Affiliated Engineers · U.S. Department of Energy

Important to consider regional economy

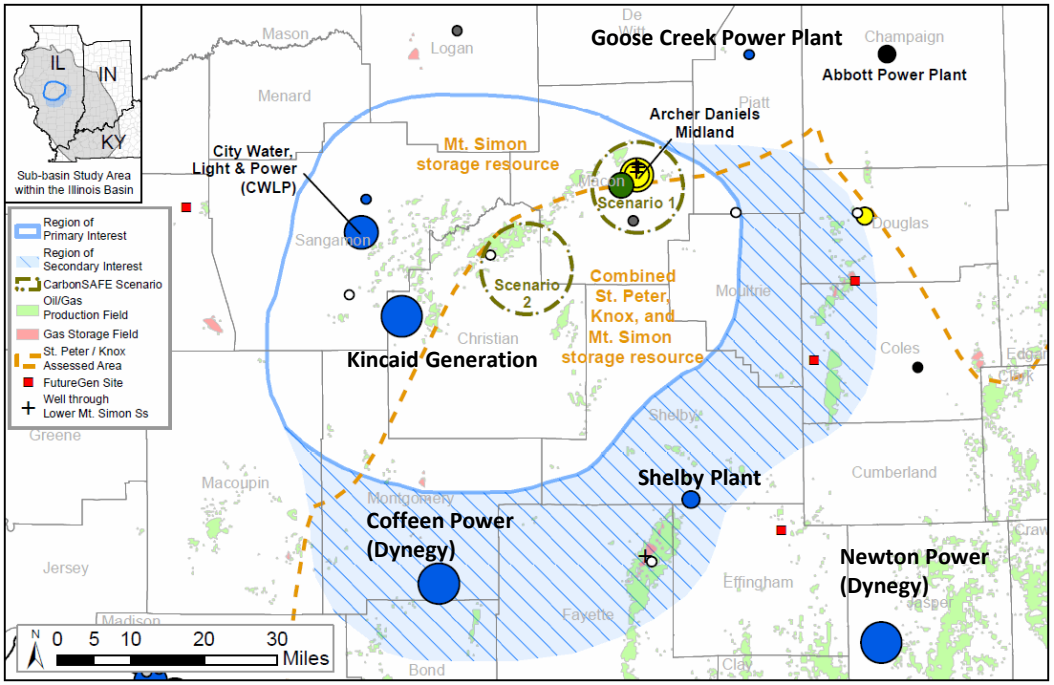
SYNERGISTIC UTILIZATION OPTIONS

CarbonSAFE ILLINOIS

Funded to match carbon "sources" with carbon "sinks"

$12M funding - Commercial-scale CCS opportunities for 50+ million tonnes CO_2 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**



