Front-End Engineering Design Study for Retrofit Post-Combustion Carbon Capture on a Natural Gas Combined Cycle Power Plant

DE-FE0031842

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U.S. Department of Energy
National Energy Technology Laboratory
Carbon Capture Front End Engineering Design Studies and CarbonSafe
2020 Integrated Review Webinar
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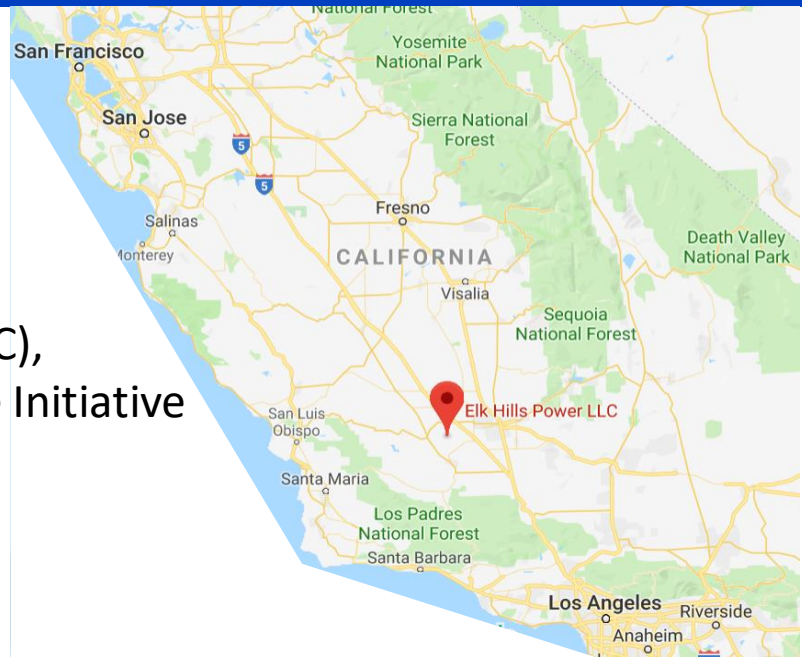
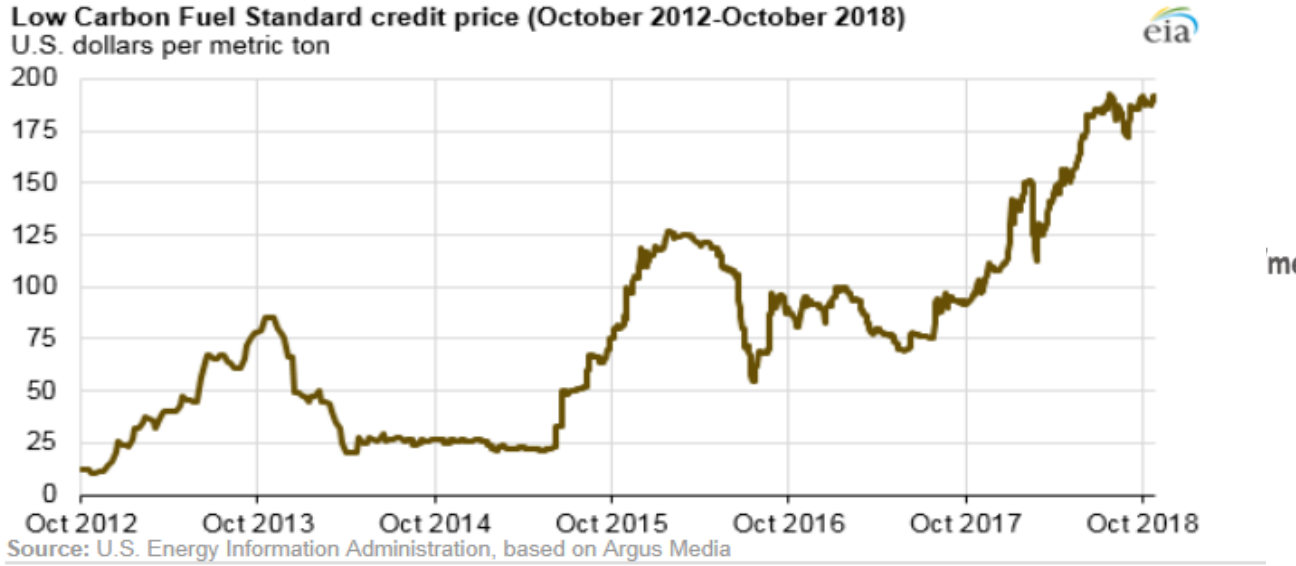
Overview: CalCapture FEED Study



- Funding Total $8,644,807
  - DOE: $6,915,845 (80%)
  - Cost-Share: $1,728,962 (20%) from EPRI, California Resources Corporation (CRC), and Elk Hills Carbon, LLC, a Joint Venture between CRC and Oil and Gas Climate Initiative
- Project Performance Dates
  - October 1, 2019 – March 31, 2021
- Project Participants
  - NETL: Sai Gollakota
  - EPRI: Abhoyjit Bhown, Adam Berger, Des Dillion
  - CRC: Kenneth Haney, Braden Carroll
  - Fluor: Satish Reddy, Timothy Simonson, John Gilmartin
- Project Objectives
  - Determine technical and economic feasibility of deploying Fluor's Econamine FG+^{SM} post-combustion carbon capture process on CRC's 550 MWe NGCC Elk Hills Power Plant (EHPP)
  - Captured CO_2 used for enhanced oil recovery (EOR) and/or storage surrounding EHPP (outside FEED scope)
- Commercial Drivers
  - EOR, Federal 45Q, California Low Carbon Fuel Standard, California Cap & Trade provide significant commercial drivers
  - Pending results of this FEED study, CRC plans on construction completion and project startup by mid-decade

