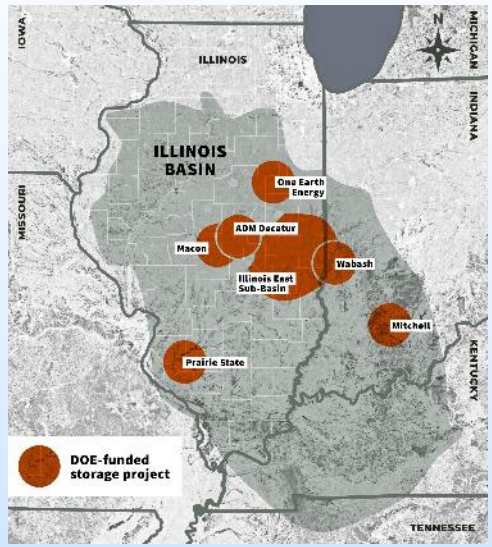
Illinois Basin Regional Direct Air Capture (DAC) Hub

Project Number: DE-FE0032375



Kevin C. OBrien, PhD and Chinmoy Baroi, PhD

University of Illinois Urbana-Champaign

Prairie Research Institute

Net-Zero Center of Excellence

2024 FECM/NETL Carbon Management Research Project Review Meeting
August 5 – 9, 2024

Disclaimer

Project Overview

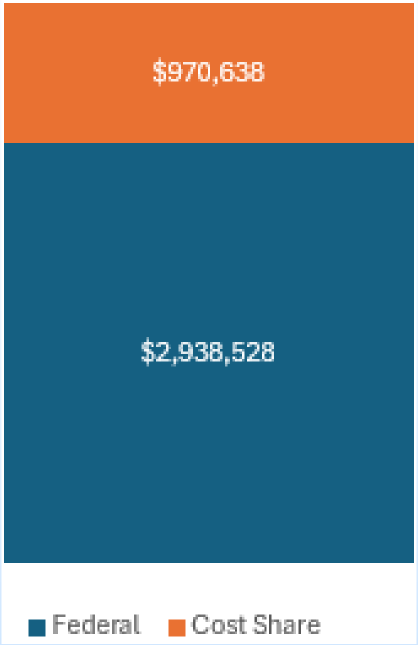
Total Funding: $3,909,166

DOE: $2,938,528

Cost Share: $970,638

Work Period 1: Jul 1, 2024 – Mar 31, 2025

Work Period 2: Apr 1, 2025 –Jun 30, 2026



Project Participants:

