

What are the drivers of current CCS project development?

MODERATOR:

PATRICIA LORIA, SENIOR CLIENT ENGAGEMENT LEAD, GCCSI

SPEAKERS:

LYNN BRICKETT, CARBON CAPTURE PROGRAM MANAGER, DOE

KEN HANEY, EOR/CCS MANAGER, CALIFORNIA RESOURCES CORPORATION

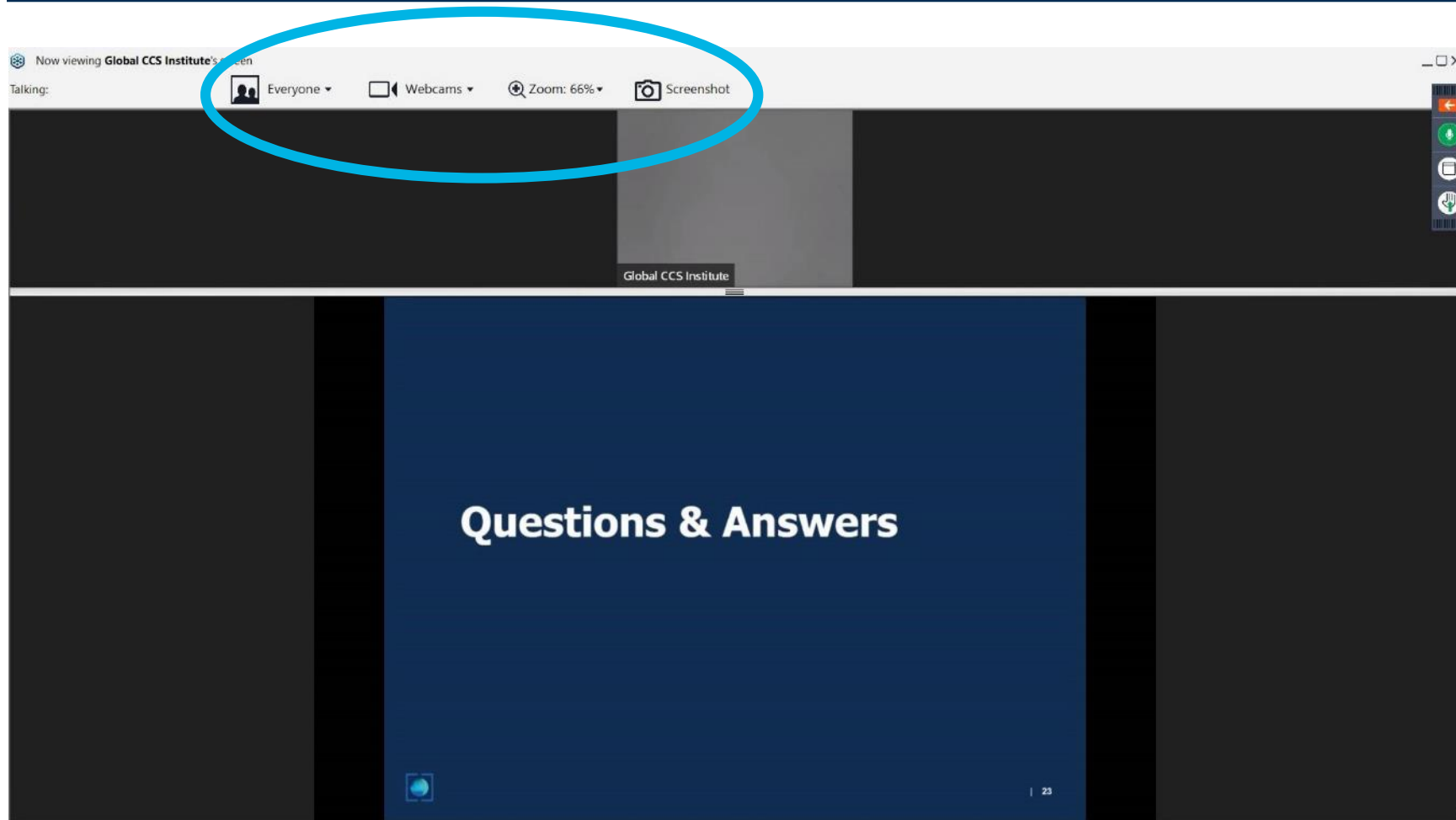
WILLIAM BARRETT, COMMERCIAL DIRECTOR, OXY LOW CARBON VENTURES



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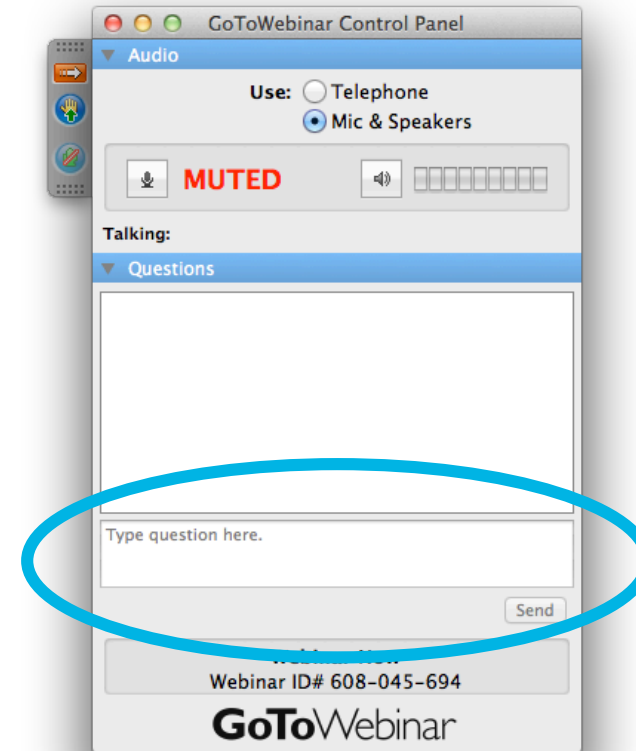


ADJUSTING THE VIEW



ASKING QUESTIONS

- We will collect questions during the presentations.
- Moderator will feed these questions into the conversation during the Q&A session.
- Please submit your questions directly into the GoToWebinar control panel.

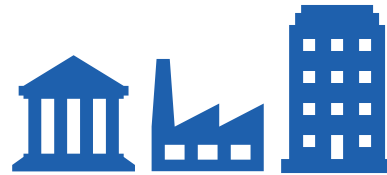


THE GLOBAL CCS INSTITUTE



International
think tank

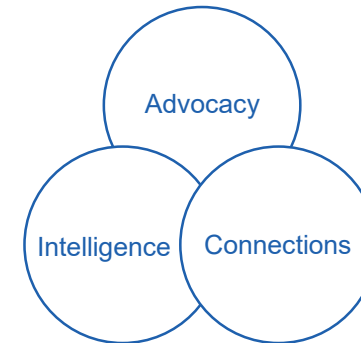
Backed by
governments,
businesses and NGOs



Mission: To accelerate
deployment of CCS

76 MEMBERS

6 locations



NEW PROJECTS MAY 2020



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CCS Facilities

Extensive, up to date database of all CCS facilities and projects.

Learn More



POLICIES



STORAGE



LEGAL & REGULATORY



CCS REQUIREMENT



CCS READINESS INDEX



EMISSIONS



CO₂RE UPDATES

WHAT IS CO₂RE

- [CO₂RE](#) is the world's first global CCS intelligence database.
- [CO₂RE](#) is a unique database of CCS facilities, policy, regulatory, storage and emissions data, together with in-depth analysis from across the CCS world.
- [CO₂RE](#) is a complete knowledge management resource, CO₂RE organizes, maintains and makes accessible, all key information and data related to the global deployment of CCS.









LARGE SCALE CCS FACILITIES

Recent developments



Facilities added

-  DRAX BECCS PROJECT
-  LARAGEHOLCIM CARBON CAPTURE PROJECT
-  THE ZEROS PROJECT
-  VELOCYZ BAYOU FUELS NEGATIVE EMISSIONS PROJECT
-  PRAIRIE STATE GENERATING STATION
-  MUSTANG STATION OF GOLDEN SPREAD ELECTRIC COOPERATIVE
-  SAN JUAN GENERATING STATION
-  PLANT DANIEL CARBON CAPTURE
-  GERALD GENTLEMAN STATION CARBON CAPTURE
-  CAL CAPTURE