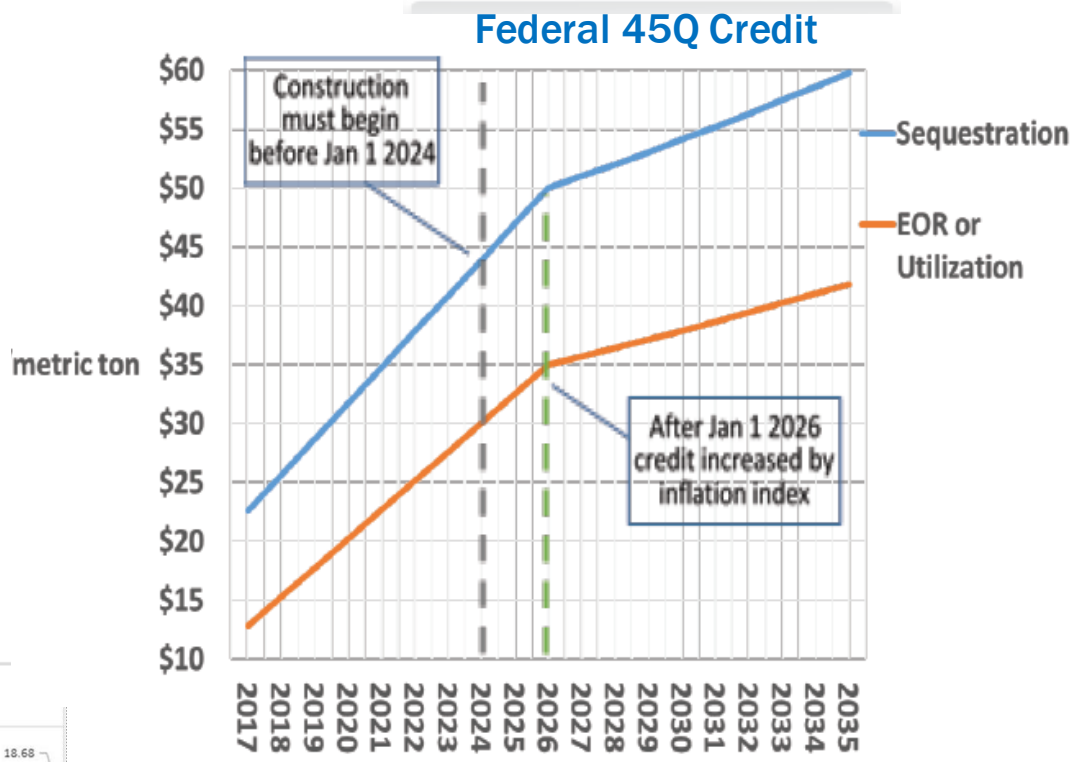
Carbon Storage Credits Make Carbon Capture Economically Viable

California Low Carbon Fuels Standard (LCFS)



California Cap & Trade

Federal 45Q Credit



Additional Upsides:
Clean Power Contract
Emissions Reduction Credits

Technical Approach

- FEED Scope
  - Design basis document led by CRC
  - Completed 1Q20
- FEED Study
  - Engineering design and economics led by Fluor
  - Expect late 4Q20
- FEED Package = FEED Scope + FEED Study
  - Final deliverable 1Q21
- Project Success Criteria
  - A comprehensive FEED Package submitted to DOE
  - Sufficient information for CRC to make a yes/no decision for deployment at site
- Project Risks
  - Design changes, mitigated by project team focusing on highest priority items

Site Selection

- Elk Hills Power Plant is a 550 MW NGCC located in the middle of the Elk Hills Oil Field providing both EOR and storage options co-located with the facility
- The site has been extensively reviewed over the past decade for EOR, storage and capture
- Current and expected policy allows for economic development of carbon capture including benefits from:
  - IRS 45Q Tax Credits
  - California's Low Carbon Fuel Standard
  - California Cap & Trade Avoidance

