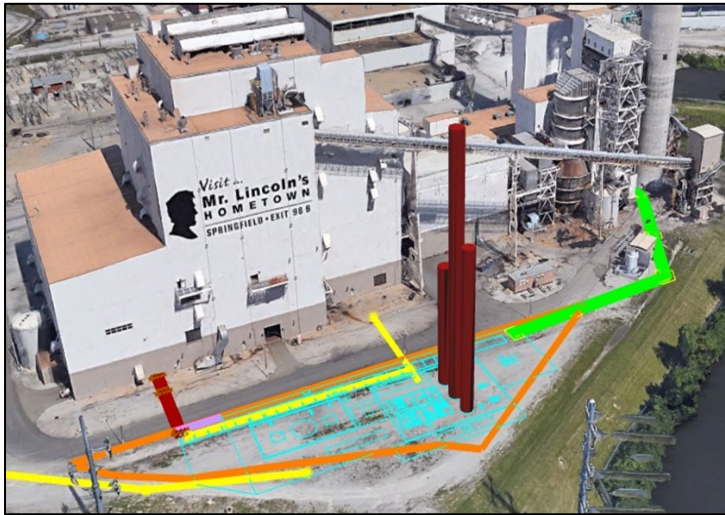


## Phase III Update

# Large Pilot Testing of Linde-BASF Advanced Post-Combustion CO<sub>2</sub> Capture Technology at a Coal-Fired Power Plant (FE-0031581)



***Kevin C OBrien, PhD***  
***Director, Net Zero Center of Excellence***  
***Director, Illinois Sustainable Technology Center***  
***Prairie Research Institute***  
***University of Illinois at Urbana-Champaign***

***Stephanie Brownstein***  
***Technical Lead Carbon Capture Scale-Up***  
***Illinois Sustainable Technology Center***  
***Prairie Research Institute***  
***University of Illinois at Urbana-Champaign***

***FECM/NETL 2024 Carbon Management Research Project Review Meeting***

***August 5, 2024***



**Prairie Research  
Institute**  
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN



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# PROJECT OVERVIEW

**Phase III Funding: \$80,727,332**

DOE: \$54,501,858

Non-DOE: \$26,225,474\*

Work Period: June 1, 2021 – May 31, 2026

*\*\$20 MM cost share supplied by the state of Illinois*

# PROJECT PARTICIPANTS



# PROJECT OBJECTIVES

**Overall:** Design, construct, and operate a 10 MW capture system based on the Linde / BASF advanced amine-based, post-combustion carbon dioxide (CO<sub>2</sub>) capture technology at CWLP Dallman Unit 4, Springfield, IL.

