Red Rocks DAC Hub TA-1

DE-FE0032384
2024 FECM/NETL Carbon Management Research Project Review Meeting

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Agenda

- Project Overview
- Technology Background
- Project Scope
- Progress and Current Status of Project
- Summary of Community Benefits
- Lessons Learned
- Plans for Future Testing / Development / Commercialization
- Summary
- Questions

Project objectives

Feasibility study for a geothermal energy driven direct air carbon capture (DAC) and sequestration hub in southwest Utah starting May 2024 through April 2026.

- **Fill a gap in DAC deployment:** Access to abundant, reliable, firm, carbon free heat and power
- **Help to stand up carbon storage infrastructure in SW Utah:** Build relationships across the transportation, sequestration, and utilization landscape
- **Innovate through integration:** CapEx reduction for geothermal + DAC, siting prioritization
- **Path to scale:** Determine how to scale from feasibility to deployment of a large-scale hub

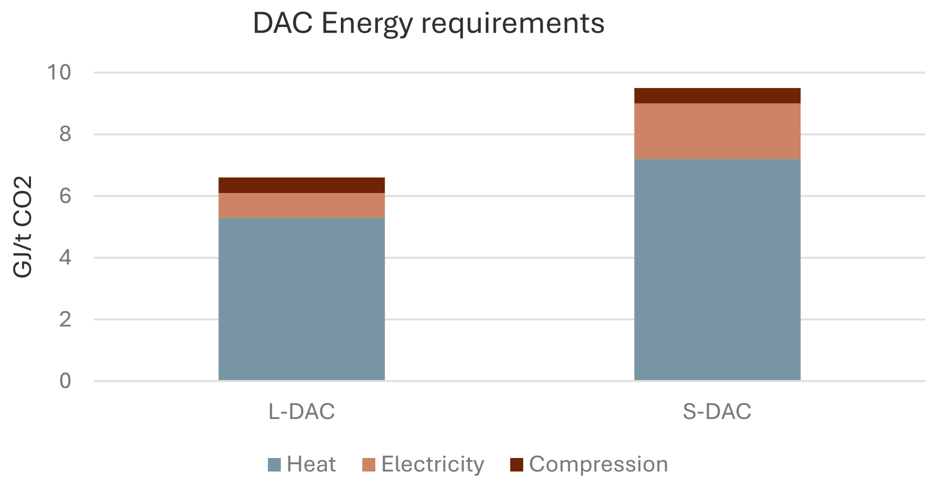
Budget Period	Federal Funds	Cost Share	Cost Share %	Total
BP 1 (9 mo)	$1,379,456	$405,496	23%	$1,784,952
BP 2 (15 mo)	$1,481,650	$318,966	18%	$1,800,616
Total	**$2,861,106**	**$724,463**	**20%**	**$3,585,569**

PARTNERS

FERVO ENERGY · AIRMYNE · EPRI ELECTRIC POWER RESEARCH INSTITUTE · UTAH GEOLOGICAL SURVEY · THE UNIVERSITY OF UTAH

DAC energy requirements

Direct Air Capture (DAC) is an energy intensive process[1]



- In most instances, using grid connected power to power DAC results in net carbon emissions. **Renewable energy must be used**
- L-DAC requires higher temperatures than geothermal can provide, only **S-DAC heat integration will be studied**

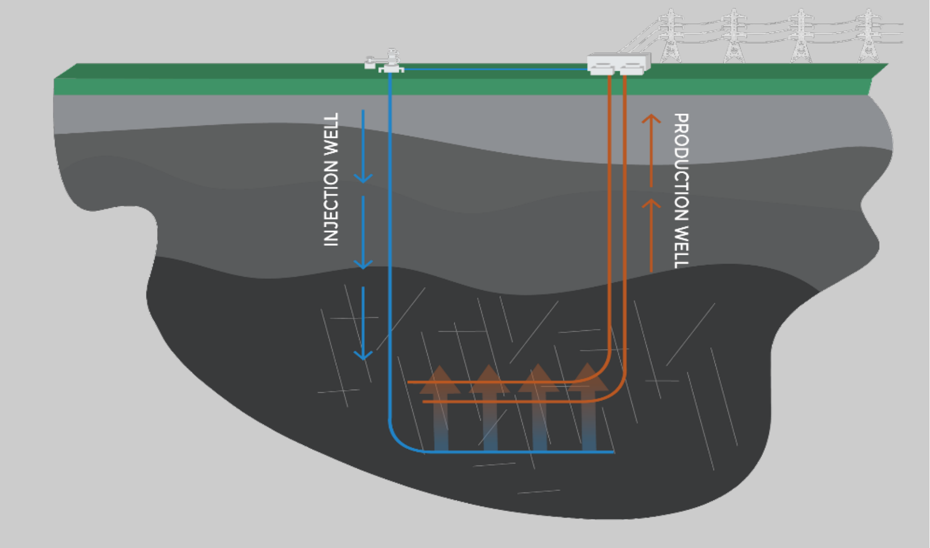
Geothermal is a clean, firm electricity source

