Identifying and Addressing Hurdles For CO_2-geothermal Power

Jonathan Ogland-Hand, PhD

July 10, 2025

USEA Webinar | Beneath the Surface: Exploring Synergies Between Geothermal Energy and Carbon Capture

CARBON SOLUTIONS

Carbon Solutions Background

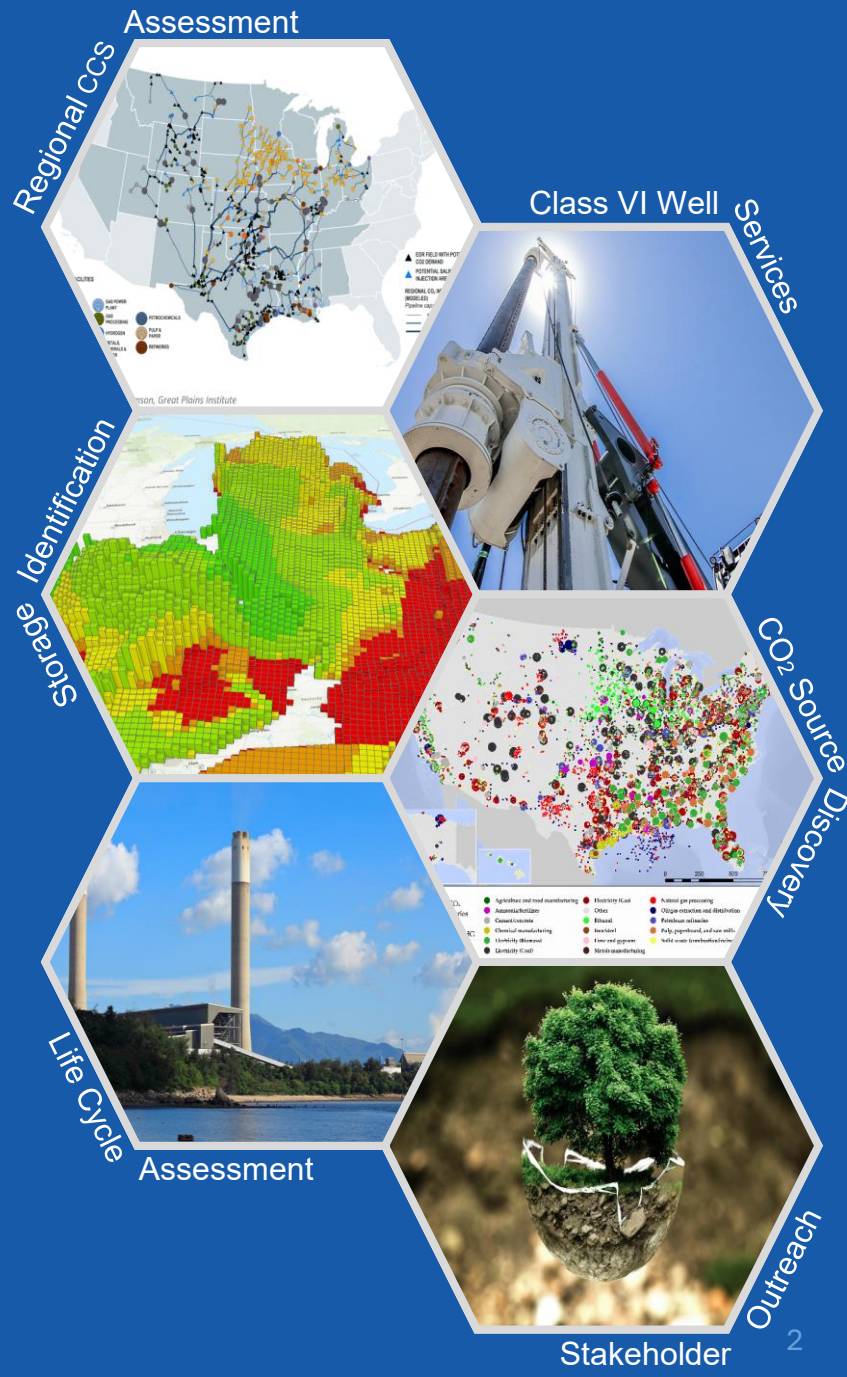
- Work with industry, government, policy experts, & researchers to deliver energy solutions.
- Launched 2021 | ~25 employees (15+ PhD's) | 100+ projects.
- Consulting, Software, and R&D.

Client Examples

- Technology and/or Project Developers (CO_2 Capture, CO_2 Transport, CO_2 Storage, CDR, Geothermal, Hydrogen, etc.)
- Utilities
- Consultants
- Federal & State Governments
- NGOs and Nonprofits

Products

- Data, LCAs/TEAs, Maps, Engagement Plans & Stakeholder Profiles, Reports, Software, Proposals, Peer-reviewed papers



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CO_2-Geothermal Hurdles

Generate Power

Prove the theory with a field demonstration

Site-level Optimization

Well-spacing, power system design & subsurface integration

System-level Grid Studies

What is the value of CO_2-geothermal to the electricity system?

