The Carbon Utilization and Storage Partnership: Accelerating Commercial De-Carbonization of the Western United States

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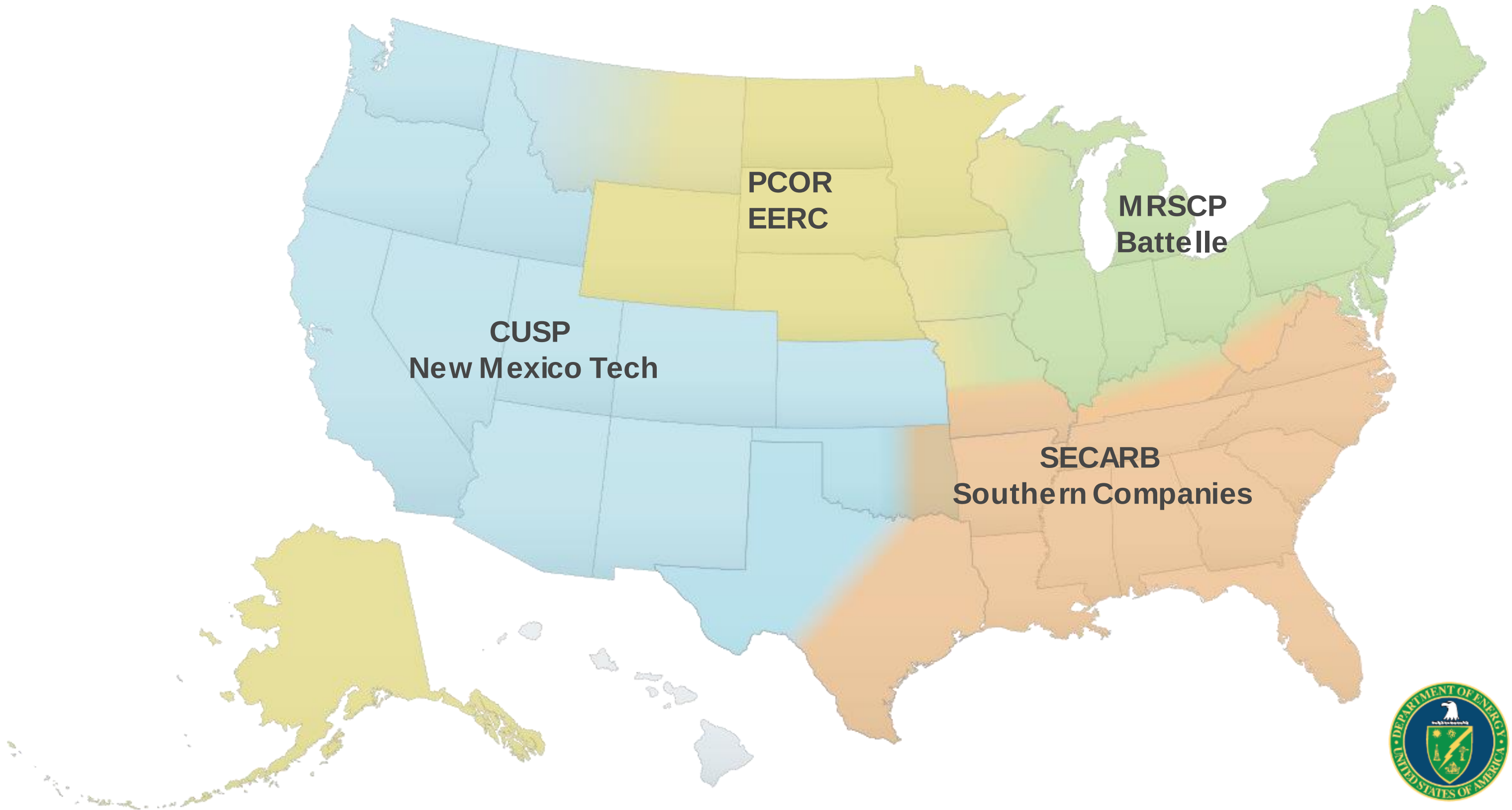
University of Utah

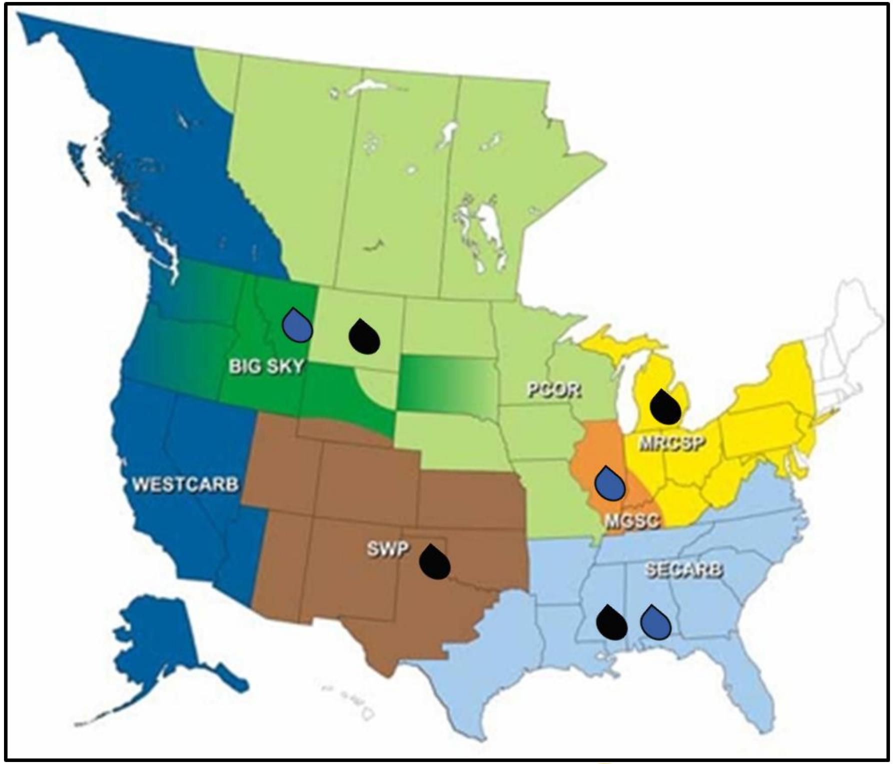
DOE Carbon Management Project Review Meeting, Pittsburgh, August 15, 2022

Regional Initiatives to Accelerate CCUS Deployment (2019)



USA Case Studies for CCS (2003-2022)

- US Department of Energy Regional Carbon Sequestration Partnerships
  - Seven regional partnerships
  - Dozens of pilot projects
- Each partnership tasked with demonstrating injection of at least 1,000,000 metric tons of CO_2 as a final project
- Four projects demonstrated storage in conjunction with EOR
- Developed "best practices" for utilizing captured CO_2



Modified from http://energy.gov/fe/science-innovation/carbon-capture-and-storage-research/regional-partnerships

Who is the CUSP?

- Parts, or all, of three of the original RCSPs: SWP, WESTCARB, and Big Sky
- States represented - through a survey, a university, or a research institute: AZ, CA, CO, ID, KS, NM, NV, MT, OK, OR, TX, UT, WA
- National Laboratories - Los Alamos, Pacific Northwest, and Sandia
- Additional collaboration with Indiana University for technical support (SIMCCS)
- Industry engagement: Schlumberger, Bright Energy, EDP, and Enchant NM. Other states will be bringing in more interested parties

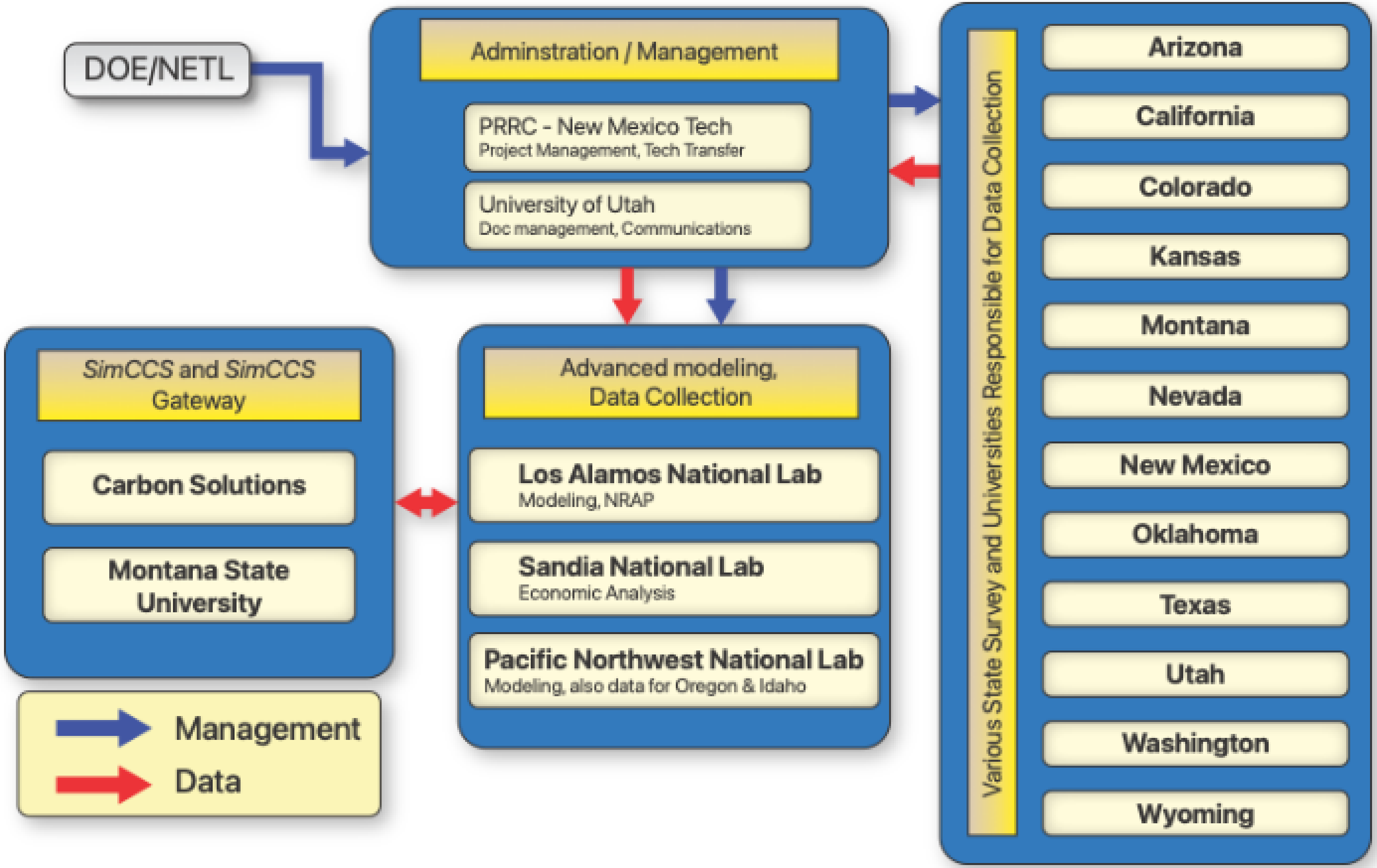
Who is the CUSP?

