The Carbon Utilization and Storage Partnership of the Western US

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NETL
The Changing Landscape

• Exxon Proposing $100 Billion regional storage hub on the Gulf Coast

• Occidental Petroleum has a position statement that they will stop taking Natural CO₂ in the near future.
  • A large proportion of the 20 million metric tonnes of CO₂ delivered annually to the Permian (about 18 mmcf CO₂/tonne)

• Major industrial Investors such as Goldman-Sachs and Riverstone seeking Carbon Reductions/Neutrality
  • In response to investor pressure, these investment companies are looking for “greener” pastures

• Tax incentives and the potential for regulatory pressure have dramatically impacted the viability of CC(U)S projects
  • Green house gas reporting
  • 45Q tax credits
Some History of US Carbon Storage Research

• EOR has been doing this for years
  • Large literature and project base in US and Canada

• Regional Carbon Storage Partnerships (2003)
  • US DOE established regional partnership program to understand regional and national storage potential, technologies, and to perform demonstration projects

• CarbonSAFE (2016)
  • DOE program to promote large scale capture and storage for coal plants

• New Regional Initiative program (2019)
  • Doe doubled down on partnerships with focus on commercialization
USA Case Studies for CCS (2003-2022)

• US Department of Energy Regional Carbon Sequestration Partnerships
  • Seven regional partnerships
• Each demonstrating injection of at least 1,000,000 metric tons of CO₂
• Four projects demonstrated storage in conjunction with EOR
• Developing “best practices” for utilizing captured CO₂

Modified from http://energy.gov/fe/science-innovation/carbon-capture-and-storage-research/regional-partnerships
The Carbon Storage Assurance Facility Enterprise (CarbonSAFE) Initiative

- Focused on development of geologic storage sites for the storage of 50+ million metric tons (MMT) of carbon dioxide (CO2) from industrial sources.
- CarbonSAFE projects improve understanding of project screening, site selection, characterization, and baseline monitoring, verification, accounting (MVA), and assessment procedures.
- Help determines information needed to submit appropriate permits and design injection and monitoring strategies for commercial-scale projects. (50+ MMT storage sites in anticipation of injection by 2026)

Modified from https://www.netl.doe.gov/coal/carbon-storage/storage-infrastructure/carbonsafe
Who is the CUSP?

- 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

- 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
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Regional Storage is Diverse

Oil and Gas basins
Saline Aquifers
Basalts

* NatCarb Atlas V
Proven EOR Potential and Infrastructure
Anthropogenic Supply:
500-600,000 Metric tons CO$_2$/year supply

Legend
- Green: Utilization & Storage
- Blue: Carbon Capture
- Red: Transportation
- Gray: Oil Fields

Other CO$_2$ Sources
- Yellow circle: 0.1 to 0.7 MT/yr
- Yellow circle: 0.7 to 1.8 MT/yr
- Yellow circle: 1.8 to 4 MT/yr
- Yellow circle: 4 to 10 MT/yr
- Yellow circle: 10 to 20 MT/yr

MRV Approved
Programmatic Goals of The Carbon Utilization and Storage Partnership For the Western USA (CUSP)

• Accelerate onshore CCUS technology deployment in the Western Region of the United States.

• Coordinate capabilities and experience within (and outside of) CUSP region to accelerate CCUS deployment in four key activities:
  • Addressing key technical challenges;
  • Facilitating data collection, sharing and analysis;
  • Evaluating regional infrastructure;
  • Promoting regional technology transfer.
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)
  • CO₂ 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 (3 years) we added funds to each organization to cover tech transfer and education in the subsequent 2 years

• A portion of the new funds were set aside to support the Smart Initiative

• Funds set aside to jumpstart 45Q ready projects in the region
  • Farnsworth EOR project conversion to storage focus – Perdue Petroleum – Ion 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
Progress and Current Status of Project

- Looking at Sources, Sinks, transportation pathways both existing and potential
- Have identified existing and several potential regional hubs
- Beginning process of refining Atlas style data and converting older static databases into self-updating data sources
- Working towards integrating machine learning tools such as SimCCS to analyze results
- The project team has done an initial survey of the region for opportunities and issues related to those opportunities
- **Funding has been regular:**
  - ~$6 million (including cost-share) in 2019, 2020, and now in 2021
  - With the second round of funding we selected three companies to assist with MRV planning
Outreach

• The CUSP project has developed a website for dissemination of CCS/CCUS materials to the general public and more detailed geologic storage and economic data/analysis information to industry and stakeholders.