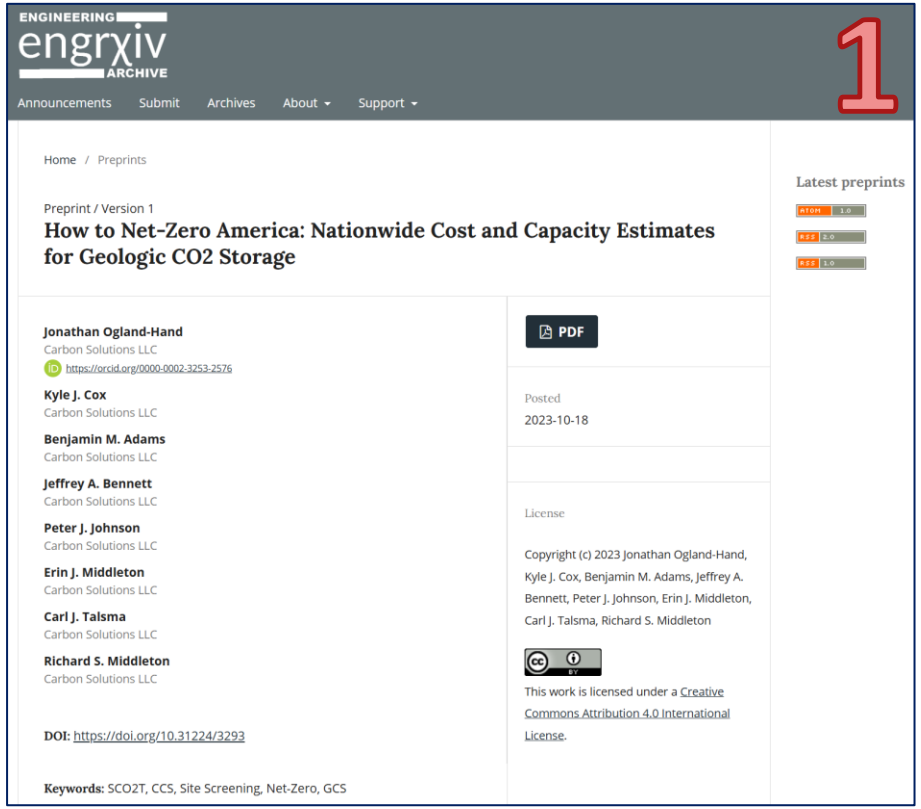
Integration with CCS Projects

Where will CO_2 be stored? Where will it come from? How will it be transported?

Can every CCS project support a CO_2-geothermal power plant?

Engagement

How to approach community engagement? Who to partner with? How to develop industries?



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How to Net-Zero America: Nationwide Cost and Capacity Estimates for Geologic CO2 Storage

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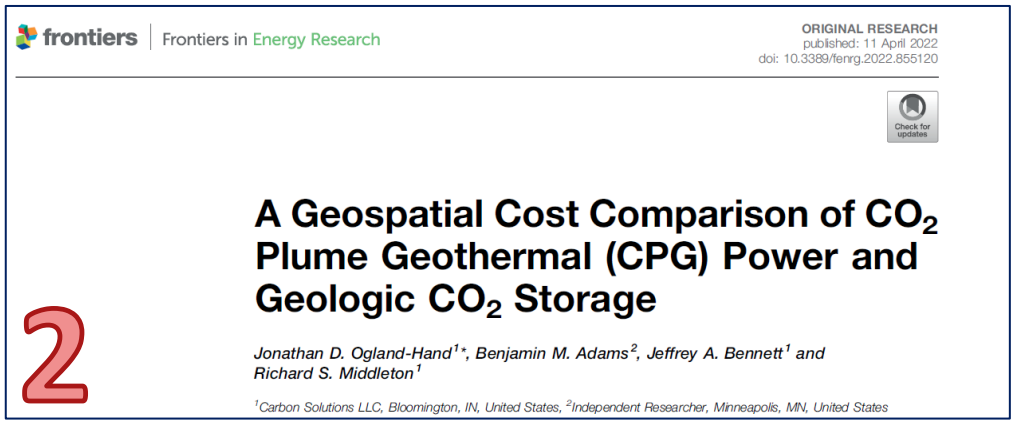
Keywords: SCO2T, CCS, Site Screening, Net-Zero, GCS



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A Geospatial Cost Comparison of CO_2 Plume Geothermal (CPG) Power and Geologic CO_2 Storage