CUSP West

- Parts of three of the original RCSPs: SWP, WESTCARB, and Big Sky
- States represented - through a survey, a university, or a research institute: AZ, CA, CO, ID, KS, NM, NV, MT, OK, OR, TX, UT, WA
- National Laboratories - Los Alamos, Pacific Northwest, and Sandia
- Parts of three of the original RCSPs: SWP, WESTCARB, and Big Sky
- **Has funded to date: 15 CCUS commercialization projects in the western US**
- **Have 4 additional projects wholly funded by industry**

NATIONAL ENERGY TECHNOLOGY LABORATORY

Organization



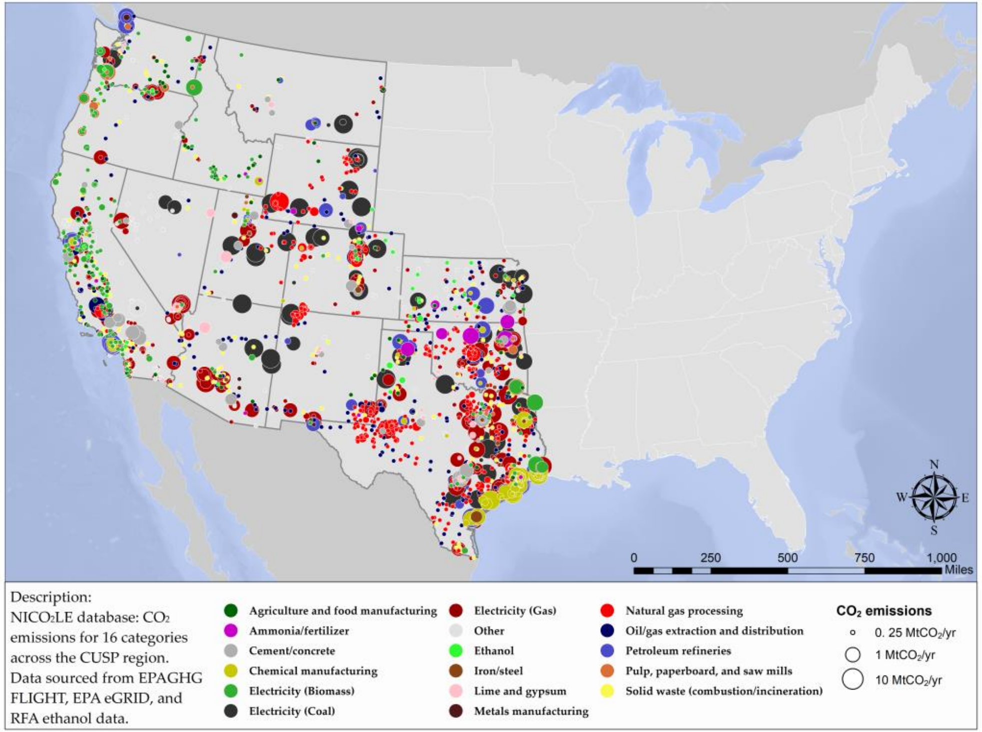
CUSP – Original Scope of Work (2019)

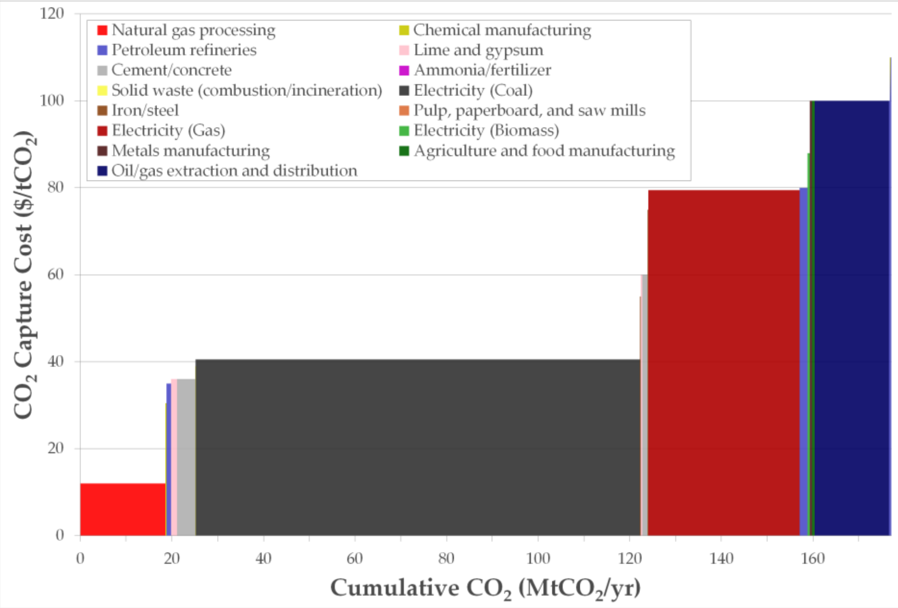
- Focus on collecting, synthesizing, and using existing data sets.
- Data to be incorporated into analytical and optimization models to evaluate CCUS potential and readiness. Goals include:
  - Identifying best prospects for commercial CCUS
  - Quantifying potential economic impacts
  - Developing Readiness Indices (w/ SimCCS) to identify best areas for short-term, mid-term, and long-term CCUS projects
- State organizations assessing, updating, augmenting, and verifying data used in data analysis and modeling
  - Geological storage complexes (saline, stacked storage, ROZs)
  - CO_2 emission sources
  - Existing infrastructure
- Strong emphasis on technology transfer and outreach

CUSP – Expanded Scope of Work (2020)

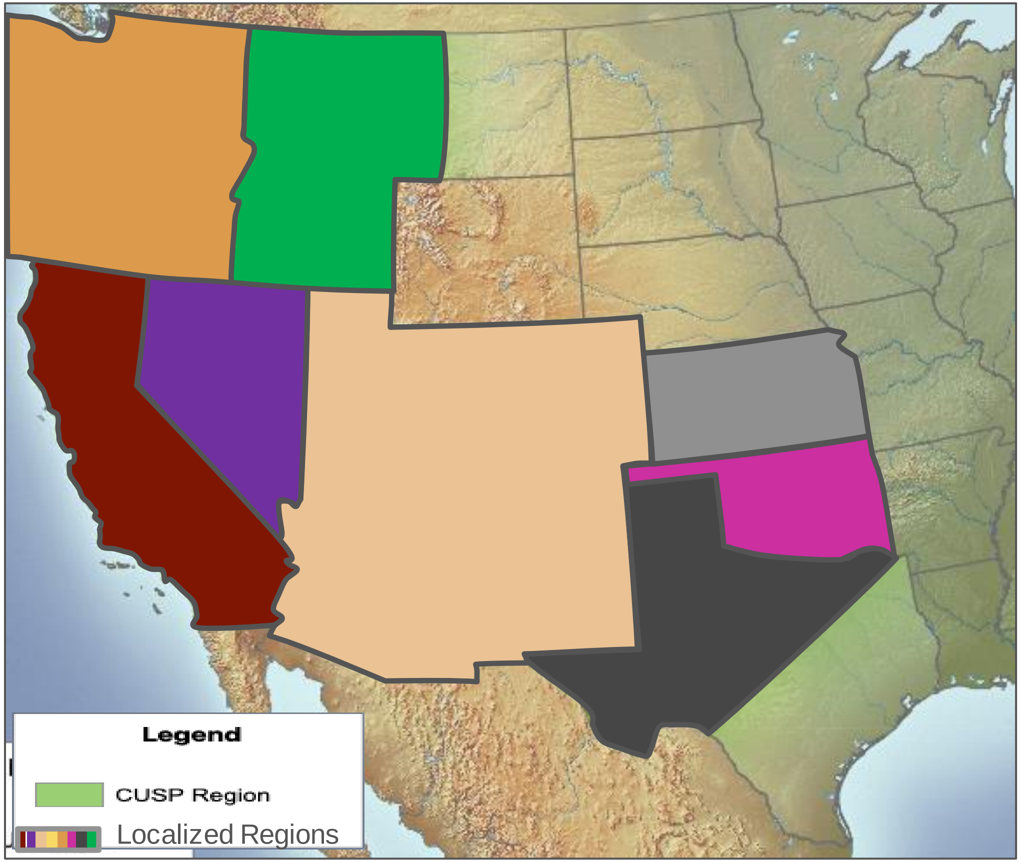
- While maintaining original scope and duration for atlas work, we added funds to each organization to cover tech transfer and education
- Funds set aside to jumpstart 45Q ready projects in the region
  - Farnsworth EOR project conversion to storage focus – **Perdure Petroleum** – In Conjunction with SWP team
  - Provide support for MRV planning at CarbonSAFE III San Juan Project – **Enchant Energy** – In conjunction with CarbonSafe San Juan team
  - Red Hills and Metropolis separation facilities, Permian basin – **Lucid Energy**

Preliminary Source Assessment in CUSP Region Using NICO2LE





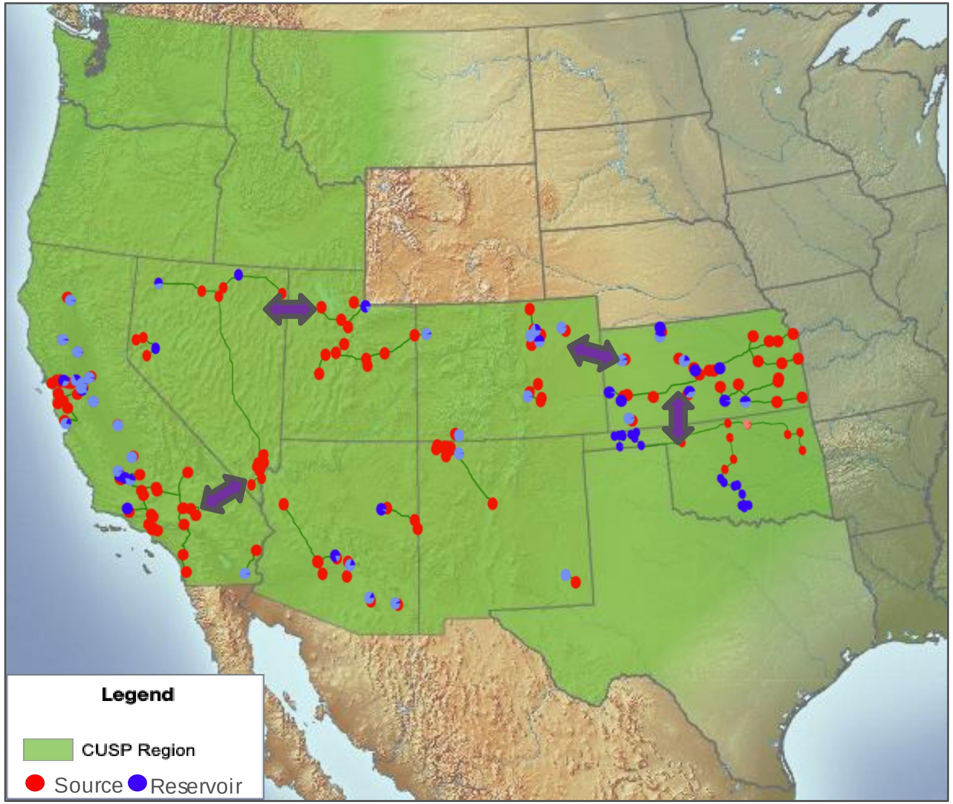
Current State of Source-Sink Mapping



CCS Readiness Assessment Approach:

1. Conduct case studies of localized regions (KS, OK, NV, CA, Four Corner region currently).

Source-Sink Mapping

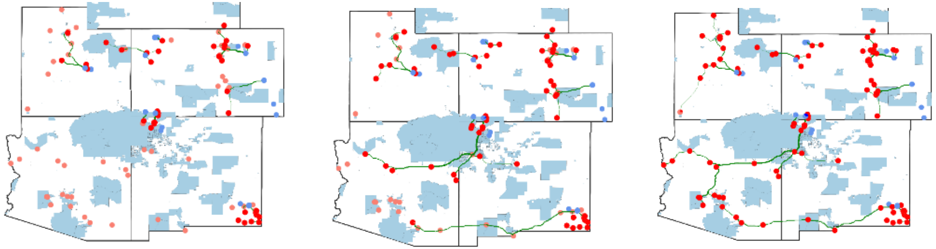


CCS Readiness Assessment Approach:

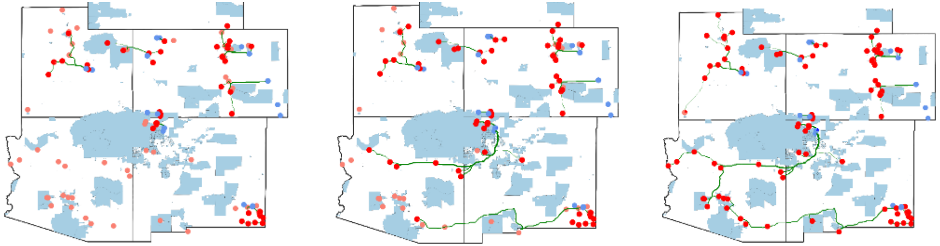
1. Conduct case studies of localized regions (KS, OK, NV, CA, Four Corners, Permian basin regions currently).
2. Identify potential hubs and opportunities of localized regions.
3. Permian and Northwest are in the queue for detailed mapping
4. Explore inter- and cross-region integration and deployment assessments

Latest Source-Sink Mapping

Four corner region:



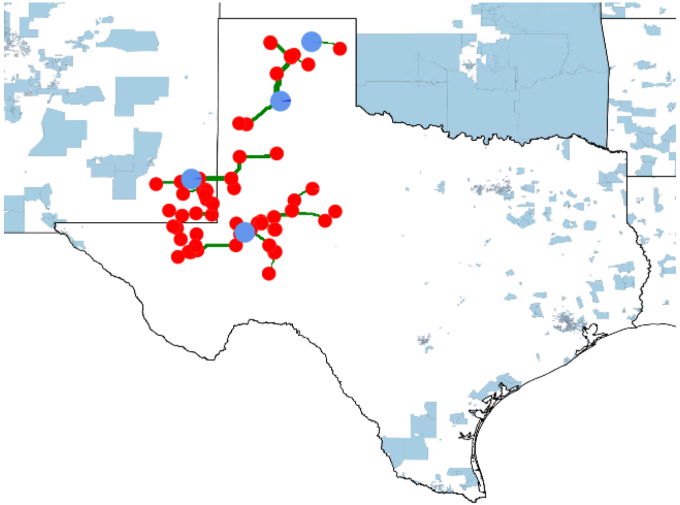
Phase-based pipeline routes without the constraint of E&J. Light blue areas correspond to the E&J communities.