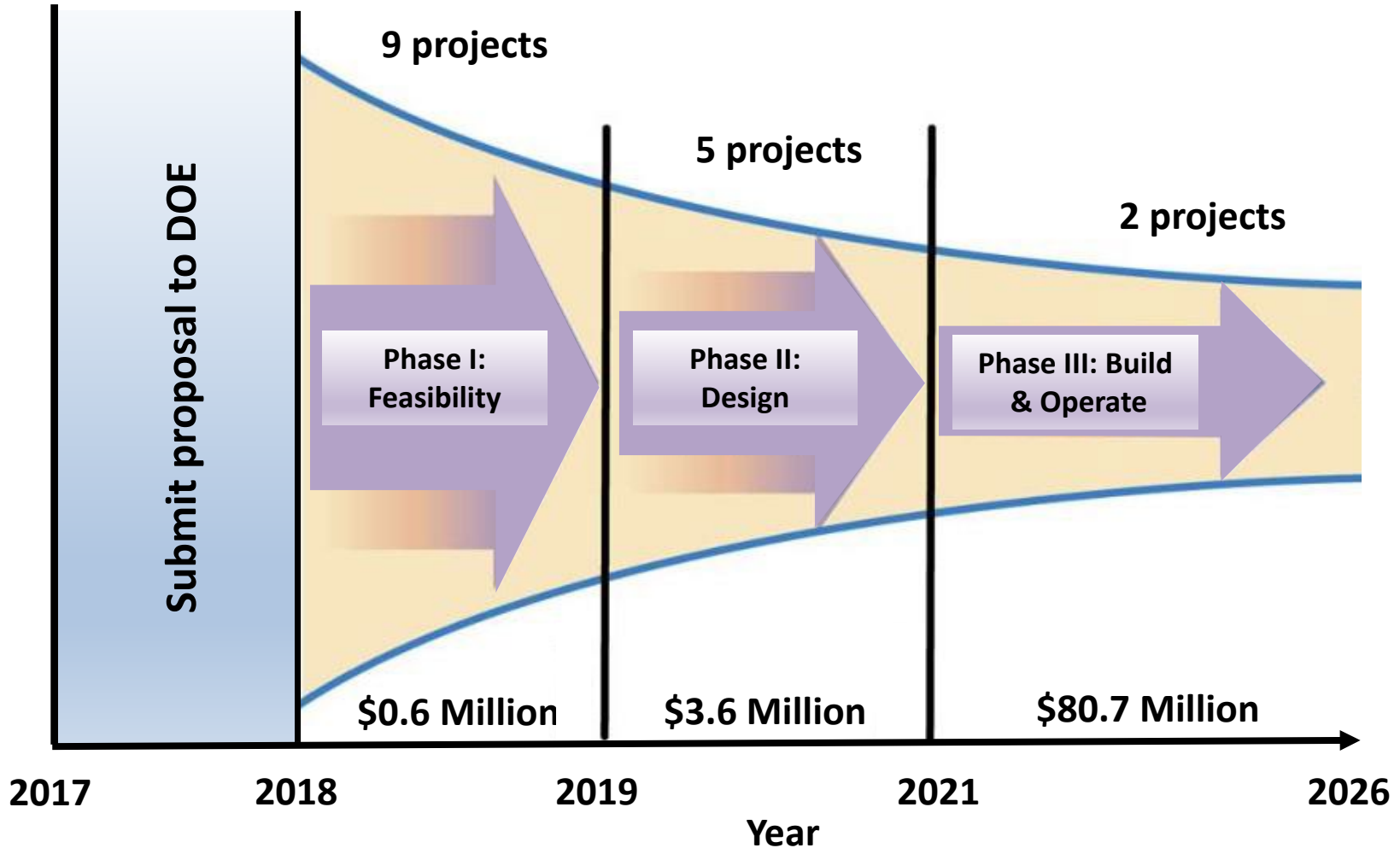
**Phase III:** Build / Operate 10 MW capture system and compare performance with results from 1.5 MW testing at the NCCC. If successful, keep system for evaluating future capture and utilization testing technologies.



*City Water, Light & Power (CWLP) in Springfield, IL  
Dallman Unit 4*

# UIUC / CWLP Team Wins Highly Competitive Phase III Award

*First-of-a-kind large carbon capture pilot: 10 MW advanced Linde/BASF solvent system*



# Prairie Research Institute: Experts in CCUS

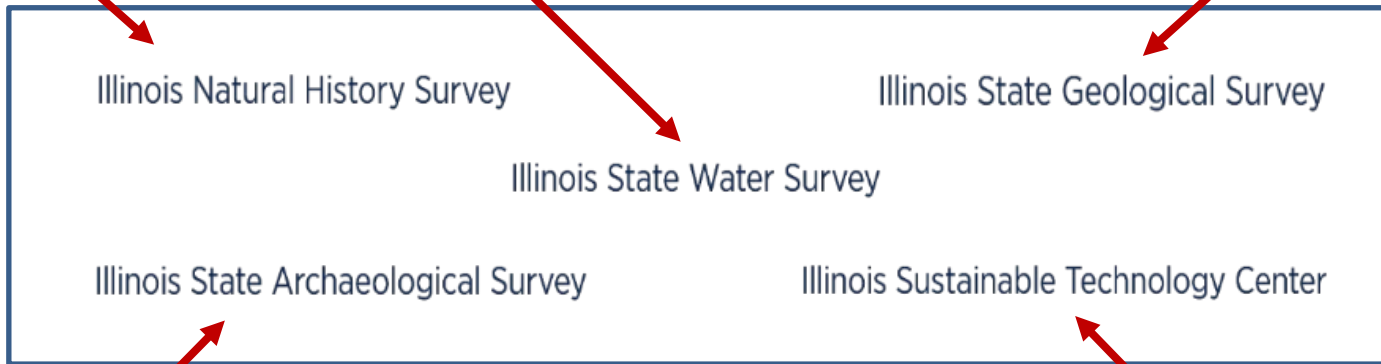
*“One-stop shop” to address project needs*