ILLINOIS STATE GEOLOGICAL SURVEY
PRAIRIE RESEARCH INSTITUTE

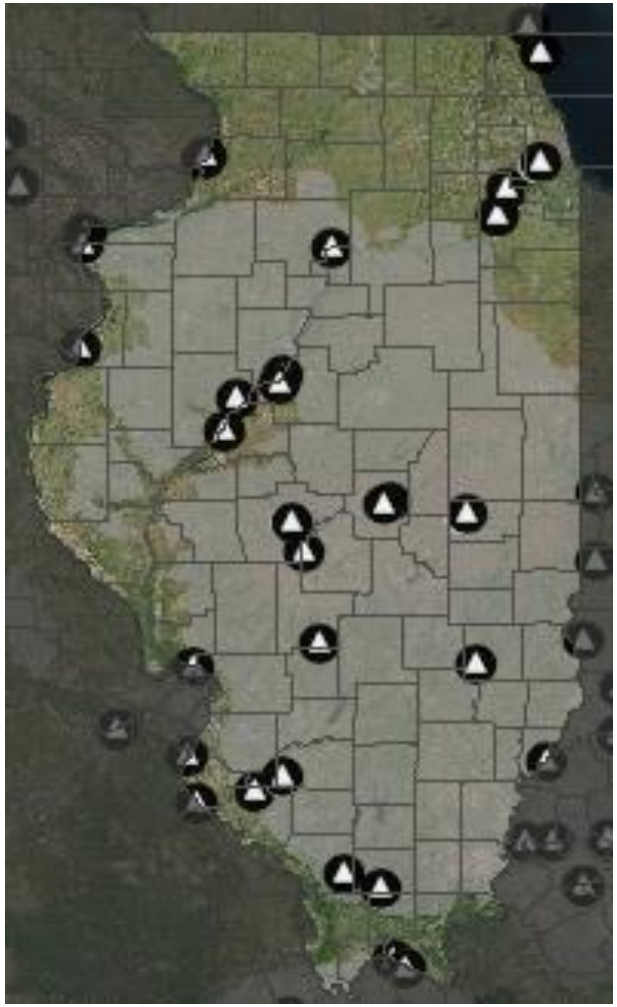
ILLINOIS SUSTAINABLE TECHNOLOGY CENTER
PRAIRIE RESEARCH INSTITUTE

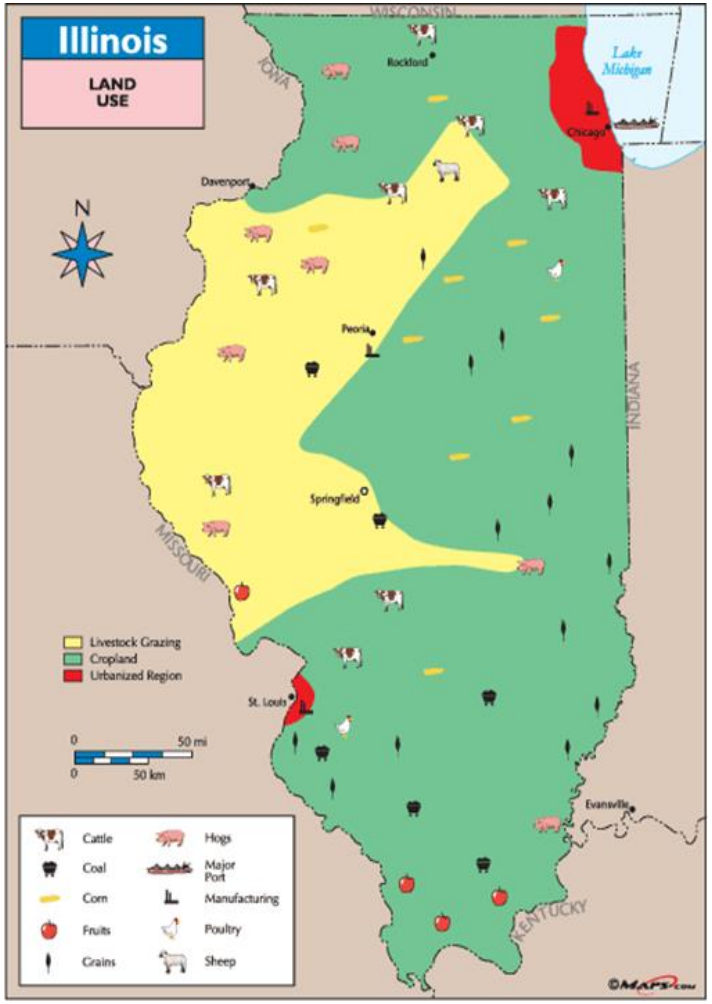
PRAIRIE RESEARCH INSTITUTE · ACS Design · Construction · Integration · Linde · BASF We create chemistry · NETL National Energy Technology Laboratory · AEI Affiliated Engineers · U.S. Department of Energy

