Pigman College of Engineering University of Kentucky

Institute for Decarbonization and Energy Advancement at PPL R&D Center

The DAC Hub for Appalachian Prosperity
DE-FE0032387

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http://uknow.uky.edu/research/unique-public-private-research-consortium-established-caer-co2-capture-pioneers

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

Project Objective

Reinvent underserved traditional coal communities in Appalachian States to carbon-negative green energy hubs via DAC and storage using renewable electricity

Performance Dates: 6/1/2024-5/31/2026

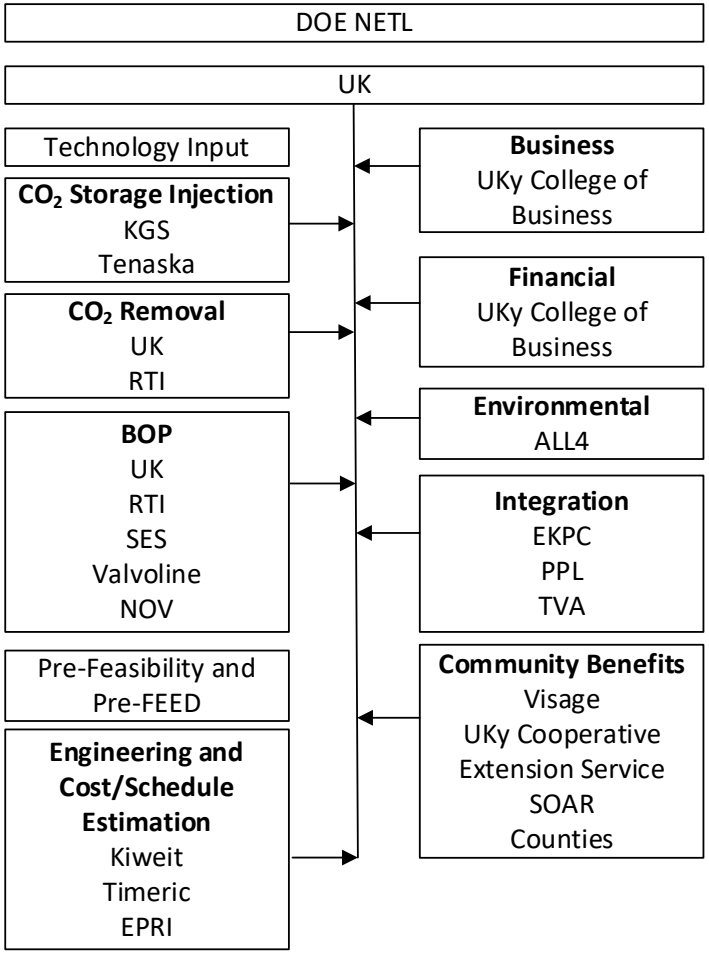
BP1: 06/1/24-2/28/25

- Location identification for centralized regeneration/sequestration, distributed capture and biomass electrical generation, Preliminary LCA, EHS, CO_2 storage potential survey/permitting activities etc.

