CO_2 Capture Solution for Industrial Decarbonization

California Air Resources Board – 2022 Scoping Plan Update – Engineered Carbon Removal Technical Workshop

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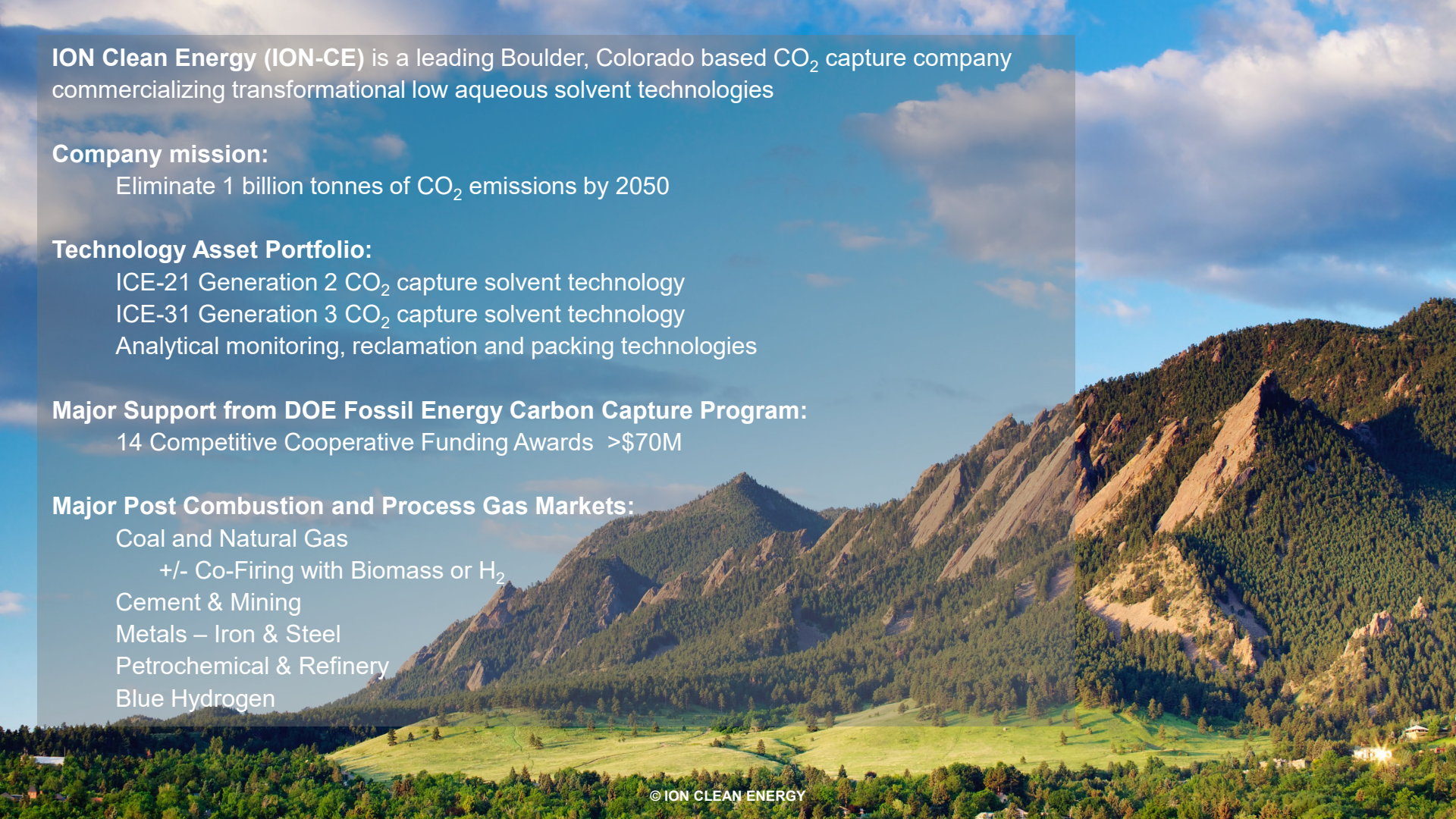
August 2, 2021



