

October 6, 2025

California Air Resources Board
1001 I Street, Sacramento, CA 95814

RE: Information Solicitation to Advise Implementation of the Carbon Capture, Removal, Utilization, and Storage Program: Senate Bill 905

Context and General Comments

The California Air Resources Board (CARB) continues to lead in implementing policy frameworks that support California's decarbonization goals. The SB 905 solicitation is a critical step toward integrating Carbon Capture, Utilization, and Storage (CCUS) technologies into the state's climate strategy. cKinetics appreciates the opportunity to contribute insights based on our data-driven analysis of environmental markets and decarbonization mechanisms.

The cCarbon division at cKinetics specializes in business intelligence, analytics, and forecasting for global environmental markets. Since 2012, we have covered the Western Climate Initiative (WCI) and now provide insights on global compliance and voluntary carbon markets (including carbon dioxide removals), sustainable fuels, and other environmental commodities. Our clients rely on our data tools and analyst-driven insights for strategic decisions around compliance, investment, and forecasting.

Regarding SB905, we are tracking technological developments on four fronts:

- A. Carbon Capture from point sources
- B. Carbon Capture Utilization (CCU)
- C. Carbon Dioxide Removal (CDR)
- D. Carbon Transportation and Storage

Carbon capture from point sources

This segment is maturing rather quickly. As per cCarbon research, the cost of capture has dropped to values between \$45 and \$80 per ton of CO₂ for point sources such as cement, ethanol production and natural gas power plants. Costs and logistics around carbon transportation and storage need to be addressed. The latter also tend to have a high compliance burden and lead times for implementation.

Coming reduction in the cost of carbon removal

In the last 5 years, over \$9.8 billion has been committed to the carbon removal sector, encompassing both engineered and nature-based solutions. This capital is a mix of equity, government grants, and a smaller portion of debt, reflecting an industry in its early stages where risk tolerance is higher and government support is critical for de-risking new technologies

We estimate that against the above investment, approximately 12 million tCO₂e of annual removal capacity has been created globally. Further, when we analyze this by removal segment, we get the data as outlined in the table below.

**Annual carbon removal capacity by type and capital efficiency estimated
(for incremental investments)**

	Annual sequestration (tCO₂e per year)	Efficiency of capital (\$ invested for every ton CO₂e per year of capacity)
Bioenergy with CCS (BECCS)	2,785,000	\$113
Biomass Carbon Removal and Storage (BiCRS)	477,253	\$513
Direct Air Capture	62,907	\$503
Enhanced Rock Weathering	100,000	
Soil Carbon	900,000	\$102
Af/ reforestation ¹	8,000,000	\$97

Source: cCarbon analysis presented at the Carbon Removal Investment Summit²

The above estimates are based on data gathered from actual investments and actual capacities. As scale is achieved and we get closer to the 100 MMT sequestration per year, **we expect the cost curve to start bending down³. Engineered solutions that are earlier in their evolution will see a more rapid fall in their costs.**

CDR can become an important part of compliance programs globally:

1. **As CDR costs decrease, they represent an upper bound for prices in emission trading programs.** So far, most emission trading schemes (ETS) have been able to meet their trajectories mainly by decarbonization of the power sector. That has happened more on account of renewables becoming cheaper than fossil. The ETS prices are gradually phasing out inefficient sources of fossil. Transportation, where covered, is meeting its objectives by having biogenic fuel and increasing use of EVs. All this has happened in the range of USD 30-80 / ton, depending on market.

As the cap reduces, hard-to-decarbonize sectors may find the shortage of (free) allowances and their increasing cost become a double whammy.

CDR solves that at two levels. First CDR options will represent an upper bound of around USD 150-200 / ton over the next decade. Second, their likely increasing volume will allow ETS programs to maintain their goals, if removals are incorporated in them.

2. CDR also represents new infrastructure creation that will also create more jobs. CDR projects that have multiple and bankable revenue streams will be the first to grow. In that category, we expect to see many more BECCS and ARR projects coming online in the next 5 years.

¹ We see an excess issuance of Af/ reforestation projects compared to land allocated. We expect some market correction.

² Publicly available data is at <https://removals-offsets.ccarbon.info/>

³ The compass reports on <https://removals-offsets.ccarbon.info/> list out some of these costs. Additional data can also be provided.