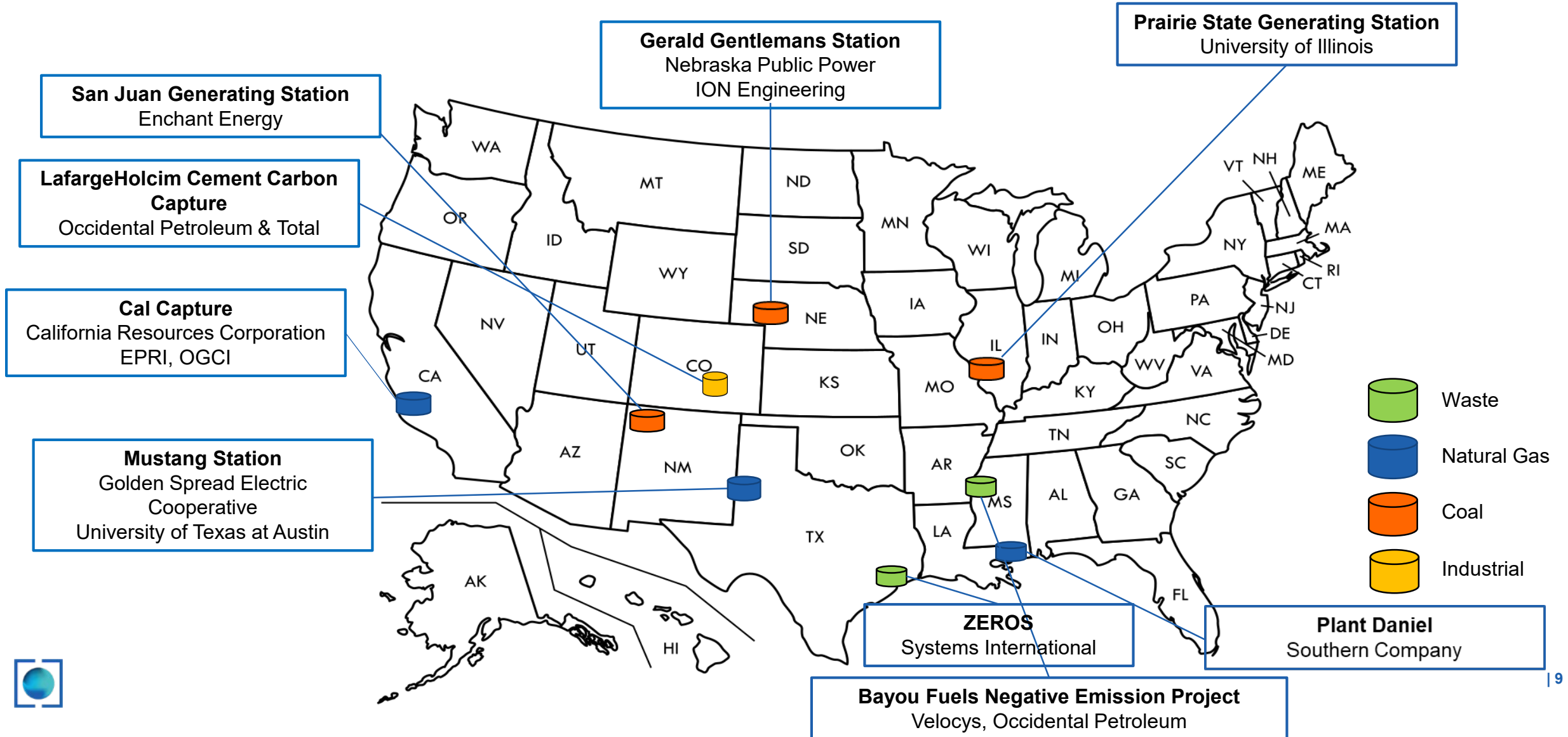
LARGE-SCALE CCS FACILITIES BY REGION OR COUNTRY

| | Early development | Advanced development | Construction | Operating | Total |
|---------------------------------|-------------------|----------------------|--------------|-----------|-----------|
| North America | 5 | 12 | 1 | 14 | 32 |
| China | 3 | - | 2 | 1 | 6 |
| Europe | 9 | 2 | - | 2 | 13 |
| Gulf Cooperation Council | - | 1 | - | 2 | 3 |
| Rest of World* | 2 | 1 | 0 | 2 | 5 |
| Total | 19 | 16 | 3 | 21 | 59 |



* Includes facilities in Australia, Brazil and South Korea

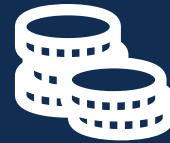
LOOK AT WHERE/ WHAT THE PROJECTS ARE IN US



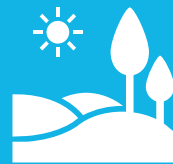
KEY MESSAGES



The facilities added continue trends in CCS deployment that include non-traditional applications such as natural gas power, negative emissions and cement, along with increased scale.



Drivers of success in the US include financial incentives from 45Q, public-private partnership with DOE, and increased commitment to net-zero by companies and countries alike



Trends in storage include stacked storage, sites that plan to use both EOR and geological storage as well as offshore geologic storage.

OUR SPEAKERS

Lynn Brickett, Carbon Capture Program Manager, DOE

William Barrett, Commercial Director, Oxy Low Carbon ventures

Ken Haney, EOR/CCS Manager, California Resources Corporation

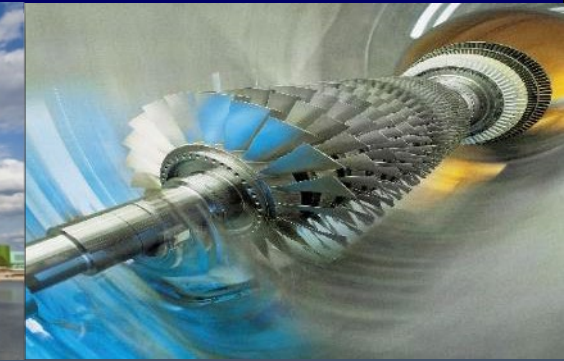
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U.S. DEPARTMENT OF
ENERGY

Office of
Fossil Energy



Office of Clean Coal and Carbon Management

CCS Talks: What are the drivers of current CCS project development?

Lynn Brickett
Program Manager- Carbon Capture

June 25, 2020

MAJOR CCUS DEMONSTRATION PROJECTS

Petra Nova CCS (Thompsons, TX) – operations began in 2017



- Joint venture by NRG Energy, Inc. (USA) and JX Nippon Oil and Gas Exploration (Japan)
- Demonstrating Mitsubishi Heavy Industries' solvent technology to **capture 90% of CO₂ from 240-MW flue gas stream** (designed to capture/store 1.4 million metric tons of CO₂ per year)
- **Over 3.3 million metric tons of CO₂** used for **EOR** in West Ranch Oil Field in Jackson County, Texas since January 2017

Air Products Facility (Port Arthur, TX) – operations began in 2013



- Built and operated by Air Products and Chemicals Inc. at Valero Oil Refinery
- State-of-the-art system to capture CO₂ from two large **steam methane reformers**
- **Over 5.0 million metric tons of CO₂** captured and transported via pipeline to oil fields in eastern Texas for **enhanced oil recovery (EOR)** since March 2013

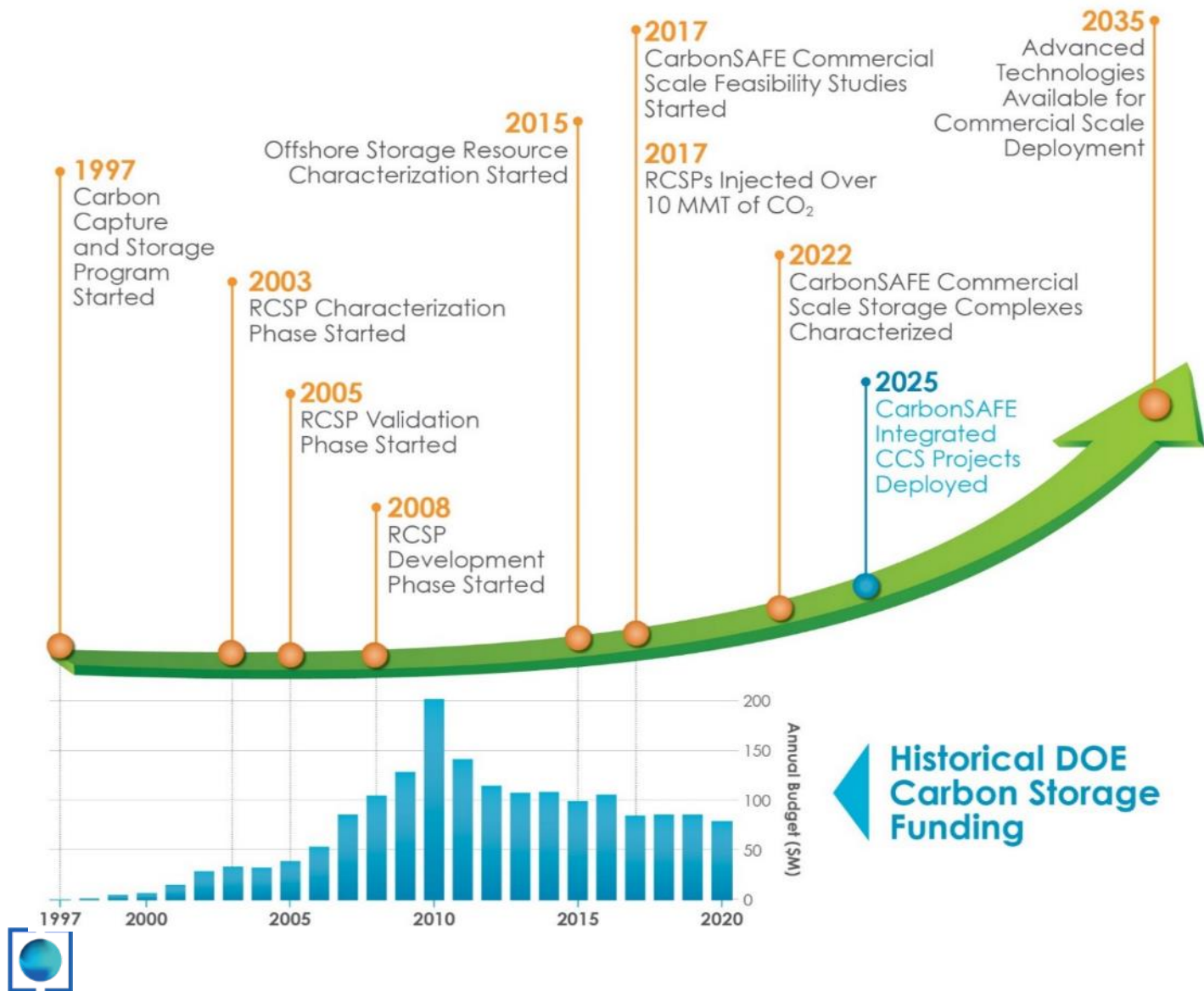
ADM Ethanol Facility (Decatur, IL) – operations began in 2017



- Built and operated by Archer Daniels Midland (ADM) at its existing biofuel plant
- CO₂ from **ethanol biofuels production** captured and stored in **deep saline reservoir**
- **First-ever CCS project** to use new U.S. Environmental Protection Agency (EPA) Underground Injection **Class VI well permit**, specifically for CO₂ storage
- **Over 1.5 million metric tons of CO₂** stored, since April 2017