ION Clean Energy (ION-CE) is a leading Boulder, Colorado based CO_2 capture company commercializing transformational low aqueous solvent technologies

Company mission:

Eliminate 1 billion tonnes of CO_2 emissions by 2050

Technology Asset Portfolio:

ICE-21 Generation 2 CO_2 capture solvent technology
ICE-31 Generation 3 CO_2 capture solvent technology
Analytical monitoring, reclamation and packing technologies

Major Support from DOE Fossil Energy Carbon Capture Program:

14 Competitive Cooperative Funding Awards >$70M

Major Post Combustion and Process Gas Markets:

Coal and Natural Gas
+/- Co-Firing with Biomass or H_2
Cement & Mining
Metals – Iron & Steel
Petrochemical & Refinery
Blue Hydrogen

ION's CO_2 Capture Technology Development

Accelerated development path leveraging existing research facilities

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2010

ION-CE Lab-pilot
Simulated Flue Gas
3 kWe
Boulder, CO, USA

2012

UND EERC
Coal
0.05 MWe
Grand Forks, ND, USA

2015

National Carbon Capture Center
Coal
0.5 MWe
Wilsonville, AL, USA

2016 - 2017

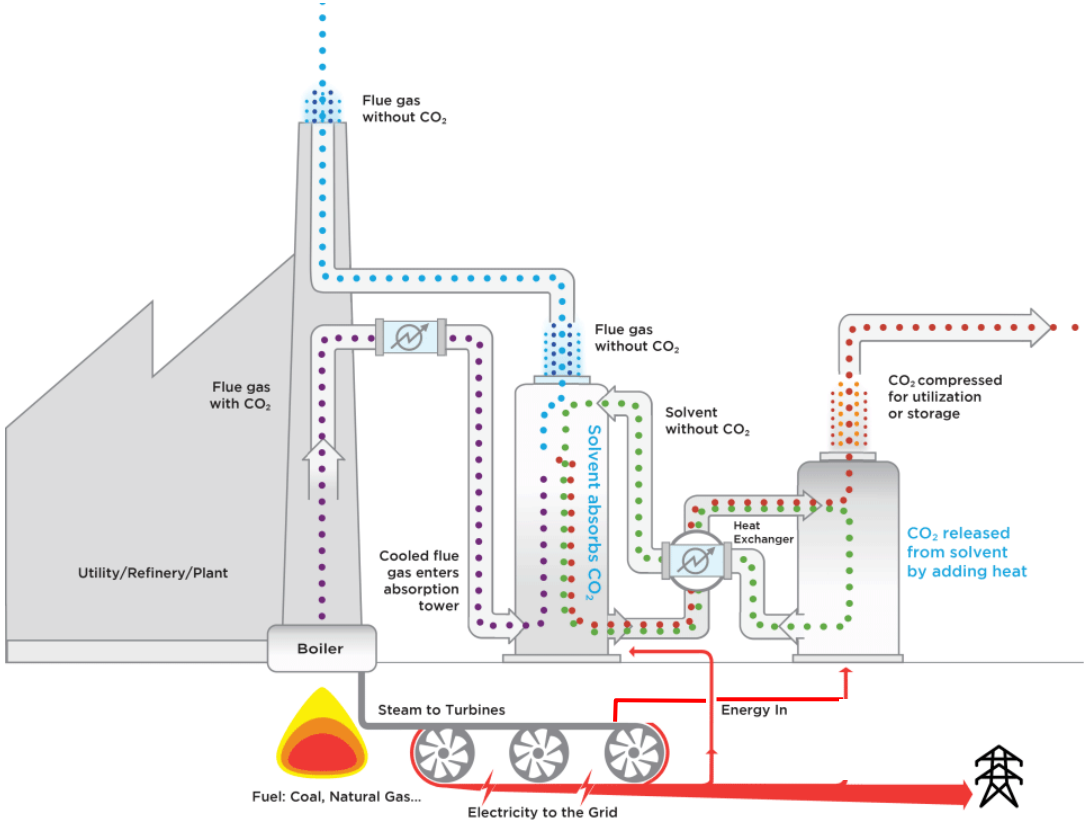
CO_2 Technology Centre Mongstad
Refinery & Natural Gas
30 – 60 ktpa
Mongstad, Norway