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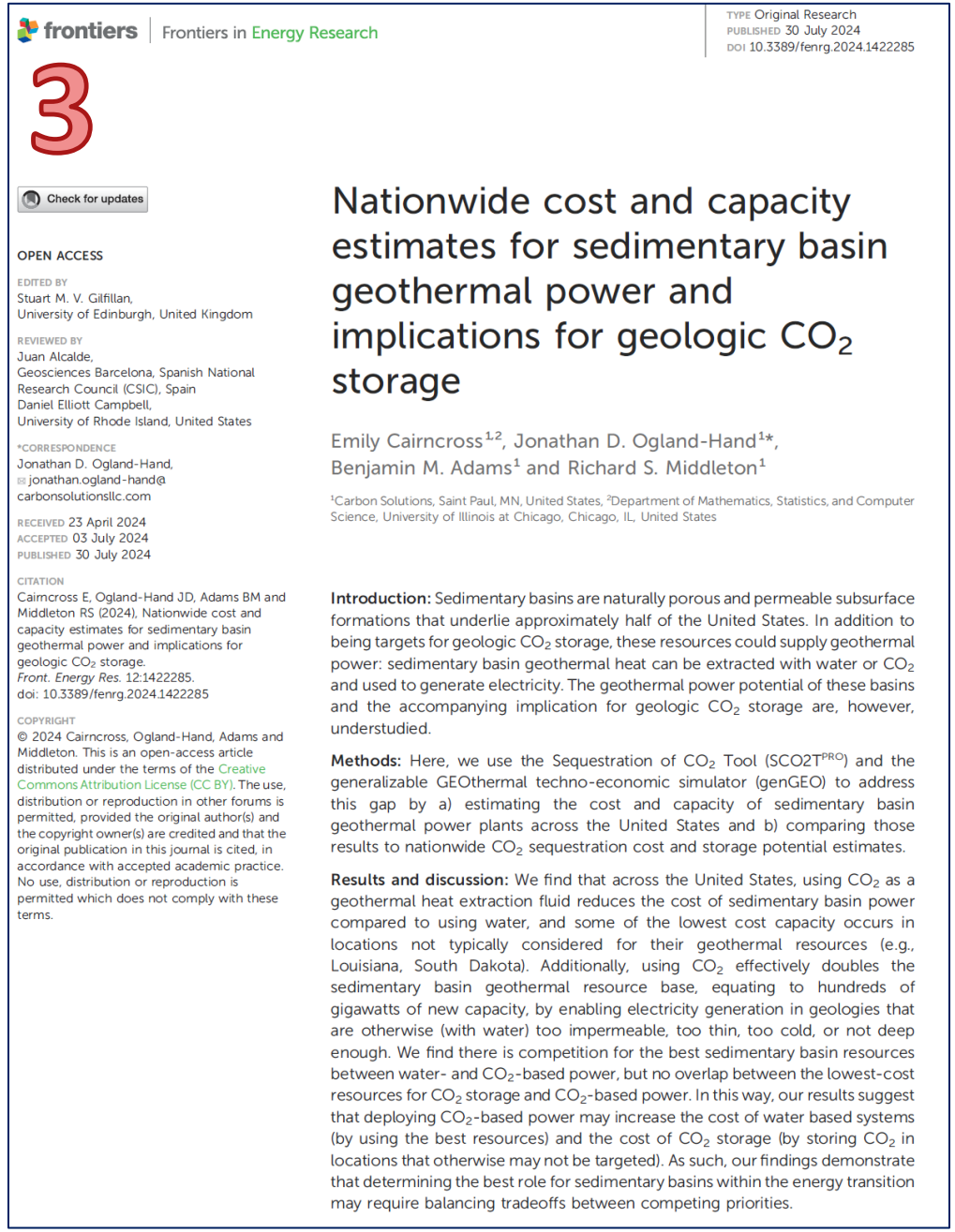

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Nationwide cost and capacity estimates for sedimentary basin geothermal power and implications for geologic CO_2 storage

Emily Cairncross[1,2], Jonathan D. Ogland-Hand[1]*, Benjamin M. Adams[1] and Richard S. Middleton[1]

[1]Carbon Solutions, Saint Paul, MN, United States, [2]Department of Mathematics, Statistics, and Computer Science, University of Illinois at Chicago, Chicago, IL, United States

Introduction: Sedimentary basins are naturally porous and permeable subsurface formations that underlie approximately half of the United States. In addition to being targets for geologic CO_2 storage, these resources could supply geothermal power: sedimentary basin geothermal heat can be extracted with water or CO_2 and used to generate electricity. The geothermal power potential of these basins and the accompanying implication for geologic CO_2 storage are, however, understudied.

Methods: Here, we use the Sequestration of CO_2 Tool (SCO2T^{PRO}) and the generalizable GEOthermal techno-economic simulator (genGEO) to address this gap by a) estimating the cost and capacity of sedimentary basin geothermal power plants across the United States and b) comparing those results to nationwide CO_2 sequestration cost and storage potential estimates.

Results and discussion: We find that across the United States, using CO_2 as a geothermal heat extraction fluid reduces the cost of sedimentary basin power compared to using water, and some of the lowest cost capacity occurs in locations not typically considered for their geothermal resources (e.g., Louisiana, South Dakota). Additionally, using CO_2 effectively doubles the sedimentary basin geothermal resource base, equating to hundreds of gigawatts of new capacity, by enabling electricity generation in geologies that are otherwise (with water) too impermeable, too thin, too cold, or not deep enough. We find there is competition for the best sedimentary basin resources between water- and CO_2-based power, but no overlap between the lowest-cost resources for CO_2 storage and CO_2-based power. In this way, our results suggest that deploying CO_2-based power may increase the cost of water based systems (by using the best resources) and the cost of CO_2 storage (by storing CO_2 in locations that otherwise may not be targeted). As such, our findings demonstrate that determining the best role for sedimentary basins within the energy transition may require balancing tradeoffs between competing priorities.

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Software

SCO_2T^{PRO}

What?

- Coupled tool-and-geologic database.

Why?

- Rapidly characterize individual locations for geologic CO_2 storage.

How?

- Machine-learning, geology, hydrogeology, techno-economics.

Example Customers

- Energy providers.
- CCS companies.
- EPC firms.
- Government/NGOs.