- Geothermal development **capital expenditure is 50% subsurface development and 50% power generation equipment** development
- As more projects are developed, **subsurface costs will decline**
- Eliminates long lead power facilities such as turbines
- **Co-located projects eliminate long lead items** necessary to tie into the electrical grid such as circuit breakers and transformers
- **Leveraging integration** will increase **cost competitiveness**

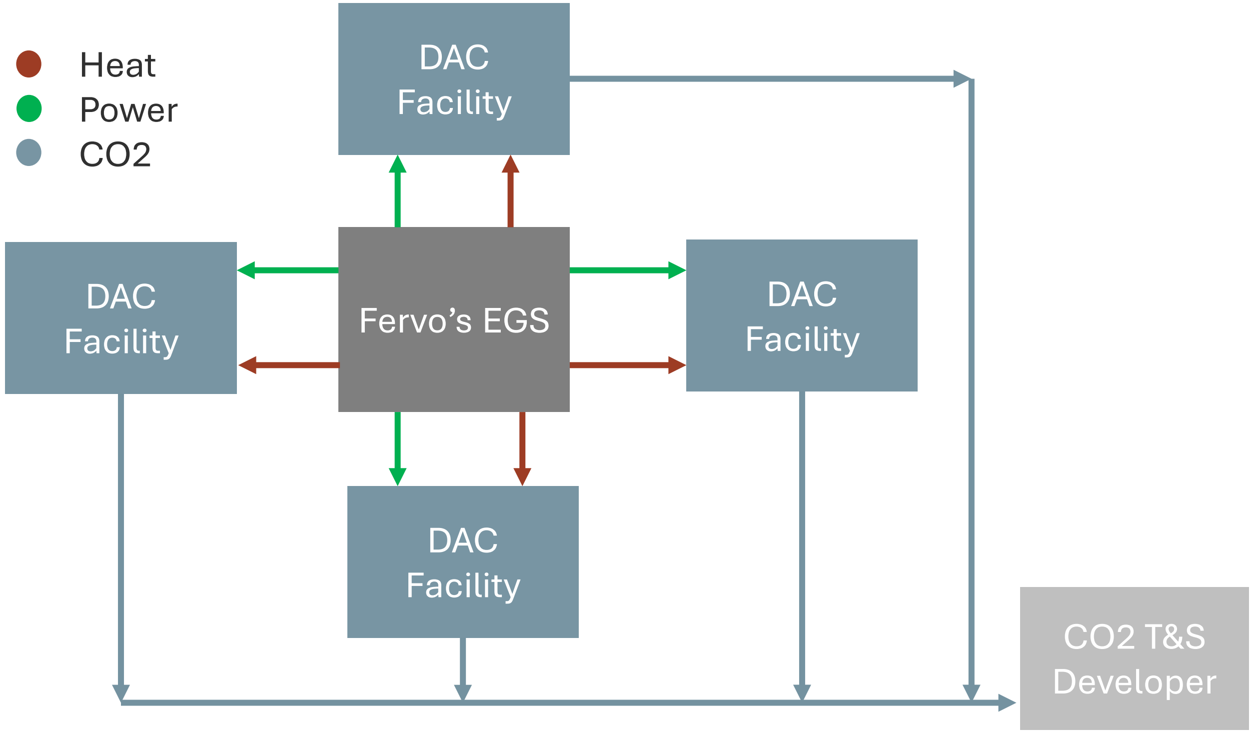
1) Direct Air Capture - Energy System – IEA

Technology background

Fervo's Technology: Enhanced Geothermal System



- Fervo Energy's first greenfield utility scale project is in **Milford, Utah**
- Current size of the project (400 MW) is due to **transmission constraints**
- The P50 estimate of the **geothermal resource is 1.9 GW** of electricity generation capacity