2018 - 2021

Commercial FEED
Coal
2 – 5 Mtpa
Sutherland, NE, USA

ION Technology Overview

- Proprietary Solvent-based Technology
- Low Cost of Capture
  - Smaller columns, heat exchangers and overall facility footprint
  - Lower energy requirements
  - Lower emissions
  - Lower parasitic load
- Established Engineering Process
- Wide applicability across power and industrial point sources



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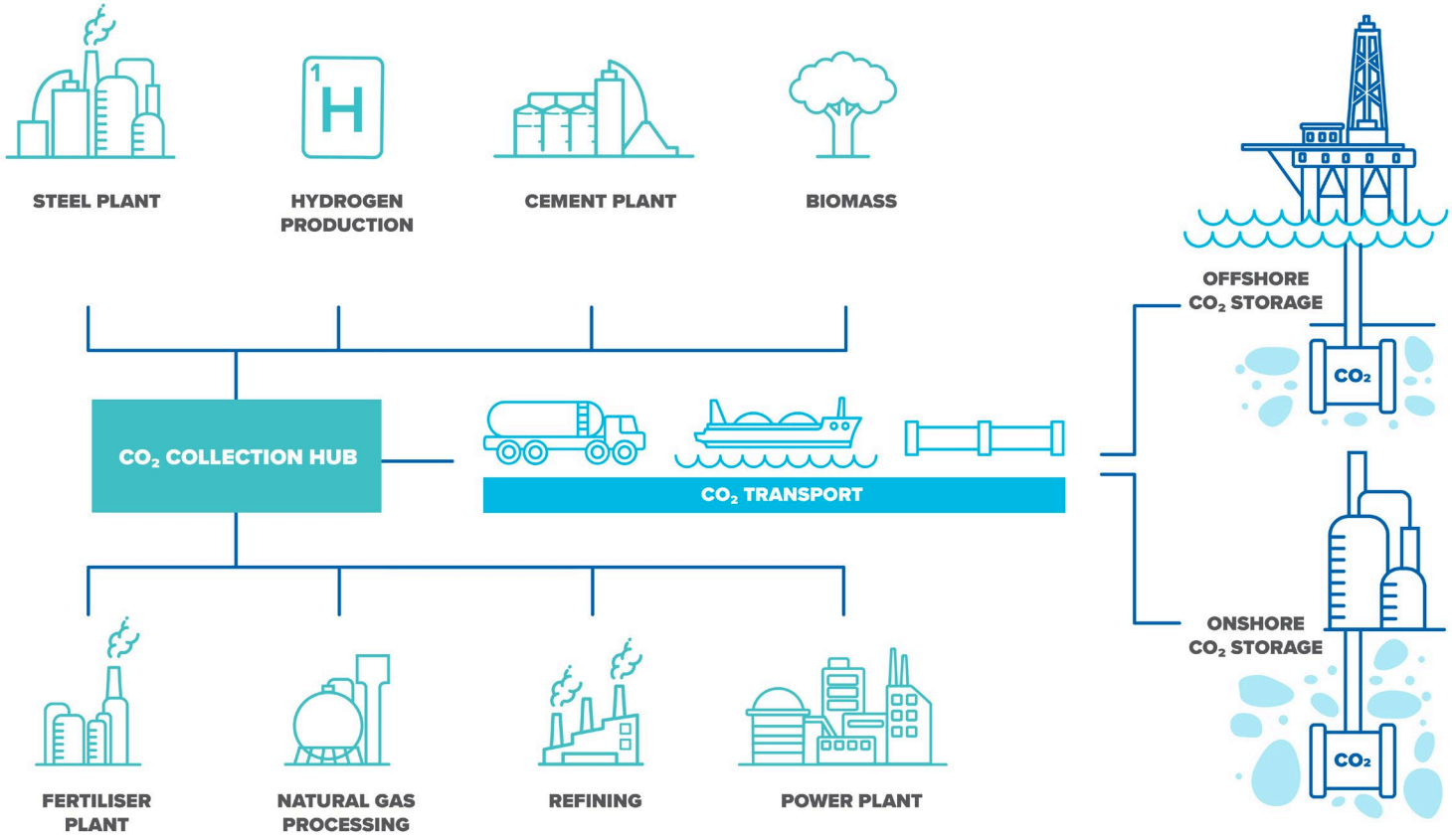