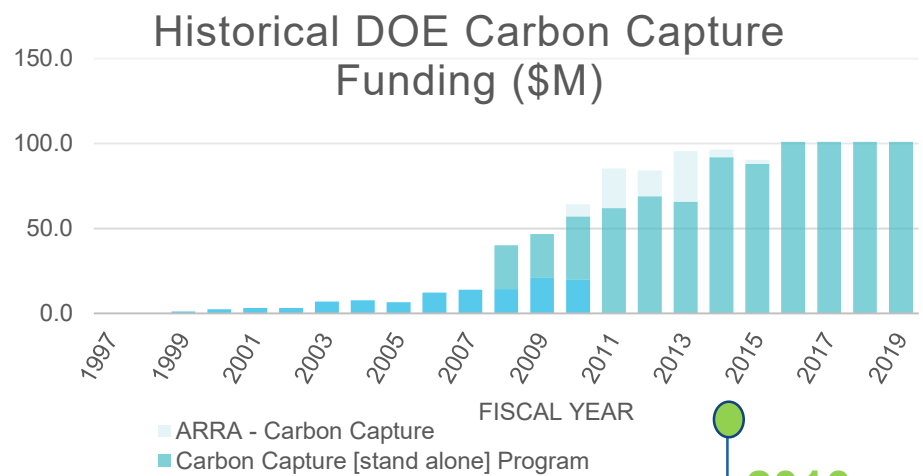
CARBON STORAGE FUNDING



| Carbon Storage Program Funding (\$M) | | |
|--------------------------------------|---------------|---------------|
| FY 18 Enacted | FY 19 Enacted | FY 20 Enacted |
| 86 | 86 | 79 |

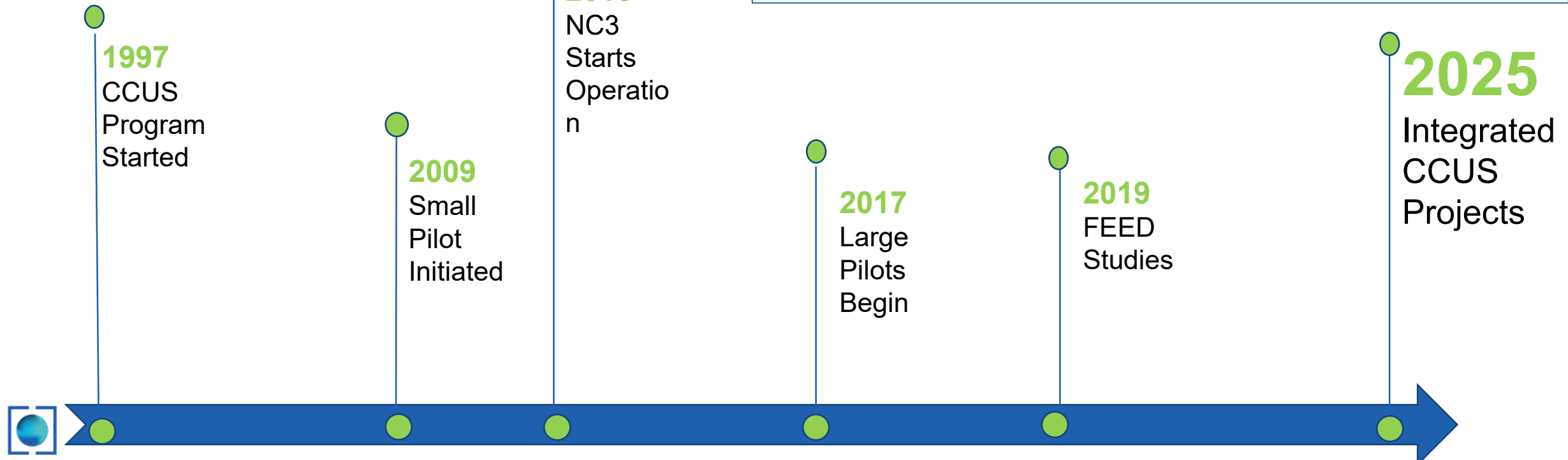
20+ years of investments in a diverse portfolio of applied research projects

CARBON CAPTURE FUNDING

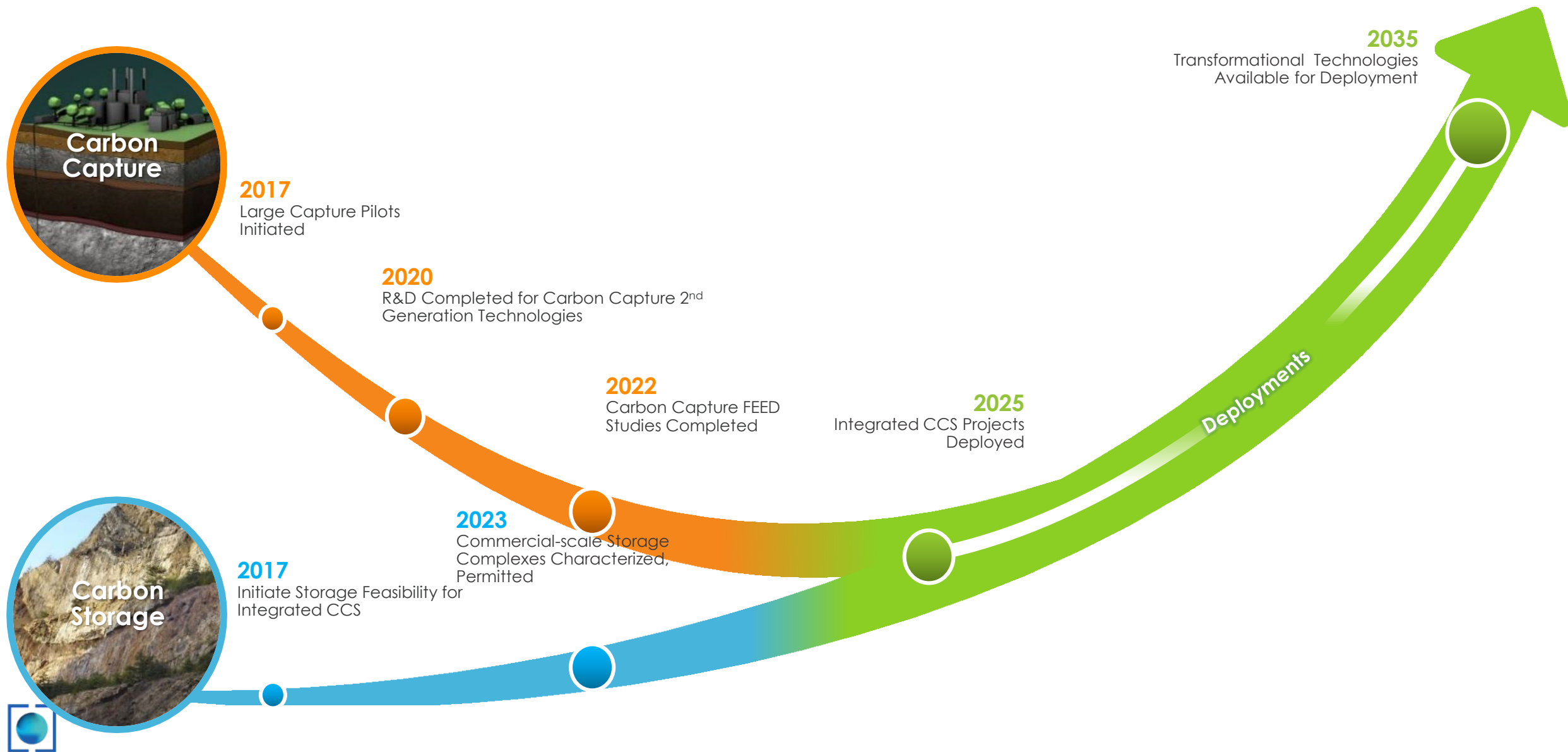


| Carbon Capture Program Funding (\$M) | | |
|--------------------------------------|---------------|---------------|
| FY 18 Enacted | FY 19 Enacted | FY 20 Enacted |
| 101 | 101 | 109 |

20+ years of investments in a diverse portfolio of applied research projects



FUTURE COMMERCIAL-SCALE DEPLOYMENT INTEGRATED R&D APPROACH

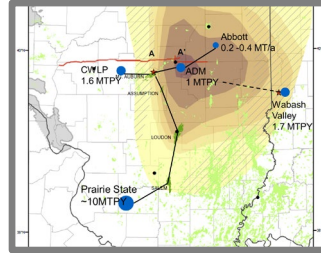


CARBON STORAGE ASSURANCE FACILITY ENTERPRISE



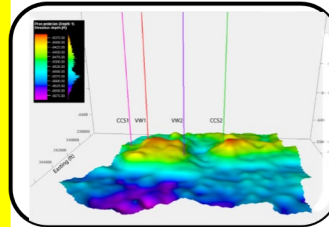
Phase I: Integrated CCS Pre-Feasibility 18-month initiative

- Formation of a team; development of a feasibility plan; and high-level technical evaluation of the sub-basin and potential CO₂ sources
- Thirteen projects funded



Phase III: Site Characterization and CO₂ Capture Assessment 3-year initiative

- Detailed site characterization; obtain Underground Injection Control (UIC) Class VI Permit to construct; CO₂ Capture Assessment; NEPA approvals



Phase II: Storage Complex Feasibility 2-year initiative

- Data collection; geologic analysis; analysis of contractual and regulatory requirements; subsurface modeling; risk assessment; evaluate monitoring requirements; and public outreach
- Six projects funded