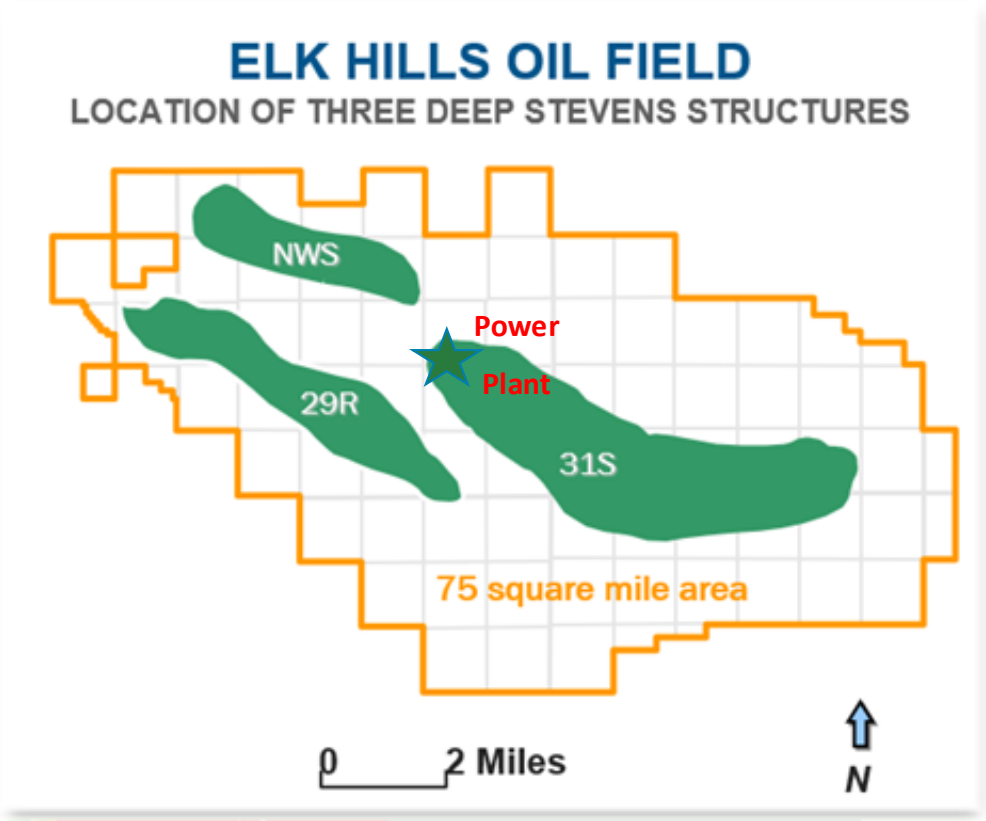


Image from CRC

"Elk Hills Field one of the most suitable locations for the extraction of hydrocarbons and the sequestering of CO_2 in North America."

Appendix F. URS Report on CO_2 Sequestration for California Energy Commission. 2010

Elk Hills Power Plant

- Commissioned 2003
- Powered by two General Electric (GE) 7FA technology combustion turbine generators (CTG's).
- Exhaust gas from the CTG's is directed to two supplementary-fired heat recovery steam generators (HRSG's) for the generation of high-pressure, intermediate-pressure, and low-pressure steam that drives the steam turbine generator (STG).
- Supplementary (duct burner) firing capability is provided in each HRSG to generate additional steam for peak power production.
- Selective Catalytic Reduction (SCR) systems for the control of NO_x emissions and oxidation catalysts for the control of CO and VOC emissions.
- Fuel for the CTGs and duct burners is natural gas.
- A mechanical draft cooling tower provides heat rejection for the steam cycle.

Image from CRC

Technology Selection

- CRC selected best technology options in early 2019.
- Narrowed to amine absorption after an evaluation of technical readiness and performance metrics at scale.
- Fluor's Econamine FG+^{SM} selected because:
  - Over 30 commercial Econamine FG operating plants around the world validating the design of the process
  - Technology commercially proven on a gas turbine flue gas with 15 years of operating experience
  - Solvent maintenance system provides for low air emissions and waste generation
  - Energy efficient and low solvent make-up

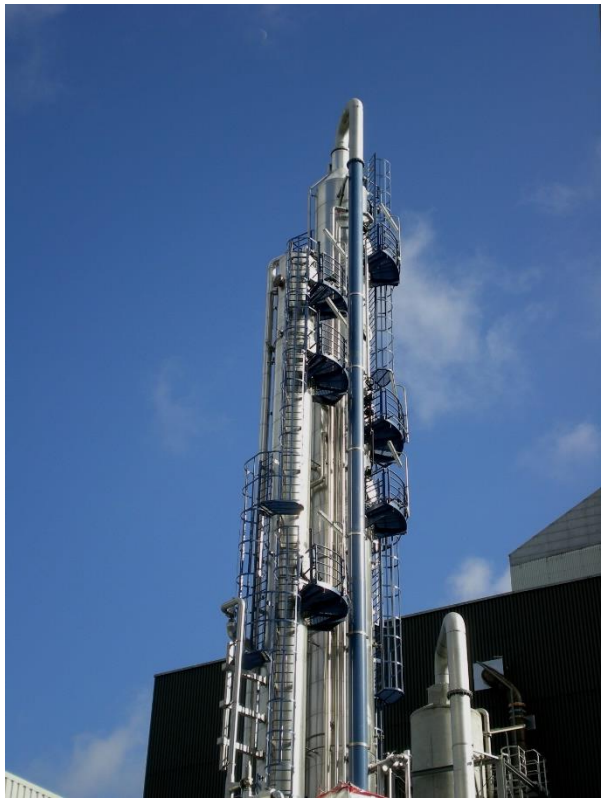


Image from Fluor

Demonstration Plant, Germany

FLUOR®

Finalized FEED Scope – Design Basis

- 4,000 tonnes CO_2/day design capacity
- 1.3 MMSCF/min flue gas supply with 5% CO_2 at 200°F
- Delivery of pipeline grade CO_2 at 2,300 psi
- Completed detailed analysis of flue gas characteristics
- Aligned on off-plot tie-in parameters
- Expanded plot space to meet design requirements