BP2: 3/1/25-5/31/26

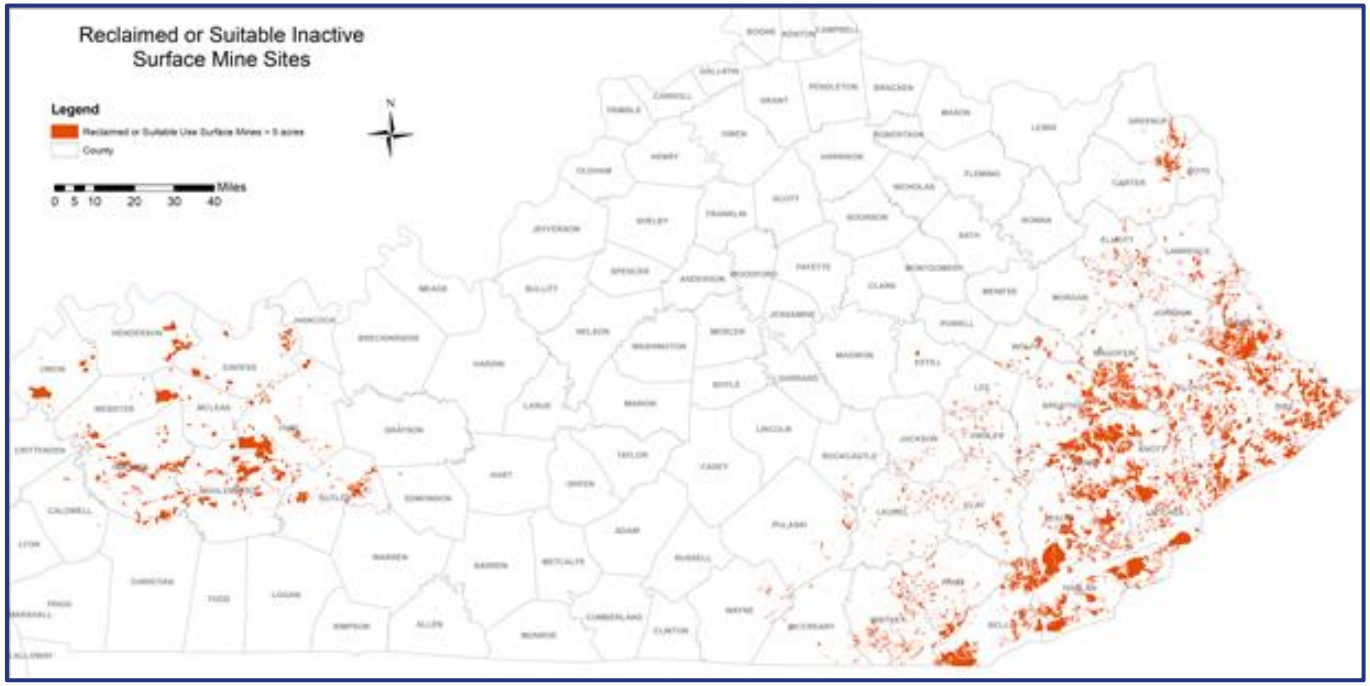
- Integrated DAC Pre-FEED, Finalize locations, LCA, EHS etc.

Project Team and Funding



	DOE-NETL	Cost Share	Total
Total	$2,999,250	$754,289	$3,753,539
Percent Share	80%	20%	100%