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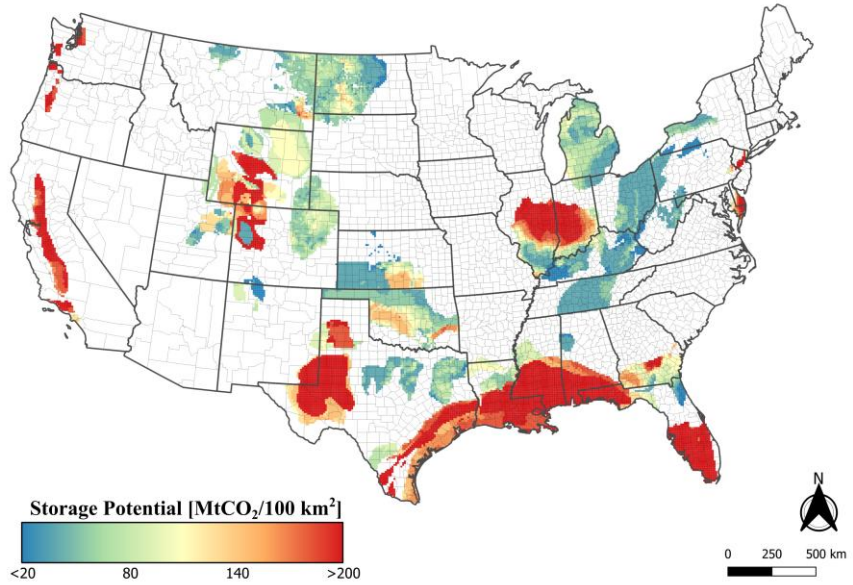

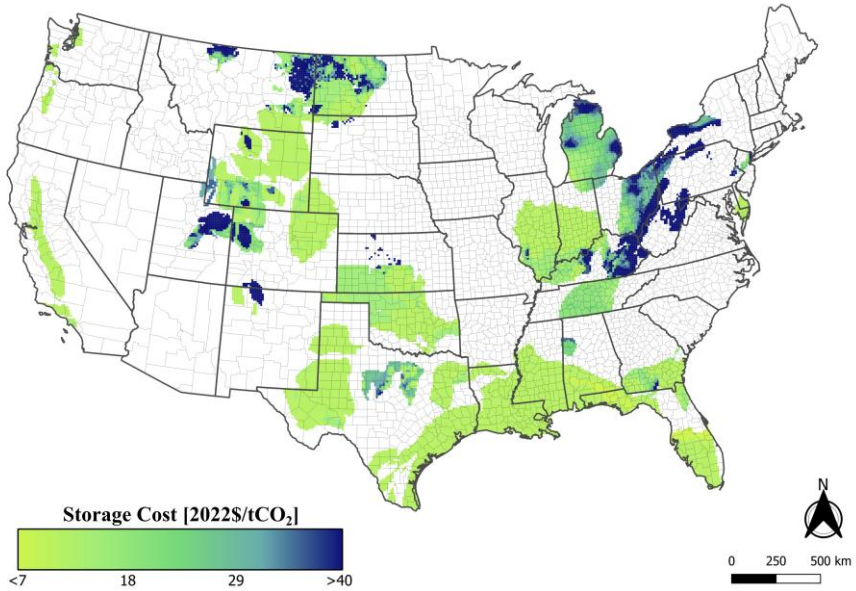

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Software Extension

SCO_2T^{PRO}

What?

