

America's Premier Competitive Power Company ... Creating Power for a Sustainable Future

Unpacking the IRA: A Perspective on CCUS in the Power Sector

Harvard Electricity Policy Group May 31st, 2023

Key Messages

- We believe CCUS will play a key role in both power sector decarbonization AND reliability, and IRA support is timely
 - CCUS is one of few technologies that enables *firm dispatchable non-duration-limited low-carbon power* generation
 - CCUS leverages *existing* power grid infrastructure, reducing the need for protracted and costly transmission grid expansion as well as vast land use
- California and Texas are both emerging as supportive environments for CCUS deployment in the power sector
 - Both have favorable CO2 storage geology, and both have multiple active CO2 transport and sequestration projects under development
 - Both have supportive elected officials and local communities
 - In both locations, cogeneration facilities offer the appeal of baseload run profiles, scale, and industrial hubbing potential
- We continue to advance our portfolio of CCUS projects
 - Equipment installation is almost complete for the Enterprise amine test facility at Los Medanos (DOE funded effort with ION Clean Energy)
 - FEED studies are underway at four sites: Delta (DOE funded), Deer Park (DOE funded), Baytown, and Sutter
 - Air permits are in hand for Baytown and Deer Park

IRA support for CCUS in the power sector is timely: the power markets need firm capacity, and CCUS technology is ready for prime time - this decade can be the inflection point for the industry

Our perspective is informed by our national operations ...

National generation portfolio of approximately 26,000 MW with complementary services platform







Serve customers in 23 states, Canada and Mexico

Largest geothermal power producer in the world

More than 2,300 employees









24 hour trade desk and expertise in load management







Data management and call center services



... as well as our extensive CCUS efforts



Calpine differentiating factors: (1) national scope and scale, (2) prominence of cogeneration, which lends itself to industrial hub development, and (3) our competitive business model (no utility rate base – if we can make it work, broad deployment is possible)

California policy is supportive of CCS as part of the solution

California Reliability and Electrification Planning

- Both the SB100 Joint Agency Report (CPUC, CEC, and CARB) and the CPUC IRP PSP model found a need to retain gas-fired plants into the mid-century
- CARB's Scoping Plan projects a need to retain all existing gas-fired generation to meet demand through 2045

Recent Legislative Support for CCS

- <u>SB 905</u>: Established permitting pathway to foster development of CCS projects in California
- <u>AB 1279</u>: Established policy to achieve net-zero GHG emissions no later than 2045 and 85% reduction in anthropogenic GHG emissions by that date

CCS Now Part of Plan

- To achieve these targets, CARB Scoping Plan includes 16.7 million tons per year of existing fossil generation utilizing CCS by 2045 to achieve AB 1279's 85% reduction target
- CCUS needed not just for industrial applications, but gas-fired power generation

Significant Opportunity in Electricity and Industrial Sectors

- Stanford Study:
 - 76 facilities are suitable candidates for CCS retrofits
 - 60 mm tonnes per year

CCS is one of the only technologies that can enable firm, dispatchable, non-duration limited low-carbon generation to backstop the reliability of the grid

Calpine CCUS Pilot Projects

Los Medanos Energy Center to host two pilot CCUS projects





Enterprise Carbon Capture Pilot

CLEAN ENERGY

- With DOE funding, ION Clean Energy has developed a proprietary solvent and process that captures >90% of CO2 from power plant emissions at <\$50/ton (and declining)
- Calpine and ION, with DOE funding, are piloting an installation at Los Medanos that will be the first installation of a carbon capture facility at a natural gas combined cycle

Blue Planet. Carbon Utilization Pilot

- Innovative technology to mineralize captured CO2 to create light-weight building materials and other products
- Pilot project for ~5 tons/day to commence operations in 2022
- The Blue Planet pilot project can be scaled up after the pilot phase to capture and convert more CO2 with the intent of eventually reaching commercial scale
- Successfully tested lightweight concrete at a parking facility at SFO

Ion Clean Energy: https://ioncleanenergy.com/ Blue Planet: https://www.blueplanet-ltd.com/

ION Carbon Capture Pilot at Calpine's Los Medanos Energy Center



DOE funded carbon capture pilot at power plant in Pittsburg, CA







Update on Leading Projects: Significant Progress with Many Challenges Still Ahead

Project	Status
(DOE Funded w/ ION Clean Energy)	 Construction underway, equipment installation almost complete COD this summer
Delta (DOE Funded w/ ION Clean Energy)	 Critical Design Review complete HAZOP complete DOE FEED nearing completion
Deer Park (DOE Funded, Shell customer)	 Major Vendor Request for Quote (RFQ) packages submitted Constructability review complete DOE FEED nearing completion Air permit received
Sutter Energy Center (Public power customer)	 <i>Early FEED completed</i> Full FEED in progress CEC and air permit amendment review ongoing CO2 transport/storage FEED completed, and Class VI application filed
(Covestro customer)	 Technology comparison and selection complete Early FEED completed Full FEED in progress Air permit received