• Educational videos are being developed to expand upon the information contained on the website; these will cover the many technical aspects and states within the CUSP region.
Industry Advisory Board

• 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
  • CO₂ emitters
  • CO₂ capture and transport companies
  • Oil/Gas operators
  • Policy think tanks
2020 Case Study – Perdure Petroleum

- Perdure Petroleum operates the Farnsworth Unit, a CO₂ Enhanced Oil Recovery field in Ochiltree County, Texas

- The Farnsworth Unit has been injecting anthropogenic CO₂ from the Agrium fertilizer plant at Borger, Texas and the Arkalon ethanol plant at Liberal, Kansas

- Perdure plans to continue CO₂ 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
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 CO₂ capture technology and locally store more than 2 MMT/yr CO₂

• 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.
2020 Case Study – Lucid Energy

- 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 H₂S and CO₂ concentrations in the raw sour gas it receives into the facility.

- Roughly 50% of Lucid’s CO₂ emissions are from vented CO₂ resulting from Amine Treating.

- Capturing, sequestering and storage of vented CO₂ is the most economic option to capture 45Q tax credits and impact Lucid’s carbon footprint.

- Additional CO₂ capture likely with proven economics.
Selected 2021 Portfolio

- Internally selected by management team, the advisory board will assist if future funding is given
- Most projects have industry partners and target injection in 1-3 years
- Includes a unique study for injection into basalts
- Includes bench scale work on the use of CO2 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
  - Paulsson Inc
  - And other interests...

Legend
- CUSP Region
Selected 2021 Portfolio

De-risking CO2 Mineralization Storage in Basalt Reservoirs
This project seeks to address research gaps crucial to derisking and demonstrating commercial scale basalt storage, and to provide critical information to key stakeholders and developers seeking CO2 storage opportunities in our region, and beyond.

Laying the Cornerstones of a Regional Storage Hub in California
This project seeks to accelerate the implementation of a shovel-ready pilot project by Sentinel Peak Resources to capture, transport, and store 70,000 tCO2/yr from steam generation for thermal oil recovery, including supporting a Class VI well permit application.

CUSP Focused Project proposal: Characterization of CO2 storage potential in Harquahala basin, western central Arizona
This project proposes multiple phases of work, including evaluation of existing seismic and gravity, that will eventually lead to testing of the Harquahala basin for CO2 storage potential
Selected 2021 Portfolio

Regional-Scale Assessment of CO2 Geological Storage in Sedimentary Basin Geothermal Reservoirs of Nevada

The objectives of the proposed effort are to: 1) perform a regional-scale assessment to fill a data gap of critical information related to CCUS technologies to mitigate CO2 emissions in Nevada, and 2) to develop an approach to regionally assess the potential that using CO2 geological storage in sedimentary basin geothermal reservoirs may have for increasing the states capability for CCUS.

CCS at the Iron Mountain Iron Mine and Direct Reduced Iron Processing Plant, Southern Utah

This project will seek to deploy a commercial-scale carbon capture and storage site at or near its Iron Mountain iron mine, near Cedar City, Utah, so that the project partners can build an iron processing plant near the mine, which will produced CO2 as a by-product.

Laboratory Feasibility Study for Eventual Field Deployment of a Downhole Source Tomographic Design for CO2 Plume Detection

This project will seek to develop a thorough design plan for both laboratory and field-scale testing (feasibility study) of a novel seismic tomography technology to significantly improve CO2 plume monitoring.
Selected 2021 Portfolio

Planning Amongst Uncertainty: Designing CCS Infrastructure Resilient to Capture, Transport, and Storage Uncertainty
The overarching aim of this project is to develop a CCS infrastructure design model that will endogenously account for uncertainty throughout the CCS supply chain, with a particular focus on storage uncertainty.

Feasibility Study on a Potential CCUS Project in Colorado: CO2 Capture from a Refinery and Sequestration in the DJ Basin
This project seeks to: 1) assess the technology and economic feasibility of capturing CO2 from a refinery by Suncor; 2) study transport by CSM; 3) sequestering the purified CO2 to a nearby saline aquifer in Colorado by Oxy; 4) evaluate sequestration by CO2-EOR opportunities in conventional and unconventional reservoirs by CSM and 5) develop monitoring and verification program by CSM.