Motivation/ Distributed Capture Site

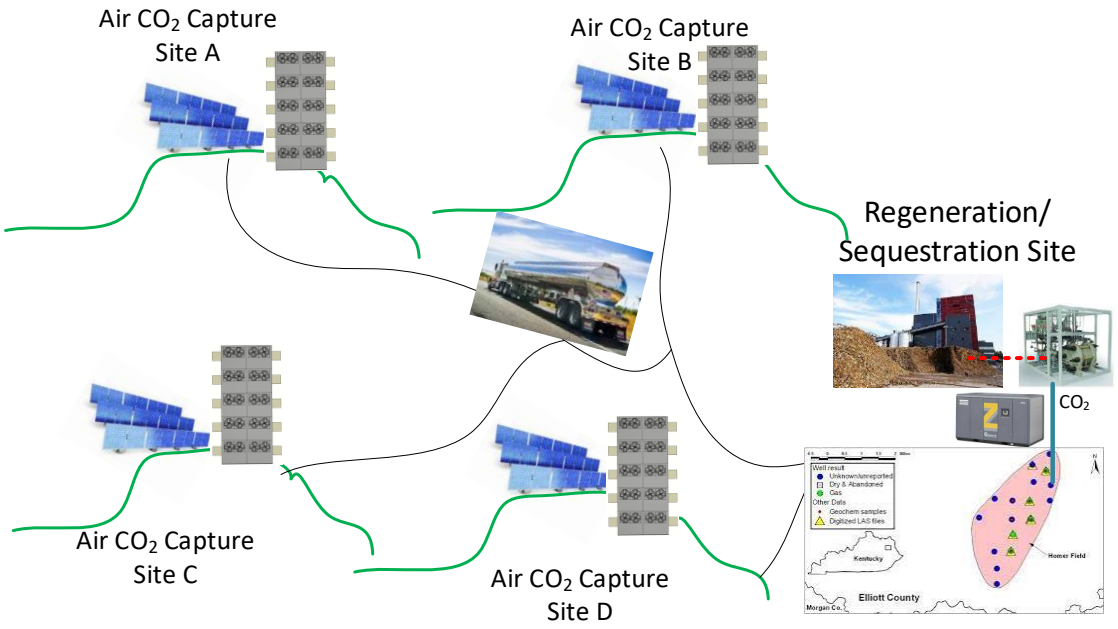


- ~1.5 million acres of reclaimed land available
- Targeted CO_2 injection site is a depleted NG field in EKY
- No impact on agricultural production

Kentucky Geological Survey

Technology Background

DAC Hub Concept



- Deploy UKy DAC technology in decoupled absorption-desorption mode with distributed CO_2 capture on reclaimed mines.
- Power operations by distributed solar and wind kinetic energy
- Centralized regeneration in close proximity to geologic storage sites and powered by biomass

Resource Available

Kentucky's Biomass Resources
Corn Produced (Silage and Grain)[13]
5,601,520 tons
Soybeans Produced[13]
1,808,400 tons
Wheat Produced[13]
681,600 tons
Conservation Reserve Program[14]
354,149 acres enrolled
Municipal Solid Waste[15]
6,212,770 tons generated
Logging Residues[4]
1.2 million dry tons
Poultry[13]
311,299,000 head
Livestock[13]
2,881,000 head

Potential Energy Source:

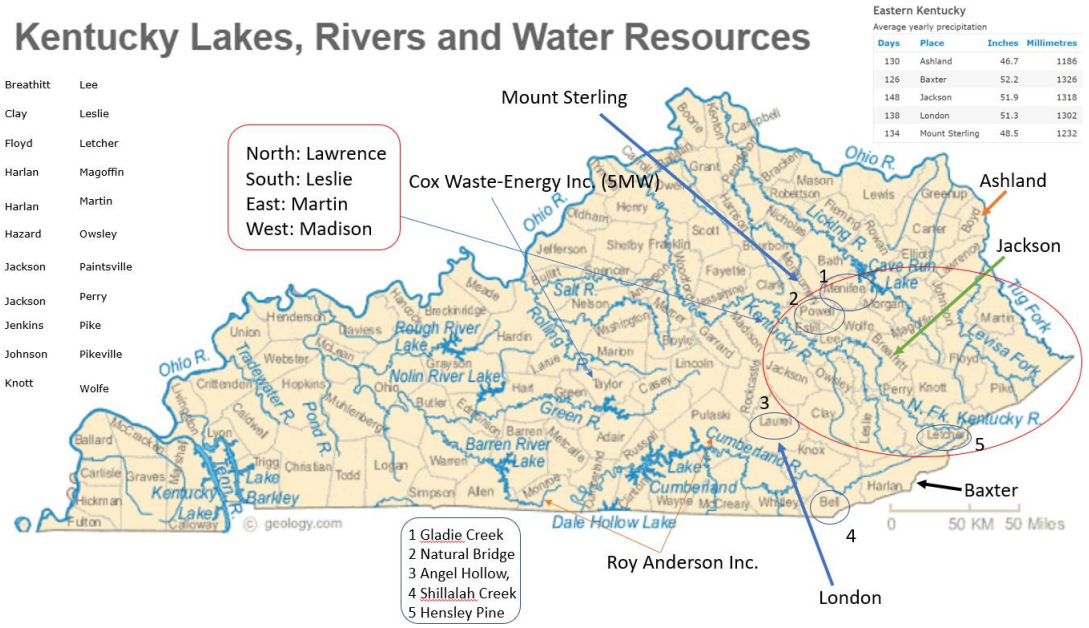
Forest Resources

~1.2 million tons dry harvesting residues

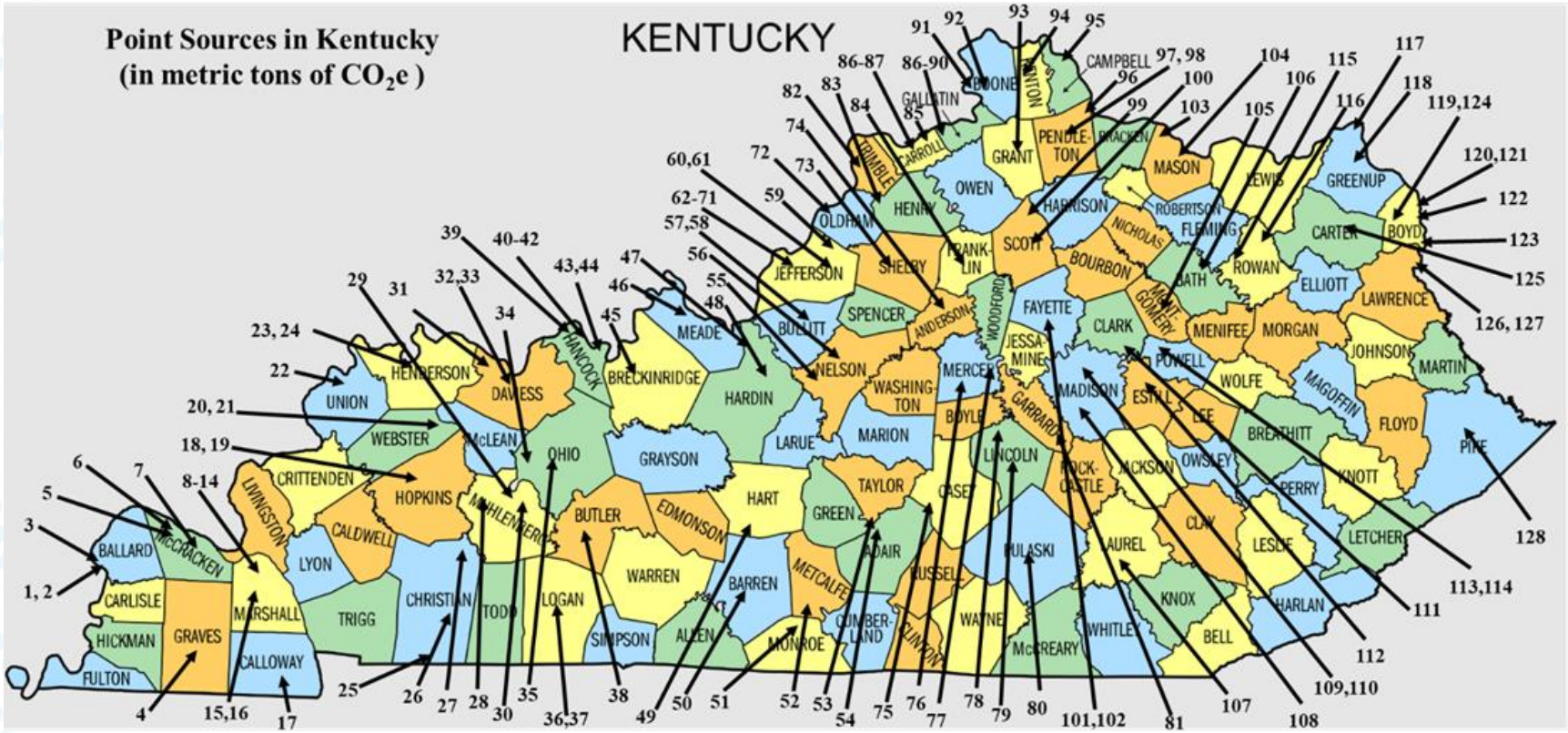
~1.4 million tons dry primary mill residues