If 10 GT of CDR capacity is to be created globally by 2050 (which will only happen based on policy mandates), then cCarbon estimates an investment between USD 2 and 6 trillion over the period. The resultant carbon negative economy could generate an annual value between USD 1 and 5 trillion per annum by 2050, representing 0.5% to 2% of global GDP⁴.

Under SB 905, we anticipate seven types of activities will emerge:

Activity types	Impact on atmosphere
1. Carbon capture co-located with point emission sources.	None, till it is stored
2. Carbon dioxide removal (CDR) projects only.	None, till it is stored
3. Carbon dioxide removal (CDR) projects with sequestration	Removes emissions
4. Carbon utilization projects that result in long-term sequestration (example of using CO ₂ in concrete).	Removes emissions
5. Carbon utilization projects that replaces other CO ₂ sources (example of replacing CO ₂ usage in synthetic fuels)	Reduces emissions: lesser CO ₂ used in system as a whole
6. Carbon burial and storage projects.	Removes emissions
7. Carbon transportation projects: engaged in moving carbon from #1 and #2 above to different projects in #4, #5 and #6.	None. Transportation only.

- The importance of boundary definition cannot be overstated, to integrate these projects into the GHG inventory and programs run by the state.
- The permanence of storage also determines the way the removal gets accounted in the state's GHG inventory.

⁴ Refer [white paper](#) on "Investing in Carbon Dioxide Removals (CDR)- Opportunities, Challenges, Solutions and Lessons Learned While Building a Carbon Negative Economy"

Response to Selected Questions from the Information Solicitation

22. What role could projects developed under SB 905 play in these programs and are there other programs or policies in which carbon capture removal, storage, and utilization could play a role for compliance?

SB905 and California's Cap and Invest

Integrating the six activities into California's Cap and Invest can be done in the following ways:

Activity types	Incorporating into Cap and Invest
1. Carbon capture co-located with point emission sources.	None, till it is stored
2. Carbon dioxide removal (CDR) projects only.	None, till it is stored
3. Carbon dioxide removal (CDR) projects with sequestration	Creates emission reduction
4. Carbon utilization projects that result in long-term sequestration (example of using CO ₂ in concrete).	Creates emission reduction
5. Carbon utilization projects that replace other CO ₂ sources (example of replacing CO ₂ usage in synthetic fuels)	Extend entity boundary to include emission reduction reported annually.
6. Carbon burial and storage projects.	Creates emission reduction
7. Carbon transportation projects: engaged in moving carbon from #1 and #2 above to different projects in #4, #5 and #6.	None. Transportation only.

One important imperative from the point of view of impacting the Cap and Invest Program, is that the CCUS/ CDR plant or operator be recognized as entities which can generate emission reductions. Accordingly, the relevant accounting and reporting provisions may be instituted to enable proper treatment and verification of these emission adjustments.

CCUS/ CDR is not as widespread given high capital costs. Most projects also have long implementation periods (5+ year implementation timeline after a decision to break-ground has been taken). Most projects usually have a 20+ year planning horizon i.e. period for which they are expected to have a productive life for the upfront investment incurred. They are classic infrastructure projects.

Given the long gestation, there is an immediacy of the need to set up GHG reduction infrastructure, since all emission reduction trajectories modeled for California in the last [scoping plan](#) indicate a role for CCUS and CDR.

However, with subdued CCA allowance prices, and affordability concerns making it unlikely that upcoming C&I program amendments will have a very high carbon price which would compel entities to make CCUS investment; it is important to find ways to bridge the viability-gap and make it feasible for entities to scale up CCUS and CDR.

CCUS can play a role in mitigating emissions from sectors that have point-emission sources, have historically been (and will continue to be) difficult to decarbonize, such as oil, gas, refining

(OGR), cement, and natural gas processing. These industries are characterized by process-related emissions that cannot be easily eliminated through renewable energy substitution or efficiency improvements alone. These are also industries that are integral to the state's economy for the next 30 years.

CCUS offers a technologically viable pathway by capturing carbon dioxide directly from the point of production and either utilizing it in value-added applications or securely storing it underground. This enables these sectors to maintain production while substantially reducing their net greenhouse gas footprint.

Scaling CCUS projects can also help California's Cap-and-Invest system meet its long-term reduction targets by addressing residual emissions that other mitigation measures cannot offset. Without such technologies, the program risks drifting into a deep deficit as allowance supply tightens and compliance costs escalate. Incorporating CCUS ensures that large industrial emitters can achieve verifiable emission reductions and support market stability, thereby preserving the program's sanctity. By treating CCUS facilities as valid compliance-linked entities, California can both expand its decarbonization toolkit and prevent the market from being overly dependent on limited allowance supply.