Phase-based pipeline routes **with the constraint of E&J**. Light blue areas correspond to the **E&J communities.**

	Without E&J	With E&J
Total cost $/tCO_2$	4.22	4.65

West Texas:



Outreach and Industry Advisory Board

Cuspwest.org


Carbon Utilization and Storage Partnership

CO₂ CAPTURE

Large (>25,000 metric tons), stationary emission sources (power plants, cement factories, ethanol plants, etc) are fitted with special hardware to capture and concentrate produced CO_2, where it is then transported to a site for utilization and/or storage.

CO_2 TRANSPORT

Captured and concentrated liquid phase CO_2 is gathered for conveyance to a long-term storage site. The most economical form of CO_2 transport is by pipeline. For new capture-to-storage sites, CO_2 pipelines must be constructed along rights-of-way, often requiring significant legal and regulatory negotiations.

CO_2 STORAGE

Captured liquid phase CO_2 is transported to a utilization or storage site via pipeline. The CO_2 is injected into deep geologic formations. Over time,

What is the Carbon Utilization and Storage Partnership (CUSP)? CUSP is a Department of Energy-funded Regional Initiative established to accelerate onshore CCUS technology deployment in the Western Region of the United States. The CUSP project is a research consortium of all or parts of 13 states, consisting of organizations throughout the western United States including academia, government agencies, national laboratories, and industry.

The Main Objectives of the CUSP Initiative

- Addressing Key Technical Challenges
  The project will expand the understanding of storage in stacked and unconventional formations with emphasis on optimizing storage and reducing uncertainty
- Facilitating Data Collection, Sharing, and Analysis
  The project will consolidate and update the disparate and outdated datasets to improve the understanding of CO_2 injection, containment and economic feasibility
- Evaluating Regional Infrastructure
  The project will evaluated the requirements of a transportation network needed to deliver the captured CO_2 from the sources to the utilization and storage sites
- Promoting Regional Technology Transfer
  The project will engage, inform and educate CCUS stakeholders to facilitate technology transfer and the advancement of CCUS projects in the region

- The CUSP project has called on a select group of energy sector representatives to advise the team on how best to engage and communicate with industry and other stakeholders, for the purpose of advancing CCS in the western USA

The CUSP Industry Advisory Group has been formed and consists of members from:

- State regulatory agencies
- CO_2 emitters
- CO_2 capture and transport companies
- Oil/Gas operators
- Policy think tanks

Progress and Current Status of Project

- Looking at Sources, Sinks, transportation pathways both existing and potential
- Have identified existing and several potential regional hubs
- Refining Atlas style data and converting older static databases into self-updating data sources
- Integrating machine learning tools such as SimCCS The project team has done an initial survey of the region for opportunities and issues related to those opportunities
- **Funding:**
  - ~$6million (including cost-share) in 2019, 2020, 2021
    - With 2020 funding, we selected three companies to assist with MRV planning
    - 2021 funding went to 12 additional commercialization projects

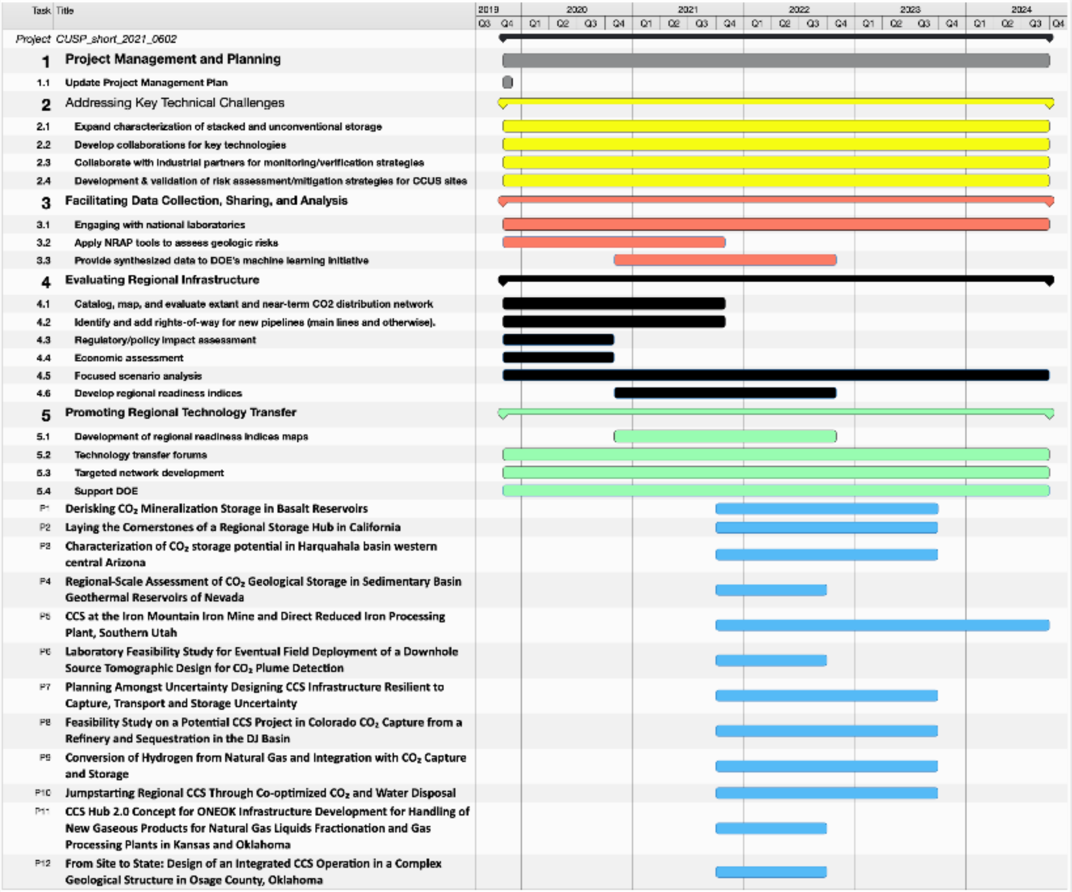
Portfolio and Timeline

CUSP West

- Industry engagement
  - Lucid Energy
  - Enchant Energy
  - Oxy Low Carbon Ventures
  - Sentinel Peak Resources
  - Perdure Petroleum
  - Suncor Energy
  - ONEOK
  - Utah Iron LLC
  - NGL Energy Partners
  - Paulsson Inc
  - And many others

Carbon America

Schlumberger



2020 Case Study – Perdure Petroleum

- Perdure Petroleum operates the Farnsworth Unit, a CO_2 Enhanced Oil Recovery field in Ochiltree County, Texas
- The Farnsworth Unit has been injecting anthropogenic CO_2 from the Agrium fertilizer plant at Borger, Texas, and the Arkalon ethanol plant at Liberal, Kansas
- Perdure plans to continue CO_2 EOR operations in the western half of the Farnsworth Unit, with likely expansion to EOR and storage in the eastern half of the unit
- The Perdure MRV plan for the Farnsworth Unit relies heavily on the work conducted by the Southwest Carbon Partnership, one of the NETL Regional Carbon Sequestration Partnerships

Farnsworth Unit, Texas

2020 Case Study – Enchant Energy

- Enchant Energy is part of the NETL CarbonSAFE initiative that will demonstrate that the storage complex in San Juan County, New Mexico can accelerate the deployment of CCS technology at the San Juan Generating Station (SJGS)
- Enchant Energy plans to retrofit the San Juan Generating Station, San Juan County, New Mexico, with 6-7 MMT/yr CO_2 capture technology and locally store more than 2 MMT/yr CO_2
- Project is currently in the Characterization phase, with an upcoming stratigraphic test well; an EPA UIC Class VI permit application is being developed in parallel to the geologic characterization.

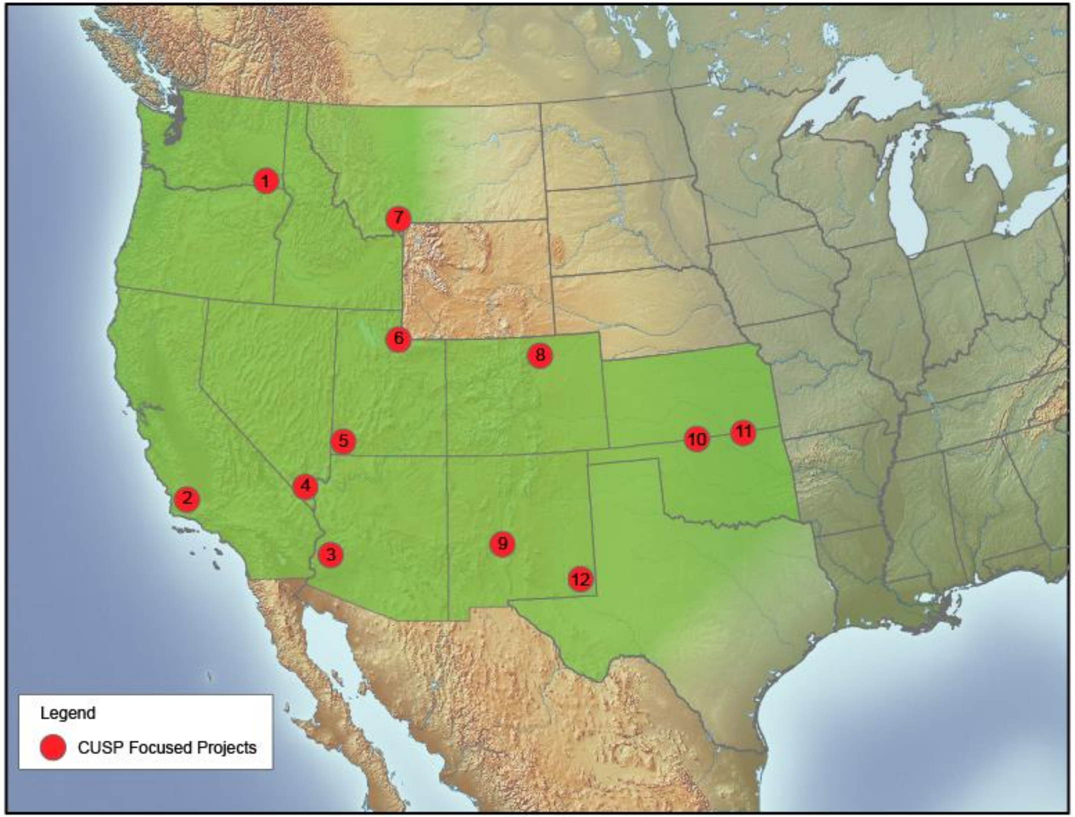
San Juan Generating Station

2020 Case Study – Lucid Energy (Now Targa)

- Lucid operates acid gas treating and disposal facilities at its Red Hills gas processing plant complex and Dagger Draw processing plants in Lea and Eddy County, New Mexico, respectively
- The Red Hills facility compresses and injects H_2S and CO_2 concentrations in the raw sour gas it receives into the facility
- Roughly 50% of Lucid's CO_2 emissions are from vented CO_2 resulting from Amine Treating
- Capturing, sequestering and storage of vented CO_2 is the most economic option to capture 45Q tax credits and impact Lucid's carbon footprint
- In the process of drilling a 2nd well, with 4 additional wells in planning stage (CUSP affiliated project)