Prairie Research Institute
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

NET ZERO CENTER of EXCELLENCE

CarbonCapture™

Heirloom

earthrise energy

Visage CLEAN ENERGY CONSULTING

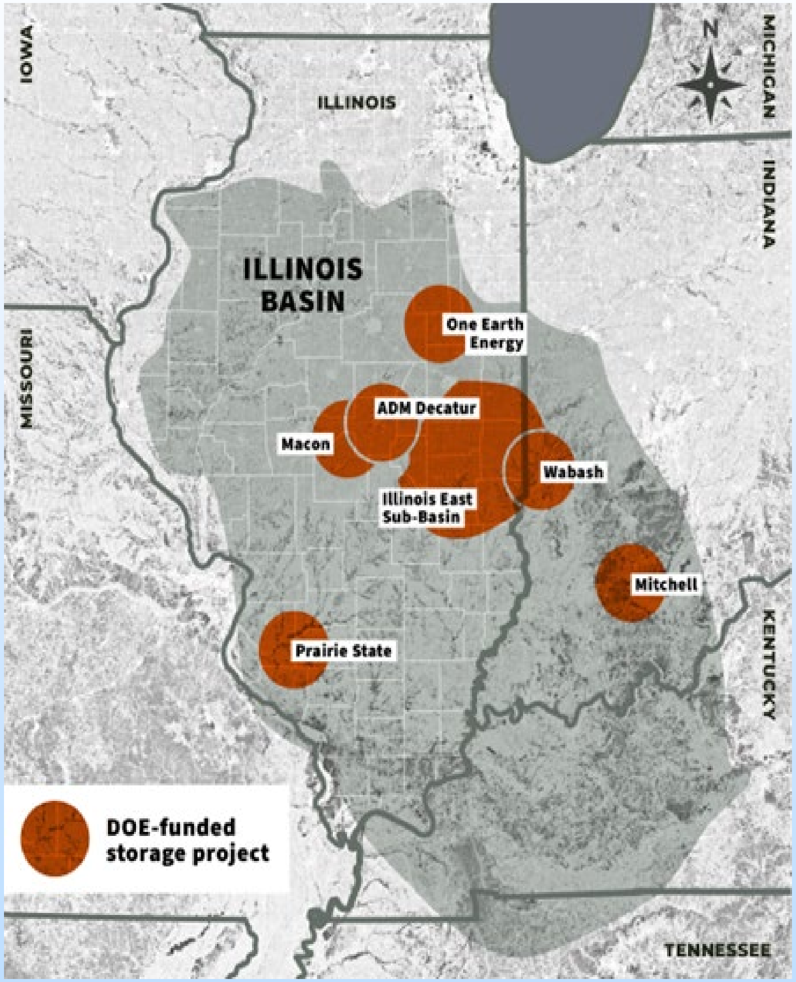
OZINGA

CARBON CURE

One Earth Energy

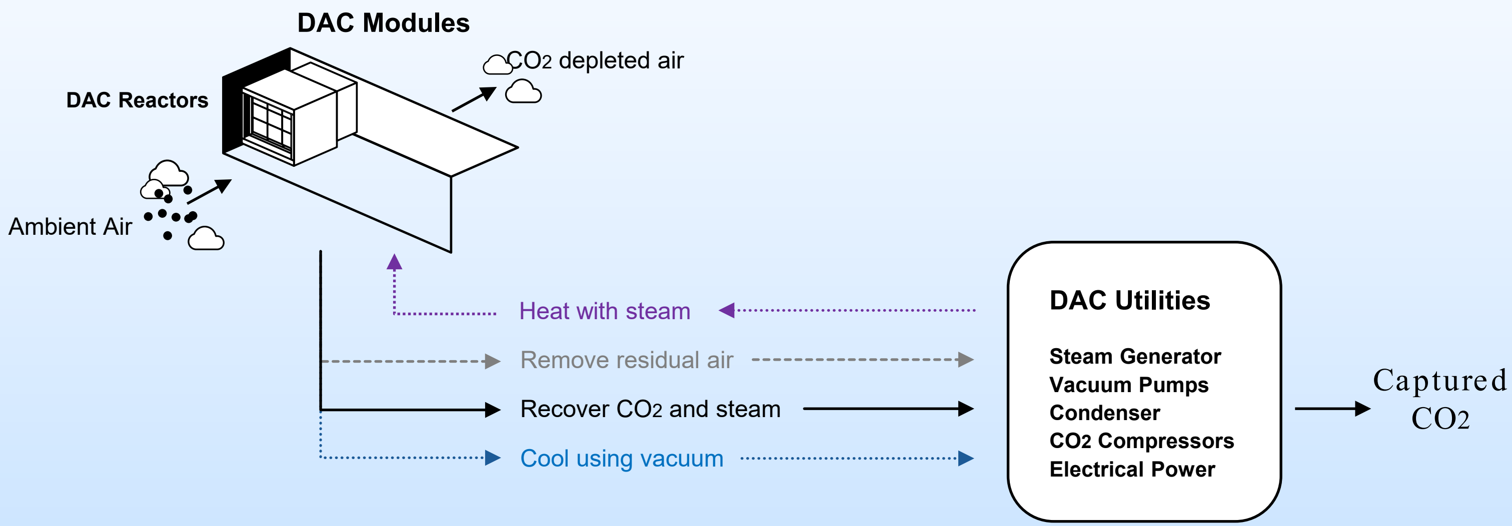
Project Objectives

- Plan and optimize the design of a DAC Hub that utilizes one of the best geological storage regions in the world – the Illinois Basin.
- Hub has simulated cumulative capacity to store nearly 1 Gigatonne of CO_2.
- 1 Megatonne CO_2 is small fraction of the total storage potential of the region.
- Hub will be designed for an initial capacity of 200 KTA (year 1 of operation) with the ability to rapidly expand above and beyond 1 MTA.
- DAC technology providers will be Carbon Capture Inc. (100 KTA) and Heirloom (100 KTA).



Carbon Capture Inc (CCI) DAC Technology

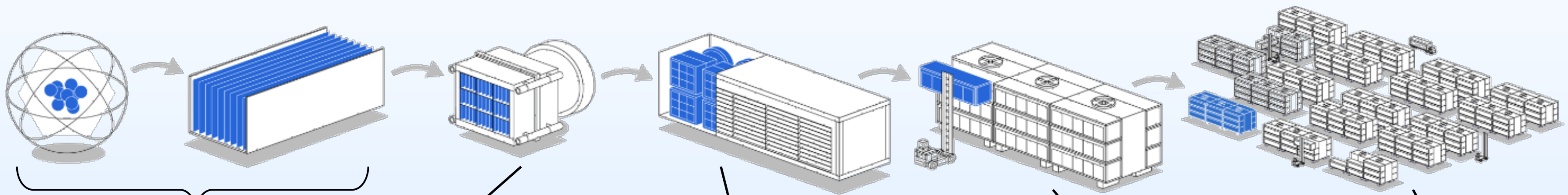
CCI advanced DAC technology adsorbs CO2 from ambient air using structured solid sorbents heated with low-temperature steam and cooled under vacuum.



Technology highlights:

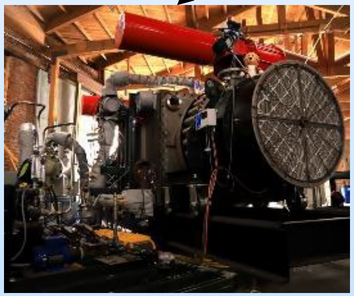
- Centered around structured sorbents (TRL 8), reduces risk and accelerates deployment of commercial projects
- Modular design accelerates deployment timelines while fostering continuous improvements in design and cost efficiencies at scale
- Open Systems Architecture allows for the upgradability of existing sorbents and hardware, ensuring ongoing enhancements in performance throughout its lifespan.

CCI Deployment Progress



Ongoing

Structured sorbent development



2022 (operational)

1st commercial scale reactor with structured sorbent

Los Angeles

Single reactor (35 tons/year)

2024 (operational)

1st commercial scale module with structured sorbent

Los Angeles

Multi-reactor module

(500 tons/year)

2025 (in construction)

Commercial pilot

Multi-module cluster

(2000 tons/year)

2026+

1st commercial scale project

CarbonCapture™

CCI Technology Demonstration

CCI Technology Demonstration

On June 21, CCI debuted its Leo Series DAC Modules in front of 150 people at an unveiling event in Long Beach, CA.