**Potential Endangered Species**

**Water Resources**

**Geological Storage**



Illinois Natural History Survey

Illinois State Geological Survey

Illinois State Water Survey

Illinois State Archaeological Survey

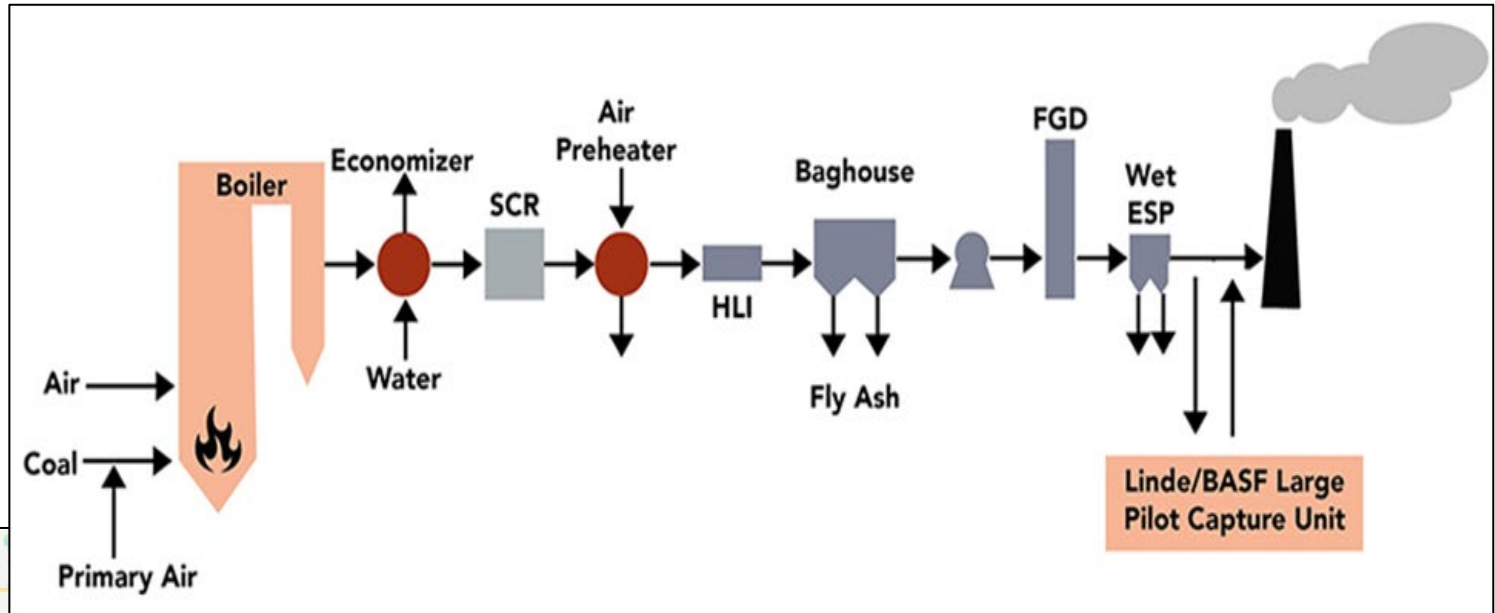
Illinois Sustainable Technology Center

**Potential Cultural Artifacts**

**Carbon Capture & Utilization**

# CWLP Location and Configuration