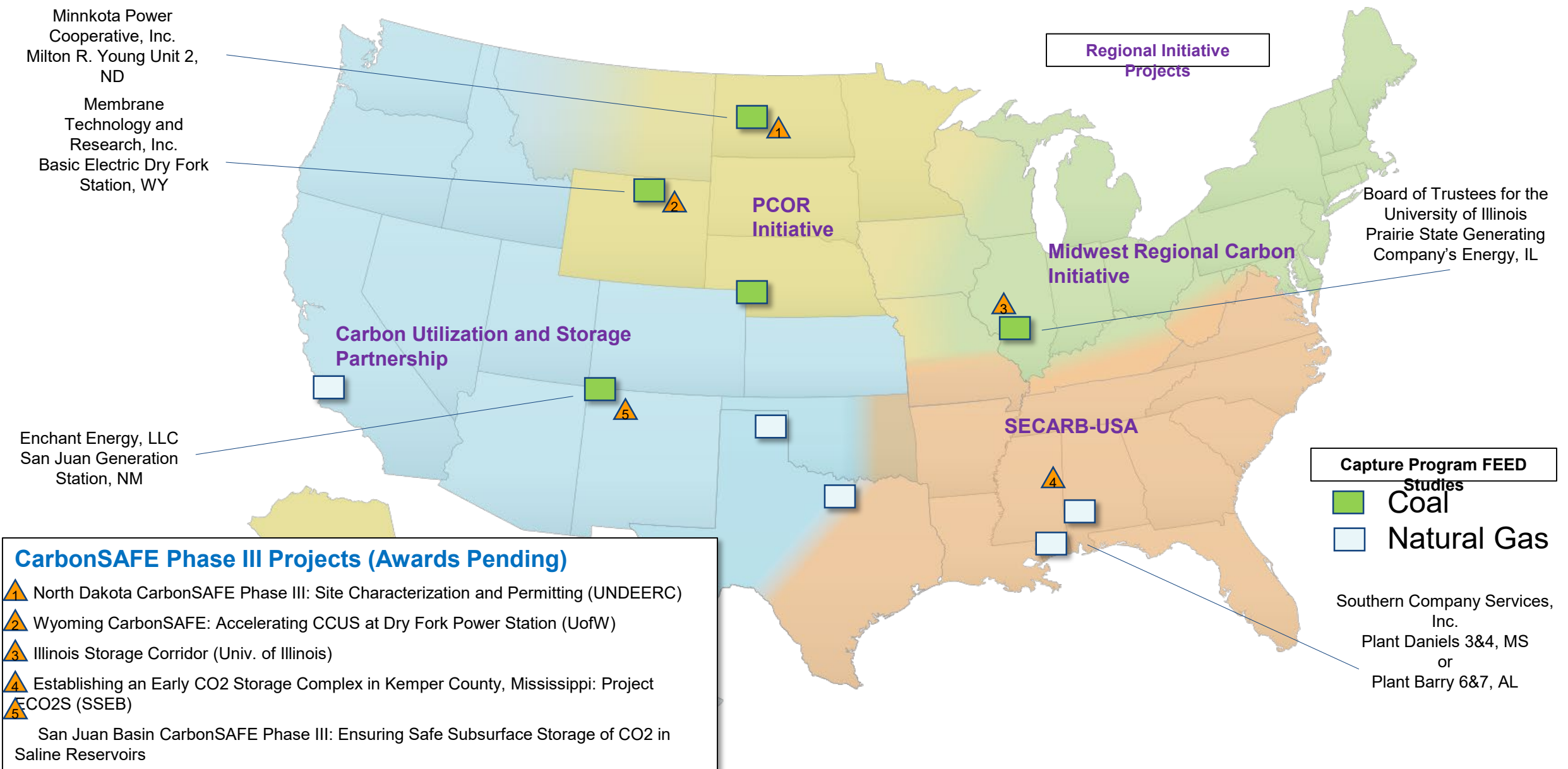


Phase IV: Permitting and Construction of Storage Complex 2.5-year initiative

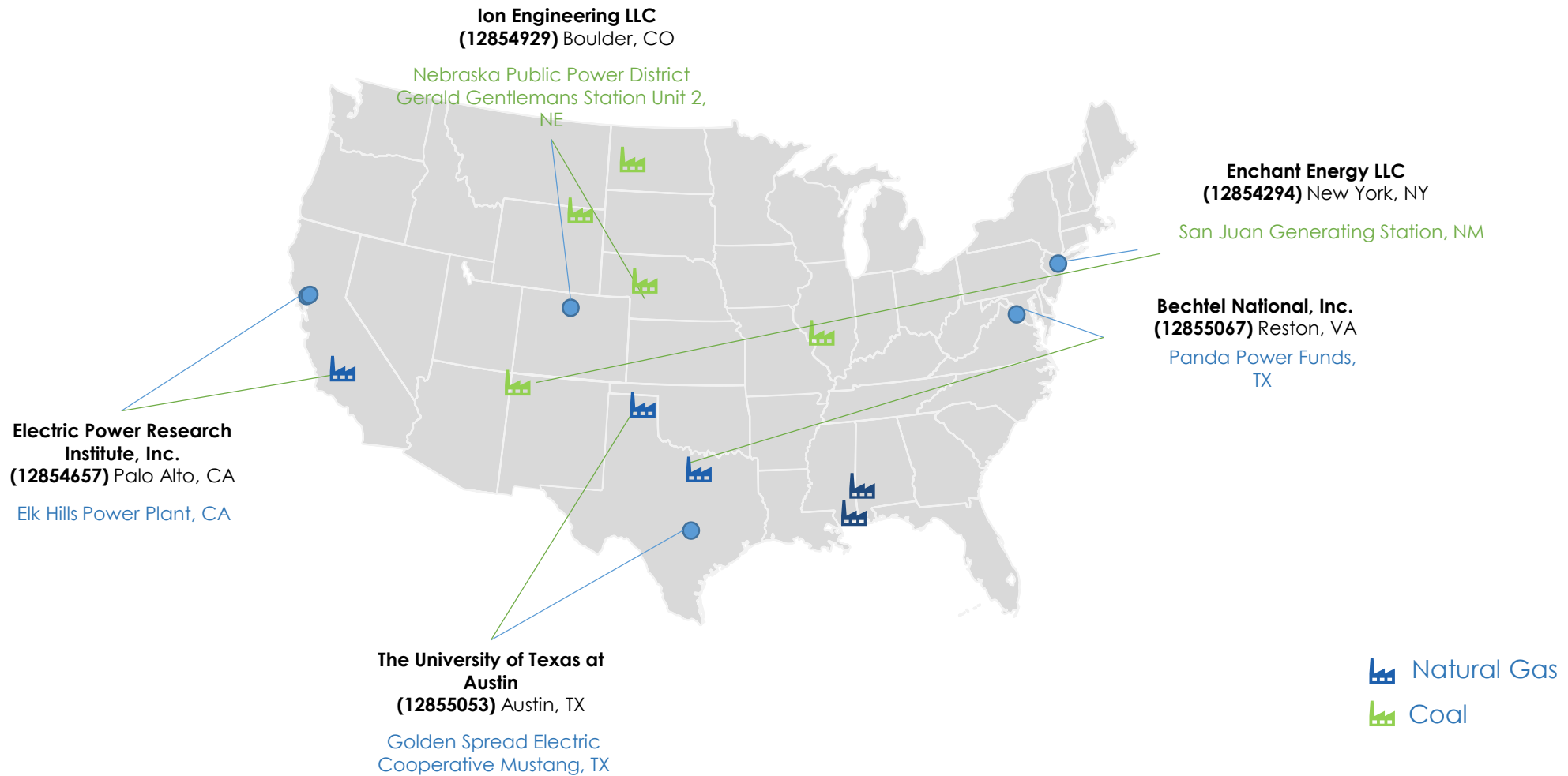
- Obtain UIC Class VI permit to inject; drill and complete injection and monitoring wells; develop risk and mitigation plans
- Subject to future funding



STORAGE PROGRAM FIELD INITIATIVES AND CAPTURE PROGRAM FEED STUDIES



CARBON CAPTURE FRONT-END ENGINEERING DESIGN (FEED) STUDIES












Applicant Locations and Host Sites



CCUS FEED STUDIES SELECTIONS

Projects will support FEED studies for Commercial-scale carbon capture systems:

- \$55.4 M DOE
- 9 projects selected
- 8 solvent (6 different) & 1 membrane
- 1 open source
- Three major types of coal

| Awardee | Project |
|--|--|
| Bechtel National  | FEED Study for Retrofitting a 2x2x1 Natural Gas-Fired Gas Turbine Combined Cycle Power Plant for Carbon Capture Storage/Utilization – MEA Solvent |
| The Board of Trustees of the University of Illinois  | Full-Scale FEED Study for Retrofitting the a coal plant with an 816 MWe Capture Plant Using Mitsubishi Heavy Industries of America Post-Combustion CO ₂ Capture Technology – MHI advanced solvent |
| Electric Power Research Institute  | Front End Engineering Design Study for Retrofit Post-Combustion Carbon Capture on a Natural Gas Combined Cycle Power Plant – Fluor's amine-based Econamine FG Plus |
| Enchant Energy  | Large-Scale Commercial Carbon Capture Retrofit of the San Juan Generating Station – MHI solvent |
| Ion Engineering  | Commercial Carbon Capture Design & Costing: Part Two – Ion Engineering Non- aqueous Solvent |
| Membrane Technology and Research Inc.  | Commercial-Scale Front-End Engineering Study for MTR's Membrane CO ₂ Capture Process – MTR, Inc Polymeric Membrane |
| Minnkota Power Cooperative Inc.  | Front-End Engineering & Design: Project Tundra Carbon Capture System – Fluor's amine-based Econamine FG Plus |
| Southern Company Services  | Front End Engineering Design of Linde-BASF Advanced Post-Combustion CO ₂ Capture Technology at a Southern Company Natural Gas-Fired Power Plant – Linde BASF amine Solvent |
| The University of Texas at Austin  | Piperazine Solvent/Advanced Stripper Front-End Engineering Design PZAS |



CLOSING THOUGHTS

- **45Q and other incentives will likely increase the deployments of CCUS**
- **Impact of Covid-19 on implementation is currently unclear**
- **DOE has had very significant programs in the areas of Capture & Storage**
- **Successful completion of FEED studies from Capture & CarbonSafe from Storage will facilitate integrated projects**
- **DOE has successfully completed three integrated CCUS commercial scale projects**
- **Opportunities for many more in either saline or EOR**





LOW CARBON
VENTURES

Global CCS Institute

CCS Talks – The Drivers of Current CCS Project Development



AN INTRODUCTION

Oxy Low Carbon Ventures

This group is dedicated to:

- Leveraging our knowledge and expertise in the field of carbon use and storage to provide global services and implementation support for CCUS projects
- Leadership in providing low-carbon solutions for a sustainable energy future



LafargeHolcim CARBON CAPTURE

- LafargeHolcim Portland Cement Plant near Florence, CO
- Carbon Capture Scoping Study commenced in February 2020
- Consortium: LafargeHolcim, Svante, OLCV, Total
- Scoping Study Comprised of 3 Tasks:
 - Task 1 – Scoping Study and Class IV TEA
 - Block Flow Diagram & Tie-in Points/Utilities
 - Utilities & Chemicals Summary, Emissions & Effluent Summary
 - Process Flow Diagram, Steam Tables, Process Description
 - List of Major Equipment, Site Layout – Conceptual
 - CAPEX, OPEX
 - Task 2 – Project Financial Model with Sensitivity Analysis
 - Task 3 – Plan for a FEED Study and further project development



Svante

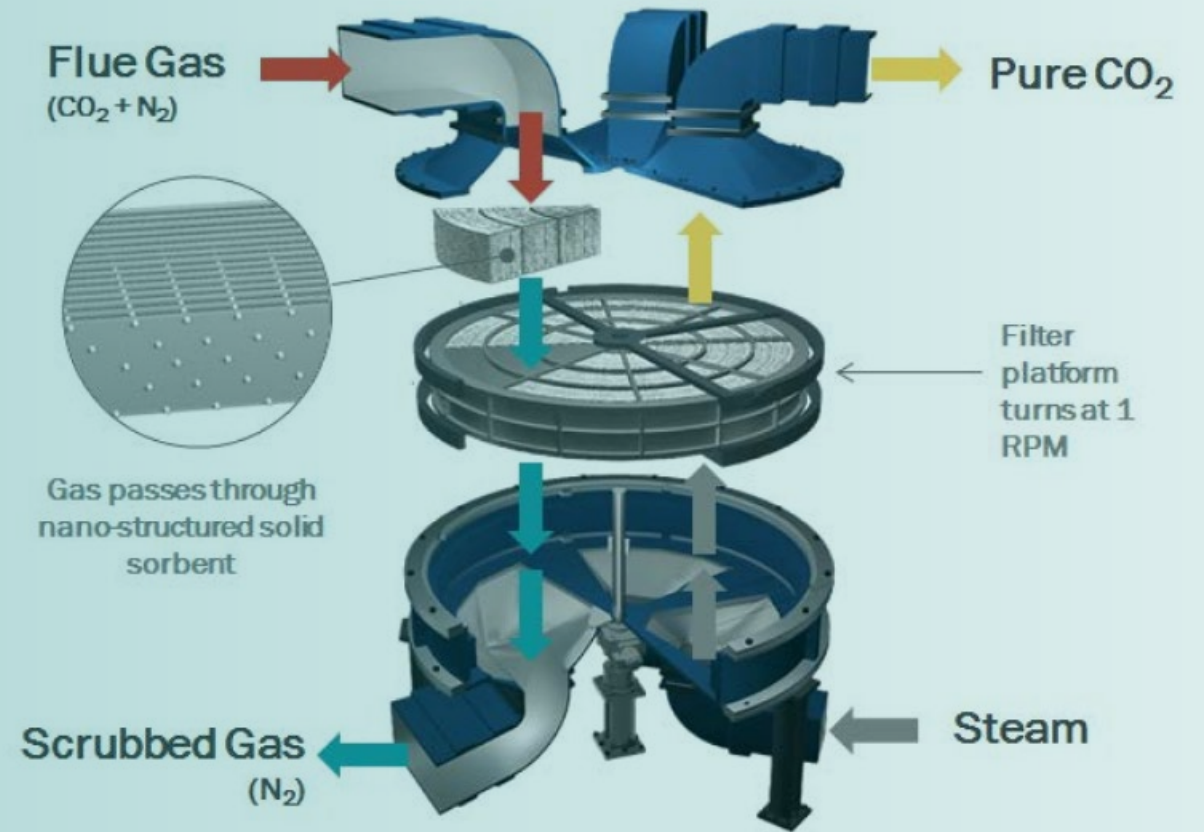


OLCV LOW CARBON VENTURES



First-of-a-Kind Technology for Cement

- Capture up to 90% of CO₂ emissions (up to 1.5 million metric tons per year)
- Capture both process and combustion emissions
- Several options for number of RAMs and trains were studied

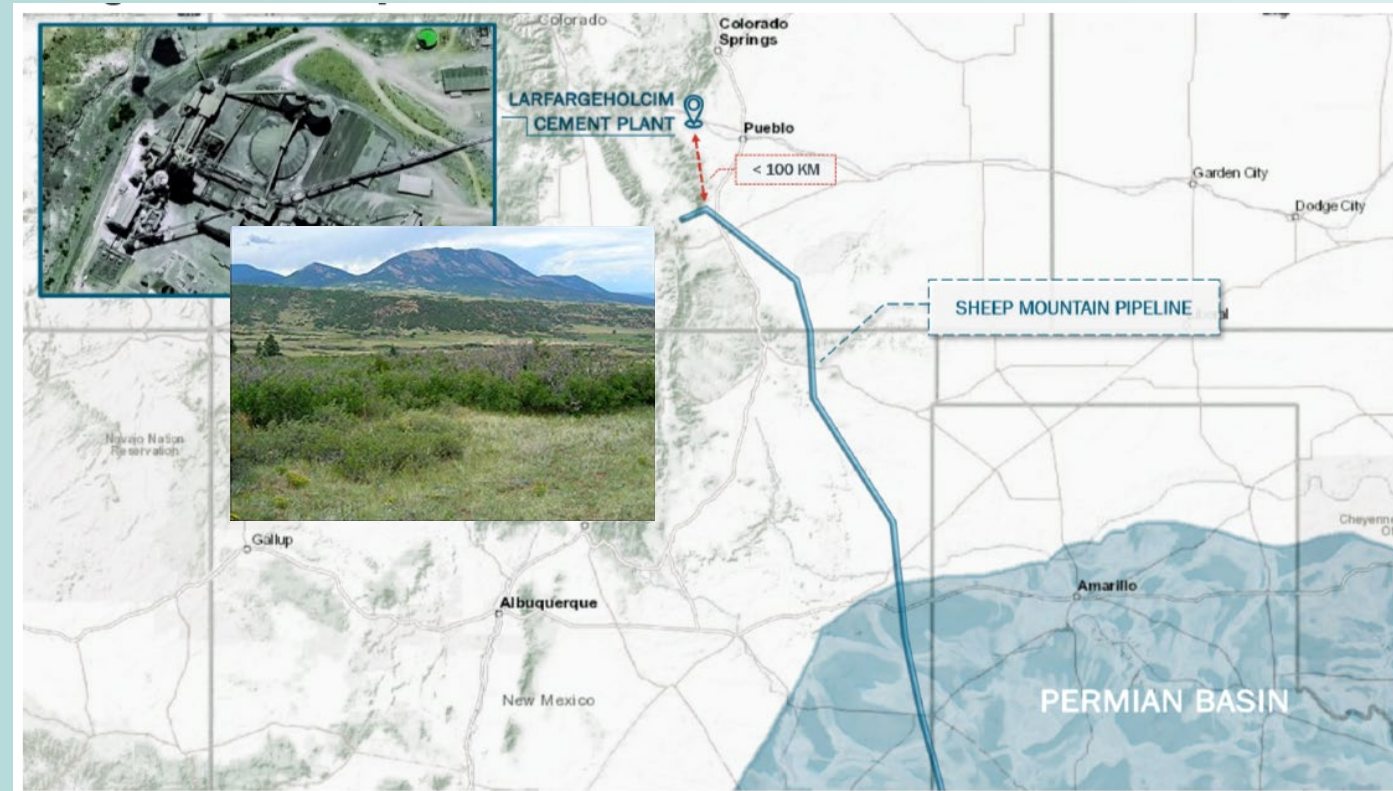


Svante VeloxoTherm™ Rotary Adsorption Machine (RAM)



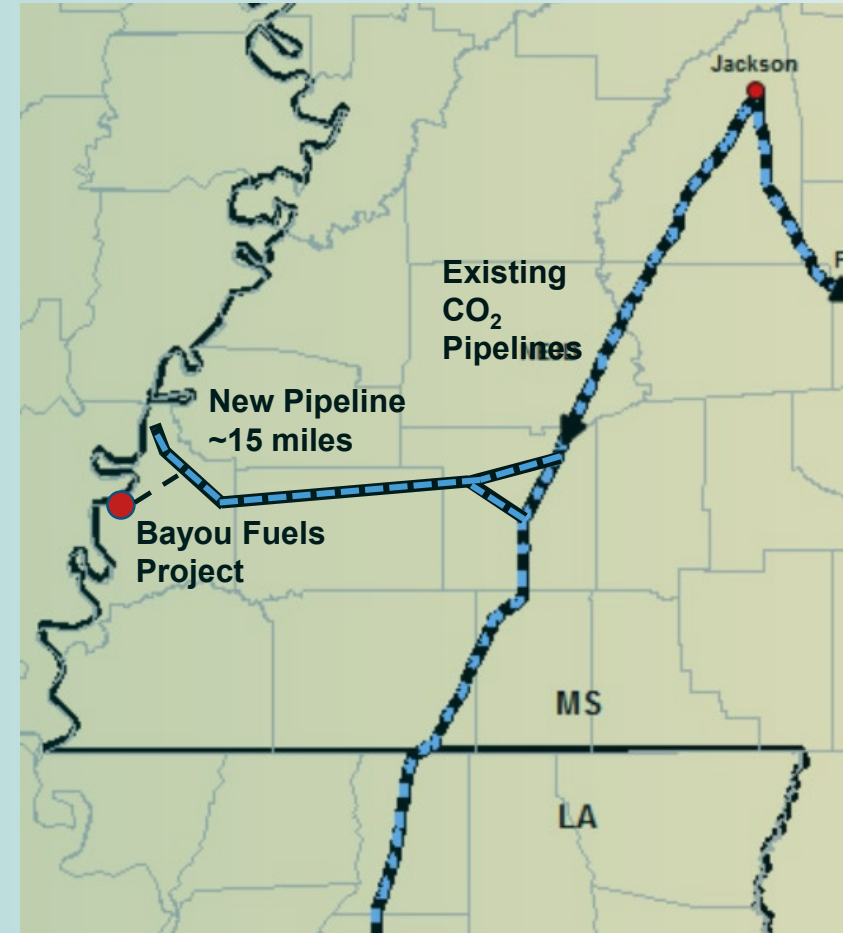
CO₂ Sequestration Options

- CO₂ EOR Sequestration in the Permian Basin
 - Oxy received the first two MRV Plans issued by EPA for CO₂ EOR projects it operates
 - Already safely stored over 10 million metric tons CO₂
 - 63 mile pipeline from LFH to Sheep Mtn PL tie-in
 - 12" diameter, 1 booster station at Walsenburg, CO
- Saline aquifer sequestration near Florence
 - NETL database shows potential – need to study
- Depleted oil/gas fields sequestration
 - Petroleum production nearby – need to study