Connection Between Coal-Fired Plants and Agriculture

Long standing relationship in Illinois

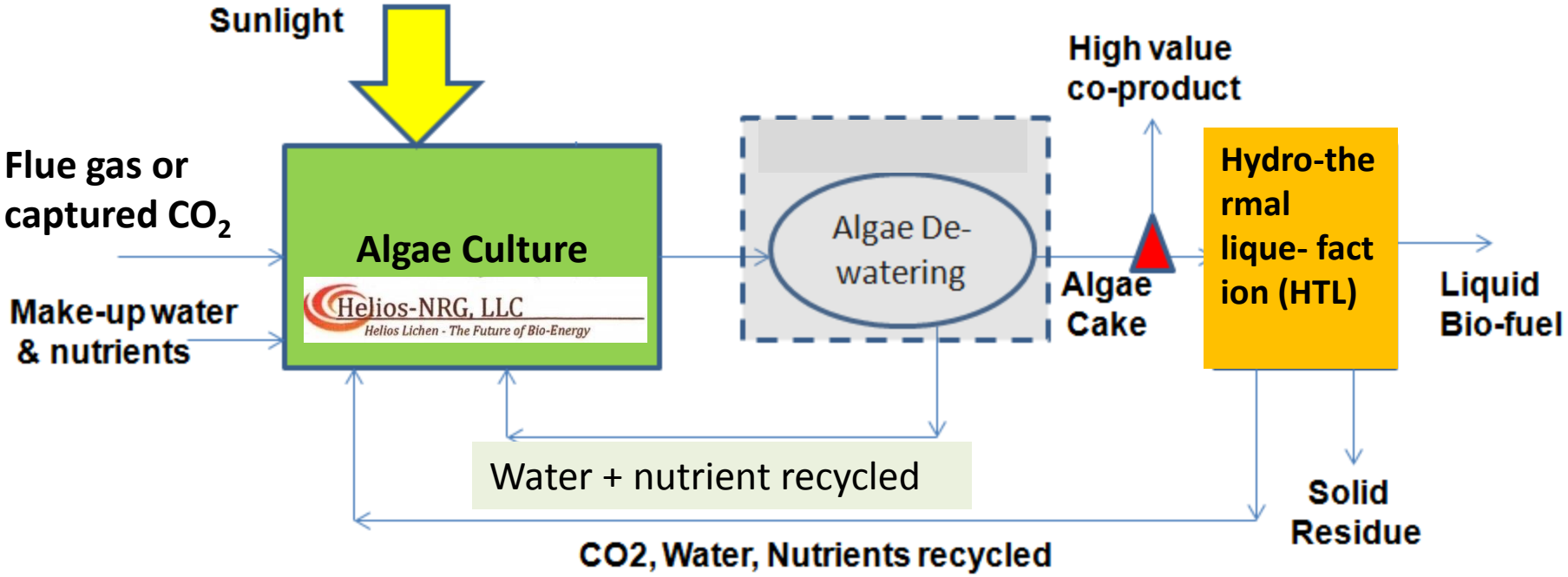
Coal fired Power Plants





CO_2 Utilization with Algae

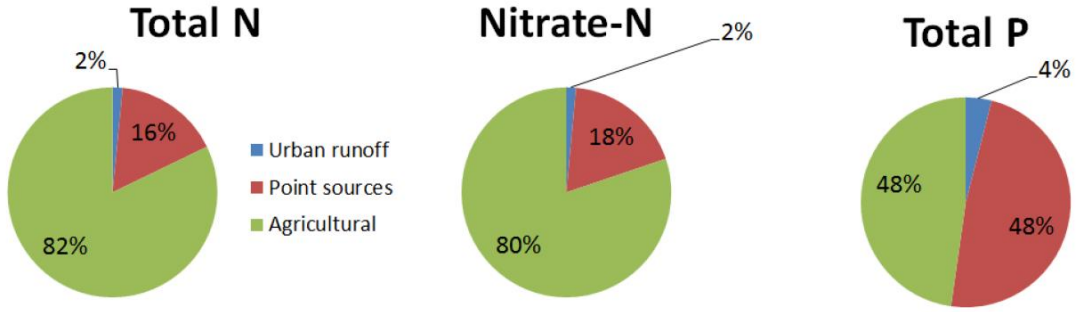
Synergistic with agricultural economy in Illinois