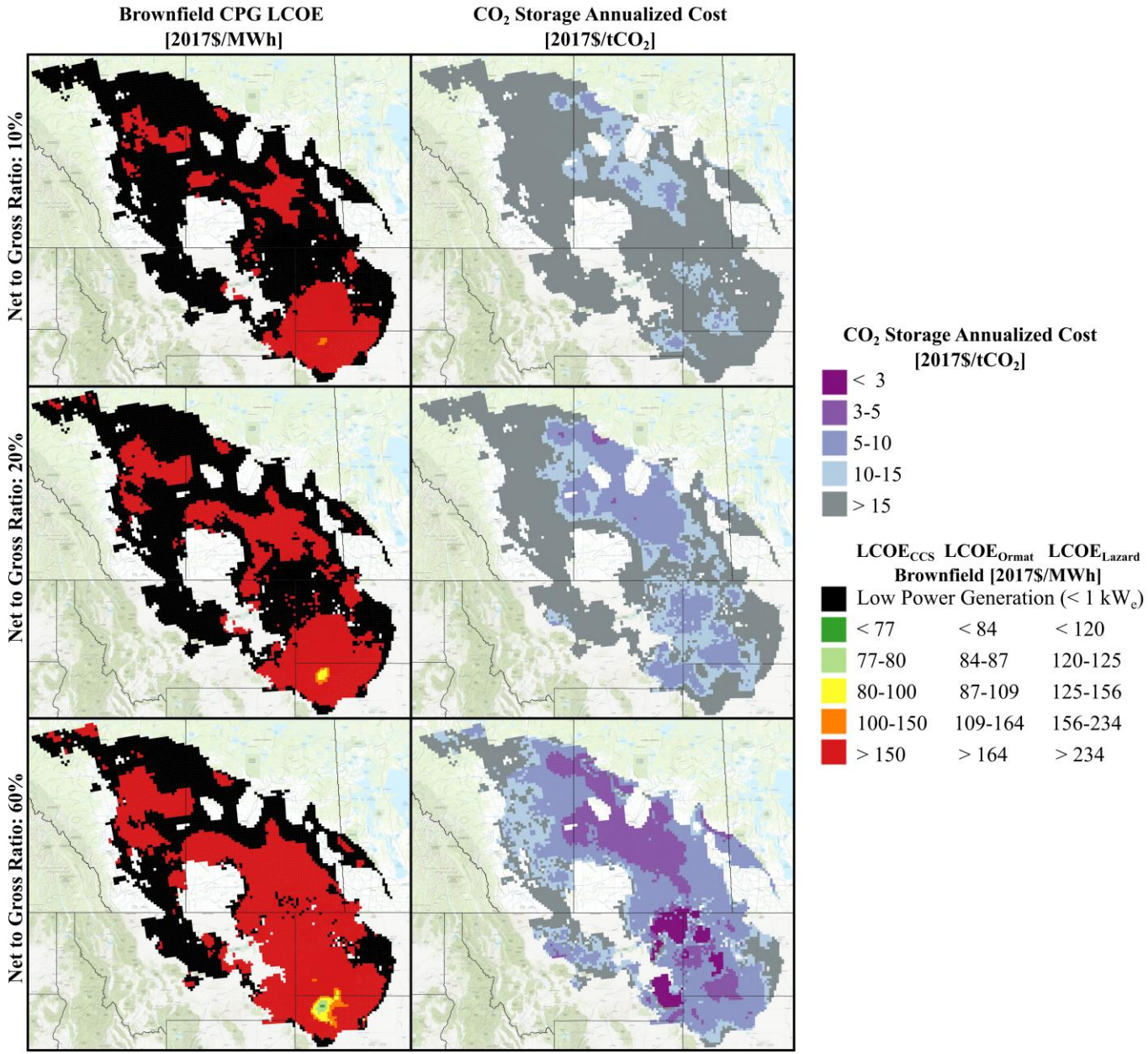
- Estimate cost and power generation of sedimentary basin geothermal power

Why?

- Understand tradeoffs between CO_2-geothermal, CO_2 storage, and water-based sedimentary basin power.

How?

- Use genGEO within SCO_2T^{PRO}



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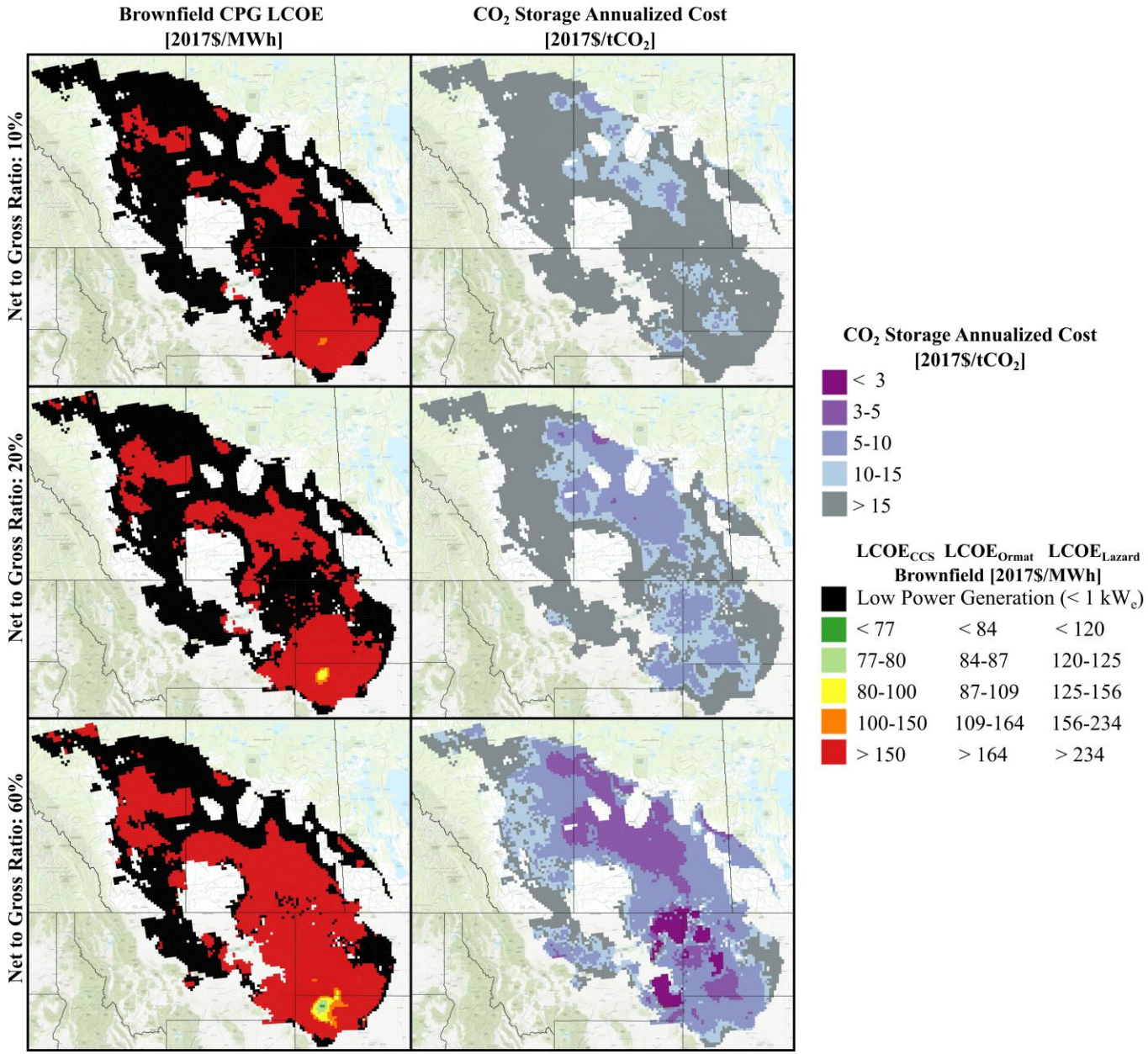
Software Extension