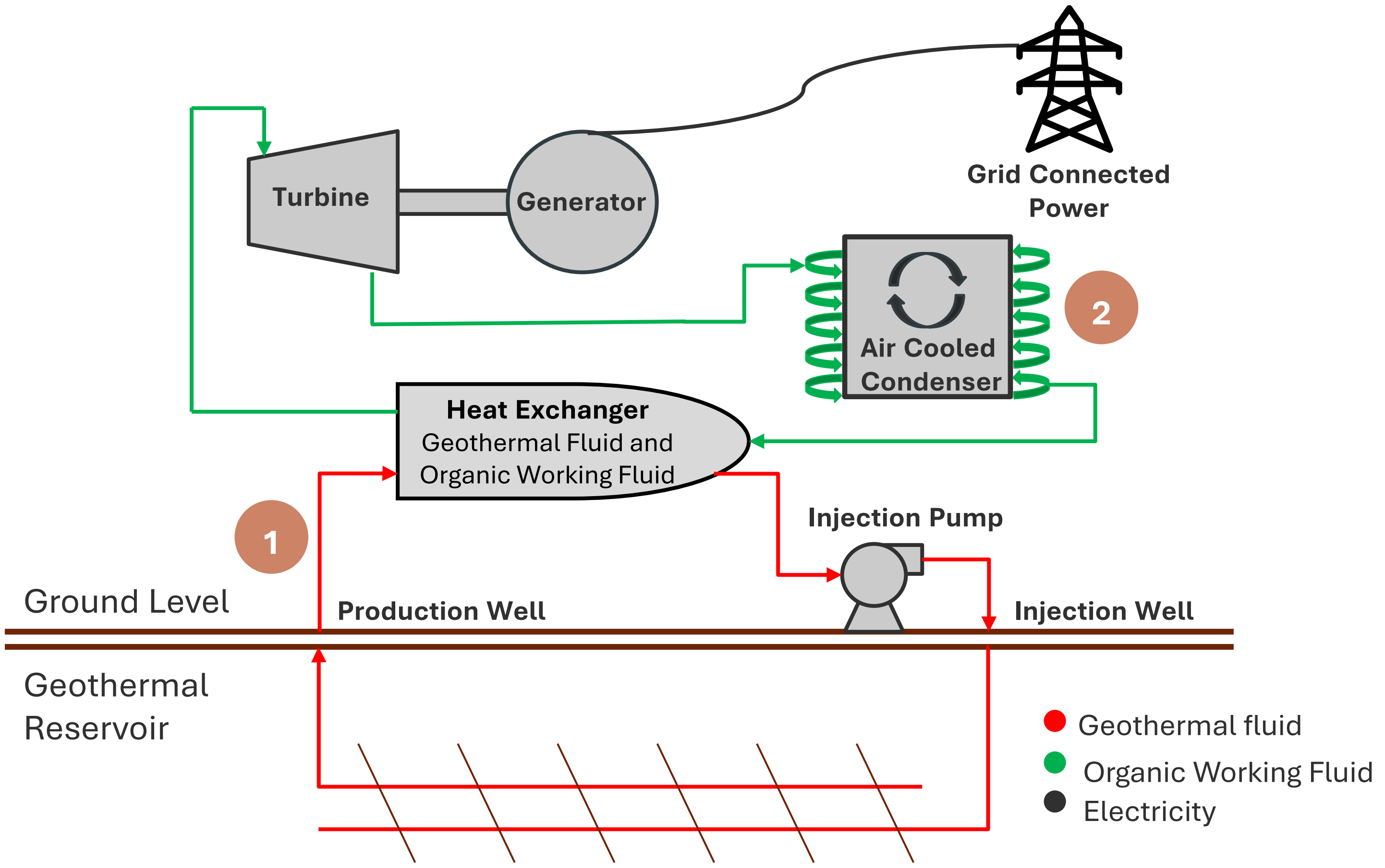


- While AirMyne is the project's anchor DAC technology, the focus of this project is to **prove scalability of EGS application to multiple different DAC developers**

Building out behind the meter energy generation will help scale EGS as well as offer the cheapest marginal clean, firm electron from the project to an emerging industry.