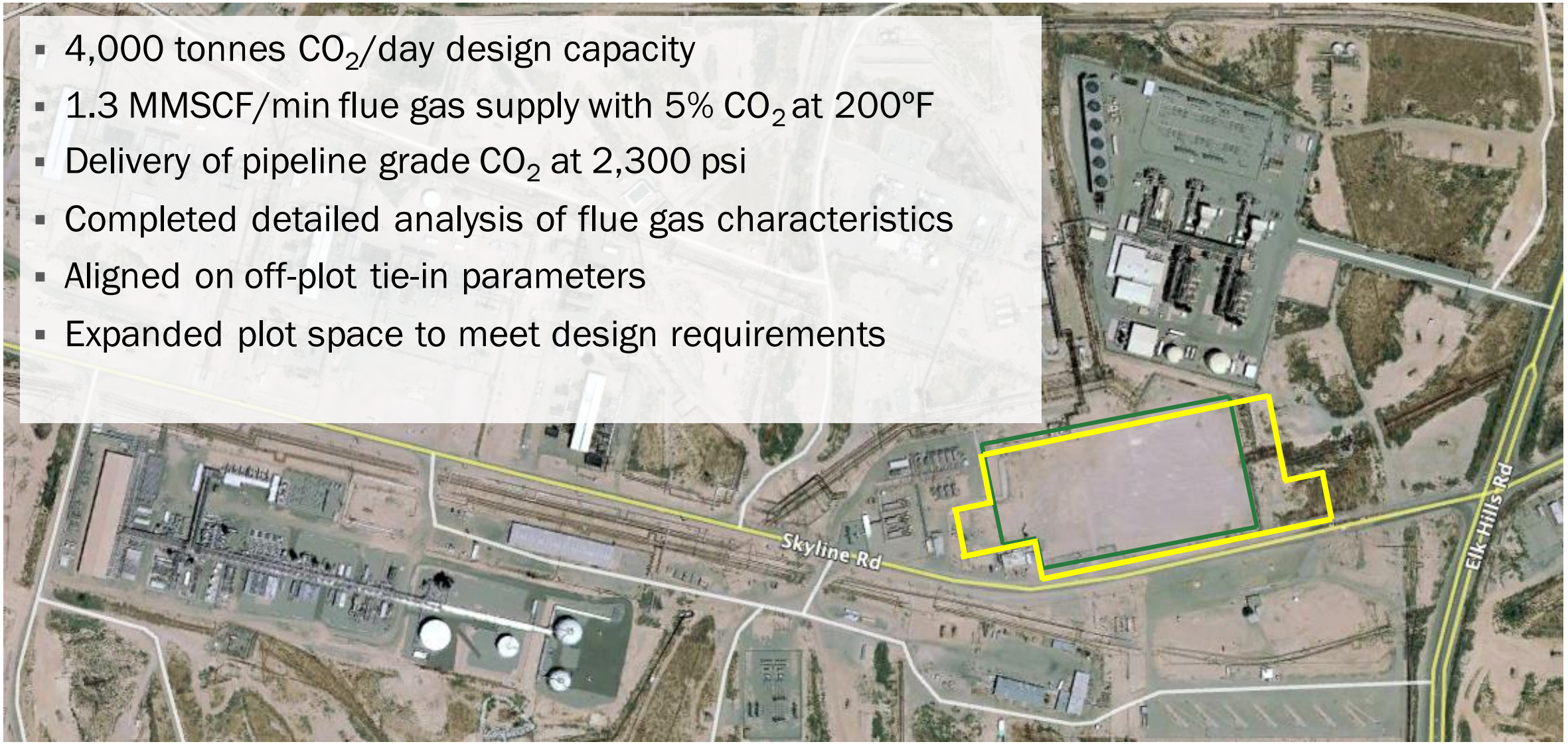
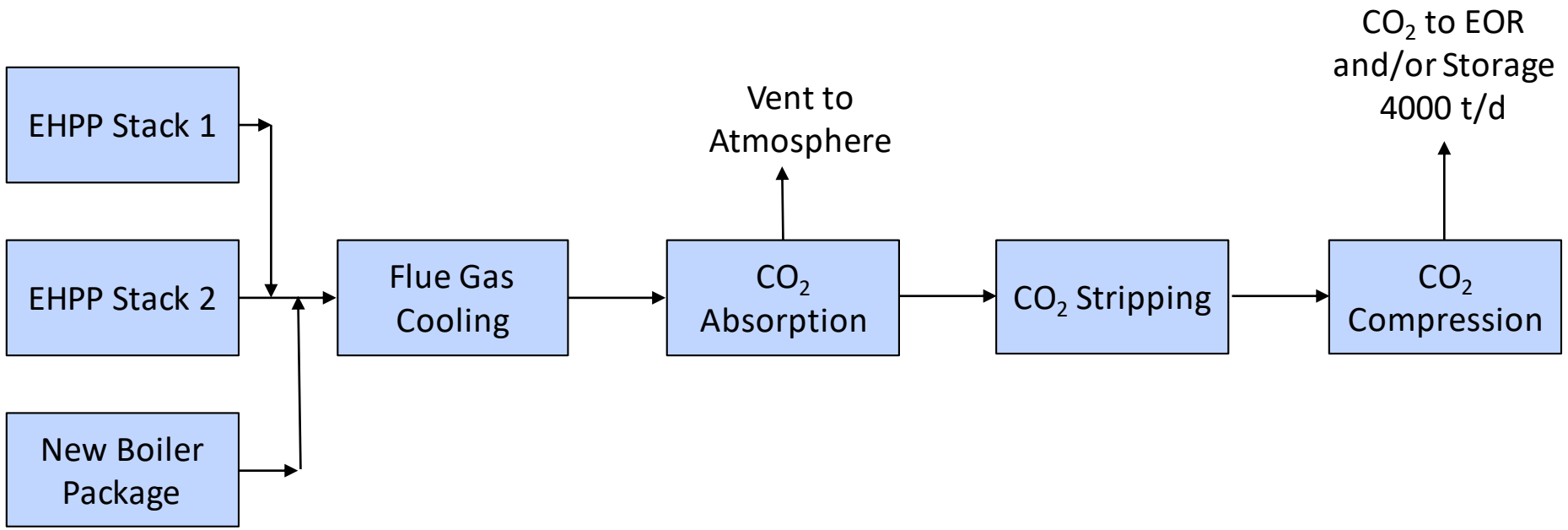