Source: Global CCS Institute

C3DC2

DOE-NETL Sponsored Class 2 FEED at NPPD Gerald Gentleman Station for 4.5Mtpy CO_2 Capture Facility – 3D Model

- Projected All-in Capture Cost: **$35/tonne** CO_2 including Compression to Pipeline Specification
- BECCS sensitivity study being completed to design and cost cofiring corn stover aiming for **net-zero** emissions

Calpine's Los Medanos Energy Center

DOE-NETL sponsored 10 tpd CO_2 Capture Pilot on NGCC Flue Gas

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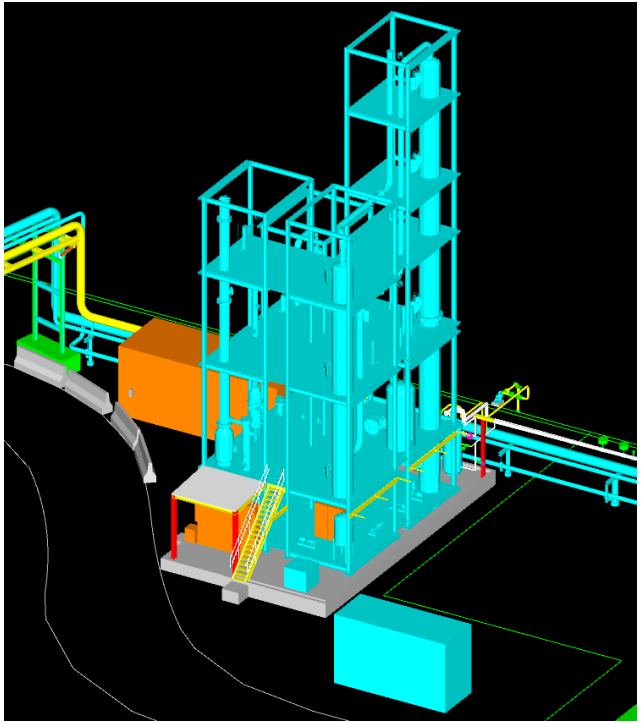
- Project Objectives:
  - Design, Fabricate, and Install a CO_2 capture pilot at Calpine's Los Medanos Energy Center (LMEC), a commercially dispatched NGCC facility in Pittsburg, CA
  - 10-tpd carbon capture system (equivalent to 1MWe) designed to take advantage of ION's ICE-31 solvent
  - Develop and execute test plan to empirically demonstrate performance of ICE-31 solvent against relevant baselines (30% monoethanolamine and ION's ICE-21 solvent)
  - Long-term steady state testing of ION's ICE-31 solvent at a commercially dispatched NGCC facility
- 36-month project; testing to start in late 2022