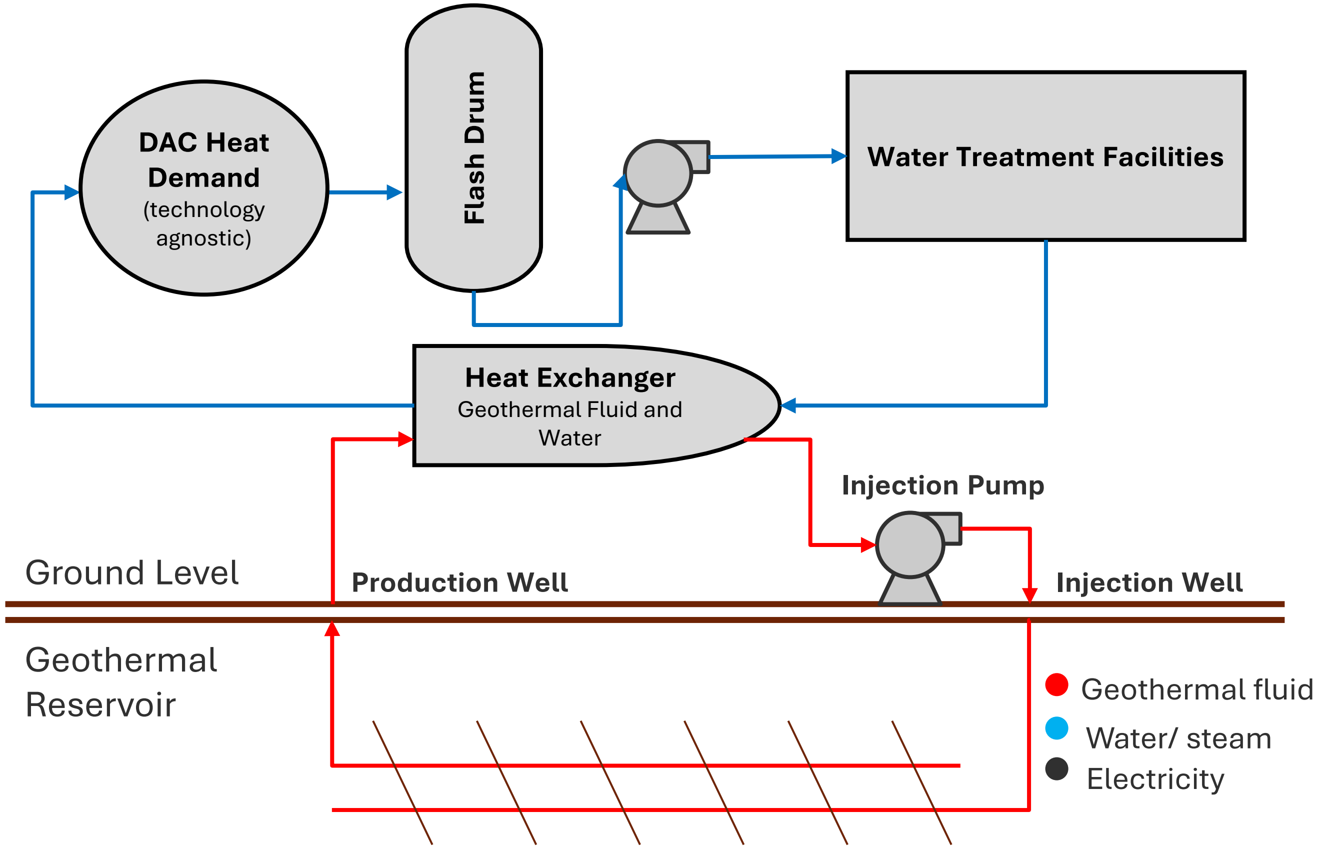
Two DAC integration opportunities on an air cooled binary geothermal power plant

- A **common way to produce geothermal** energy is using an **Organic Rankine Cycle (ORC) power plant**
  - Typical **ORC efficiencies** in conversion of thermal energy to electrical energy are **10-20%**
- An ORC generates electricity by the following process:
  - Hot geothermal **fluid vaporizes an organic working fluid** with a lower boiling point
  - This **working fluid vapor** spins a turbine **generating electricity**
  - The **working fluid is condensed** in an air-cooled condenser
- Two primary **DAC integration opportunities**
  1. Direct Heat through Fit for Purpose Wells
  2. ACC Bypass Waste Heat Integration