Image from CRC

Carbon Capture Plant Configuration



- Gas fired boiler supplies steam to the carbon capture plant
- CO_2 emissions from the boiler are captured in the carbon capture plant
- 80% of CO_2 captured is from power plant, while 20% is from boiler

3-D Model of the CCS Facility

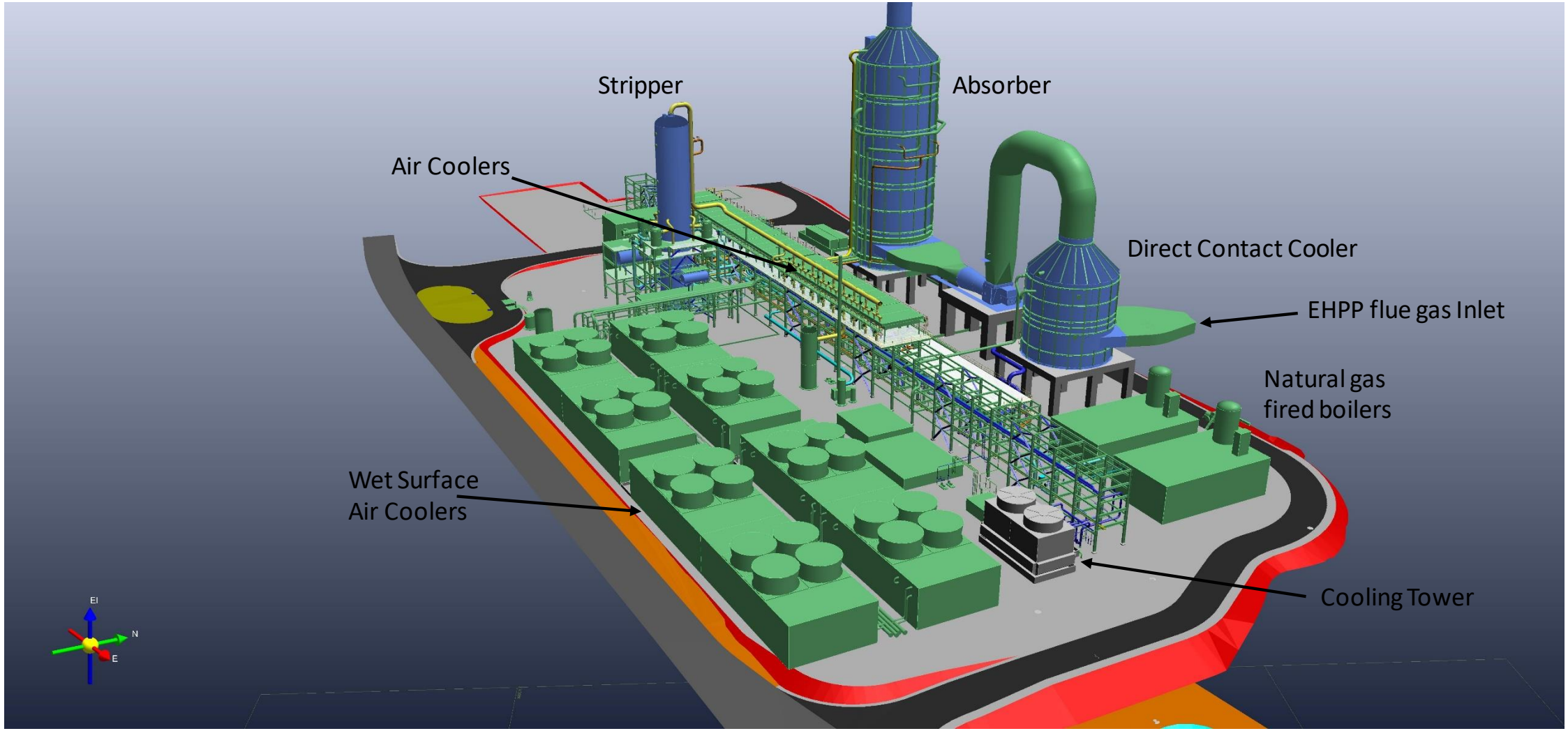


Image from Fluor

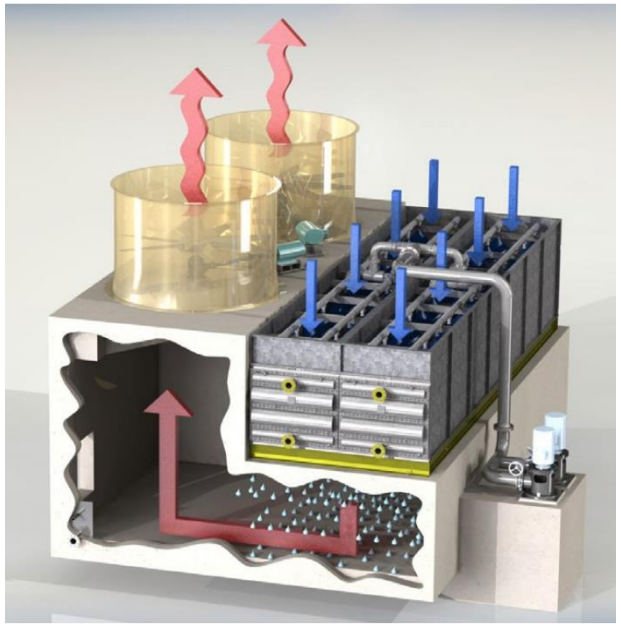
Incorporated Fresh Water Reduction into Design

- Ambient conditions and fresh water availability made this very challenging
- Cost effectively reduced freshwater consumption by over 50%

Courtesy Alfa Laval

Air Coolers

Services that do not need to be below ambient conditions + Approach



Courtesy Alfa Laval

Wet Surface Air Coolers

Large Duty Process Water Services

Courtesy SPX Cooling

Cooling Tower

Streams impractical to use other methods

Design Status

"Fit for Purpose" approach incorporating application design standards from:

- American Petroleum Institute (API)
- American Society of Mechanical Engineers (ASME)
- National Electrical Manufactures Association (NEMA)
- American National Standards Institute (ANSI)
- Process Industry Practices (PIP)

Incorporated into the issuance of (approximately):

- 200 Project Specifications
- 70 Data Sheets
- 150 Drawings

Image from Fluor

Completed design activities to date:

- ✓ Process modeling
- ✓ Heat and Material Balances
- ✓ Process Flow Diagrams
- ✓ Piping & Instrumentation Diagrams
- ✓ Equipment Sizing and Selection
- ✓ Process Hazard Analysis
- ✓ Plot Plan