Key features of CarbonCapture's Leo Series

- First to use structured sorbents
- First designed for mass manufacturing
- Each module is equipped with 12 DAC reactors
- Nominal capacity of 500 tons/year
- Generates a concentrated stream of CO2 at 95+% purity
- Each module is roughly the size of a shipping container

At the event, **Saeb Besarati**, Chief Technology Officer, and team members conducted a live cycle of Leo in what audience members touted as the most transparent and comprehensive demonstration they've seen in the DAC industry.

[Watch the demonstration]

CarbonCapture™

CCI Leo Series Module

What stakeholders are saying

"What CarbonCapture has accomplished is a direct air capture system designed for mass production. That's a critical milestone for any technology. It's especially exciting to see it in direct air capture."

Brad Crabtree
Assistant Secretary, U.S. Department of Energy

"The technology that they [CarbonCapture] have delivered today confirms that we can, when we pull together, invent and simplify incredibly powerful technologies that should give us all enormous hope in the fight against climate change."

Nick Ellis
Principal, Amazon Climate Pledge Fund

"I've been a DAC enthusiast/nerd for about 20 years and in the field for 6 and this is the first real, living breathing DAC system I've ever stood next to. I had goosebumps walking next to the unit."

Chris Neidl
Co-founder of The OpenAir Collective and Board Member of the Direct Air Capture Coalition

Trump can't cool Republicans' ardor for this climate tech

By BLANCA BEGERT | 06/24/2024 09:01 PM EDT

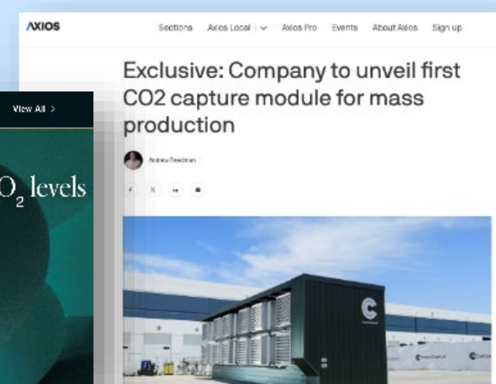
With help from Alex Nieves, Wes Venteicher and Camille von Kaenel

TOP OF THE DAY

CLIMATE CALIFORNIA | What AI farming looks like | California water usage is down | Oil wells in the path of fires | Death Valley's extreme heat | View All

CLIMATE & ENVIRONMENT

Carbon-capture projects launch in Los Angeles County as CO_2 levels reach global records



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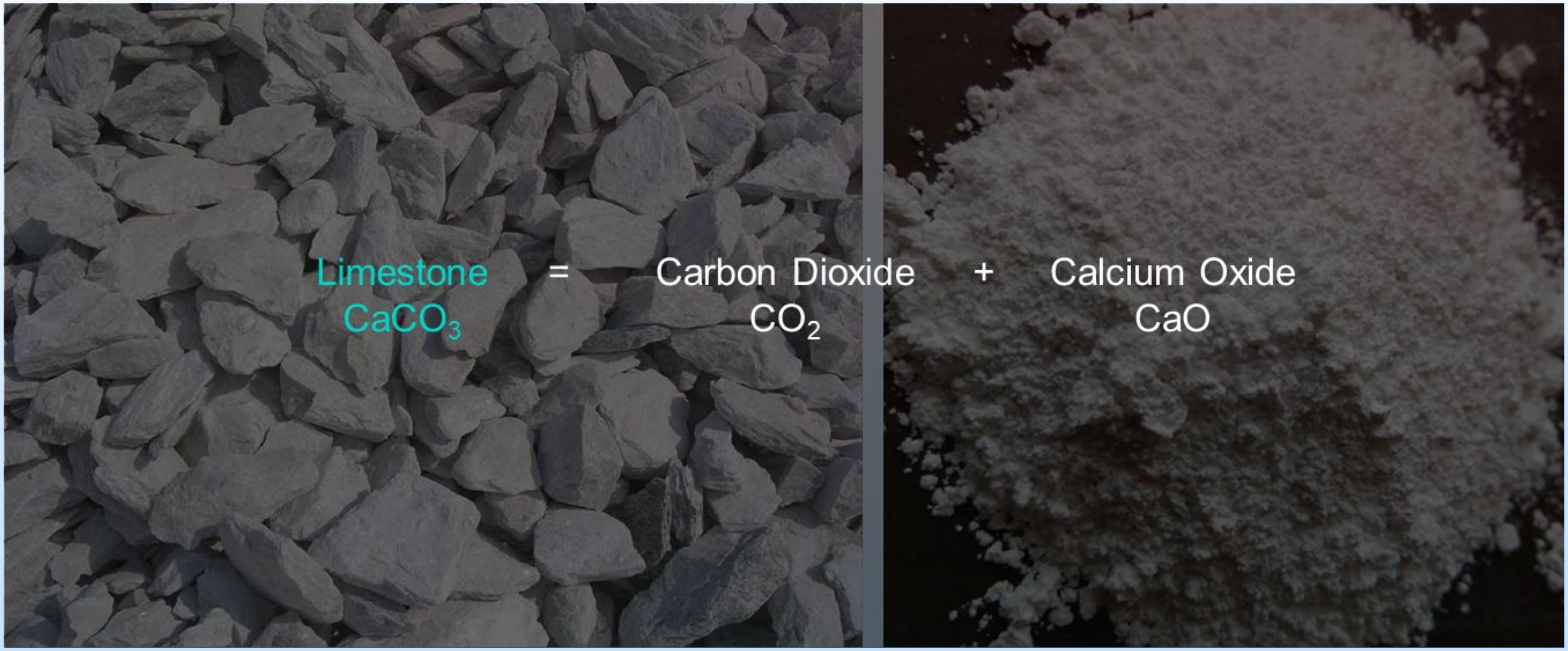
Exclusive: Company to unveil first CO2 capture module for mass production