VELOCYS – Planned Bayou Fuels Project

- Waste woody biomass to fuels
- Over 350,000 Mtpa to be captured from synthesis gas prior to conversion to fuel using Velocys' proprietary Fischer-Tropsch process
- Carbon sequestration in a saline formation
- Proximal to existing CO₂ pipeline
- Net negative carbon intensity fuels
 - utilization of low carbon fuel pathway
- Facility and CO₂ capture start-up in Q2 2024



OLCV Services

Oxy Low Carbon Ventures can provide advisory support or work as a completely outsourced carbon management resource, offering a suite of services that range from rapid assessment to full project engineering.

Project Consulting

- Determine Carbon Capture Feasibility
- Independent Peer Reviews
- Financial Model Development
- Carbon Management Strategy Development

Engineering

- Capture Plant Design & Engineering
- Sequestration Well Engineering
- Sequestration Well-Site Selection
- Seismic Analysis & Reservoir Modeling

Project Development

- Comprehensive Project Execution for Capture Facilities and Sequestration Well Development

CO₂ Offtake

- Secure Geologic Sequestration using either Saline Aquifer or CO₂ EOR Storage Options
- Provides Surety and Contributes to Storage Project Development





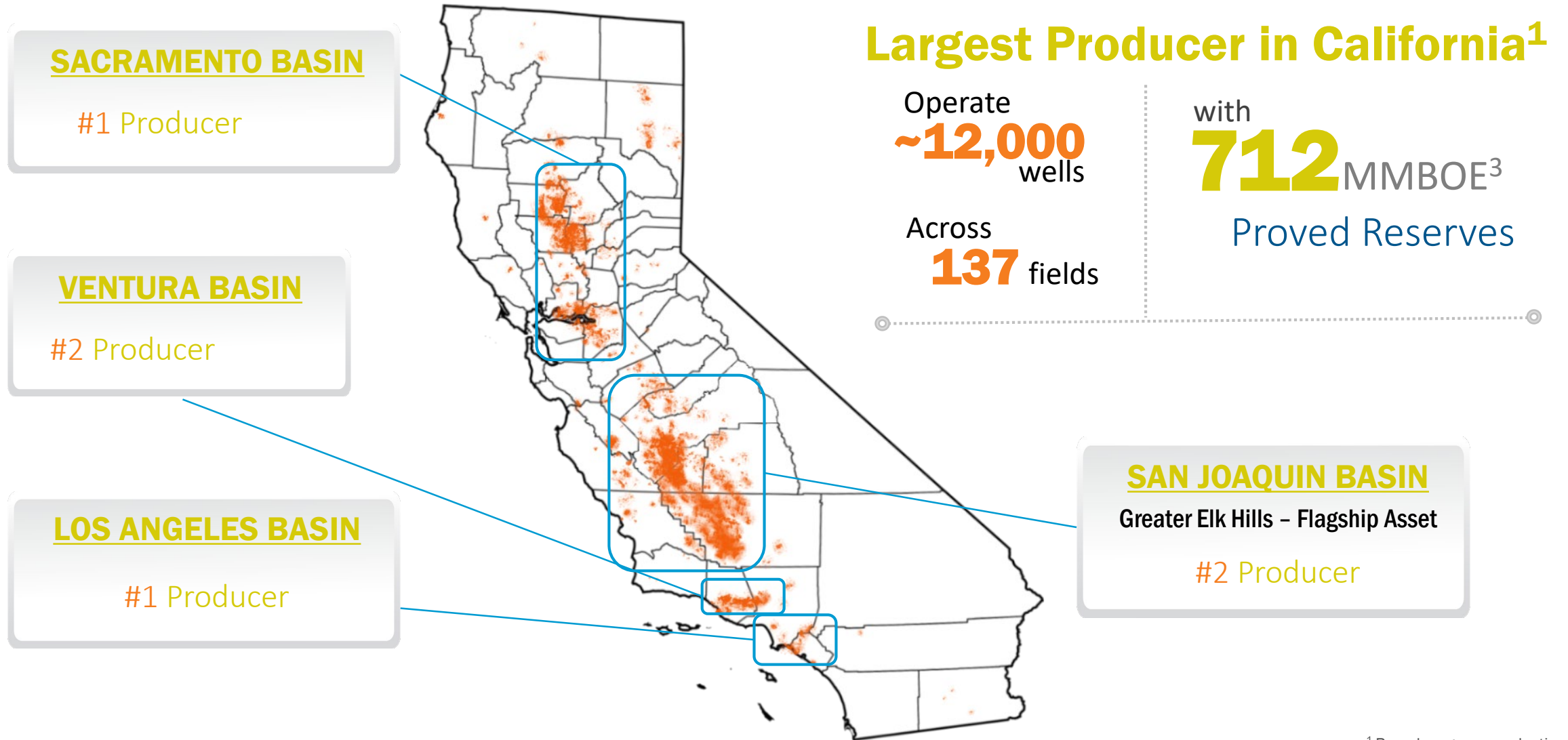
VALUE-DRIVEN

CalCapture
Elk Hills CCS with EOR

Ken Haney:
EOR/CCS Manager