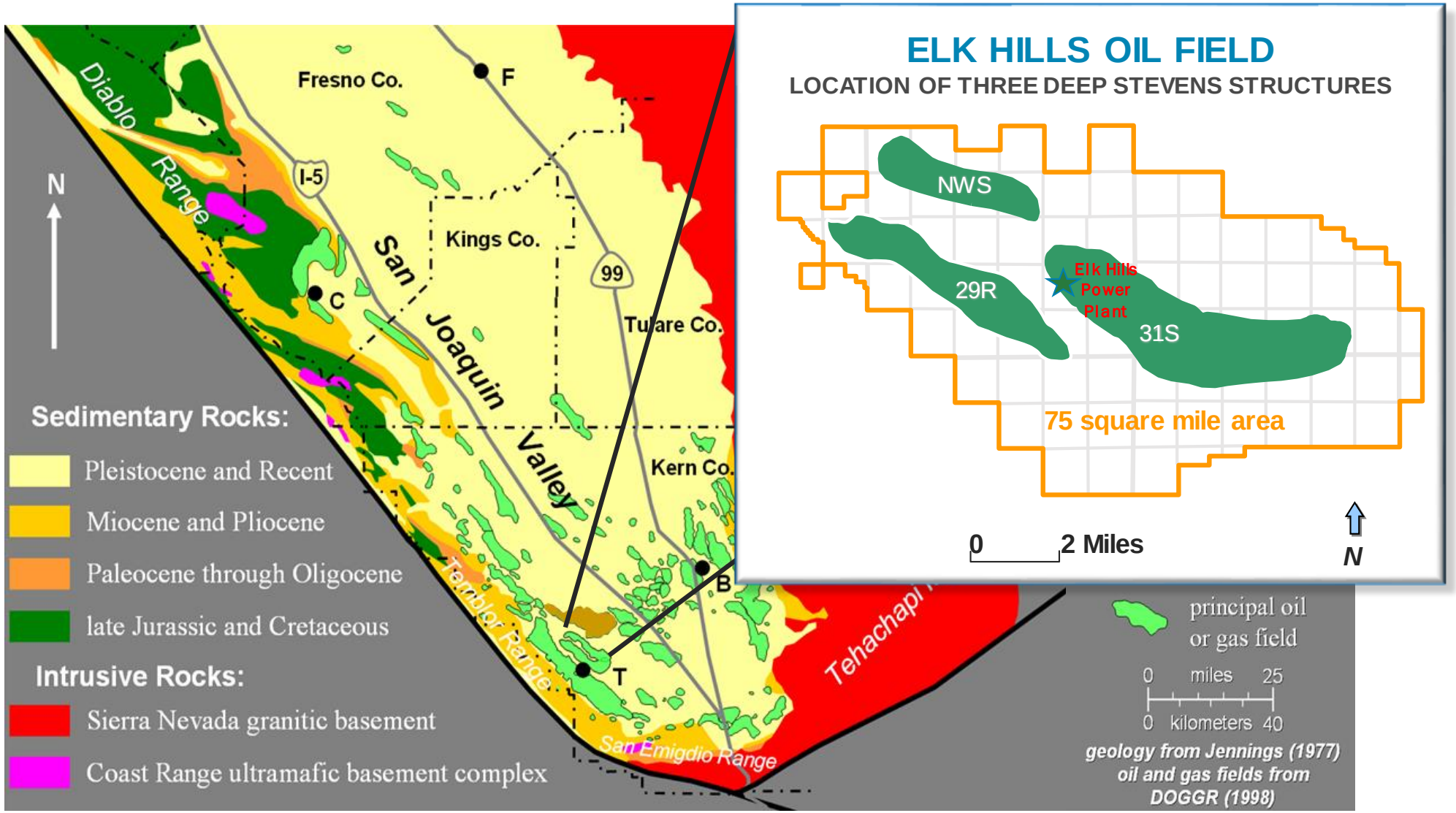
Design Challenges

- Logistics are resulting in increased field work
  - Large flue gas flow rate → Large equipment sizing
  - Landlocked site with relatively small shipping window
- Plot space availability
  - Expansion of plot has been incorporated to accommodate wet surface air coolers
  - Relocation of existing infrastructure is required
  - Additional plot space needs may be identified in execution planning
- Freshwater sourcing
  - Freshwater mitigation has been implemented reducing required freshwater make-up
  - Aligning with CRCs Sustainability Goals

CRC Sustainability Focus

Image from CRC

CRC's Elk Hills Field Is Primed to Lead California into CCS



Images from CRC

CCS with EOR Cuts Lifecycle Oil Emissions by 40% - 50%

Conventional Oil Production

emits 0.51 tons CO_2 per barrel oil

Enhanced Oil Recovery

Emits 0.54 tons CO_2 per barrel oil
Stores 0.30 metric tons of CO_2 per barrel
Net emissions are 0.24 tons CO_2 per barrel