Red Hills Acid Gas Facility

CUSP 2021 Focus Projects



- Internally selected by management team, the advisory board will assist if future funding is given
- Most projects have industry partners have timelines of 1-3 years
- Includes a unique study for injection into basalts
- Includes bench scale work on the use of CO_2 as Geothermal working fluid
- Includes development of regional Storage Hubs

Selected 2021 Portfolio

- Industry engagement
  - Lucid Energy
  - Enchant Energy
  - Oxy Low Carbon Ventures
  - Sentinel Peak Resources
  - Perdure Petroleum
  - Suncor Energy
  - ONEOK
  - Utah Iron LLC
  - NGL Energy Partners
  - Carbon America
  - Schlumberger

  - And other interests…

CUSP Focused Projects

CUSP Project Title	Project Type	Team Member	Notes
Site Characterization for CO_2 storage to Support Escalante Hydrogen Power Plant Project	Bench-scale	NMT	Institute: New Mexico Tech PI: Sai Wang (sai.wang@nmt.edu)
Laboratory Feasibility Study for Eventual Field Deployment of a Downhole Source Tomographic Design for CO2 Plume Detection	Bench-scale	UU	Institute: University of Utah PI: Kevin Mccormack (kmccormack@egi.utah.edu)
Characterization of CO_2 storage potential in Harquahala basin, western central Arizona	Characterization	AGS	Institute: Arizona Geological Survey | University of Arizona PI: Brian Gootee (bgootee@email.arizona.edu)
Derisking CO_2 Mineralization Storage in Basalt Reservoirs	Characterization	PNNL	Institute: PNNL PI:Todd Schaef (todd.schaef@pnnl.gov)
Feasibility Study on a Potential CCUS Project in Colorado: CO_2 Capture from a Refinery and Sequestration in the DJ Basin	Field-centric	CSM	Institute: Colorado School of Mines PI: Ali Tura (alitura@mines.edu)
CCS Hub 2.0 Concept for ONEOK: Infrastructure Development for Handling of New Gaseous Products for Natural Gas Liquids Fractionation and Gas Processing Plants in Kansas and Oklahoma	Field-centric	KGS	Institute: Kansas Geological Survey PI: Franek (franek@ku.edu)
Laying the Cornerstones of a Regional Storage Hub in California	Field-centric	SU	Institute: Stanford University PI: Tony Kovscek (kovscek@stanford.edu)
From Site to State: Design of an Integrated CCS Operation in a Complex Geological Structure in Osage County, Oklahoma	Field-centric	UO	Institute: University of Oklahoma PI: Rouzbeh G. Moghanloo (rouzbeh.gm@ou.edu)
Lucid Energy Group: Carbon Utilization and Storage Partnership of the Southwest Project	Field-centric	NMT	Institute: New Mexico Tech PI: George El-Kaseeh (George.El-kaseeh@nmt.edu)
CCS at the Iron Mountain Iron Mine and Direct Reduced Iron Processing Plant, Southern Utah	Field-centric	UU	Institute: University of Utah PI: Brian McPherson (b.j.mcpherson@utah.edu)
Regional-Scale Assessment of CO_2 Geological Storage in Sedimentary Basin Geothermal Reservoirs of Nevada	Paper Study	DRI	Institute: Desert Research Institute PI: Steven Bacon (Steven.Bacon@dri.edu)
Planning Amongst Uncertainty: Designing CCS Infrastructure Resilient to Capture, Transport, and Storage Uncertainty	Paper Study	MU	Institute: Montana State University PI: Sean Yaw (sean.yaw@montana.edu)

CUSP Project #1

Derisking CO_2 Mineralization Storage in Basalt Reservoirs

Location

Pacific Northwest US (Columbia River Basalt Group)

CUSP Team

Project Lead: Todd Schaef (PNNL)

Sub-Contract: Washington State University

Primary goal

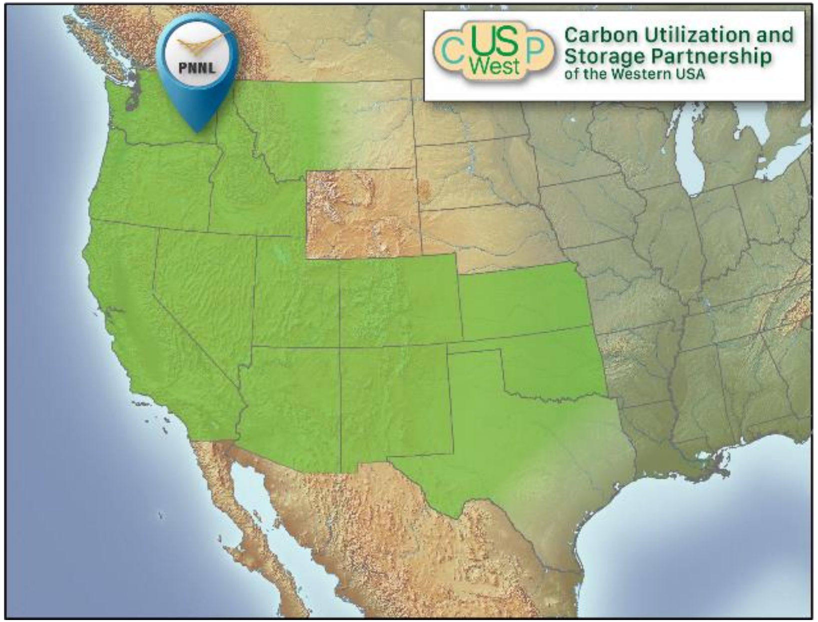
Develop R&D for commercial-scale CO_2 storage in basalt

Impact on Carbon Storage

Validation of simulation, characterization and monitoring approaches necessary to support successful Class VI application and demonstration for basalt reservoirs

Project duration

24 months



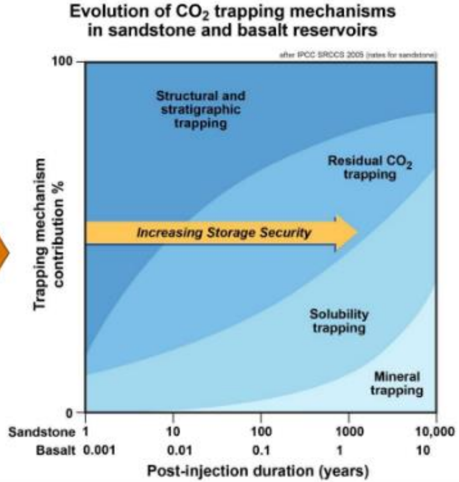
Project summary - PNNL

Project Objectives

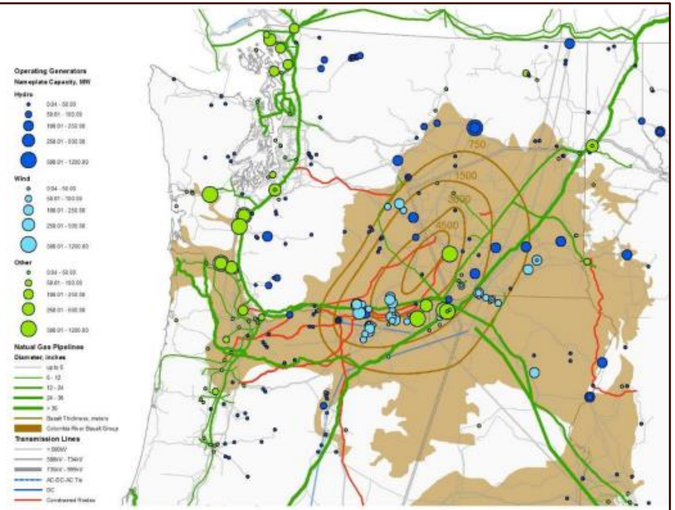
Address Gaps/Barriers to Commercialization of CCS projects in Basalts.

Following workflow:

1. Regional Geologic Model
2. Numerical Simulation
3. Preliminary Site Screening
4. Characterization, Permitting and Development Planning
5. Stakeholder Engagement



Basalts **convert CO_2 to solid minerals** much more rapidly than other rock types. Mineralized CO_2 is immobile and poses **no risk of leakage.**



Key infrastructure, existing generation, and extent of the CRBG in the PNW. Contours are depths of basalt in meters.

Main challenges:

- Field derived mineralization rates are faster than laboratory values
- Impacts on porosity and permeability around a well and at the formation scale are unknown
- Estimating storage capacity, injection rates, and fluid migration at scale is difficult
- Detecting, and surveying injected fluids at reservoir scale is challenging in layered basalts.

CUSP Project #2

Laying the Cornerstones of a Regional Storage Hub in California

CUSP Team

Project Leads: Tony Kovscek & Elliot Kim (Stanford Univ.)

Sub-Contract: Carbon Solutions, Montana State University

Primary goal

Accelerate pilot project to capture, transport, and store 70 ktCO2/y; Support an EPA Class VI well permit application; Demonstrate the feasibility of a CCS storage hub in Kern Co.

Impact on Carbon Storage

Near term impact is to build capacity

Industry partner: Sentinel Peak Resources

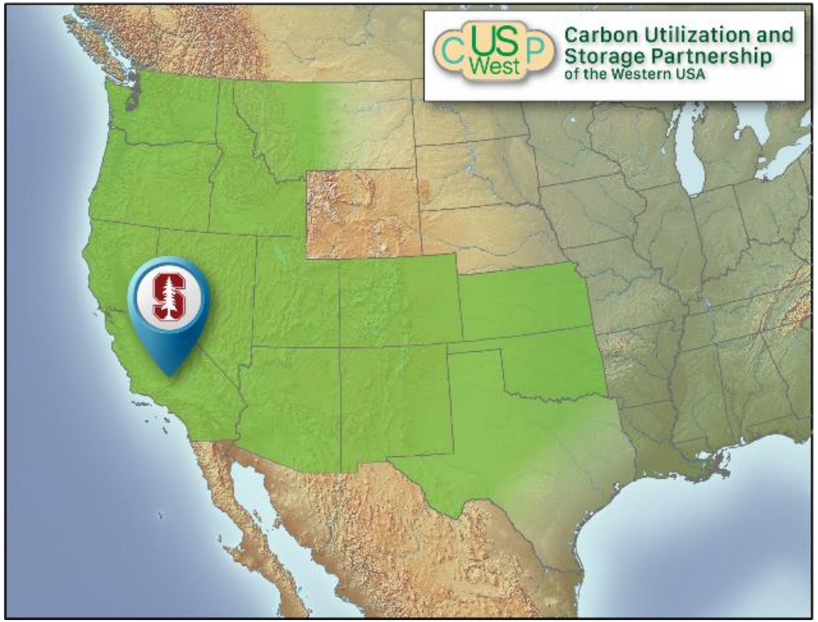
Project duration: Two years

Anticipated time to storage

Aiming for Class VI permit during the project time frame.