Heirloom DAC Technology

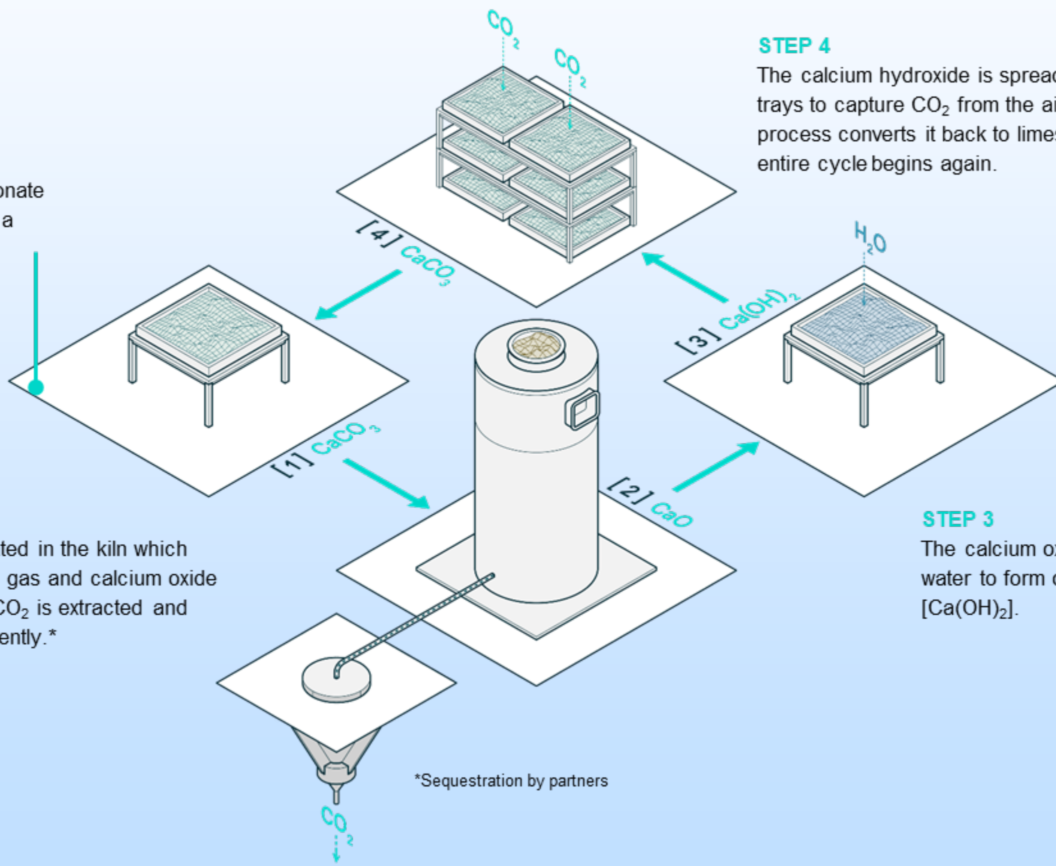
Use limestone to pull CO_2 from the atmosphere at low-cost



Heirloom Looping Process

STEP 1
Heirloom takes crushed calcium carbonate [CaCO3] or limestone and places it in a renewable-powered electric kiln.

STEP 4
The calcium hydroxide is spread onto stacked trays to capture CO_2 from the air for 3 days. This process converts it back to limestone, and the entire cycle begins again.