Agricultural Resources

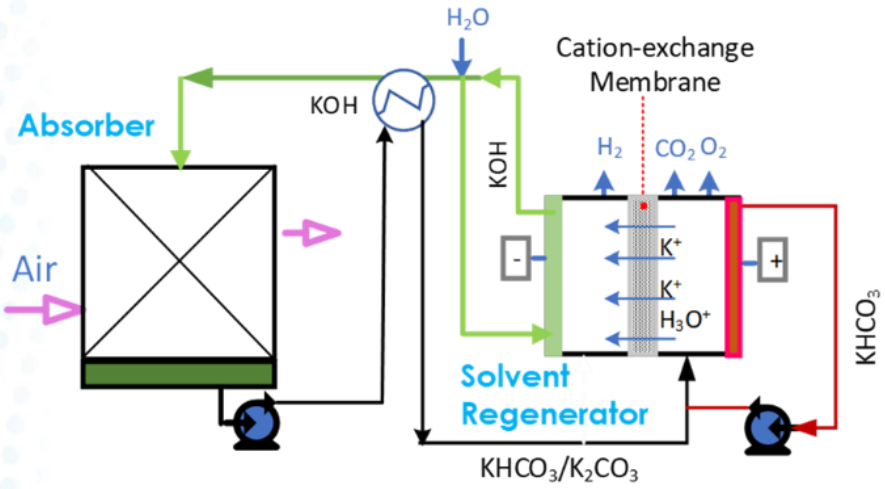
>2.3 million tons agric residue biomass



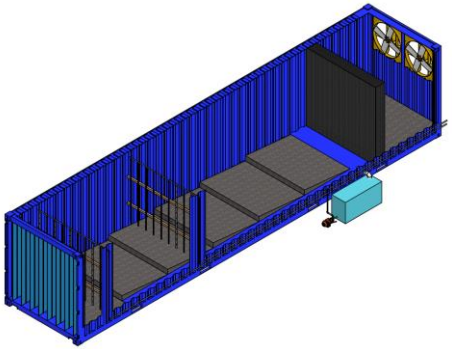
Nearby Industrial Point Sources



Technology Background



1. Does not require thermal regeneration – electrical regeneration possible
2. High capacity chemicals allow for decoupling of absorption and regeneration
3. Produces H_2 – sale, storage or cell depolarization to lower voltage



- Low-cost scalable DAC configuration
- Proven in prior DAC projects DE-FE0031962 and 0032125