## Traditional PC plant

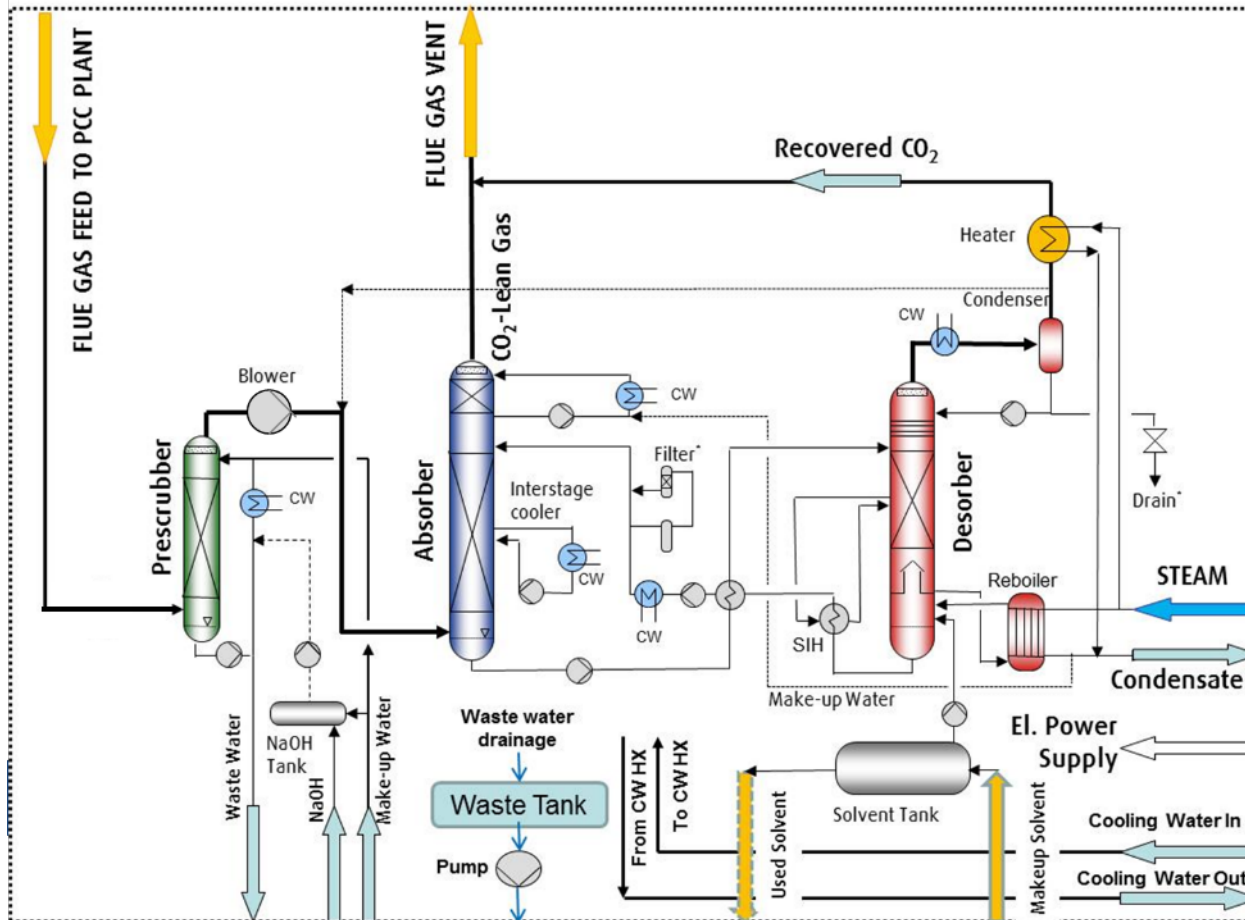


Dallman Unit 4 configuration

Location of city of  
Springfield within the  
state of Illinois



# Linde / BASF Solvent Based Capture System



## Reduced capital/energy costs

- Optimized BASF OASE® blue solvent
- Efficient CO<sub>2</sub> capture from low-pressure sources
- Longer solvent stability
- Lower solvent circulation rate