SCO_2T^{PRO}

Findings:

- The locations with lowest-cost CO_2 storage are different than the locations with lowest-cost CO_2-geothermal.



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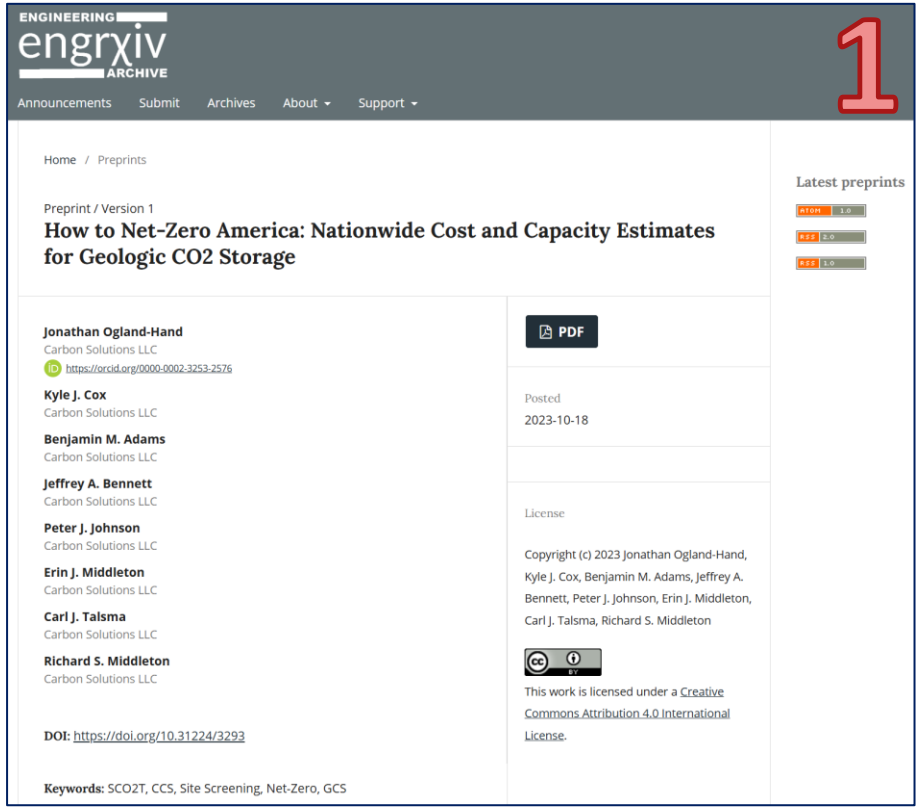

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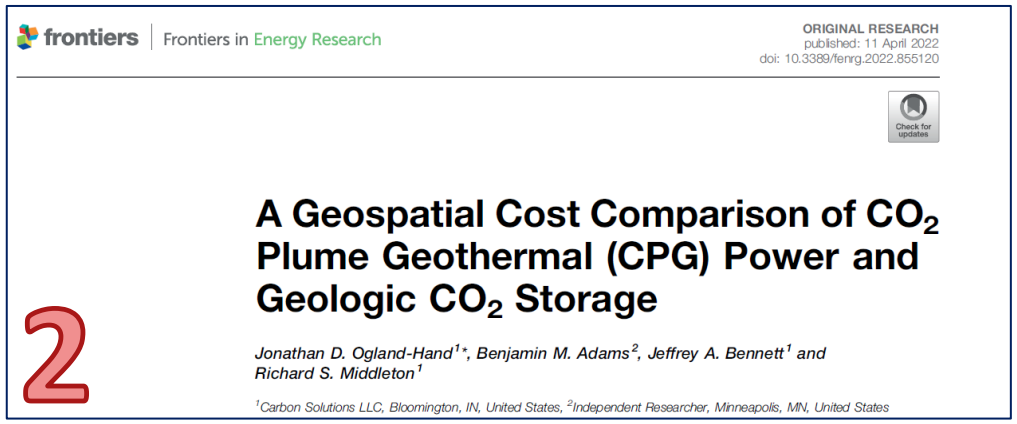