Anticipated volume/year

initially 70,000 t/y and potentially expanding to 10 Mt/y

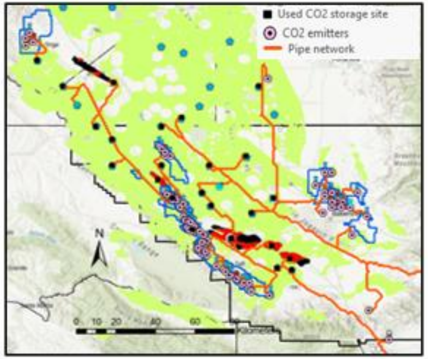


Project summary - SU

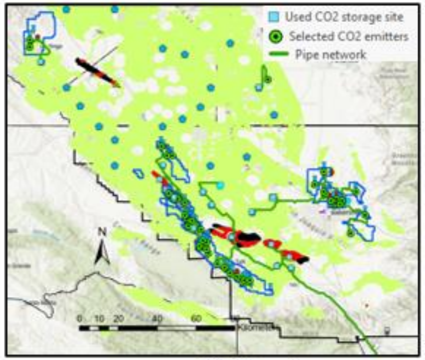
Project Objectives

- Leverage LCFS (low carbon fuel standard) credits to deploy a CCS project in California
- Investigate storage volumes and dynamic storage capacity in targeted saline formation
- Establish similar projects for oil & gas companies
- Forge a pathway to deploy a regional storage hub in the Southern San Joaquin Basin

- Storage resource estimate: 5.8 $GtCO_2$; 41 optimal storage sites.
- SIMCCS CAP mode: Capture and store for all emissions
- SIMCCS PRICE mode: Capture and store for cost-beneficial projects (pipeline network is limited)



CAP mode



PRICE mode

Tasks	Year 1				Year 2				Deliverables	Partner		
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8		SU	SPR	Carbon Solutions /MSU
1. Distributed emitters									- Identification of OG prod. facilities - Techno-economic analysis	√	√	√
2. Subsurface model									- Build a reservoir model of saline formation	√	√	
3. Storage assessment									- Assess the dynamic storage capacity	√	√	√
4. Plume migration									- Predict CO_2 plume transport and leak	√	√	√
5. Field project									- Assist with planning, monitoring, and pipeline network	√	√	√
6. Risk assessment									- Investigate geomechanical risk	√	√	
7. Industrial engagement									- Present the results at conferences or workshops	√	√	√
8. Forward look									- Provide the regional CCS scenarios	√		√

CUSP Project #3

Characterization of CO_2 storage potential in Harquahala Basin, western central Arizona

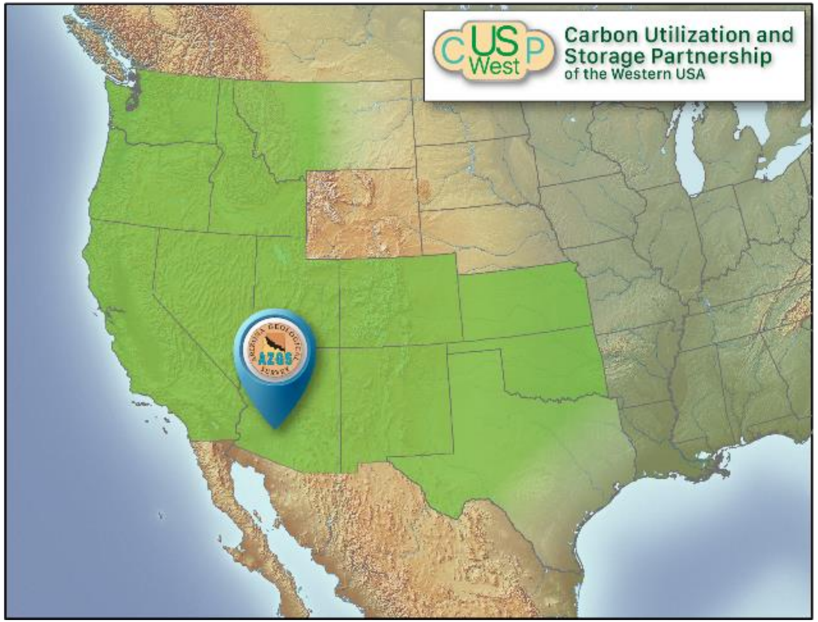
CUSP Team

Project Lead: Brian Gootee (Arizona Geological Survey)

Primary goal

Pre-feasibility evaluation for underground storage potential of CO_2

Project duration: 24 months



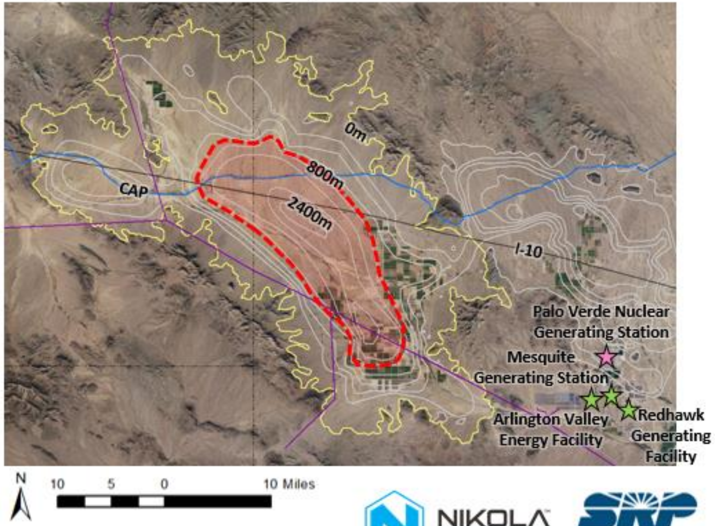
Project Summary - AGS

CUSP West

Project Objectives

- Collect data, process seismic, create cross-sections and construct initial 3D model
- Cultivate partnerships with energy companies
- Working group participation and outreach
- Identify data needs and recommendations for Phase 2
- Update CUSP databases
- Publish Open-File Report
- Develop a Phase 2 project

Harquahala Basin Location Map



Why Harquahala?

- Deep basin with sufficient volume
- Mixed saline and potential basalt storage
- Probable bedded salt– adequate seal for $CO_2 + H_2$
- Proximity to large energy producers and infrastructure
- Multiple stakeholders
- Hydrogen component in bedded salt

NIKOLA MOTOR COMPANY

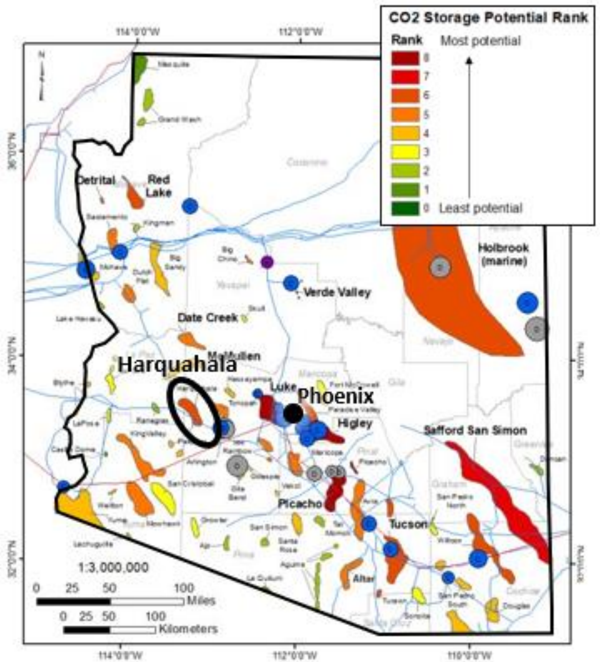
SRP Delivering power and water™

aps

TEP Tucson Electric Power

PaloVerde GENERATING STATION

AZ Basins with CO_2 Storage Potential



UNITED STATES OF AMERICA DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY

CUSP Project #4

Regional-Scale Assessment of Geothermal Reservoirs of Nevada

CUSP Team

Project lead: Steven Bacon et al (DRI)
Sub-Contract: Carbon Solutions

Desert Research Institute

Carbon Solutions LLC

Primary goal

Perform a regional-scale assessment of the potential of CO_2 geological storage in sedimentary basin geothermal reservoirs in Nevada

Impact on Carbon Storage

Mitigate CO_2 emissions in Nevada by assessing potential use of CO_2 as a geothermal working fluid

Project duration

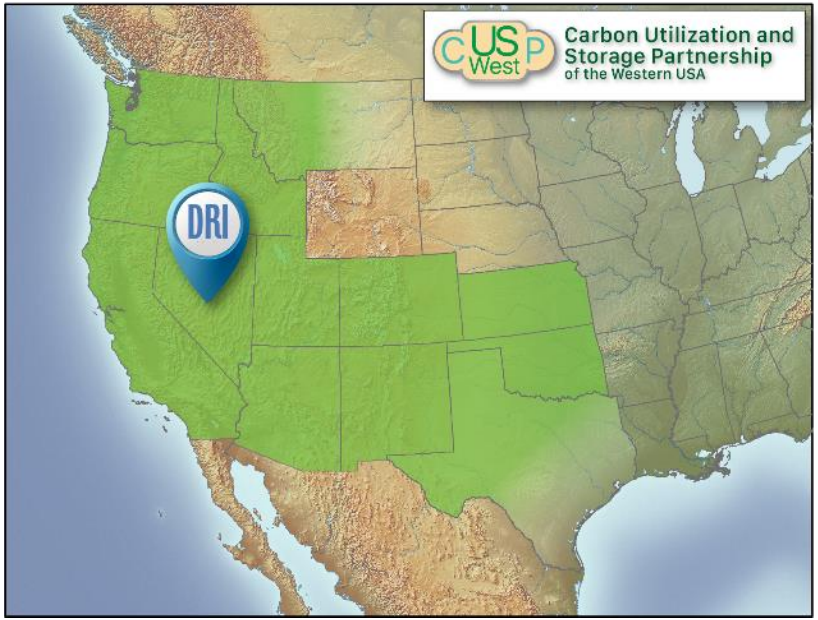
One year

Anticipated time to storage

Reconnaissance-level assessment

Anticipated volume/year

An analysis will be performed to estimate potential volumes



NATIONAL ENERGY TECHNOLOGY LABORATORY

Project summary - DRI

Project Objectives

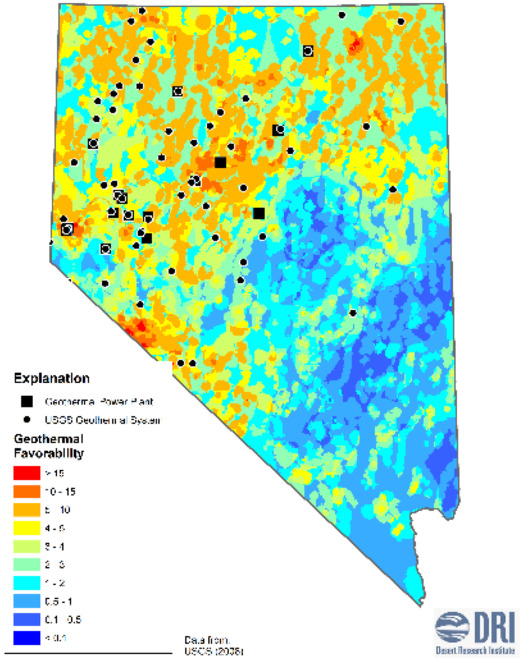
- Perform a regional-scale assessment to fill a data gap of critical information related to CCUS technologies to mitigate CO_2 emissions in Nevada.
- Develop an approach to regionally assess the potential that using geologic CO_2 storage in sedimentary basin geothermal reservoirs may have for increasing the states capability for CCUS.