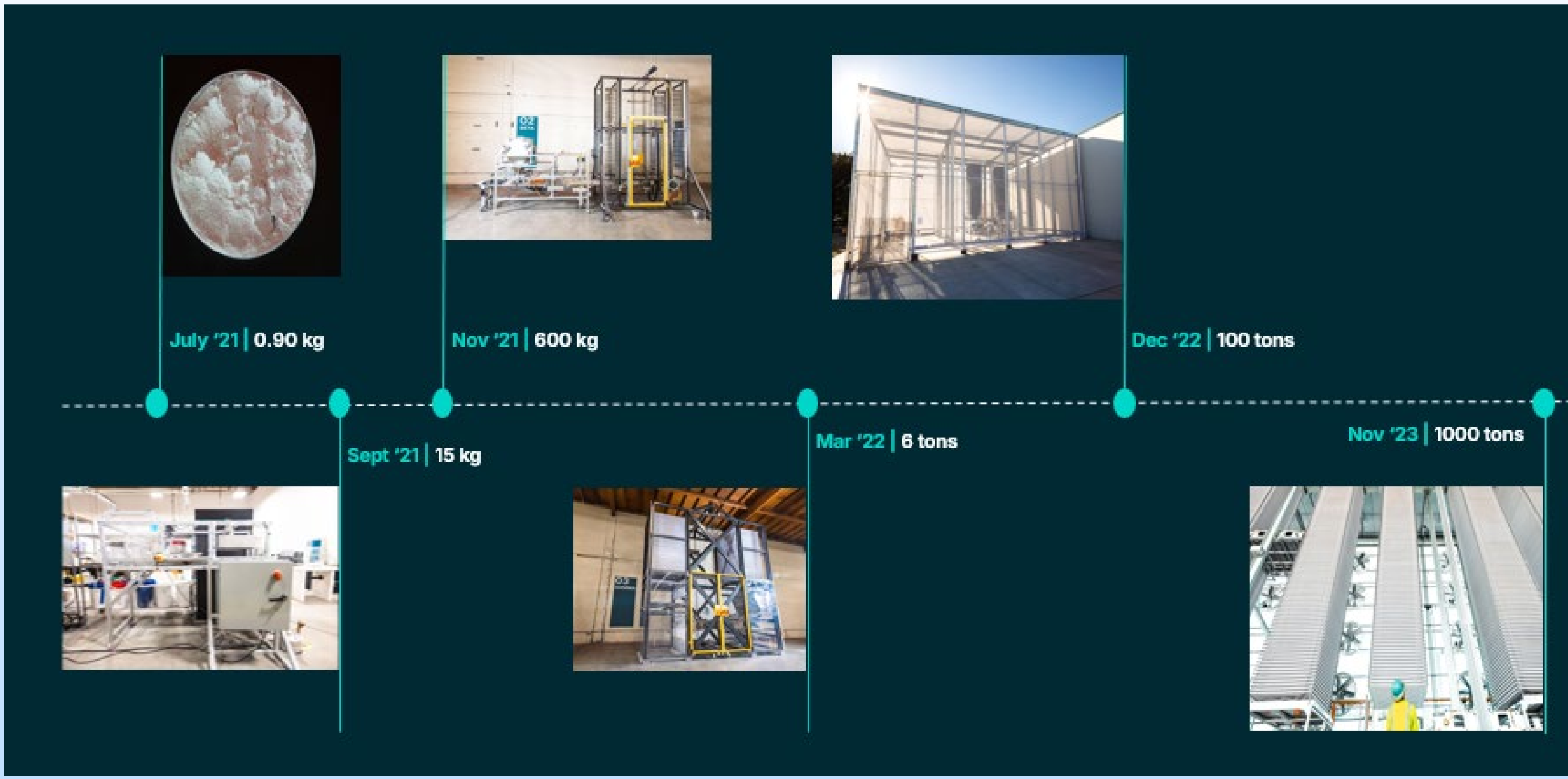
STEP 2
The limestone is heated in the kiln which separates it into CO_2 gas and calcium oxide [CaO] powder. The CO_2 is extracted and sequestered permanently.*

STEP 3
The calcium oxide is hydrated with water to form calcium hydroxide [$Ca(OH)_2$].

*Sequestration by partners

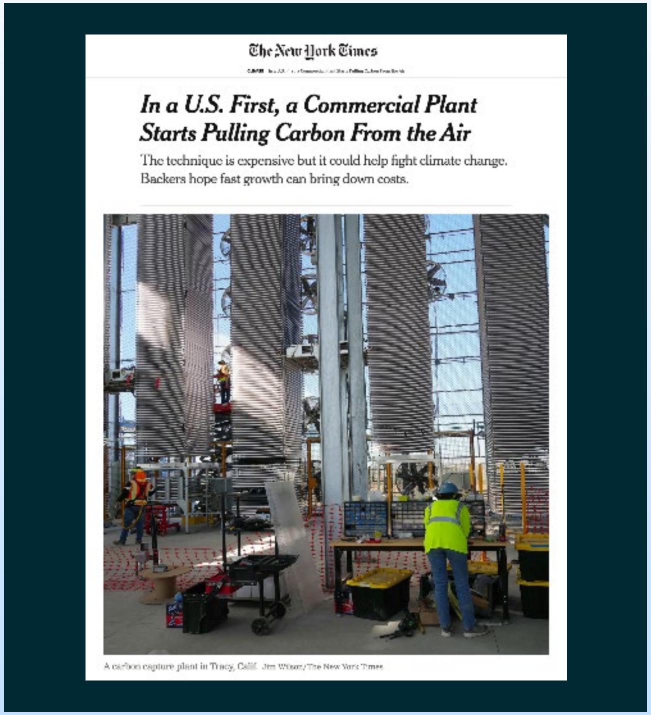
Heirloom DAC Technology Roadmap

From 1 kilogram to one tonne of CO_2 in 2 years



Heirloom’s Technology Demonstration

Nov 2023: America’s First Commercial DAC Facility (~1,000 tonnes)
July 2023: Heirloom announces two DAC facilities in Louisiana (~320,000 tonnes)



The New York Times

In a U.S. First, a Commercial Plant Starts Pulling Carbon From the Air

The technique is expensive but it could help fight climate change. Backers hope fast growth can bring down costs.

A carbon capture plant in Tracy, Calif. Jim Wilson/The New York Times

Heirloom

Technology Background (CO_2 utilization)