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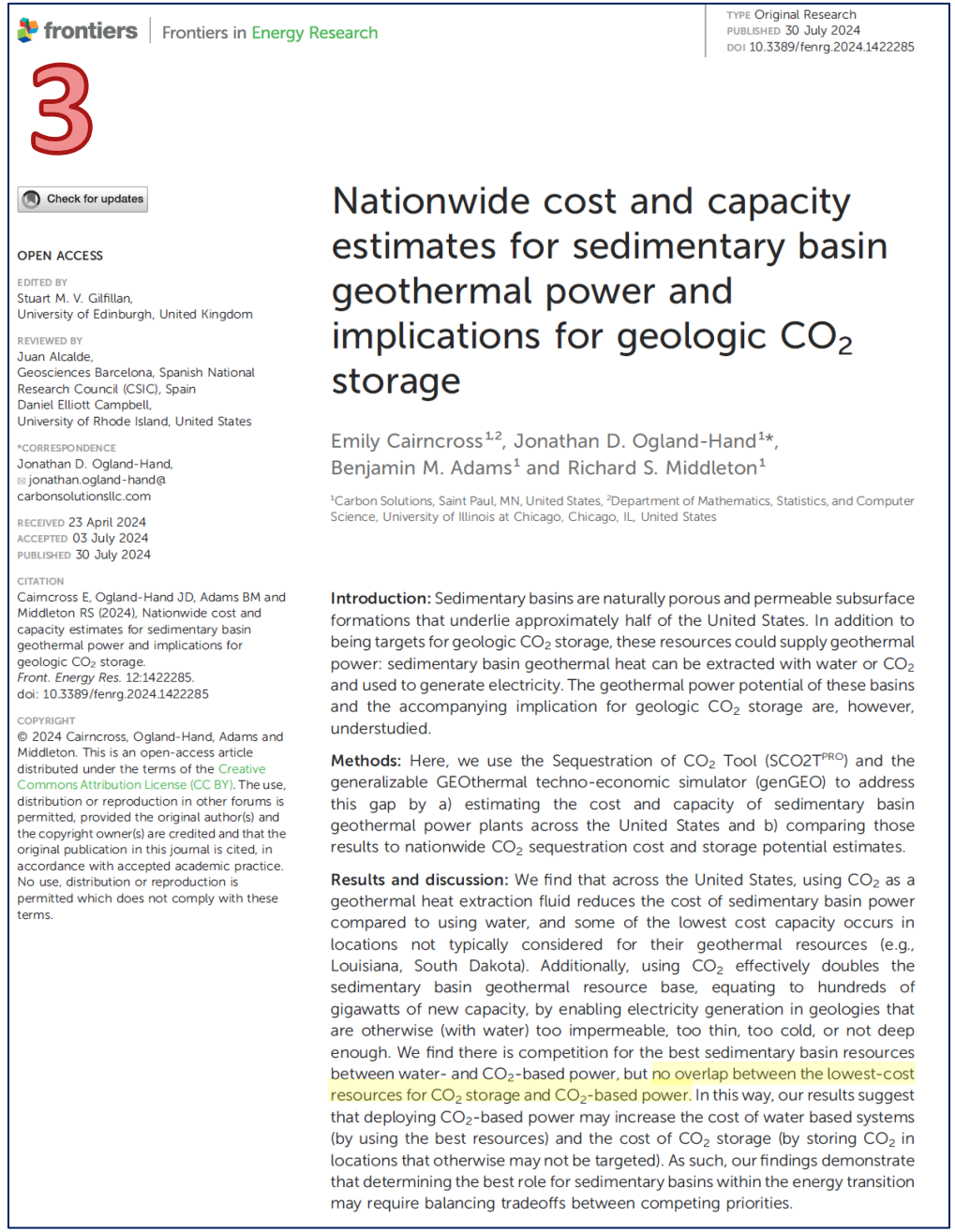

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Can every CCS project support a CO_2-geothermal power plant?

Engagement

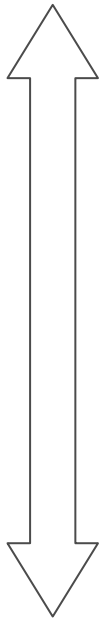
How to approach community engagement? Who to partner with? How to develop industries?

Audience Question:

What are some unique considerations when engaging local stakeholders and communities about geothermal development? In what ways is it similar to and different from CCS engagement?

Stakeholder Engagement and Strategy

Project is an Idea



Project Implementation

Best Practices in Outreach & Engagement

- Help your team understand when and what kind of engagement is a fit for each stage of project development.