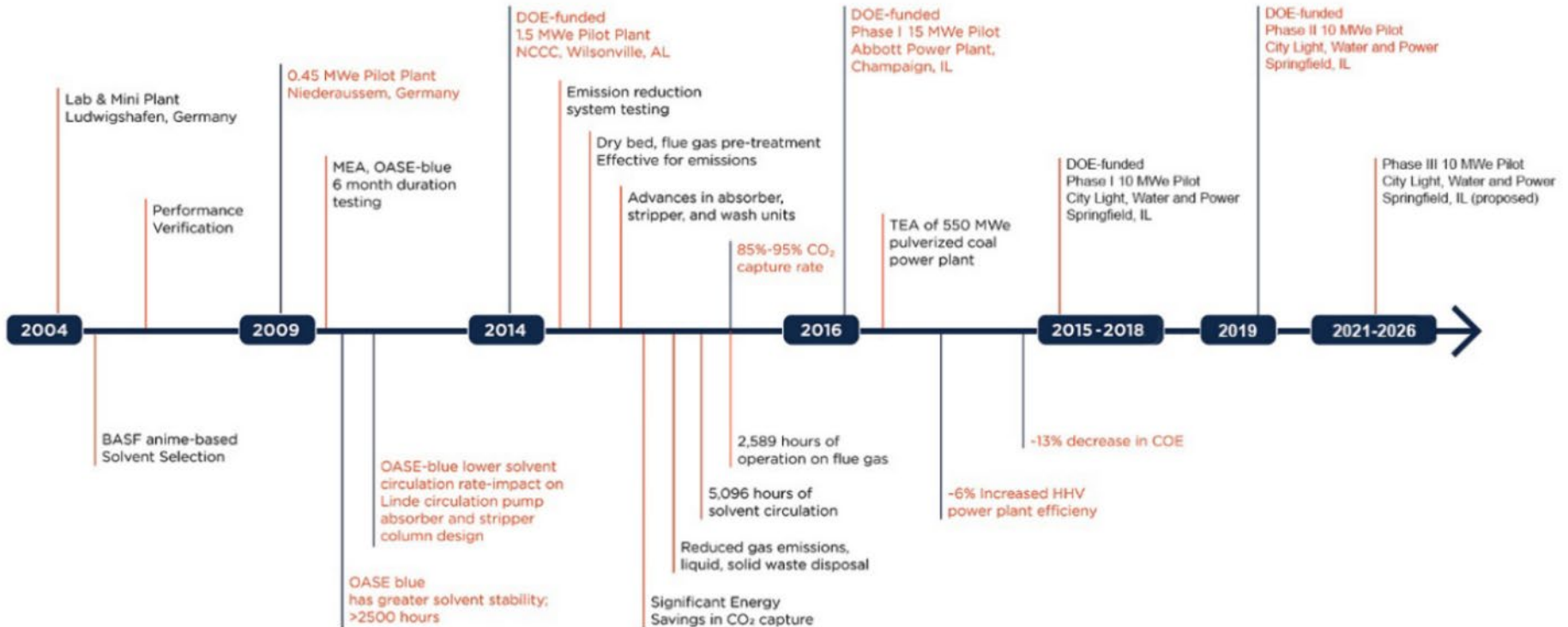
## Notable Linde process improvements

- Dry bed water wash design to minimize solvent losses
- Stripper regeneration at 3.4 bars reducing CO<sub>2</sub> compressor cost and power consumption
- Advanced Stripper Interstage Heater to reduce regenerator steam consumption



# Linde / BASF Technology Roadmap

*From lab scale to large pilot plant*



# Project Tasks for Phase III

Phase III consists of BP3, BP4, BP5

Blue = "Complete"

Orange = "In Progress"

Task #	Task	BP
1.0	Project Management and Planning	All BP
2.0	Baseline Techno-Economic Analysis (TEA)	BP3
3.0	Detailed Engineering and Specifications	
4.0	Permit Application	
5.0	Construction and Execution Plan	
6.0	Long Lead Item Equipment Procurement	
7.0	Equipment Procurement and Fabrication	BP4
8.0	Site Preparation and Foundations Installation	
9.0	Plant Construction and Installation	
10.0	Commissioning and Test Plan	
11.0	Start-up and Operations	BP5
12.0	Operations and Testing	
13.0	Analysis of Test Campaign Results	
14.0	Updated Techno-Economic Analysis (TEA)	
15.0	Update of EH&S Assessment, TMP, and TCP	
16.0	Economic Revitalization and Job Creation Outcomes Analysis	
17.0	Dismantling and Removal	

All BP3 tasks completed

Current status of BP4 tasks

Blue = "Complete"

Orange = "In Progress"

# Project Deliverables for Phase III

Task/ Subtask	Deliverable	Due Date
1	Project Management Plan	Update due 30 days after award. Revisions to the PMP shall be submitted as requested by the Project Manager.
1	Resource Loaded Schedule	Update due 30 days after award. Revisions to the PMP shall be submitted as requested by the Project Manager.
1	Earned Value & Risk Management Systems	Update due 30 days after award. Revisions to the PMP shall be submitted as requested by the Project Manager.
1	Workforce Readiness Plan	End of Budget Period 5
1	Environmental Justice Analysis	End of Budget Period 5
2	Baseline TEA	End of Budget Period 3
3.1	PFDs, P&IDs, and Utility Balances	End of Budget Period 3
3.1	Equipment Lists and Process Data Sheets	End of Budget Period 3
3.2	Plant Layout and General Arrangement Drawings	End of Budget Period 3
3	Final Detail Design Report	End of Budget Period 3
5	Construction Plan	End of Budget Period 3
10	Pre-Startup Safety Review (PSSR) Report	End of Budget Period 4
10	Pilot Commissioning and Test Plan	End of Budget Period 4
14	Updated TEA	End of Budget Period 5
15	Update of EH&S Assessment, TMP, and TCP	End of Budget Period 5
16	Updated Economic Revitalization and Job Creation Outcomes Analysis	End of Budget Period 5