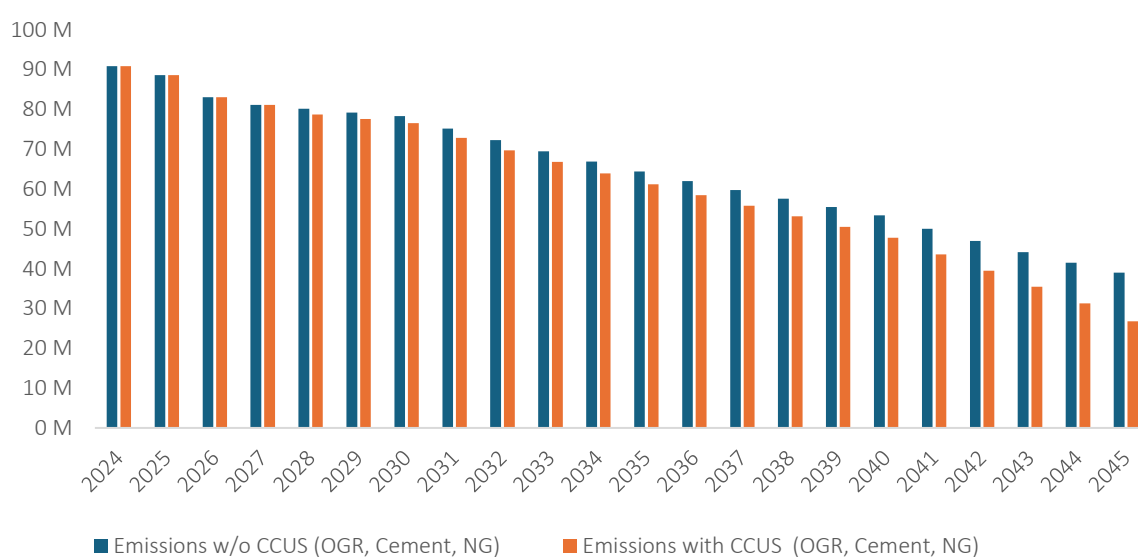


Figure 1: Baseline Emissions Forecast for OGR (Oil and Gas as well as Refinery sectors), Cement, Natural Gas (NG) with and without CCUS. Source: cCarbon Research

While CCUS facilities have long lead times to become operational, that is balanced by a durable abatement trajectory that can materially strengthen the Cap-and-Invest program's cumulative emission performance. As more capture units come online, the incremental gains aggregate, stabilizing the carbon market and reducing the likelihood of deep allowance deficits in later compliance periods. In our current BAU forecast, as shown in Figure 1, CCUS starts ramping up significantly only in the late 2030s.

However, this ramp up is unable to abate enough, and at a high enough rate, to prevent the program from going into a deficit. Cumulative CCUS abatement in our current BAU scenario is about 86 M (2027-45). However, the total emissions of the OGR, Cement and NG sectors in the same period are about 1.4 B tons of emissions. With current price dynamics, CCUS is only making an 86 million tons dent in the 1.4 billion tons of demand!

However, in a best-case scenario, where CCUS and CDR infrastructure gets built from 2027 onwards, there is much more abatement. This scenario takes out 500+ million tons out of the 1.4 billion tons of emissions in the OGR sector from 2027-45, easing the pressure on the bank of allowances for CCAs.

Accordingly, we conclude that CARB should consider (a) implementing relevant accounting provisions to integrate CCUS facilities, and (b) hasten incentives for CCUS deployment to ease pressure in the C&I market, and ensure that the market is balanced and in equilibrium.

SB905 and California's Low Carbon Fuel Standard (LCFS)

SB905 and LCFS can be combined to promote bio-energy with carbon capture and storage (BECCS).

The production of ethanol, coupled with carbon capture and storage, leads to a carbon negative cycle. That is to say that for every unit of ethanol produced, if the carbon emitted in the production process is buried, then the overall cycle will lead to carbon being removed from the atmosphere.

The ethanol can be used for blending or as a feedstock for other bio-based fuels.

While a majority of the pathways and ethanol plants registered under the LCFS are based out of the U.S. mid-west, there are existing ethanol plants in California. These plants have had active registered pathways under the LCFS in the past. There is a case to be made for fuels from plants that incorporate CCS to have negative CI scoring.