June 25, 2020

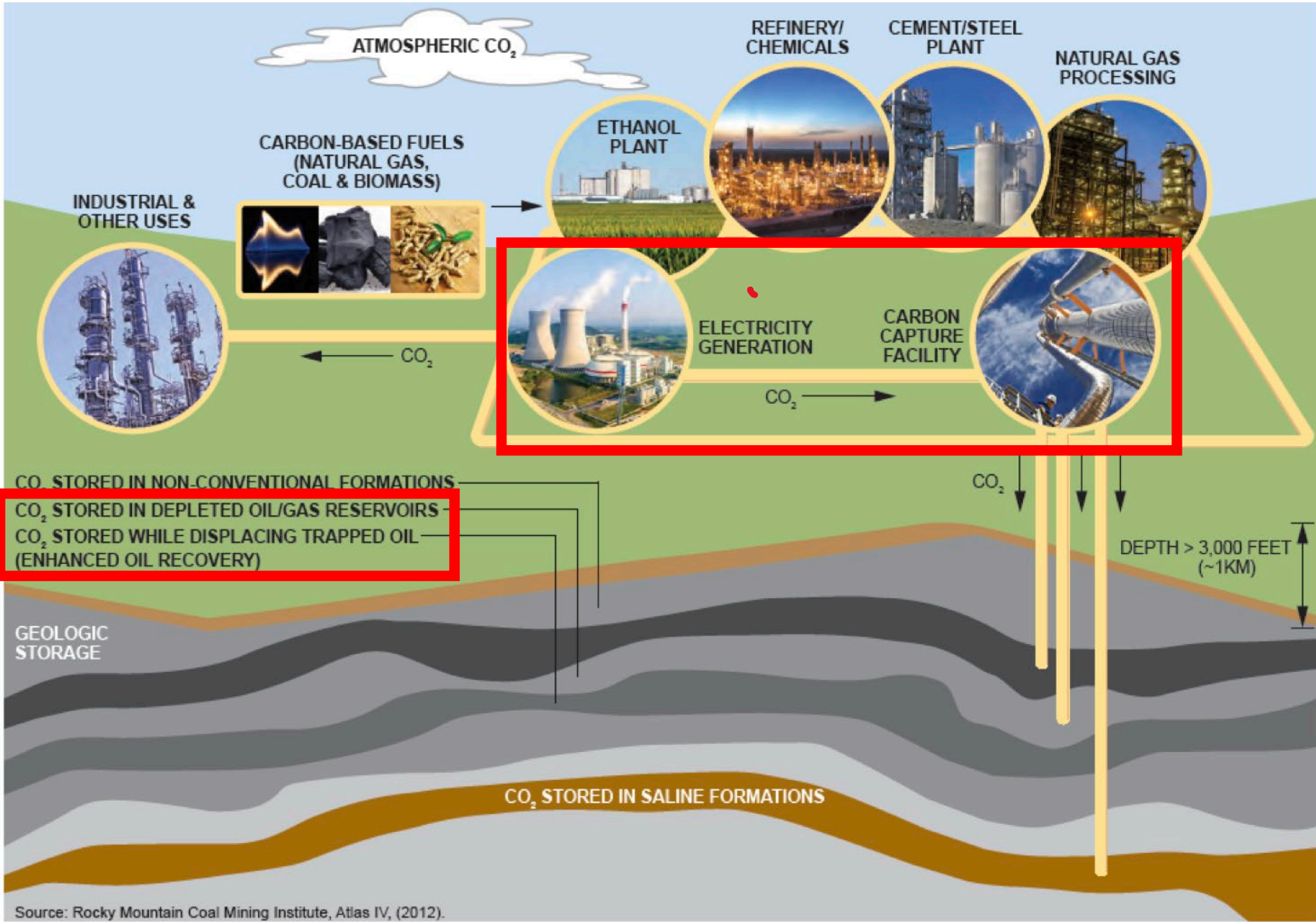


CRC is a Top Operator in California

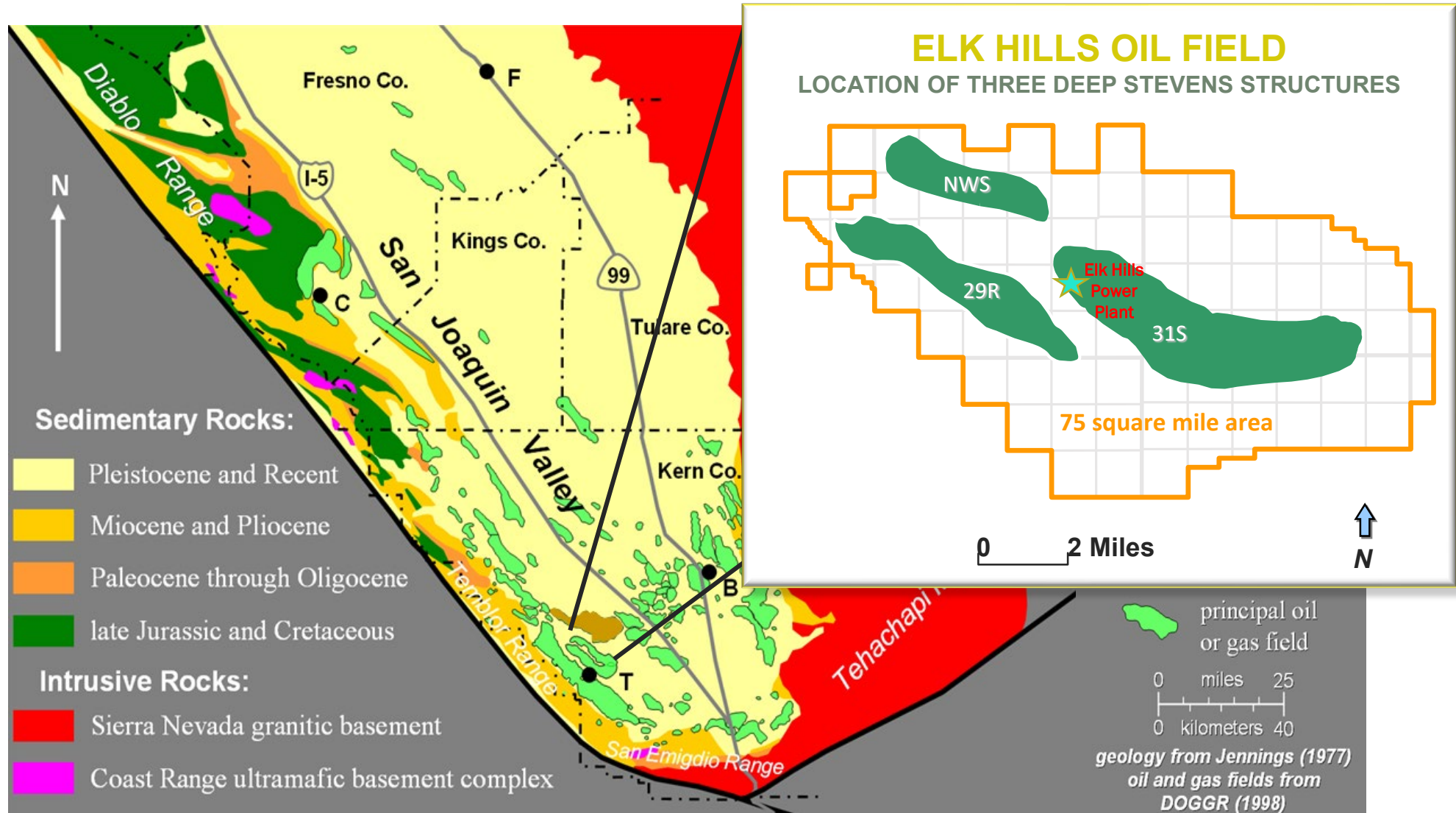


¹ Based on gross production.

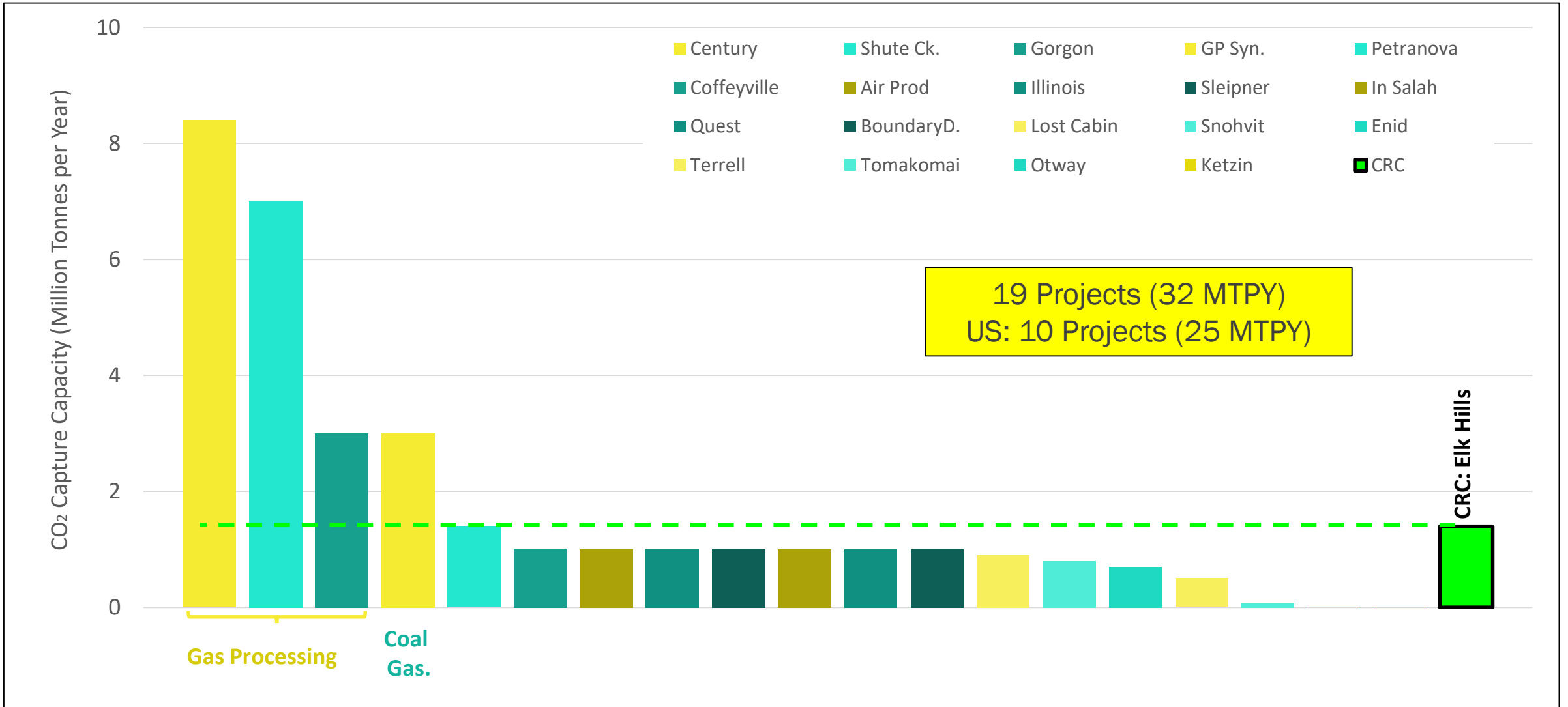
The CO₂ Supply Chain for Carbon Capture and Storage



CRC's Elk Hills Field Is the 3rd Largest in California



5th Largest CCS Project World-Wide, 1st for NGCC Power Plant



Investment Partners Have Joined the Project

US Department of Energy

- **Funding Assistance for Carbon Capture FEED**
 - \$7mm Federal award: pays for majority of FEED
- **Partners**
 - FLUOR: Amine Absorption Technology/Construction
 - Electric Power Research Institute (EPRI): Lead Applicant and Project Manager



Department of Energy (DOE)
Office of Fossil Energy (FE)

**FRONT-END ENGINEERING DESIGN STUDIES FOR CARBON
CAPTURE SYSTEMS ON COAL AND NATURAL GAS POWER
PLANTS**

Funding Opportunity Announcement (FOA) Number: DE-FOA-0002058
FOA Type: Initial FOA Release¹
CFDA Number: 81.089 – Fossil Energy Research and Development

Oil and Gas Climate Initiative (OGCI)

13 global energy companies collaborating to lower the carbon footprint of energy & industry

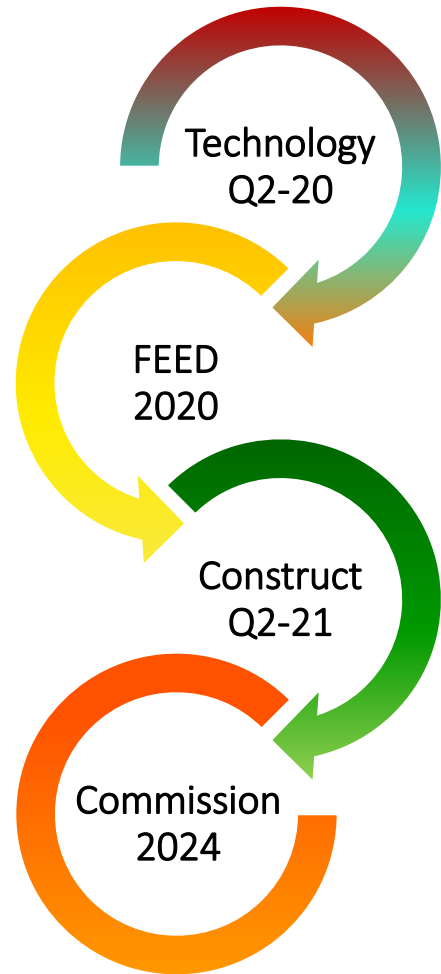
OGCI Climate Investments LLC

- \$1B+ fund for climate improvement initiatives
- Minority equity investor in Elk Hills Carbon LLC
- Technical consultation