# Cost Challenges

## *Equipment/material and labor market changes*

### ***Hurdle #1: Equipment and Material Costs (2022)***

- Supply chain issues
- Limited vendor bidding
- Shorter guaranteed quote period
- Moved quickly to “lock in” PO pricing and finish construction, reduce operation duration

### ***Hurdle #2: Mechanical, Electrical & Instrumentation (ME&I) Construction Costs (2023)***

- The “Great Retirement” removed highly experienced trades people from the work force
- Results in trades people with less experience performing tasks
- Bidders account for reduced efficiencies based on less experienced work force
- Negotiated additional funding with DOE and project team members to support operations

***ISTC is working to help alleviate work force constraints through DEIA initiatives.  
Create more trades people from disadvantaged groups.***

# Risk Management Review

*Most recently updated April 2024*

Probability of Occurrence	Impact of Risk				
	1 Very Low	2 Low	3 Medium	4 High	5 Very High
5 Very High					
4 High					
3 Medium					
2 Low					
1 Very Low					

## *Items removed from “high risk”*

- ISBL equipment and module cost overruns (based on updated budget)
- ISBL construction and installation cost overruns (based on updated budget)
- OSBL construction and installation cost overruns (based on updated budget)

## *New risks identified*

- Impact of construction safety events to the project
- Impact of operations safety events to the project
- Unplanned or exceeded emissions or releases during operations

## *Remaining “high risk” item*

- Unavailability of operators and key individuals with relevant experience and know-how
  - Linde will utilize a 3rd party union contractor for daily operations
  - Shortened duration of test period may create challenges in sourcing operators (higher risk)
  - Linde will provide experienced engineers and site managers to oversee testing and analysis (low risk)

# Summary of Societal Considerations and Impacts

## *Environmental Justice of major interest in the Illinois region*

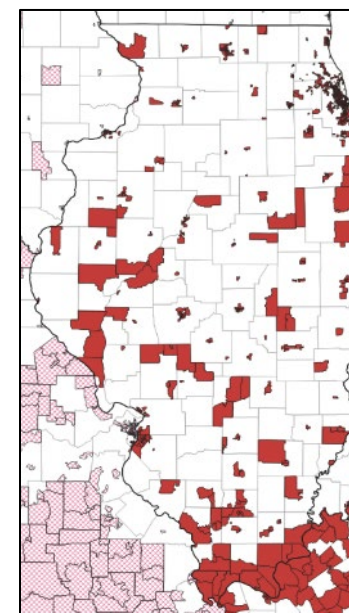
### Project Deliverables

- **Workforce Readiness Plan** – describe the skillset and availability of the workforce needed for future commercialization and deployment of the technology
- **Environmental Justice Analysis** – focus on the impact of the project in terms of advancing racial equality and support for underserved communities

### Project activity update

- Initiated social characterization/stakeholder mapping process of the surrounding areas to assess key EJ issues impacting regions
- Leveraging coalition building and community engagement accomplished through Illinois Climate and Equitable Jobs Act which is aligned with DOE’s Justice40 Initiative objectives