Technology Background

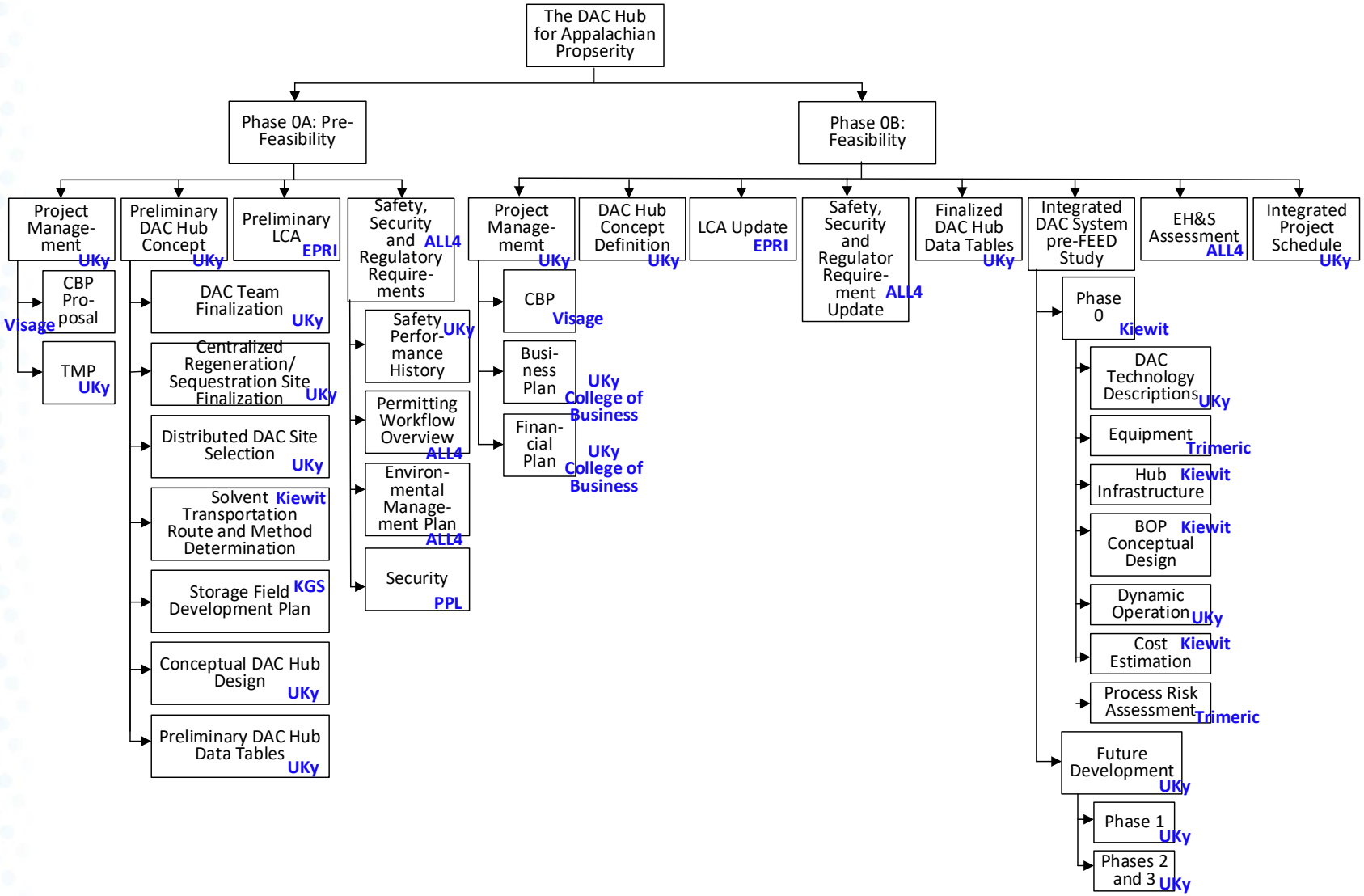
Technical Advantages

- Leveraging existing infrastructure reduces initial investment and minimizes environmental and community impacts from new construction
- Decoupled absorption and desorption steps will eliminate long-range CO_2 pipelines
- Well-understood geological formation and availability of abundant cost-effective renewable energy

Potential Project Constraint

- Coordination among government agencies to leverage brownfield opportunities and other regulatory programs

Technical Approach



Project Milestones

BP	Milestone	Due Date
1	DAC Hub Owner Identified and Technologies Finalized	8/31/2024
1	DAC Hub Concept Defined and Data Tables Complete	1/15/2025
1	Decision Point Application Submitted	1/15/2025
2	Cost Estimation Complete	9/15/2025
2	Phase 0 Pre-FEED Study Complete	1/15/2026

Project Success Criteria

Decision Point	Date	Success Criteria
Completion of BP1	2/28/2025	1. DAC Hub Team in place 2. Storage capacity for at least 12 years of operation with a final capacity of at least 1 MTA 3. Preliminary LCA shows favorable environmental impact scenario for 50 KTA CO_2 sequestration
Completion of Project	5/31/2026	1. Supportive community relationships are established 2. No EH&S, safety, security, regulatory or permitting impediment identified that precludes further development