CARBON CURE™

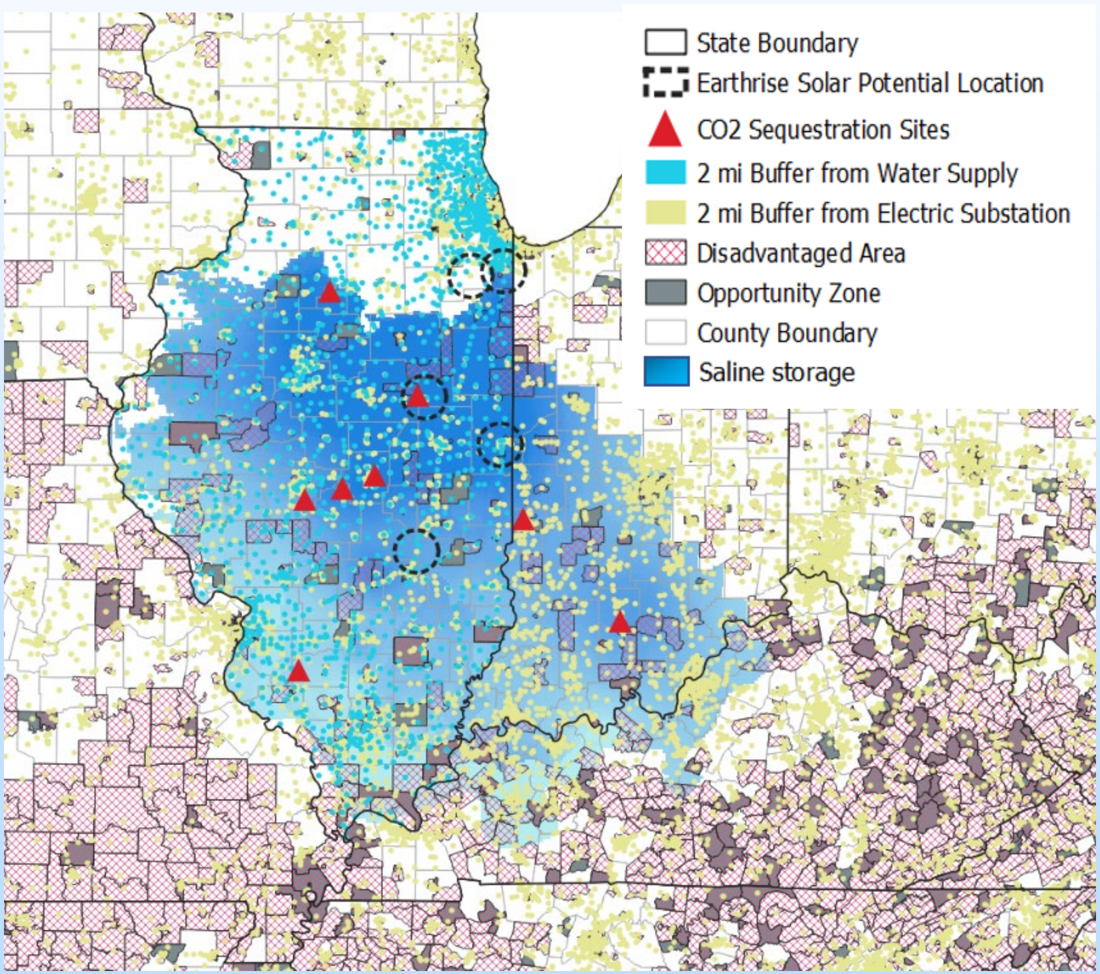
OZINGA®

CarbonCure's CO_2 Dosing Tank and Utilization System

CO_2 incorporated into cement

Technical Approach

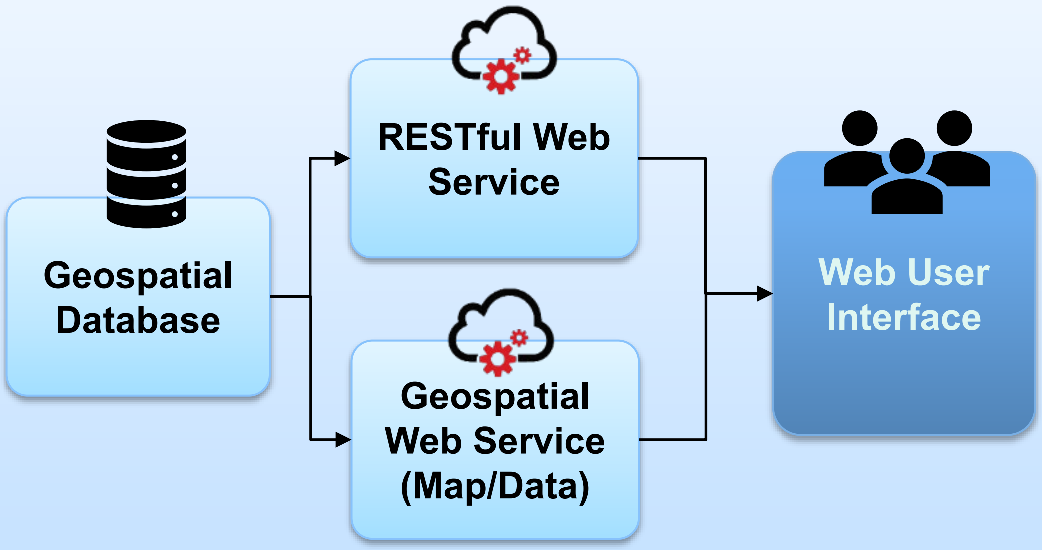
IL Basin DAC Hub: A master planned community



- Methodology that could be applied to other hubs
- Identify proximity to existing storage networks
- Identify current point source and DAC projects
- Identify locations of renewable energy close to DAC units and substations
- Availability of water
- Minimize CO_2 transport requirements
- Identify EJ communities and explore impact on communities

Technical Approach

IL Basin DAC Hub: Planning Tool



- Possible example requirements:
  - Identify proximity to existing storage networks
  - Identify current point source and DAC projects
  - Identify locations of renewable energy close to DAC units and substations
  - Availability of water
  - Minimize CO_2 transport requirements

Project Scope

Milestone Title & Description	Planned Completion Date
Project Management Plan	30 days after award
Business Plan	90 days prior to end
Financial Plan	90 days prior to end
Initial Technology Maturation Plan(s) (TMP)	45 days before Phase 0a completion
Final TMP	90 days within project end
CBP Development Proposal	45 days before Phase 0a completion
Full CBP	90 days prior to end
Preliminary LCA	45 days before Phase 0a completion
DAC Hub Data Tables	Due at project completion
Integrated DAC System pre-FEED Study	90 days prior to end
DAC Hub BOP Concept Design	90 days prior to end
Updated LCA	90 days prior to end
Storage Field Development Plan	90 days prior to end
EH&S Risk Analysis	90 days prior to end
Integrated Project Schedule	90 days prior to end