Main Tasks:

- Task 1: State-Wide Geologic Characterization
- Task 2: CO_2 Plume Geothermal Assessment

Northwestern Nevada has the highest geothermal favorability:

- 18 operational geothermal plants
- Over 65 active geothermal systems that could be developed



CUSP Project #5

Iron Mountain Subsurface Characterization

CUSP Team

Project Lead: Nathan Moodie (University of Utah - EGI)
Sub-Contract: UGS, KGS, OU, OGS, MSU, LANL, Utah Iron, CarbonSolution, CandaceCandyConsulting

Primary goal

CCUS Feasibility Study for Direct Reduced Iron Project

Impact on Carbon Storage

First of its kind commercial-scale iron ore processing + CCS

Industry Partner

Utah Iron LLC

Project duration

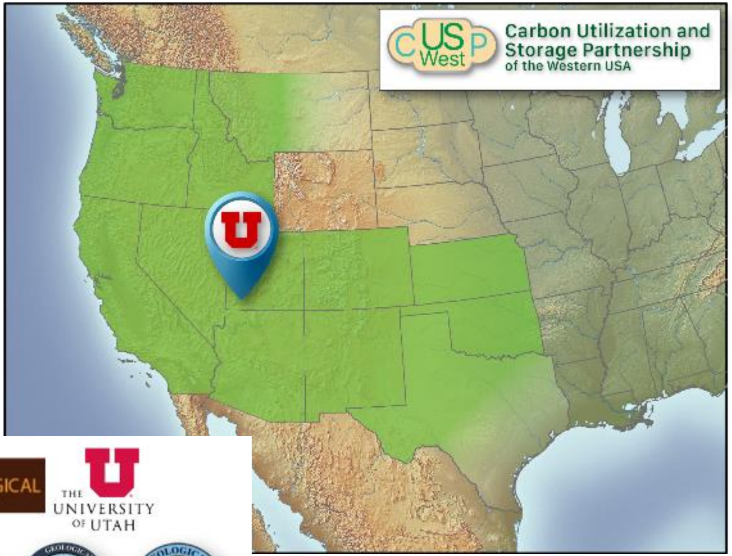
Three years

Anticipated time to storage

5 to 8 years

Anticipated volume/year

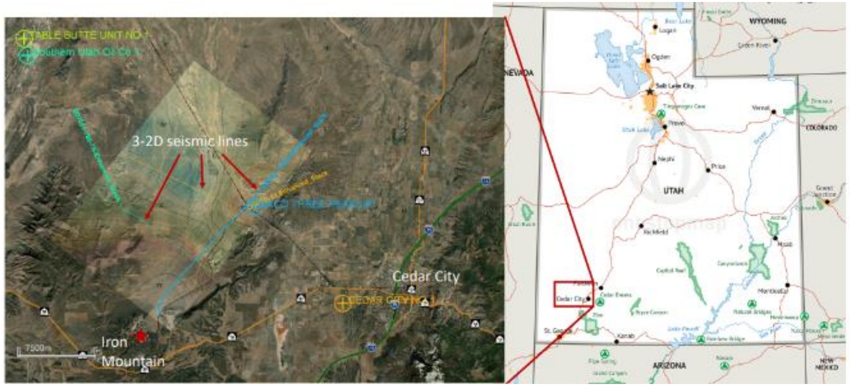
0.5 to 1.0 Mt/year over 30 years



Project summary - UU

Project Objectives

1. Rigorous site characterization and analysis of storage capacity, risks and economic options for CCUS at Iron Mountain
2. Comprehensive plan for developing a monitoring, reporting, and verification (MVA) plan
3. Comprehensive plan for 3D seismic survey and stratigraphic well
4. Comprehensive plans for assembling UIC Class VI and 45Q tax credit applications



Direct Reduced Iron (DRI) Process

- Direct Reduced Iron refers to the solid-state processes of reducing iron oxides to metallic iron at temperatures below the melting point of iron
  - Lower temp than blast furnace <1,000 °C
- CO and H_2 are produced by CH_4 catalysis and heated before entering the reactor
- Iron reduction reactions occur producing CO_2 and water
- CO_2 can then be stripped, compressed, and stored
- Iron is cooled and sent for further processing into steal

First of its kind commercial-scale iron ore processing + CCS. It will prove the viability of using CCS to make green steal.

CUSP Project #6

From Site to State: Design of an Integrated CCUS Operation in a Complex Geological Structure in Osage County, Oklahoma

Location: Laboratories in Utah and California

CUSP Team

Project lead: Rouzbeh Moghanloo (University of Oklahoma)

Sub-contract: PNNL, Carbon Solution

Primary goal

Develop a two-step roadmap to help accelerate CCUS deployment in Oklahoma, focusing on designing and permitting a novel stacked storage CCUS complex

Impact on Carbon Storage

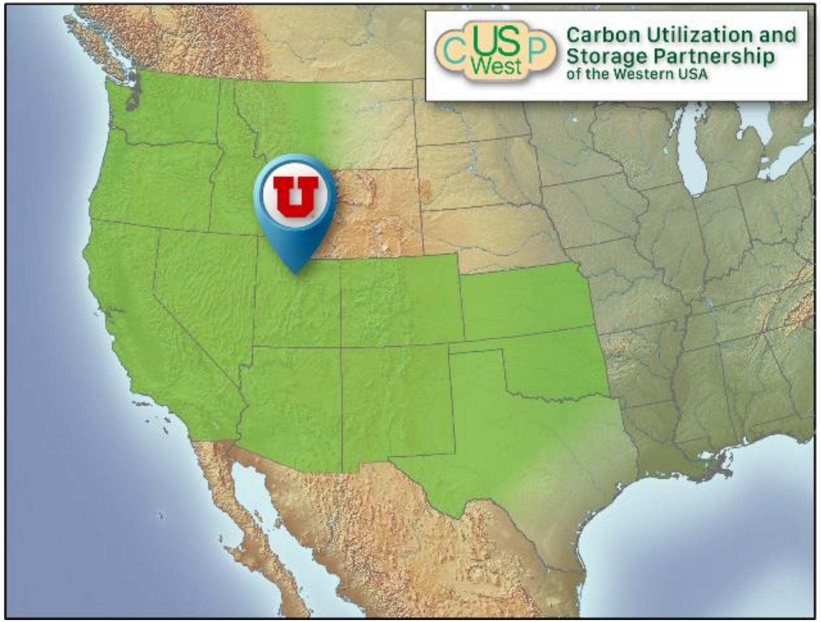
CCUS development in Oklahoma based on stacked storage.

Industry partner (If applicable)

Capture Point LLC

Project duration

1 year



NATIONAL ENERGY TECHNOLOGY LABORATORY

Project summary - UO

Project Objectives

1. Thorough formation evaluation of Arbuckle formation in Osage county
2. Determine the economic feasibility of a stacked storage site, combining CO_2-EOR and CO_2 sequestration operations
3. Develop a representative geological model of the Arbuckle saline formation in Osage county
4. Develop a multi-pathway CCUS roadmap for Oklahoma centered on the stacked storage concept
5. Evaluation of Environmental and Social Justice parameters

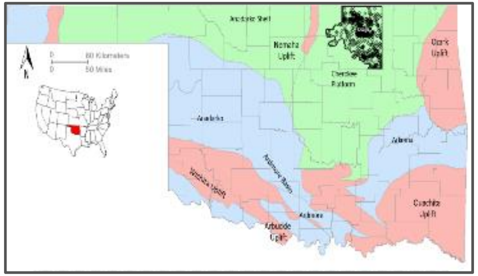
CO_2 storage for AOI that meets the criteria

Three trapping mechanisms for this study:

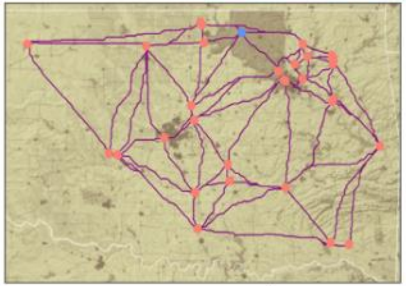
1- **caprock** above CO_2 Arbuckle group: Woodford Shale available

2- **storage potential** (porous and permeable) of Arbuckle rocks: vuggy porosities may contribute to the porosity and permeability.

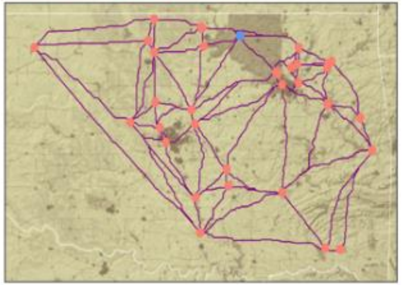
3- supercritical **depth** of Arbuckle group: The depth of west side wells in Osage is >2500 ft.



SIMCCS EXTERNAL SOURCES AND SINKS GEOLOCATION



32 CO2 sources from Carbon Solutions LLC



36 CO2 sources from in-house evaluation

CUSP Project #7

Planning Amongst Uncertainty: Designing CCS Infrastructure Resilient to Capture, Transport, and Storage Uncertainty

CUSP Team

Project Lead: Sean Yaw (Montana State University)

Sub-Contract: Carbon Solutions

Primary goal

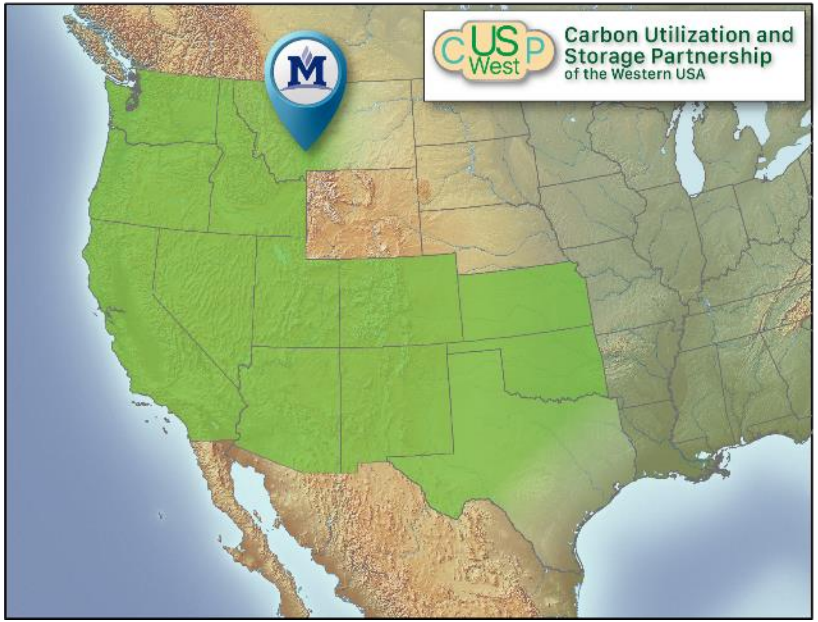
Develop a CCS infrastructure design model that will account for uncertainty throughout the CCS supply chain, with a particular focus on storage uncertainty.

Impact on Carbon Storage

Output from this project will be used throughout the CUSP region to quantify the cost of accounting and not accounting for uncertainty in the infrastructure design process.

Project duration

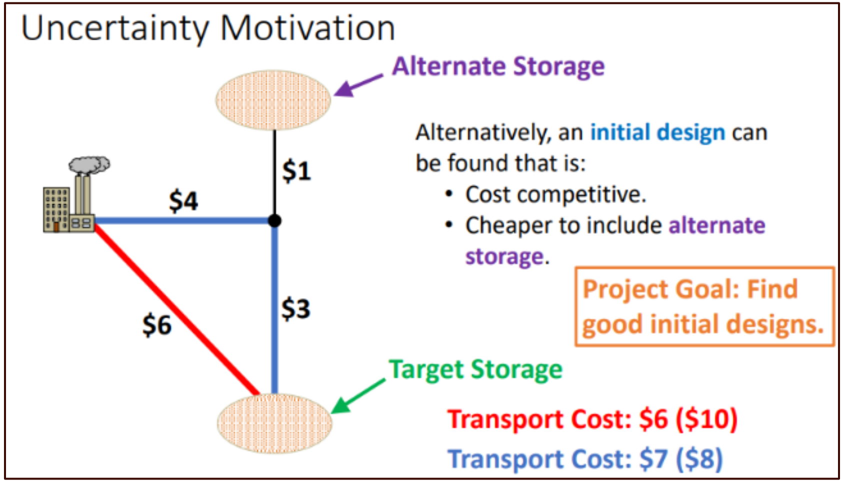
Two years

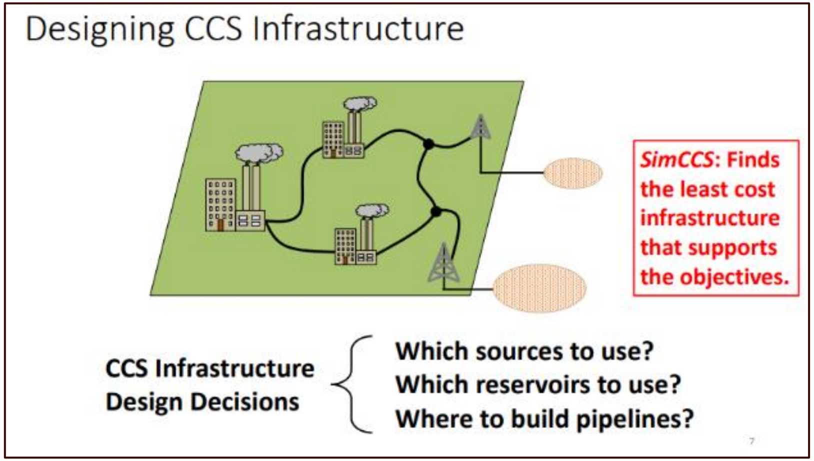


Project summary - MU

Project Objectives

- Identify priorities for uncertainty assessment
- Explore techniques for endogenously integrating uncertainty into model
- Modify code to serve as test bed for various approaches being developed