Note: The diagram is simplified from actual power generation facilities

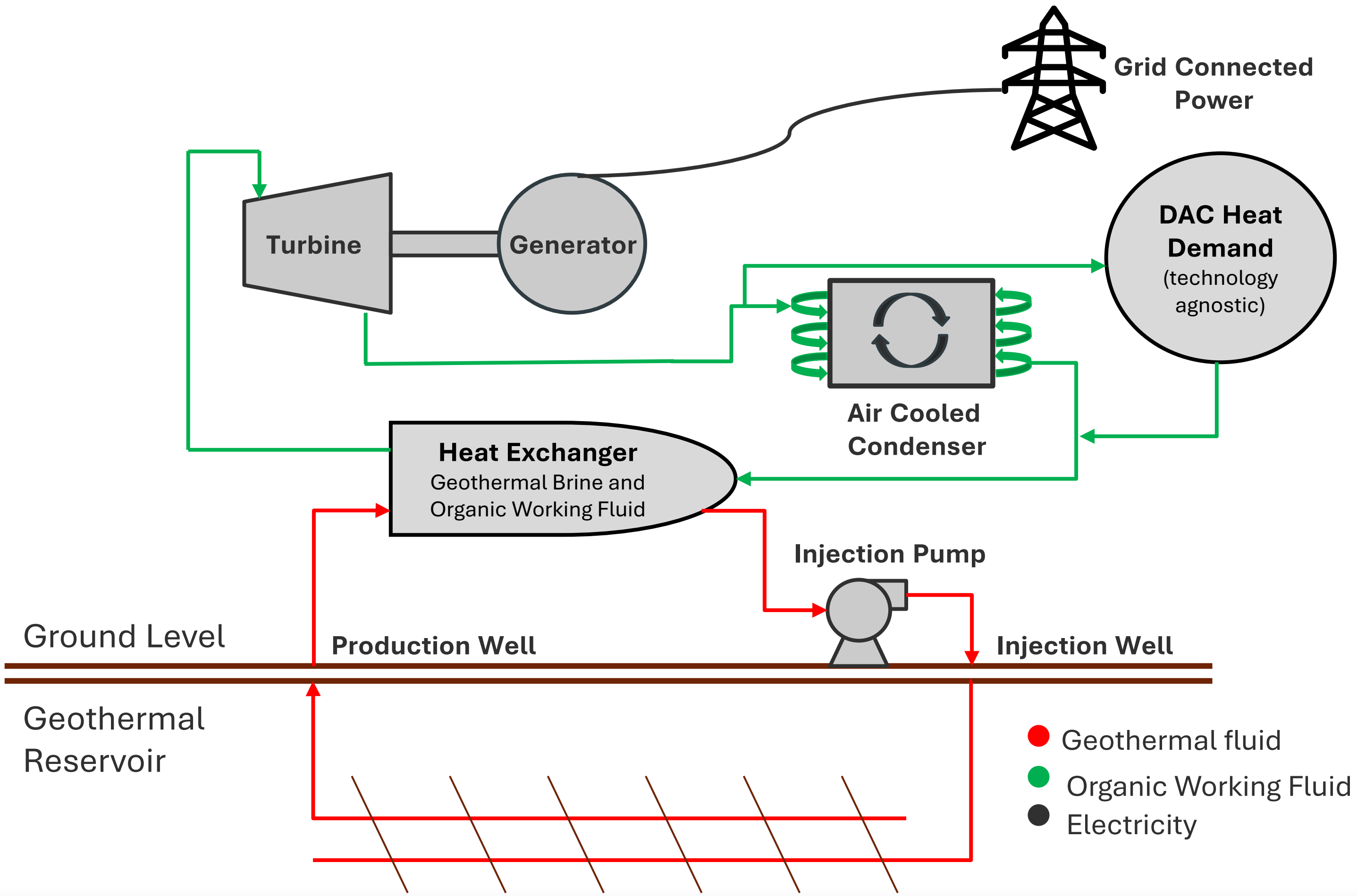
1 **Direct heat application**: Direct heat for DAC supplied by geothermal fluid



- **No power generation equipment**
  - Significantly **reduces geothermal capex** allowing for more attractive cost of heat structure
  - **Increases usable heat** from each well pair due to efficiency gain
- Can be **applied depending on well depth and geothermal resource** to many different low temperature DAC technologies
- **Fit for purpose** geothermal wells, **not waste heat**