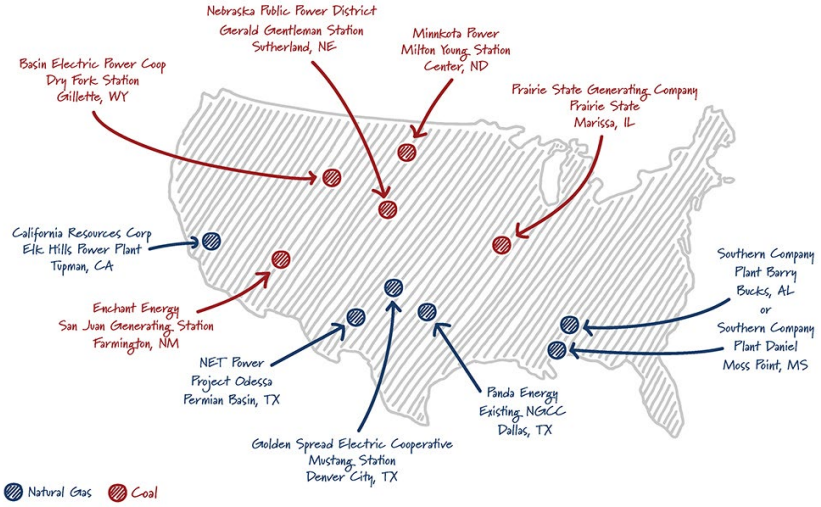


STATE OF CCUS INDUSTRY

State of the Industry

- Since the announcement of 45Q, significant interest has been generated in deployment of CO_2 Capture, Utilization and Storage technologies
  - $35/tonne for CO_2 utilized in Enhanced Oil Recovery
  - $50/tonne for CO_2 stored in permanent geologic storage
    - Recently, there has been increased interest into sequestration given volatility of oil prices
- Significant investment in “FEED” studies by DOE-NETL for point source capture
  - Focus on Power Sector and Industrial Point Sources

Map of FEED Studies in Progress



Source: ClearPath

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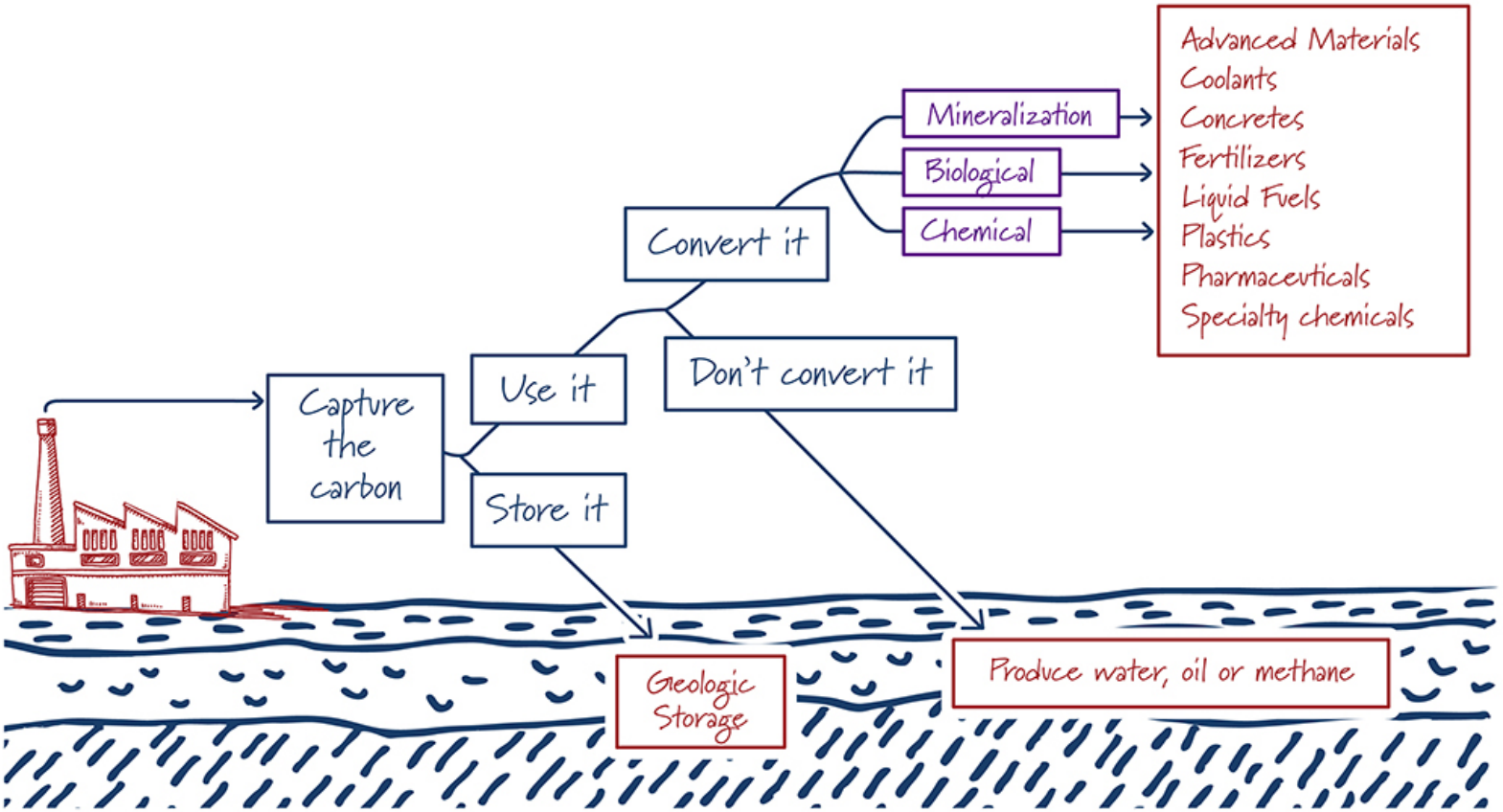