Disadvantaged communities (dark red) in Illinois



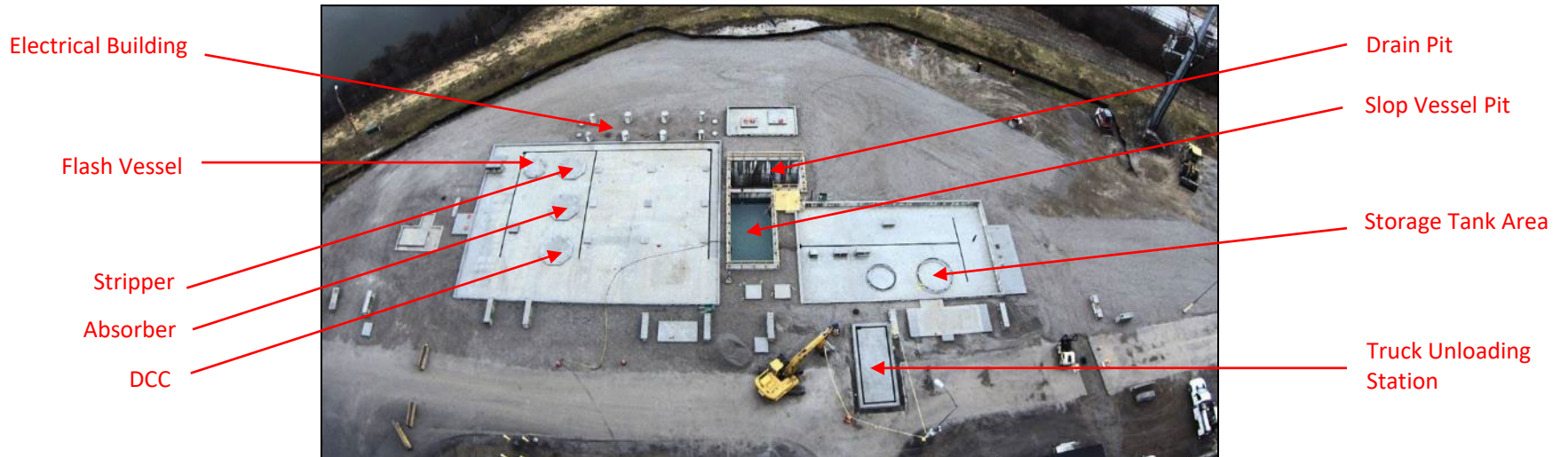
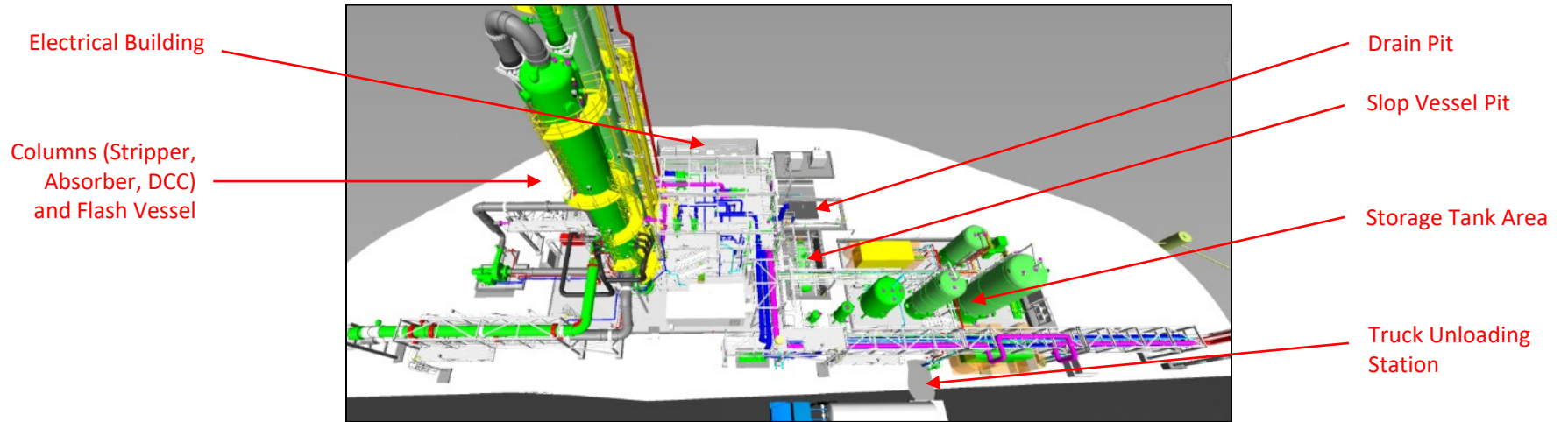
EJ profile of Springfield, IL and surrounding communities

Census Tracts	Region	DAC	Coal Employment	Job Access	Low Income Population	Less High School Education	Energy Burden	RMP Proximity
17167001400	Springfield, Sangamon	0	0.000396432	-10	0.503816794	0.242663657	2	1.139092131
17167000800	Springfield, Sangamon	0	0.000396432	-9.9	0.658695652	0.25786802	6	3.22086381
17149952800	Nebo village, Pike	1	0.000940937	-1.2	0.262	0.148560209	6	0.459473255
17115000200	Decatur, Macon	1	0	-4.8	0.605683837	0.195710456	7	2.525183636
17163504500	East St. Louis, St. Clair	1	0.000369986	-6.8	0.685061846	0.145545797	7	4.382510421