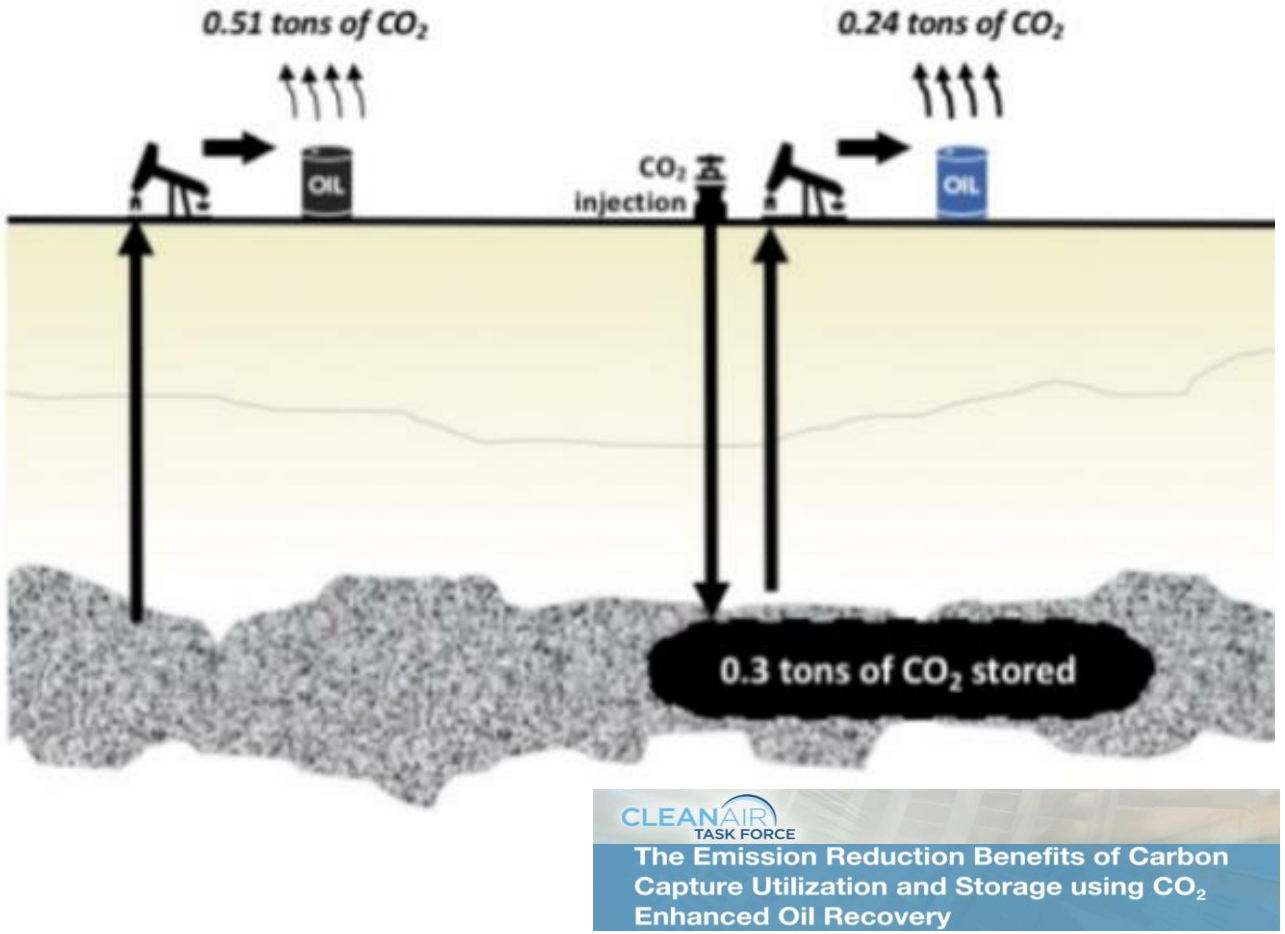


Image from CRC

Phase 1 (10-15 years)

Captures 15-20 million metric tons of CO_2
~250,000 vehicles/year

Additional Targets

Up to 20 million metric tons

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