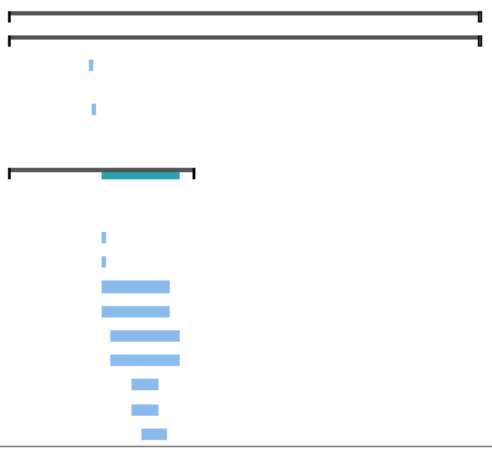
Project Risks and Mitigation Strategies

Perceived Risk	Risk Rating			Mitigation Response Strategy
	Probability	Impact	Overall	
	(Low, Medium, High)			
Unpredictable renewable energy generation needed by DAC.	L	H	M	Tie-in with grid with net metering Agricultural waste as an alternate to lumber waste
The unbearable capital cost relating to electrochemical regenerator	L	M	M	Reconsider the balance between capital and operating Identify alternative electrode and membrane
The lack of large flat land near proposed storage site	M	M	M	Short-distance CO_2 pipeline from regeneration site to storage site Decoupling the biomass-based electricity generation and CO_2 regeneration sites through transmission lines
Lack of adequate sealing interval	L	H	H	Investigate alternative storage site
Low reservoir porosity/permeability	M	M	M	Hydro-frac and acidize reservoir
Leakage points (faults and fractures)	L	H	M	Avoid or seal off problem interval(s)

Progress and Current Status

- Team Kickoff meeting complete
- One monthly meeting with external team conducted
- Digitized subtask complete
- Subcontracts are in process

20	**Preliminary DAC Hub Concept**	**7/3/24**	**12/2/24**
21	**DAC team finalization**	**7/3/24**	**12/2/24**
22	DAC Hub Owner Identification.Uky is meeting in eastern KY in Paintsvile CO Extension office on July 29th. TEAM member needs to attend this meeting and get minutes.	7/29/24	7/29/24
23	Understand the DAC technology and demonstrate by drafting "discussion points", then writing a paragraph of what you plan to say to any external party and submit to PM by 7/30.	7/30/24	7/30/24
24	**DAC Technology Recruitment and Finalization. A diverse portfolio of DAC technologies will be assembled based on technical and economic suitability to reduce risk.**	7/3/24	8/31/24
25	TGA report outline due first week	8/2/24	8/2/24
26	U.K. DAC Tech summary due first week	8/2/24	8/2/24
27	Complete section on other DAC technologies literature reviews. Duration 3 weeks	8/2/24	8/23/24
28	Contact the technology developer as needed. Duration 3 weeks	8/2/24	8/23/24
29	Finalize the DAC tech selection. Duration 2 weeks	8/5/24	8/26/24
30	Complete draft background selection. Duration 2 weeks	8/5/24	8/26/24
31	GAP analysis methodology description completed. Duration 1 week	8/12/24	8/19/24
32	GAP ID (the nature and quantification of the knowledge gaps). Duration 1 week	8/12/24	8/19/24
33	Propose a research solution to resolve each gap. Duration 1 week	8/15/24	8/22/24



Outreach Pamphlet Created

1. This project intends to introduce a new business industry, rejuvenating and bolstering traditionally coal communities and their economies.

2. The actual capture units will be installed on the removed area of flat hilltops previously used for coal extraction.

4. The captured gaseous CO2 is cooled to a liquid state, making it more transportable, similar as steam turns to liquid after cooling.

5. After transport to the injection site, the CO2 is heated and pressurized, and becomes a much higher concentration CO2. This process also returns the CO2 to a gaseous state.

Since this is direct air capture, there is no possibility of depleting natural resources over the course of this project. Moreover, no waste would be left behind.

We will use the existing geological infrastructure by reactivating and leveraging it for community development

With this Project, we estimate the creation of 300+ job opportunities

The project is fully funded and we do not require any commissions to be given (DOE grant of $ ~ 50 - 100 million).

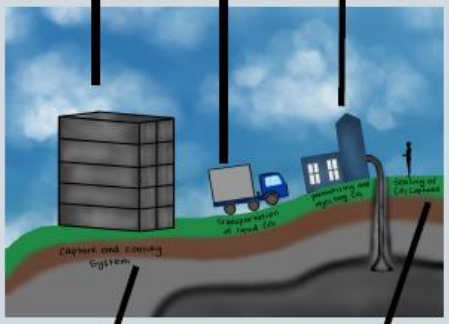
1. CO_2 is absorbed

Excess CO_2 is removed from the air with the DAC Hub, just like how excess water is removed from a boat with a bucket

3. Now the liquid is pressurized, from 400 (liquid) psi to 2200 psi (gas) and injected into the ground.

CO_2 is injected into soda to make it bubbly

The CO_2 is Transported



2. Now the CO_2 is cooled and turn to liquid. This is like when ice is heated, it turns to water, just in a different format.