Stakeholder Identification

- Map important stakeholders in each community

Community Profiles

- Understand current community needs and concerns

Engagement Plan Development

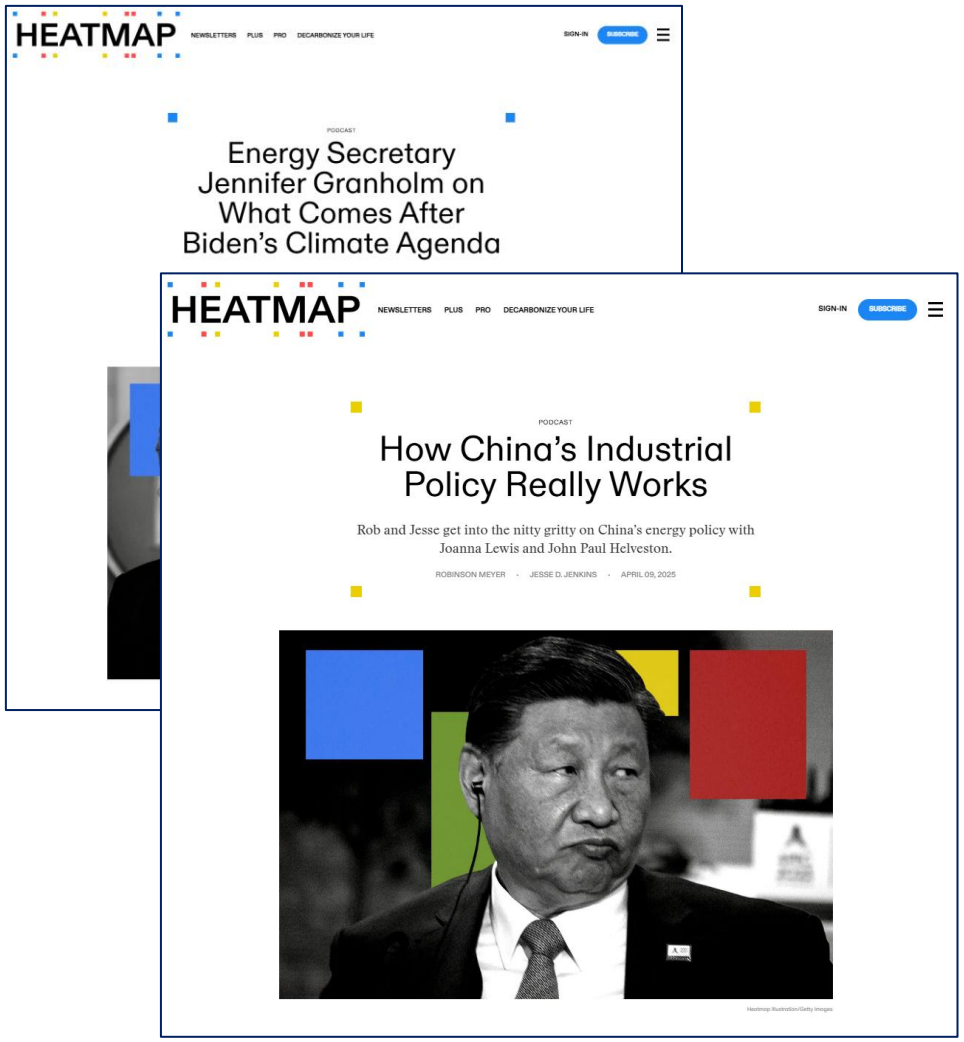
- “How to” for your engagement effort(s), integrating stakeholder outreach strategy and local community issues and concerns.

Engagement Plan Implementation

- Provide facilitation, presentation materials, and outreach strategies aligned to project milestones.

Who to partner with?

How to develop the CCS and geothermal industries?



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U.S. Department of Energy (DOE)
Office of Energy Efficiency and Renewable Energy (EERE)

Geothermal Technologies Office
Geothermal Resources' Value in Implementing Decarbonization (GTO GRID)

Funding Opportunity Announcement (FOA) Number: DE-FOA-0003346
FOA Type: Initial
Assistance Listing Number: 81.087

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Applicants are required to address all FOA goals outlined in Table 2:

Table 2: GTO GRID FOA Goals and Desired Project Outcomes

	FOA Goals	Desired Project Outcomes
1	Understand current geothermal representation and identify forward-looking best practices to incorporate geothermal power in regional utility planning processes	- Synthesis of current geothermal power representation in the proposed region's utility planning process - input assumptions, deployment forecasting, research gaps or data needs, limiting factors precluding deployment, etc. - Develop best practices recommendations based on the project's analysis results for how geothermal power representation in the proposed region's utility planning process could be improved to support future geothermal power deployment - Plans for dissemination of identified best practices recommendations for potential implementation in other utility territories

submitting an application, (2) provide a valid UEI number in the application, and (3) maintain an active SAM registration with current information when the applicant has an active federal award or an application or plan under consideration by a federal awarding

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HEATMAP

Energy Secretary Jennifer Granholm on What Comes After Biden's Climate Agenda

HEATMAP

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Policy Re

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Joanna Lewis and

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U.S. Energy Secretary Chris Wright endorses geothermal expansion

U.S. Secretary of Energy Chris Wright (source: flickr/ Gage Skidmore, CC BY-SA 2.0)

Alexander Richter
13 Mar 2025

U.S. Energy Secretary Chris Wright calls for expanding geothermal energy, citing its potential to enhance energy security, support AI, and stabilize electricity prices.

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY | EERE T 540.117-01: Funding Opportunity Announcement

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Takeaways

CO_2-geothermal is more than "just" CCS and "just" geothermal

- More valuable, more exciting, but also more complicated, more challenging, and more expensive

Deploying CO_2-geothermal will require intentional efforts outside of "just" CCS and "just" geothermal

- Finding the right locations for CO_2 storage, finding CO_2 sources, developing transportation
- Demonstrating power generation
- Grid studies that quantify the value to the electricity system
- Site-level optimization (e.g., well placement and power system design)
- Industry development

Carbon Solutions is addressing these hurdles.


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