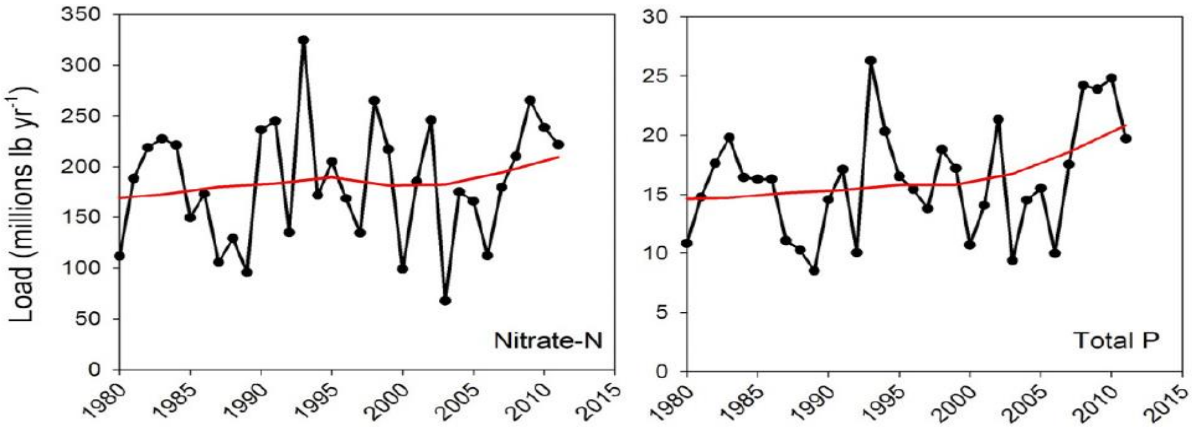
PRAIRIE RESEARCH INSTITUTE · ACS Design · Construction · Integration · Linde · BASF We create chemistry · NETL National Energy Technology Laboratory · AEI Affiliated Engineers · U.S. Department of Energy

Nutrient Loss Reduction: Critical to Illinois Agriculture

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



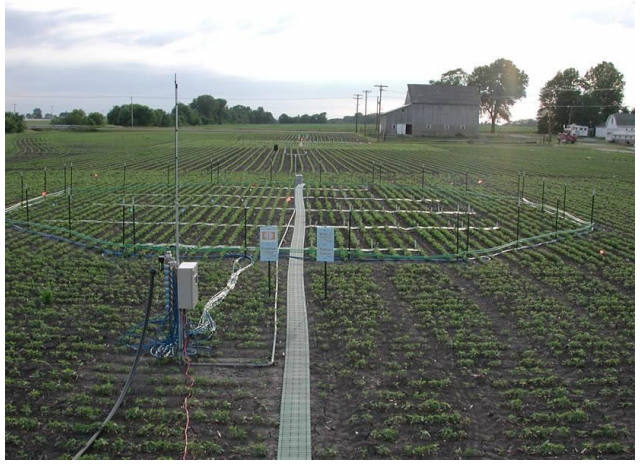
Nutrient sources in Illinois contributing to riverine nutrient export from the state



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/

Partners connected into relevant supply chains

WORKFORCE DEVELOPMENT

Training Operators and Engineers

Partners already connected into existing supply chains

ILLINOIS EASTERN COMMUNITY COLLEGES

Southern Illinois University Carbondale

Association of Illinois Electric Cooperatives

Your Touchstone Energy® Partner

EASTERN ILLINOIS UNIVERSITY

COLES-MOULTRIE Electric Cooperative

COLES Together
The economic development organization for Coles County

PRAIRIE RESEARCH INSTITUTE

ACS Design · Construction · Integration

THE LINDE GROUP Linde

BASF We create chemistry

NETL NATIONAL ENERGY TECHNOLOGY LABORATORY

AEI Affiliated Engineers

U.S. DEPARTMENT OF ENERGY

ACKNOWLEDGEMENTS

Name	Organization
Bruce W Lani	National Energy Technology Laboratory / US Department of Energy
Yongqi Lu, Vinod Patel, Hong Lu, Sallie Greenberg, Randy Locke, Deb Jacobson, Gary Miller	Prairie Research Institute / University of Illinois
Michael Larson, David Wilcoxen, Richard Rundus, Tracy Malvestuto	Abbott Power Plant / University of Illinois
Krish Krishnamurthy, Makini Byron, Joseph Naumovitz, Torsten Stoffregen, Ali Jangi, Andy Poplin	Linde
Sean Rigby	BASF
David Guth, Steve Bennett	Affiliated Engineers Inc.
Steve Davis, John Lowrey	Association of Illinois Electric Cooperatives

This project is supported by the U.S. Department of Energy / National Energy Technology Laboratory (DOE/NETL) through Cooperative Agreement No. DE-FE0026588