Project Risk Matrix

Perceived Risk	Risk Rating : L,M,H Probability	Impact	Overall	Mitigation and Response Strategy
Financial				
Cost share for project not obtained or insufficient	L	H	L	•Cost share commitment letters obtained. •All entities providing cost share are financially sound.
Capital costs of common infrastructure (e.g., storage wells, pipelines, transmission lines) excessive for relatively small scale DAC projects initially.	M	H	M	•Common infrastructure will leverage synergies with other projects. i.e., wells and pipeline will be developed with wide capacity to enable ammortization of common infrastructure with point-sources to achieve economies of scale and reduce overall costs per tCO_2 removed.
DAC is not immediately financially attractive in the USA	M	H	M	•Business case analysis will explore future projections and highlighted actions required to make this approach attractive in the USA; government support through the Infrastructure Bill and increased corporate interest are already mitigating these risks.
Cost/Schedule				
Project costs and/or schedule overruns	L	H	L	•Team has previous experience conducting DOE projects on budget and on time.
Tasks require significantly more time than expected	L	H	M	•Preliminary results from each entity (DAC / CO_2 utilization providers and engineering firms) provide good basis and understanding. •Prior scale-up performed by each entity provide a good basis of understanding.
Technical / Scope				
Challenges in identifying feasible CO_2 storage	L	H	M	•Storage developer included in Hub team, with several Class VI wells applications in process. Ample capacity in IL Basin, with well understood geology and several CarbonSAFE projects.
Challenges in securing sufficient land for DAC and supporting renewable energy infrastructure	L	H	M	•Availability of land across IL, with near access to storage, pipelines and/or utilization. A site selection tool with layers for land use, location of storage, location of power lines, environmental, water and social considerations will narrow location to most suitable areas. •A renewable energy developer is part of the DAC Hub team, and has secured land for solar PV development. Supply of energy to the DAC Hub can be through a physical transmission line (when co-located) or through virtual Power Purchase Agreement.
Insufficient water supply	L	M	L	•Preliminary water requirements have been estimated by DAC providers and are deemed to be low. •A site selection tool includes considerations for water availability, with multiple of sources in area.
Difficulties in scaling up to meet 1 million TPA	L	H	M	•Anchor technologies are of modular design. Scaleup will be based on mass production of modules at controlled manufacturing facility. This enables scaling CO_2 removal capacity with low risks to performance.

Project Risk Matrix

Management, Planning, and Oversight				
Availability of key personnel for project	L	M	L	•Commitment received from partner organizations.
Unrealistic planning base/assumptions in project schedule may result in delays of project implementation	L	M	M	•Clear and carefully planned timeline created in collaboration with designers and engineers. •Scenario-based planning, using conservative assumptions and adequate contingency time for activities on the critical path of the project. •Bottom-up planning of individual activities.
Deficient project management may result in inefficiencies and delays	L	M	M	•Integrated, holistic project management set up. •Adequate allocation of experienced/qualified personnel to project management. •Detailed milestone planning. •Structured meeting, monitoring, and reporting structure to ensure real-time transparency. •Defined decision-making structures and processes.
EH&S				
Project may create longterm risks from effluent or sorbents handling	L	M	M	•Planning efforts will consider logistics for safe handling of sorbents, reduction / treatment of any effluents, and minimization of EH&S risks to communities.
External Factor				
Negative Stakeholder response to proposed capture system/study	L	M	L	•Discussions with officials from three states show support for the project. •Community benefits plan will include stakeholder engagement activities and measures to ensure that benefits from the project will reach the community.
Issues related to COVID-19 delay execution	L	M	L	Team has worked virtually for months. Communication process currently in place that uses remote work tools, e.g. Microsoft Teams.