Note: The diagram is simplified from actual power generation facilities

2 **Waste heat application:** Air cooled condenser bypass



- **Power generation from geothermal wellfield** for either grid connected projects or **for use by DAC electricity needs**
- True waste heat application: Reduction in **equipment sizing** will **reduce** geothermal **capital expenditure**
- **Temperatures in ACC bypass** are typically **too low** for most DAC applications

Note: The diagram is simplified from actual power generation facilities

Scope of work by budget period and success criteria

Budget Period 0A

- Evaluate, select, and plan for project siting.
- Select the DAC Hub owner.
- Explore DAC technologies to identify suitable requirements and technology matches for the proposed work.
- Deliver preliminary data tables, technology maturation plans, and a preliminary life cycle analysis (LCA).
- Explore safety, security, and regulatory requirements to build a comprehensive community benefits plan development proposal (CBPDP).

Budget Period 0B

- Complete an integrated geothermal + DAC facility pre-front-end engineering design (pre-FEED) study for the initial DAC Hub capacity.
- Complete a balance of plant (BOP) conceptual design for the final DAC Hub capacity.
- Prepare a full storage field development plan.
- Submit a preliminary LCA for the initial and final DAC Hub capacities.
- Deliver updated DAC data tables.
- Finalize community benefit plan (CBP), business plan, and financial plan.

A successful feasibility study will prove a highly compelling case for large-scale combined geothermal + DAC deployment in southwest Utah and pave the way for full scale (>1,000 KTA) capture and storage (>1,000 years) at economic costs (<$100/tonne).

Project deliverables and risk matrix

Project Deliverables

Task Number	Description	Planned Completion Date
1.1	Project Management Plan	5/31/24
1.2	Business Plan	1/30/26
1.3	Financial Plan	1/30/26
1.4	Technology Maturation Plan	12/17/24
1.5	Community Benefits Plan Development Plan	12/17/24
1.5	Community Benefits Plan	1/30/26
4.1	DAC Hub Data Tables	4/30/26
4.2	Preliminary LCA	12/17/24
5.2, 8.5	Environmental Health and Safety Risk Analysis	1/30/26
6.1	Integrated DAC System Pre-FEED Study	1/30/26
6.3	DAC Hub Balance of Plant Conceptual Design	1/30/26
7.2	Storage Field Development Plan	1/30/26
8.4	Updated Preliminary LCA	1/30/26
8.5	Integrated Project Schedule	1/30/26

Project Risk Matrix

Perceived Risk	Risk Rating		
	Probability	Impact	Overall
	(Low, Med, High)		
Financial Risks:			
Fervo Fundraising	Low	High	Med
AirMyne Fundraising	Low	Low	Low
Cost/Schedule Risks:			
Scheduling	Low	Low	Low
Change in Personnel	Low	Low	Low
Over Project Spend	Low	High	Med
Lower Cost Share	Med	Med	Med
Technical/Scope Risks:			
CO2 Storage	High	High	High
DAC Technology	Med	Med	Med

Community benefits plan approach

Vision

- Affirm the prioritization of justice, DEIA, safety, and quality jobs in all planning
- Center these goals explicitly in each partnership

Assessment

- Host listening sessions in community spaces
- Meet with local representatives
- Build authentic relationships and trust
- Tailor communication to the community
- Identify underserved groups
- Map the flow of jobs and capex
- Identify hiring/participation barriers

Goals

- Establish SMART goals based on assessment, co-created with stakeholders

Outcomes

- Define clear metrics of success that align with the community's values.
- In Beaver county, we've heard prioritization for sustainable growth of quality jobs, training opportunities, and sustainable housing growth.
- Update outcomes regularly according to community feedback

Implementation

- Define clear action items to yield the intended outcomes
- Clearly allocate responsibility
- Track benefits to ensure equitable distribution

Community Benefits Plan Development Plan

Community Engagement

Quarterly in-person engagement, regular online project updates, full-time corporate presence in the area, accessible processes for collecting feedback, dissemination of job postings to the community

DEIAB

Corporate DEIAB: quarterly workshops, diverse hiring targets, communication and feedback to identify and redesign exclusive systems.

Project-based DEIAB: soliciting diverse bids & tracking spend, supporting supplier DEIAB initiatives, partnership with minority-serving institutions

Investment in Workforce

Partnership with apprenticeship and other training programs, local hiring targets, fossil-fuel workforce transition targets, DAC workforce curriculum development

Justice 40

At least 40% project spend on suppliers from Justice 40 communities, support fossil fuel workers entering DAC workforce, maintain highest health, safety, and environmental standards.