- ✓ Potentially first large-scale CCS on NGCC power plant

Image from CRC

Acknowledgment

Acknowledgment

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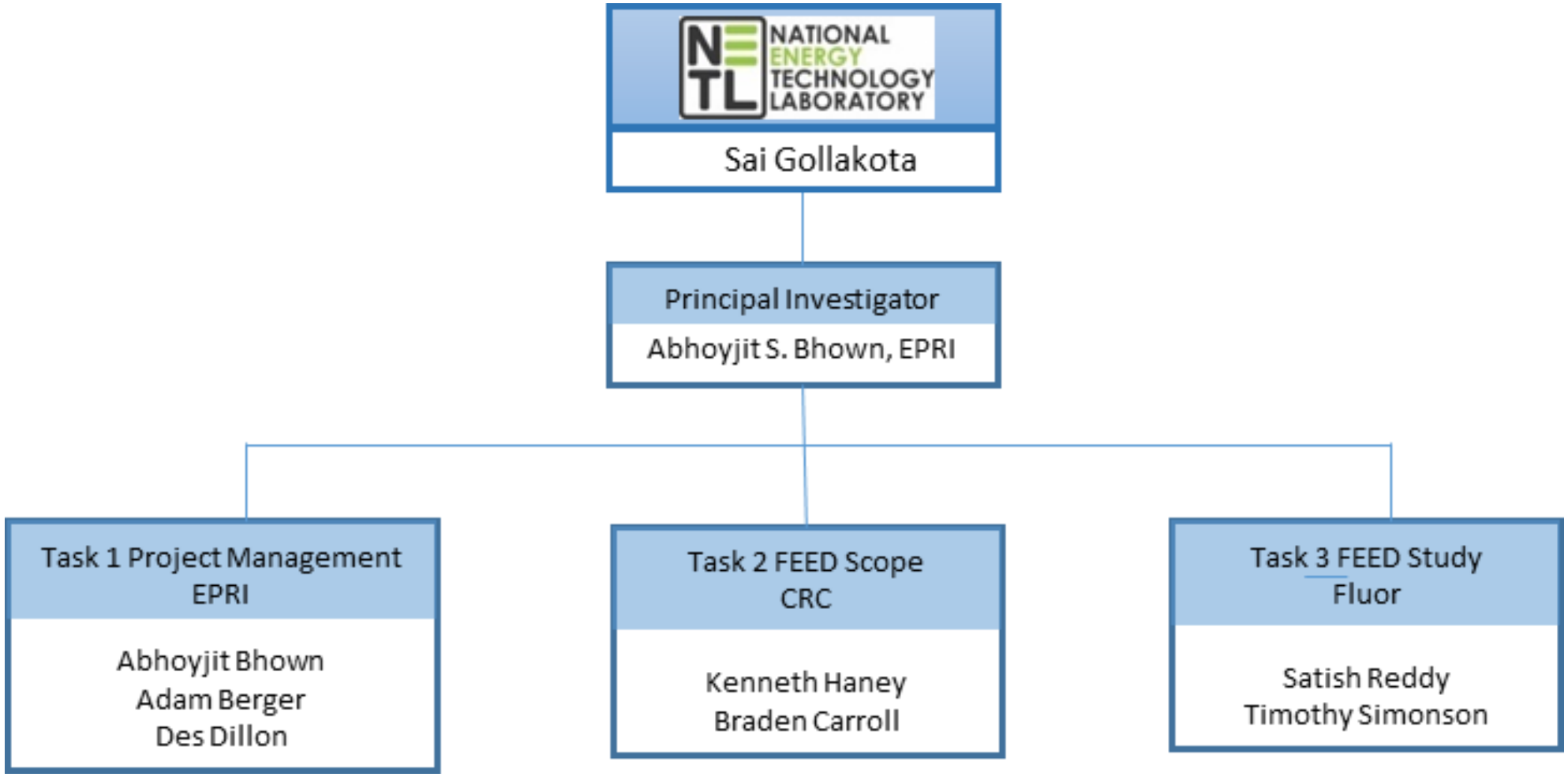
APPENDIX

Organization Chart



Gantt Chart