# **CONSTRUCTION UPDATE: A STORY IN PICTURES**



# Large Pilot – ISBL Progress



# Large Pilot – ISBL Progress



Modules at fabricator shop



Columns at fabricator shop



Columns erected on-site

- Equipment procurement complete
- Site foundations and civil work complete
- All columns/vessels fabricated, delivered, and installed
- All modules fabricated, delivered, and installed
- Oxidation system fabricated, delivered, and installed
- Finalizing ME&I construction



# Construction & Installation

*Status: Near Completion*

Construction status as of 7-29-24

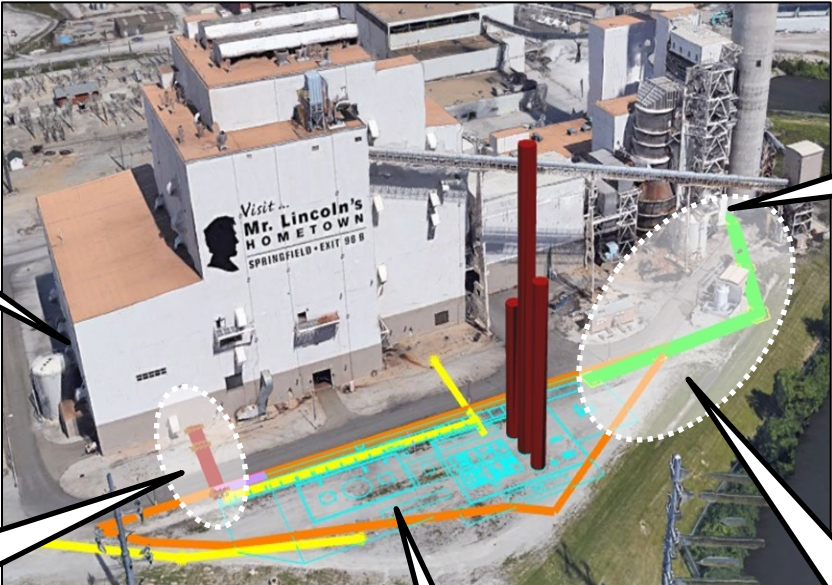




# Large Pilot – OSBL Construction



Cooling Water Piping & Tie-In



Flue Gas Ducting Tie-In



Utility Bridge



Transformer



Flue Gas Ducting Bridge

Visits from Stakeholders

Filing for Membership in International Carbon Capture Test Network

# **PROJECT CREATING HIGH VISIBILITY FOR CWLP AND SPRINGFIELD**

# Teesside University Visit

*July 2023: Transatlantic Net Zero Centre of Excellence*



Successful meeting to explore joint collaborations and better understand UIUC projects





# Sussex University Visit

*August 2023: Performing worldwide analysis of CCUS projects*



Provided on-site information to support industrial decarbonization research



# Ribbon Cutting Ceremony at CWLP

*June 2024: Stakeholders from unions, elected officials, DOE*



# **FINAL COMMENTS**

# Lessons Learned

- Weekly project team calls
- Coordination required to implement an Inadvertent Discoveries Plan during groundbreaking activity
- Strategies to manage cost increases
  - Move quickly to “lock in” pricing of PO’s
  - Adjust operation plan
  - Long term: DEIA focus, workforce engagement

# Next Steps

- Commissioning
  - Planned to begin September 2024
- Start-up and calibrations
  - Planned to begin December 2024
- Operations and testing
  - Planned to begin March 2025
  - 8 to 10 months duration

# Plans for Future Development

- Integrated demonstration FEED (200 MW)

# Summary and Conclusions

- Budget Period 3:
  - On-time completion and within budget
  - Procurement of long lead time equipment complete
- Budget Period 4 progress:
  - All equipment procurement complete
  - Site foundations and civil work complete
  - Off-site module/column/vessel fabrication complete
  - ISBL and OSBL construction close to completion
  - Market and labor induced cost increases have occurred for materials, equipment, and construction
  - Increased stakeholder financial commitment and financial support
  - Preparing for commissions, start-up, testing and operations
    - Pre-Startup Safety Review (PSSR), test plan, assigning resources

# Acknowledgements

Name	Organization
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Jesse Santos, Grace Mierl, Rodolfo Gonzalez	BASF
David Guth	Affiliated Engineers Inc (AEI)
Ted Allison	Affiliated Construction Services (ACS)
Daryl-Lynn Roberts, Will Johnson	Visage Energy

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