CUSP Project #8

Feasibility Study of a Potential CCUS Project in Colorado

CUSP Team

Project Lead: Ali Tura et al (Colorado School of Mines)
Sub-Contract: Oxy, Colorado Springs Utilities

Primary goal

Test the feasibility of CO_2 capture & sequestration in the DJ basin or saline aquifer near the CSU gas power plant

Industry partner

Oxy Low Carbon Ventures and Colorado Springs Utilities

Project duration

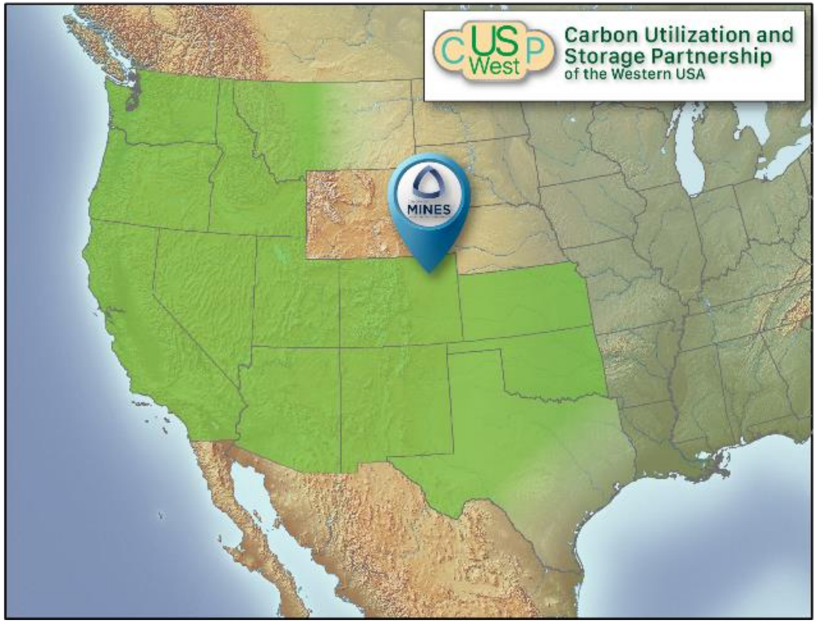
Jan 2022 – Dec 2023

Anticipated time to storage

Will be determined by this study

Anticipated volume/year

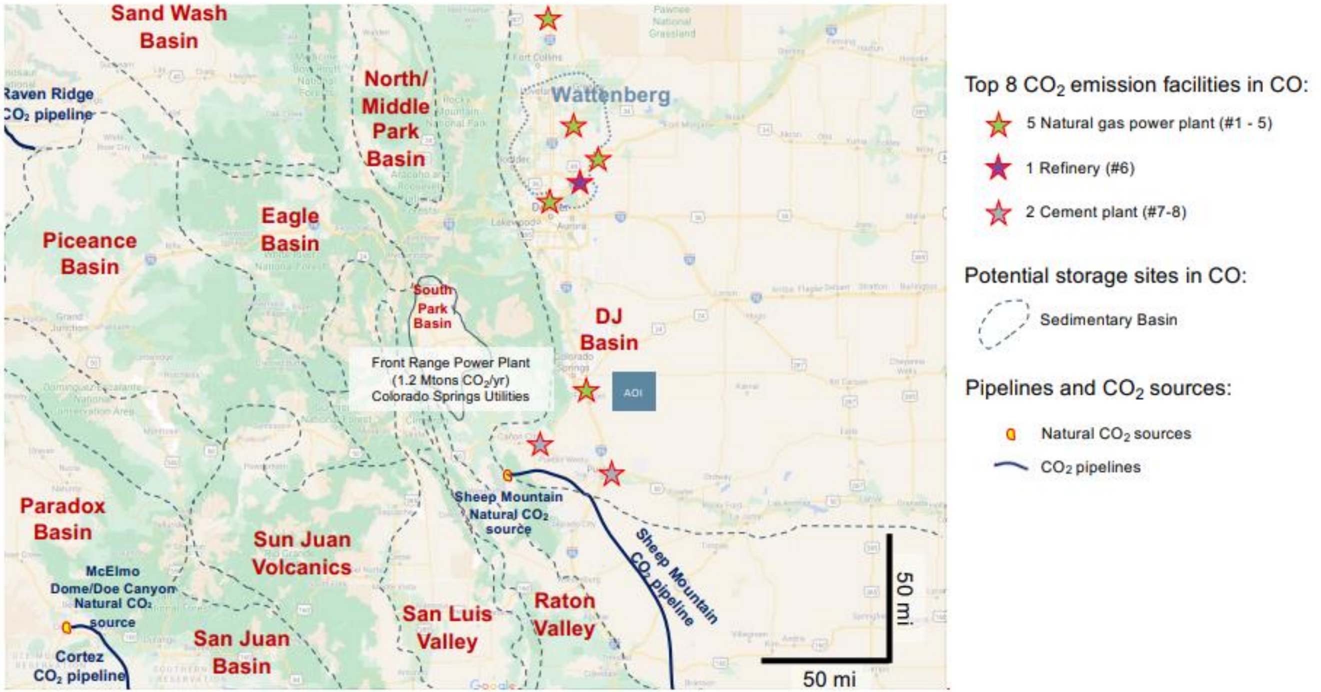
Approximately 1 MMton/year



Project summary - CSM

Project Objectives

- Estimate the captured CO_2 amount from a Gas Power Plant Source
- Understand how much CO_2 can be sequestered into the DJ Basin by studying reservoir model
- Find the most cost-effective capturing technology currently available
- Build a robust and cost-effective infrastructure network to transport the compressed CO_2



CUSP Project #9

Site Characterization for CO_2 Storage to Support Escalante Hydrogen Power Plant Project

CUSP Team

Project Lead: Dana Ulmer-Scholle & Sai Wang

Primary goal

Pre-feasibility study to ascertain storage potential
Technology venture on improving the CO_2 storage ability in coalbed formations - Establish Class VI permitting application framework

Impact on Carbon Storage

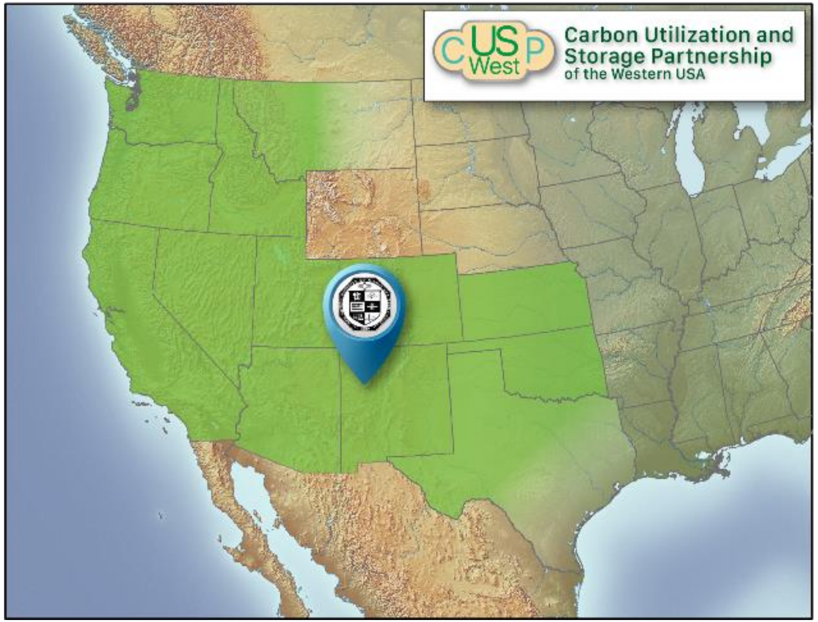
Demonstrate CO_2 storage + Blue hydrogen economical framework

Industry Partner

Logos Resources and eH2Power

Project duration

2 years

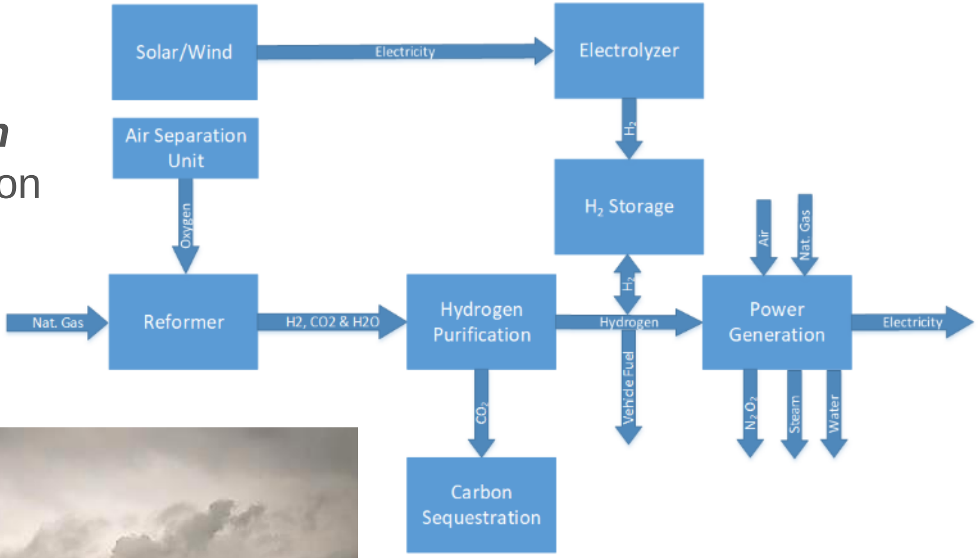


Project summary - NMT

Project Objectives

- Identify a suitable CO_2 storage complex within 75-mile radius of the Escalante Power Plant
- Determine the storage capacity and produce an injection plan designed for long-term CO_2 storage

Plant will be converted to a ***SMR-Hydrogen*** generating station



This Escalante Power Plant will be producing CO_2 as a by-product from **blue hydrogen** process utilizing natural gas. The plant is estimated to produce ***over 1.5 million metric tons*** of CO_2 for a period of not less than ***30 years***.

CUSP Project #10

Downhole Source Tomography

Location

Laboratories in Utah and California, Data Oklahoma

CUSP Team

Project lead: Kevin McCormack (University of Utah)

Sub-contract: Paulsson Inc.

Primary goal

Develop laboratory experiments to test a new tomography approach to monitor CO_2 plumes

Impact on Carbon Storage

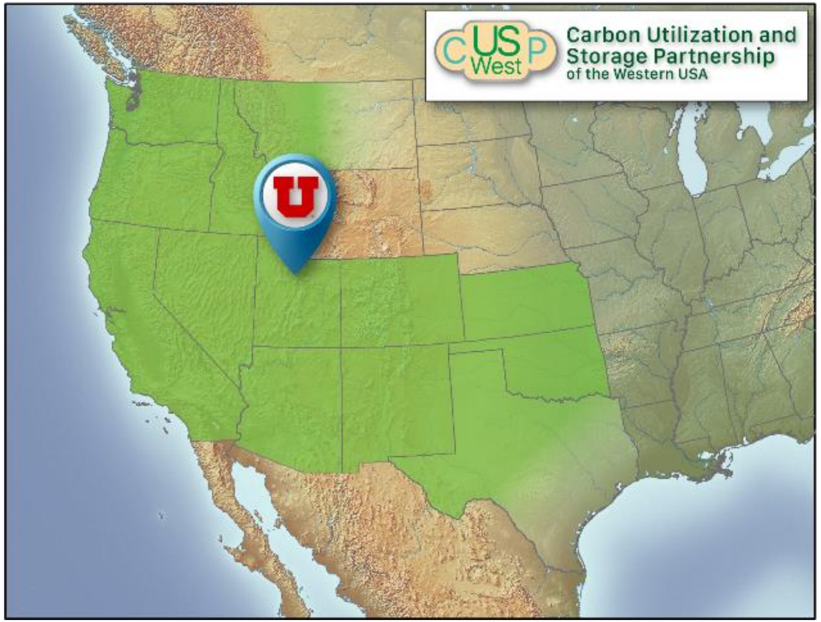
More detailed understanding of the migration of CO_2 plumes

Industry partner

Paulsson Inc.