Conversion of Hydrogen from Natural Gas and Integration with CO2 Capture and Storage
This project will seek to generate lab-scale data for the conversion and clean-up of hydrogen from natural gas taking into account contaminants introduced with produced water used as a process stream.
Selected 2021 Portfolio

Jumpstarting Regional CCUS Through Co-optimized CO2 and Water Disposal
This project has an overall goal of developing and formalizing a new and novel approach to accelerate commercial-scale CCUS, complementing existing approaches, including Class VI CO2 storage, CO2-enhanced oil recovery (CO2-EOR), and acid gas injection.

CCUS 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
This study aims to identify potential CO2 reservoirs for long-term saline storage or Enhanced oil Recovery (EOR) in the area surrounding ONEOK natural gas liquids fractionation plants near Bushton, KS, and Medford, OK, as well as several gas processing plants in Oklahoma that emit ~1M tonnes of CO2 per annum.

From Site to State: Design of an Integrated CCUS Operation in a Complex Geological Structure in Osage County, Oklahoma
This project will work with Perdure Petroleum LLC, a major CO2-EOR operator in Oklahoma, to develop the plan for a Class IV permit application for sequestration into the Arbuckle formation at their existing CO2-EOR site in Osage County.
2021 Portfolio - Timeline

- 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 other interests...

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1. Project Management and Planning
   1.1 Update Project Management Plan
   2. Addressing Key Technical Challenges
      2.1 Expand characterization of stacked and unconventional storage
      2.2 Develop collaborations for key technologies
      2.3 Collaborate with industrial partners for monitoring/verification strategies
      2.4 Development & validation of risk assessment/mitigation strategies for CCS sites
   3. Facilitating Data Collection, Sharing, and Analysis
      3.1 Engaging with national laboratories
      3.2 Apply NMAP tools to assess geologic risks
      3.3 Provide synthesized data to DOE's machine learning initiative
   4. Evaluating Regional Infrastructure
      4.1 Catalyze, map, and evaluate extent and near-term CO2 distribution network
      4.2 Identify and add rights-of-way for new pipelines (main lines and otherwise)
      4.3 Regulatory/utility impact assessment
      4.4 Economic assessment
      4.5 Focused scenario analysis
      4.6 Develop regional readiness indices
   5. Promoting Regional Technology Transfer
      5.1 Development of regional readiness indices maps
      5.2 Technology transfer forums
      5.3 Targeted network development
      5.4 Support OOE
   P1. Derisking CO2 Mineralization Storage in Basalt Reservoirs
   P2. Laying the Cornerstones of a Regional Storage Hub in California
   P3. Characterization of CO2 storage potential in Harquahala basin western central Arizona
   P5. CCS at the Iron Mountain Iron Mine and Direct Reduced Iron Processing Plant, Southern Utah
   P6. Laboratory Feasibility Study for Eventual Field Deployment of a Downhole Source Tomographic Design for CO2 Plume Detection
   P7. Planning Amongst Uncertainty Designing CCS Infrastructure Resilient to Capture, Transport and Storage Uncertainty
   P8. Feasibility Study on a Potential CCS Project in Colorado CO2 Capture from a Refinery and Sequestration in the Di Basin
   P9. Conversion of Hydrogen from Natural Gas and Integration with CO2 Capture and Storage
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   P11. CCS Hub 2.0 Concept for ONEOK Infrastructure Development for Handling of New Gasense Products for Natural Gas Liquids Fractionation and Gas Processing Plants in Kansas and Oklahoma
   P12. From Site to State: Design of an Integrated CCS Operation in a Complex Geological Structure in Osage County, Oklahoma
Take Aways

• The CUSP is actively seeking opportunities to help companies access 45Q
• Has experience in generating CO2 storage models, MRV applications, and in engaging with stakeholders
• Has databases of useful information necessary to create robust geologic models, flow models, and economics
• Has access to Intelligent computer applications and National Lab products which can optimize connecting sources and syncs, and long range development and economic analyses of projects
• Funding has been regular…
  • ~$6million in 2019, 2020, and now in 2021
  • Full allotment of DOE funds used for 2021 selected project
  • If additional funds given in Future will select an additional 5-10 projects in the region
CUSP Members

- New Mexico Tech
- UT Permian Basin
- Stanford University
- The University of Utah
- Colorado School of Mines
- The University of Oklahoma
- Montana State University
- University of Wyoming
- Los Alamos National Laboratory
- Pacific Northwest National Laboratory
- Sandia National Laboratories
- US Geological Survey
- Desert Research Institute
- Schlumberger