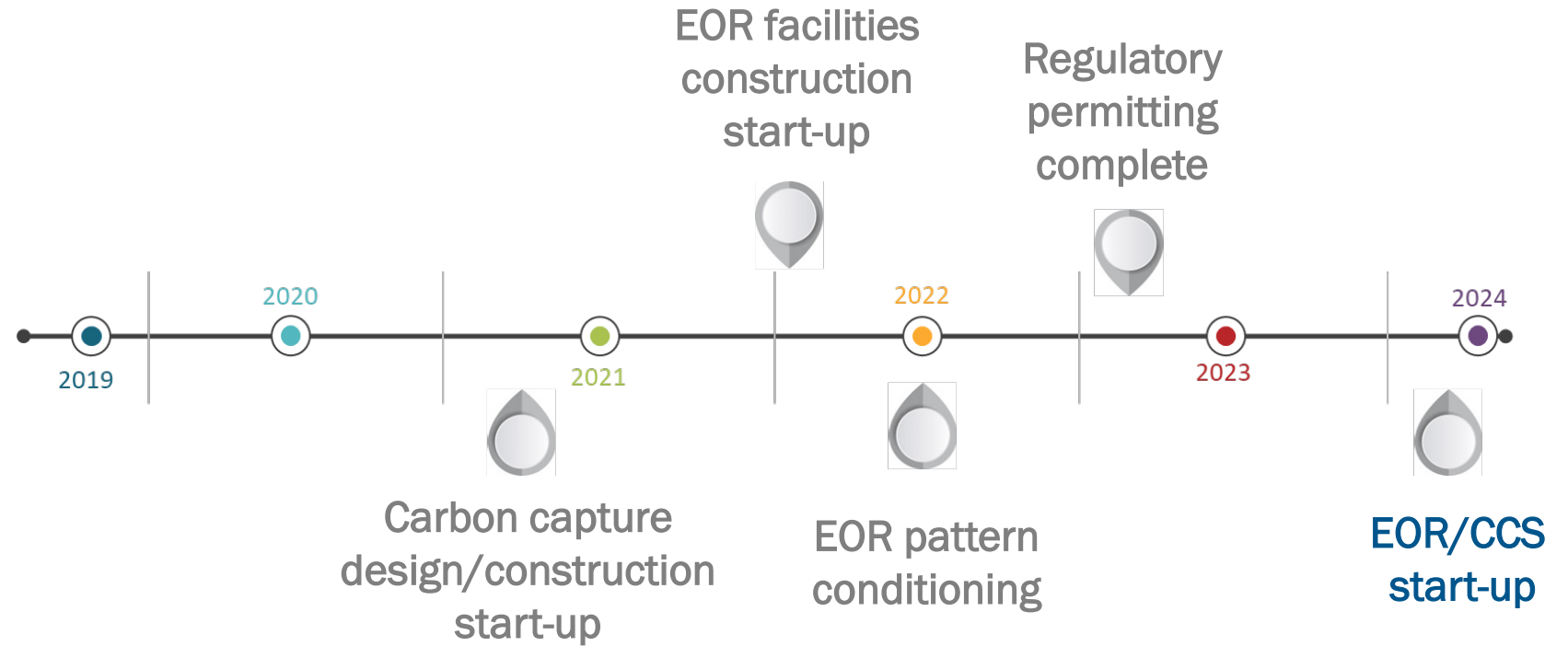


A Mid-Decade Start-up Target

Critical Path - CO2 Capture



Strategic Targets

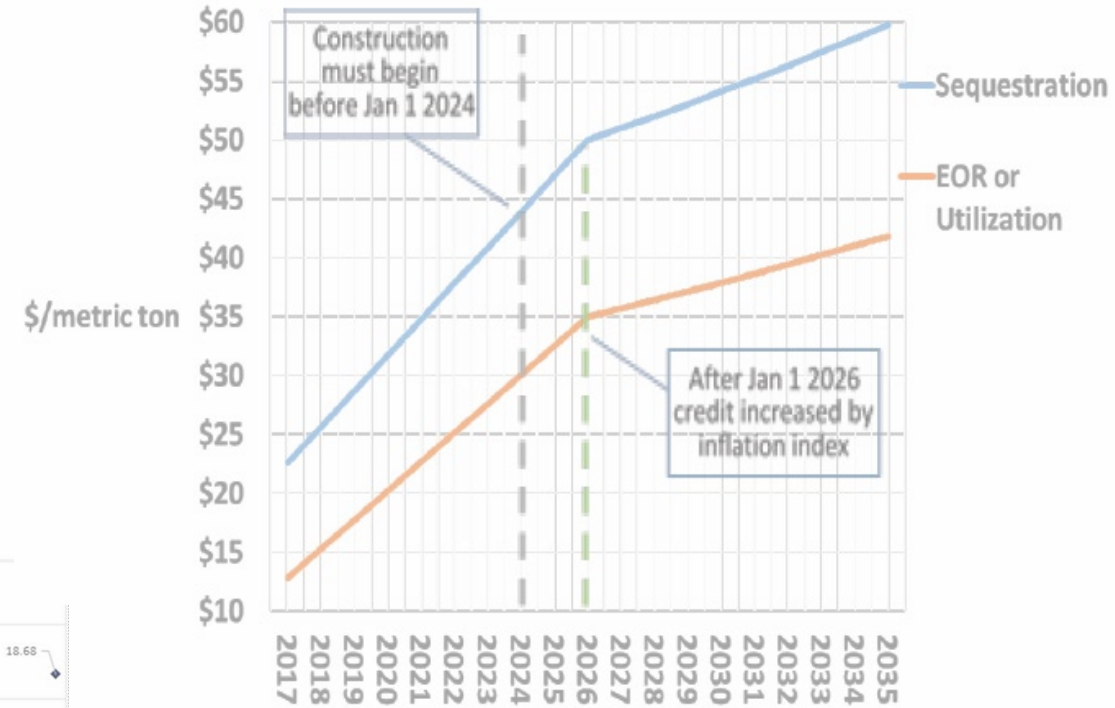


Significant Carbon Credits Enhance Project Economics

California Low Carbon Fuels Standard (LCFS)



45Q Federal Tax Credit



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California Cap & Trade



Additional Upside ?

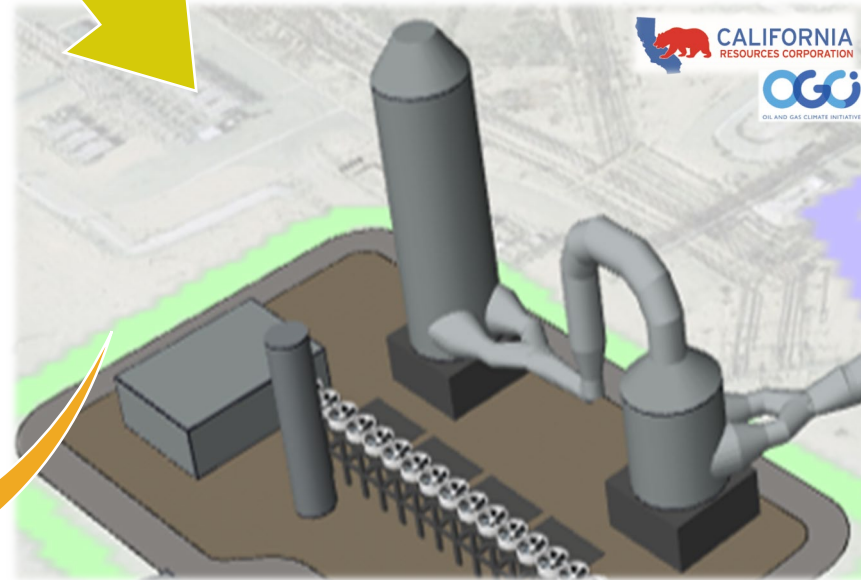
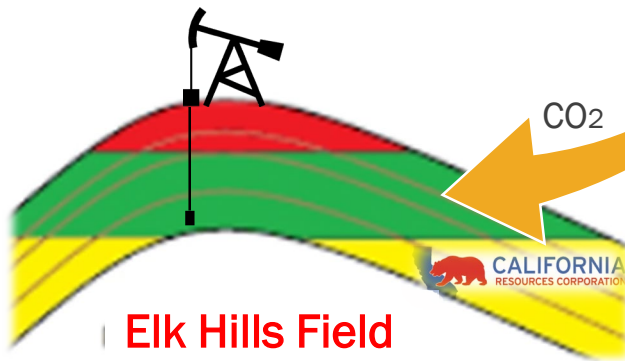
- Clean Power Contract
- Emissions Reduction Credits

CalCapture Delivers Multiple Benefits to the Energy Transition

- ✓ Significant immediate emissions reductions
- ✓ Clean, safe and affordable energy for California
- ✓ Prolific economic impact on local, state and national economies
- ✓ NGCC power plant capture technology development



CRC's CalCapture Project Structure



Elk Hills Carbon LLC

Project Revenues

- Oil and NGL Sales
- Carbon Credits (45Q, LCFS, Cap & Trade)
- *Clean Energy Premium ?*

Funding Options

- Internal Investment
- JV Equity Partner(s)
- Government Funding and Low Interest Loans

CRC's CalCapture Project

A Fully Integrated Project

- ✓ CO₂ source on location with reservoirs
- ✓ CRC owns infrastructure/surface/pore space

Commercial Readiness

- ✓ Uncertainty ranges understood
- ✓ Economics supported by carbon credits
- ✓ Successful regulatory engagement

Strong Investment Opportunities

- ✓ Carbon capture plant
- ✓ EOR project participation

Elk Hills is positioned to be a global leader on CCS for natural gas power plants

By Mid-Century

- CCS impacts 10-15% of global emissions reductions
- Future need for 2,000+ CCS projects

Questions & Answers



EVENTS AND CONTACT

Next event: 9 July - CCS Talks: The Alberta Carbon Trunk Line – Alberta’s Newest Carbon Solution

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View recordings of past events:

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