Project duration

One year

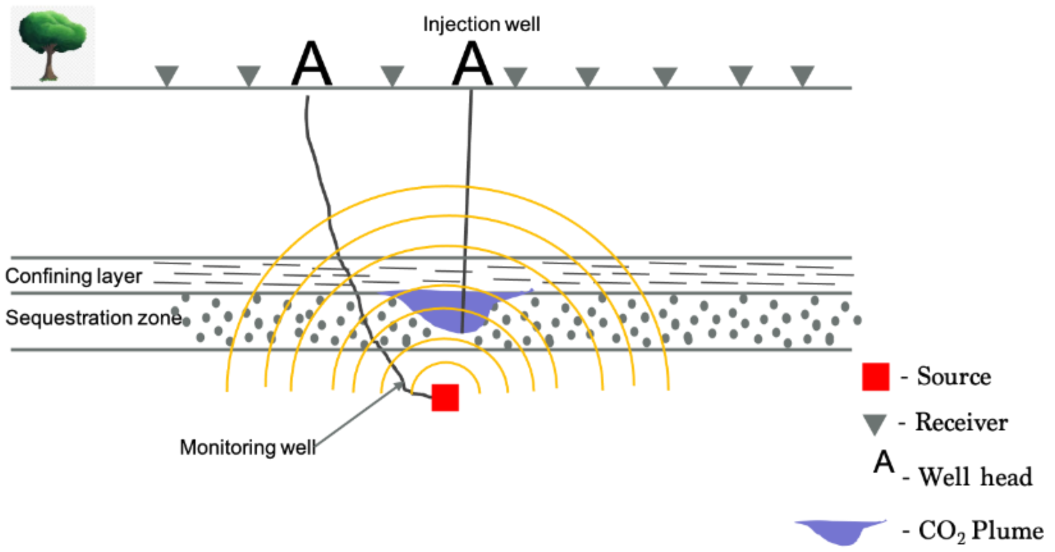


Project summary - UU

Project Objectives

1. Communicate with other CCUS projects about the needs of plume monitoring
2. Design the experiment
3. Modeling and simulation of the experiment
4. Acquire quotations (SNL and SLB)
5. Acquire additional funding to run the experiments

The primary objective is to create a new method of monitoring CO_2 plumes



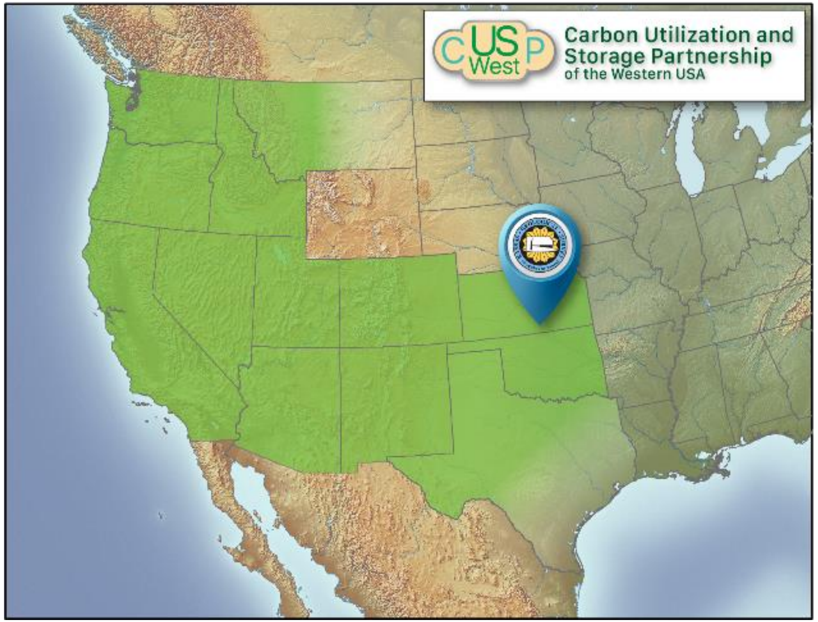
Not drawn to scale

CUSP Project #11

CCUS Hub 2.0 Concept for ONEOK

CUSP Team

Project Lead: Hasiuk “Franek” Franciszek (KGS)
Sub-Contract: OU/OGS, NMT, Sandia, PNNL, LANL, Carbon Solutions, ONEOK



Primary goal

- Identify saline storage, EOR, and unconventional resources for CCUS
- Identify salt resources for gas storage

Impact on Carbon Storage

Potential for large scale commercial project

Industry partner: ONEOK (Midstream Operator)

Project duration: Two years

Anticipated time to storage: Phase 1: 5/2021–2/2024 with potential phase 2 and 3.

Anticipated volume/year: First phase anticipates up to 500,000 tonnes/year of CO_2 storage

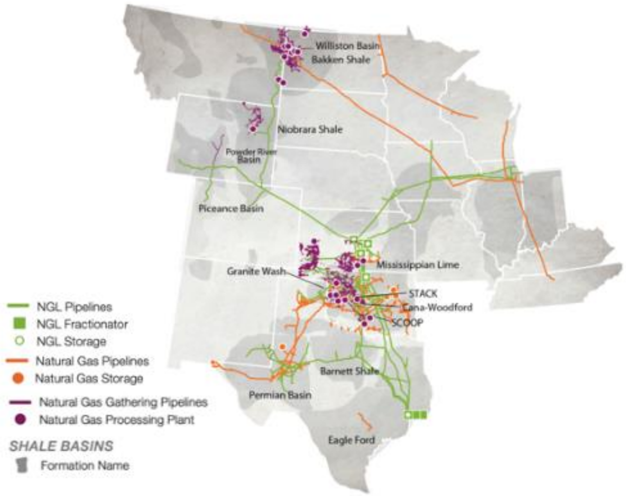
Project summary - KGS

Project Objectives

- Identify CO_2 reservoirs for long-term saline storage or EOR near Bushton, KS, and Medford, OK.
- Develop economic feasibility and business models
- Prepare necessary information and guidance for permitting, monitoring, and verification programs
- Explore feasibility of CO_2 use in unconventional reservoirs
- Quantify the feasibility of augmenting ONEOK CO_2 capture systems to ensure sufficient CO_2 volume output to qualify for 45Q tax credits

ONEOK has several gas processing plants that emit ~1M tonnes of CO_2 per year and plan to install hydrogen generation facilities that generate another 300k tons per year

If successful, this study will support a "Hub" concept that will allow for co-utilization of various hydrocarbon and non-hydrocarbon gasses and products



Task	Task Name	Task Assignments	22 Q2	22 Q3	22 Q4	23 Q1	23 Q2	23 Q3	23 Q4	24 Q1
1	Technical Review	**KGS**, CS, Sandia, ONEOK								
2	Digital Database Build	**KGS**, CS, ONEOK								
3	Reservoir Studies	**KGS**, CS, LANL								
4	Dynamic Simulations	**KGS**, PNNL, LANL								
5	Infrastructure Network Assessment	CS, Sandia								
6	UIC Class VI Preparations	**KGS**, ONEOK								
7	UIC Class VI Support	**KGS**, ONEOK, PNNL, LANL								
8	45Q Preparations	NMT, **KGS**, ONEOK								
9	MVA Program	KU Geology, **KGS**, LANL								
10	Risk Assessment	PNNL, LANL, **KGS**, Sandia								
11	Project Management	**KGS**, ONEOK								

CUSP Project #12

Lucid Energy AGI CCS Project

CUSP Team

Project Lead: New Mexico Tech

Sub-contract: Lucid Energy, Univ of Utah

Primary goal

The CUSP enables Lucid to better perform the permitting work t convert Lucid's existing and future AGI wells at Red Hills and existing AGI well at Dagger Draw to EPA Subpart RR and, subsequently, IRS' 45Q

Impact on Carbon Storage

Industry partner

Lucid Energy

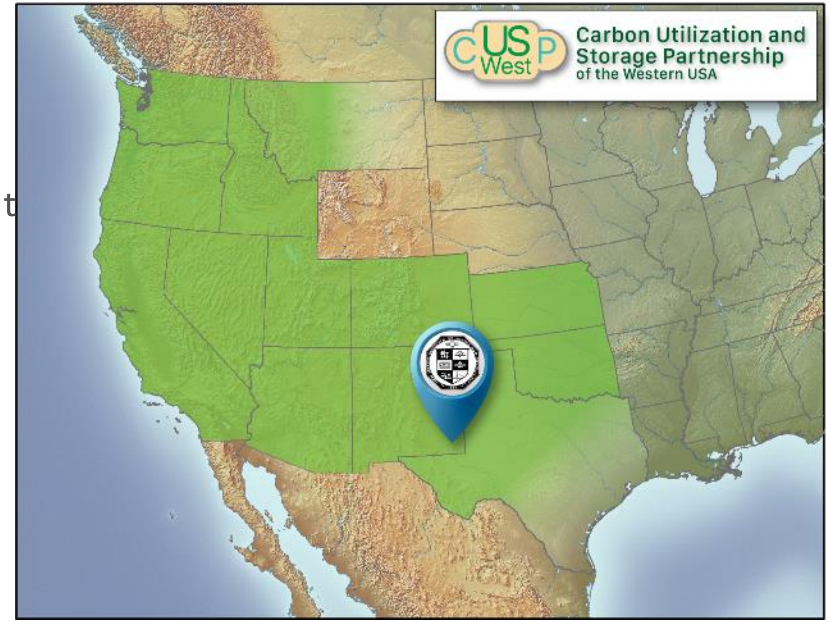
Project duration

3+ years

Anticipated time to storage

Immediately

Anticipated volume/year



Project summary - NMT

Project Objectives

- Help to develop EPA Subpart RR and IRS' 45Q applications
- Formation and reservoir modeling in the Permian
- Monitoring, Reporting and Verification (MRV) plan development
- Develop relations with regulatory representatives
- A successful sequestration project will deliver a significant GHG reduction

Red Hills Complex Capacity Overview			
Plant	Nameplate Capacity (MMcf/d)	Intalled Treating (GPM)	Date Commissioned
1 Red Hills I	60	350	Jun-13
2 Red Hills II	200	800	May-17
3 Red Hills III	200	800	Aug-18
4 Red Hills IV	230	1,800	Nov-19
5 Red Hills V	230	1,800	Nov-20
6 Red Hills AGI	-	350	May-18
Total	920	5,700	

Lucid operates an acid gas treating and disposal facilities at its Red Hills gas processing plant complex and Dagger Draw processing plants in Lea and Eddy County, New Mexico. The Red Hills facility compresses and injects H_2S and CO_2 concentrations in the raw sour gas it receives into the facility.

Roughly 50% of Lucid's CO_2 emissions are from vented CO_2 resulting from Amine Treating

CUSP Take-Aways

- The CUSP has databases of useful information necessary to create robust geologic models, flow models, and economic studies
- Has access to Intelligent computer applications and National Lab products which can optimize connecting sources and sinks, and long-range development and economic analyses of projects
- Has experience in generating CO_2 storage models, MRV applications, and in engaging with stakeholders
    - **Built a team specifically for permitting Class VI and MRV's region wide**
- The CUSP is actively seeking opportunities to help companies access 45Q and has built regional expertise to address local issues
    - Have 15 projects built using regional team leads
    - 4 Additional wholly Industry funded projects


Visit us at Cuspwest.org