4. Finally, after the injection site is full, it will be sealed off and continuously monitored. This is like sealing a soda can off once it has been fully carbonated

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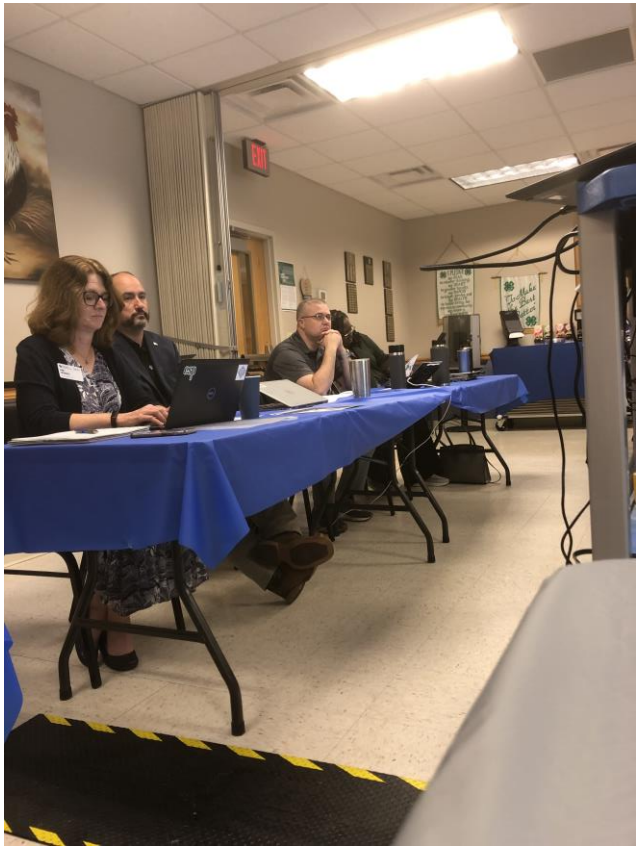
Communication with Leaders at EKy Initiated



Community Benefits and Impacts

1. Quantify increase in economic development in affected areas.

2. Assess projected job creation on specific communities economically distressed/impacted from adverse mining and industry environmental effects

3. Quantify and measure key applicable benefits such as: decrease in energy burden, environmental exposure; and increase in clean energy workforce and enterprise, job training for surrounding communities etc.

4. Jump start transition from fossil-fuel to green community region

5. Rebuild prosperity in underserved communities by using reclaimed lands

6. Project to significantly benefit surrounding communities as well by increasing local investments and job growth in other sectors.

Lessons Learned

Trust

- Building trust key to success; communities wary of outsiders
- Past experiences with unfulfilled promising ideas

Attachment to Coal

- Communities in EKY protective of coal industry
- Keep unsolicited comments on coal
- Need to establish DAC Hub as separate from coal and not seeking to replace/impose

Climate Issues

- Climate change is a touchy subject and political. Science may not matter to communities
- Main focus needs to be on what project is, execution and the immediate results/economic benefits to communities

Future Development & Commercialization

- Technology developer – Honda and Johnson Matthey
- NGO – Clean Air Task Force
- Discuss with local companies to co-develop the DAC Hub with Biomass to Power and Biomass to Aviation fuel
- Potential Investors

Summary Slide

- Team kick-off meeting completed
- Meeting with community leaders in EKY initiated
- Outreach pamphlet created
- Lessons on gaining trust and focusing on emphasizing immediate results and economic benefits of DAC Hub key to community engagement and acceptance

Acknowledgements

U.S.DOE NETL: Elliot Roth
UKy IDEA: Reynolds Frimpong, Kim Knorr, Lisa Richburg

And

All project partners