Lessons learned and next steps

Lessons learned

DAC Technology Agnostic Hub

Increasing number of DAC technology providers decreases the counterparty risk and increases funding security.

Fervo as Heat and Power Provider

Shifting Hub ownership to DAC technology providers mimics traditional industrial park set ups.

Community Engagement

Early and transparent engagement with the local community ensures equitable project development.

Next steps

- Engaging with additional DAC partners
- Working towards preliminary LCA
- Incorporating CBP learnings from Fervo into the project plan
- Identifying potential storage opportunities
- Identifying resources necessary for successful scale

Engineering Pre-FEED study kicks off 1Q25

Summary

- **Fill a gap in DAC deployment**
  - Access to abundant, reliable, firm, carbon free heat and power
- **Help to stand up carbon storage infrastructure in SW Utah**
  - Build relationships across the transportation, sequestration, and utilization landscape
- **Innovate through integration**
  - CapEx reduction for geothermal + DAC
- **Path to scale**
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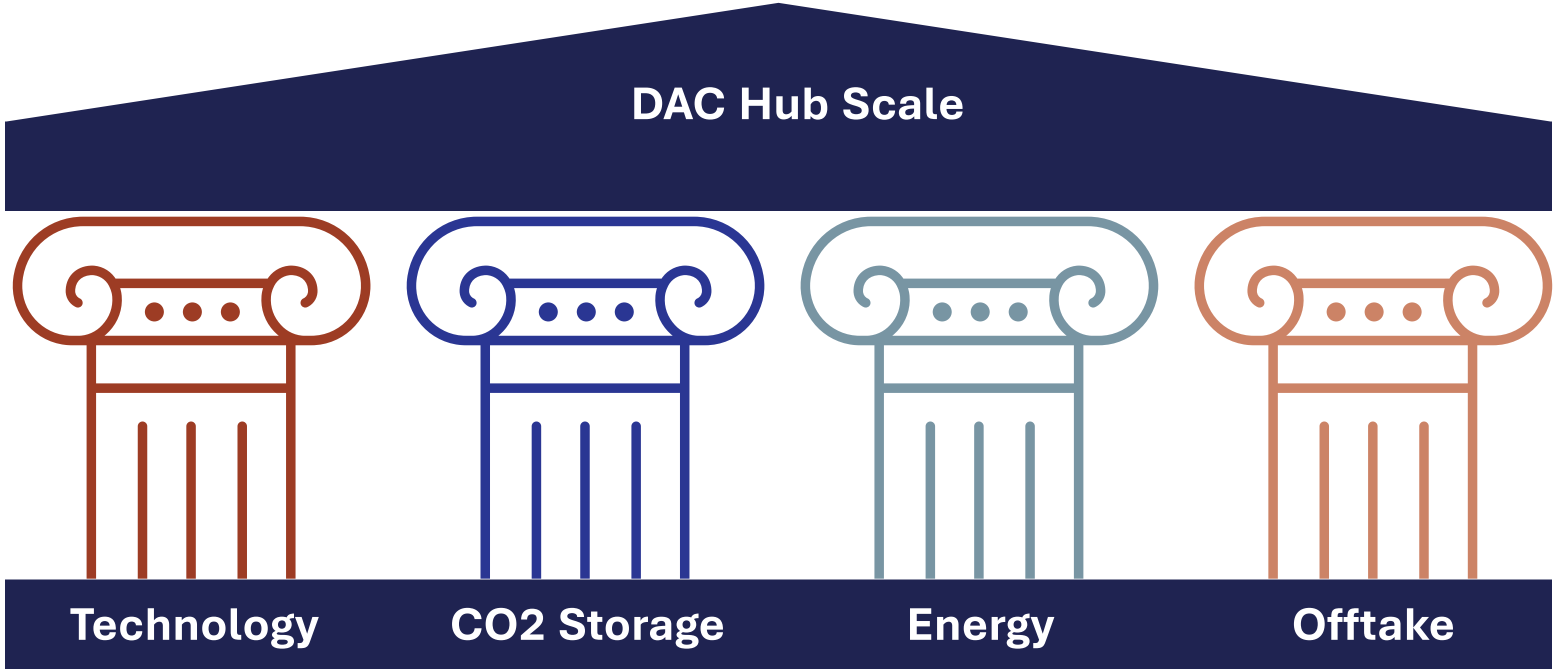

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Questions