Summary of Community Benefits

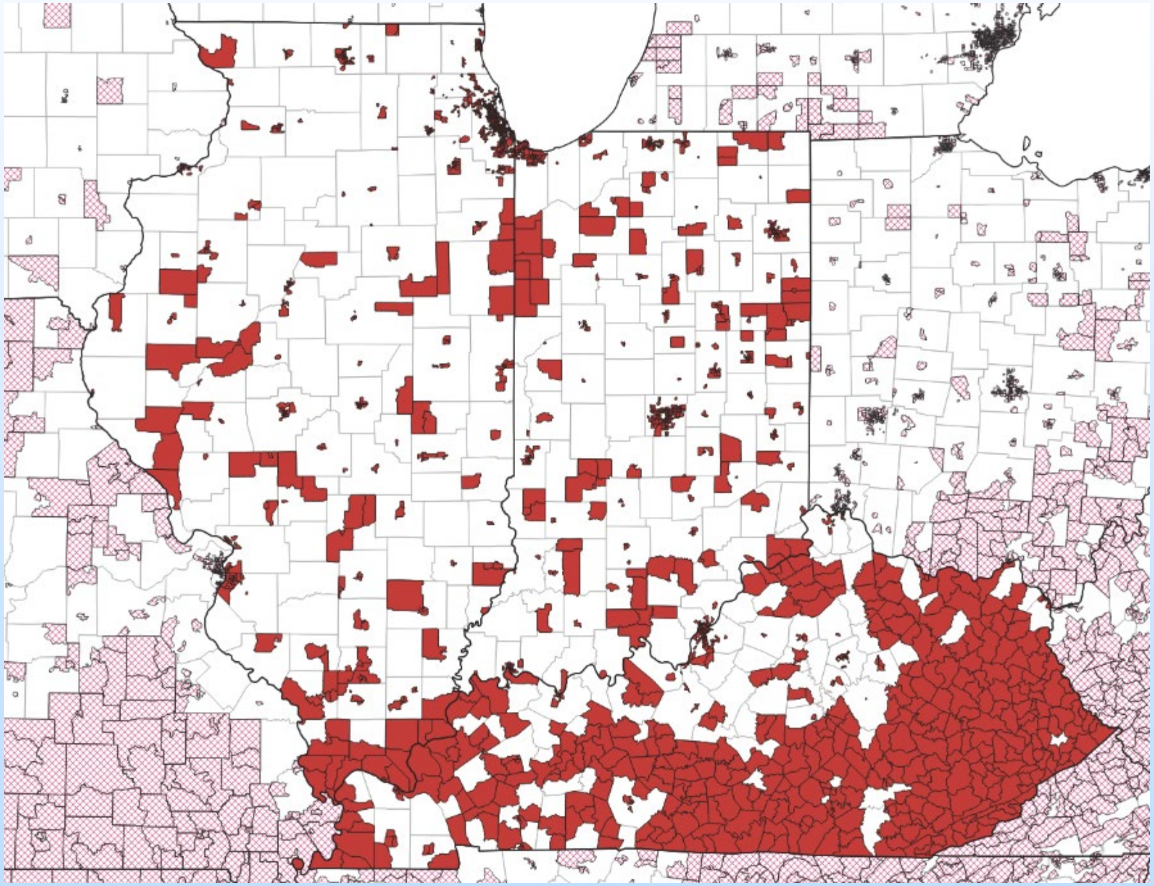


Figure. Disadvantaged communities (dark red) in Hub

- Southern region heavily impacted by coal mining, coal-based power plant emissions.
- Northern region impacted by industrial pollution.

Visage Energy Backgrounder

Stakeholder Engagement

Technology Commercialization Advisory

Industry/Market Analysis

30+ years of experience in providing strategic consulting services

Carbon Management

- Direct Air Capture
- Carbon Utilization
- Point Source Capture for:
  - Power generation
  - Industrial Sources

Environmental and Climate Justice

- Disadvantaged Community (DAC) Engagement
- Economic Revitalization and Workforce Preparedness
- Diversity Equity and Inclusion

Renewable Energy and Energy Storage

- Community Microgrids
- Investment in DAC Communities
- High Performance Computing grid modeling

Snapshot: Current/Past Client & Collaborators:

Kiewit
Prairie Research Institute, University of Illinois Urbana-Champaign
Sargent & Lundy
Holcim
USS
Ozinga
Carmeuse
Linde
Air Liquide
CarbonCure
ecotek
CarbonCapture
Frontier energy
electricore
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
SRI International
West Coast Regional Carbon Sequestration Partnership
California Public Utilities Commission
Pacific Gas and Electric Company
Edison International
State of California Energy Commission
SoCalGas
California ISO
bp
Williams
Exergonix

IL Basin DAC Hub CBP/SCI Overview

Justice40 Analysis

Justice40 Implementation:
- Develop strategies, methods, and milestones to maximize benefits and minimize negative impacts in IL Basin region.

Impact Mitigation Plan:
- Address air and water pollution with accountability, feedback, and transparency mechanisms involving IL Basin disadvantaged communities.

Community Participation:
- Ensure access to and participation in collecting project data for affected communities.

Community Engagement

Engagement Assessment:
- Determine desired community benefits, conduct research and resource evaluation (including external partners), and start developing a timeline.

Communication Channels:
- Implement a mix of bidirectional communication techniques (e.g., focus groups, small discussions, educational workshops,& surveys) and define methods to engage.

Engagement Plan:
- Provide short and long-term metrics for effective IL Basin community engagement.

Investing in American Workforce

Workforce Demand and Hiring:
- Analyze future labor needs, identify potential hiring challenges (skills gaps, competition), and highlight growth opportunities.

Creation and Retention of Jobs:
- Define quality jobs, implement workforce development programs, uphold worker rights, and establish clear strategies, milestones, timelines, and resource allocation.

Outreach and Engagement:
- Develop strategies to attract underrepresented groups and ensure local awareness of training/job opportunities through community partnerships and targeted marketing.

DEIA

DEIA Goals and Outcomes:
- Refine project specific Diversity, Equity, Inclusion, and Accessibility (DEIA) goals.

DEIA Partnerships:
- Identify partnerships with Minority-Serving Institutions (MSIs) or local DEIA organizations.

Implementation Strategies:
- Create strategies to achieve DEIA outcomes, including defining roles and responsibilities, required resources, accountability measures, and timelines.

*Disadvantaged communities (dark red) in Hub

Summary

- Project leverages Illinois Basin's enormous CO_2 storage capacity to develop a DAC Hub.
- DAC locations will be selected based on the nearby storage locations, energy and water availability, disadvantaged communities, and opportunity zones.
- Hub activities will support numerous businesses in developing technologies and partnerships, while benefitting economically depressed populations in the region.

Acknowledgement

Name	Organization
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Patricia Loria, Meghan Kenny, Matt Bright	CarbonCapture Inc.
Candice Chow-Gamboa, Max Scholten, Chakriya Srey	Heirloom Inc.
Michelle Kang	Earthrise Energy
Will Johnson, Daryl-Lynn Roberts	Visage Energy
Ryan Cialdella	Ozinga
Kevin Cail, Jamie Rogers	CarbonCure
Steve Kelly	One Earth