Source: ClearPath

CCUS Opportunities in California

Key to tie point sources with storage or utilization opportunities

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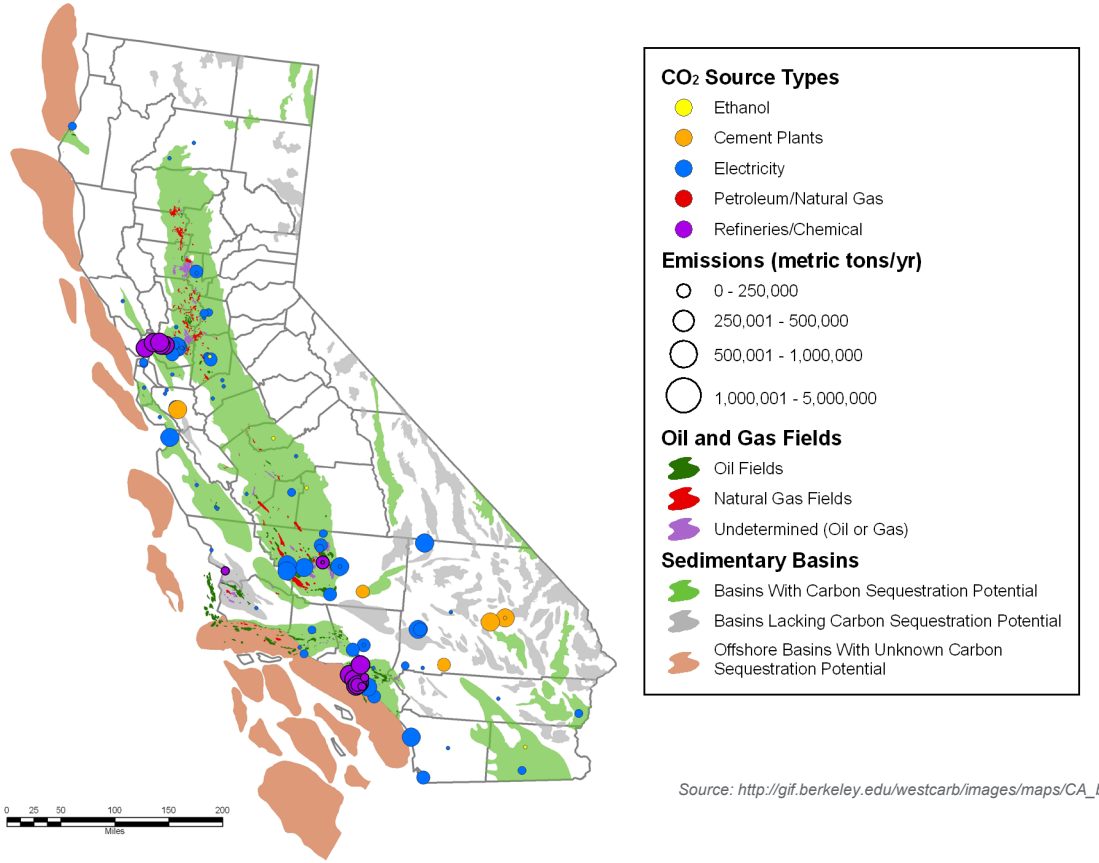

Source: http://gif.berkeley.edu/westcarb/images/maps/CA_basins_status_point.jpg

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THANKS