Figure 2, given below, shows a representative ethanol plant with a plant size of approximately 33.25 million gal/Yr⁵. This would mean, a raw material input of 205,860 MT/Yr enters the ethanol production process. The fermentation and combustion processes produce 95,434 MT/Yr of total CO₂ emissions (assuming 2.87 kg CO₂ released during the fermentation of each gallon of ethanol produced), representing approximately 46% of the feedstock mass. The carbon capture system successfully captures 80,780 MT/Yr of the available CO₂ (85% capture efficiency across all sources). The captured CO₂ undergoes pipeline transport with minimal losses, resulting in 78,356 MT/Yr being permanently stored in geological formations. The figure estimates these reductions, showing that over 38% of total CO₂ can be permanently stored while emissions

⁵ For detailed analysis refer the analyst note [Modeling The Economics Of Ethanol Production Coupled With Carbon Capture And Storage | Analyst Note | January 2024](#)

represent ~62% of the total carbon flow. A storage-to-emission ratio of 1:1.6 that validates negative CI potential. The biogenic nature of ethanol feedstock creates a significant carbon advantage, as the CO₂ originally captured from the atmosphere through photosynthesis can achieve net atmospheric removal when nearly 40% undergoes permanent geological storage.

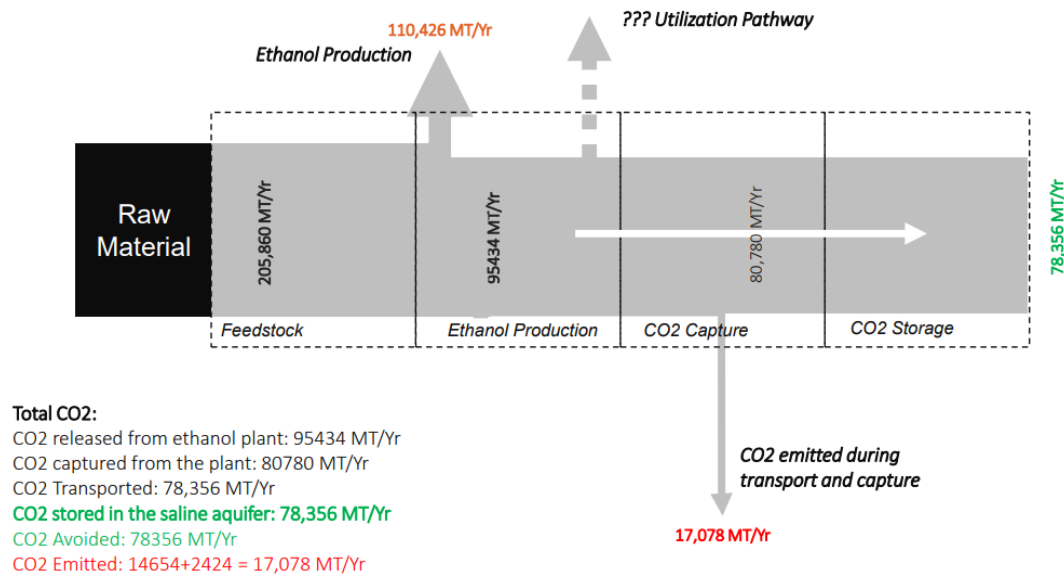


Figure 1: Illustrative mass balance of carbon in an ethanol processing facility with a 33 million gal/ year capacity (All figures above show mass of carbon equivalent)

With net CO₂ storage rates exceeding 97% of captured emissions, ethanol facilities with CCS could generate LCFS credits and incentives under SB905; and attract BECCS investments.

27. Are there examples of existing public CCUS project databases that we should look to and/or emulate for public reporting on project deployment?

Yes. cCarbon maintains a comprehensive, publicly accessible database that tracks global investments and offtake agreements in carbon dioxide removal (CDR) projects. This can be accessed here: <https://Removals-Offsets.cCarbon.info/>

This resource offers granular, up-to-date insights into project-level data and market activity across the CDR landscape. It includes registry issuances and retirements of CDR credits, enabling transparent tracking of deployment and credit lifecycle. The database is bifurcated by different CDR types including Direct Air Capture (DAC), BECCS (Bio-Energy with Carbon Capture and Storage), BiCRS (Biomass Carbon Removal and Storage), Marine Carbon Removal, Enhanced Rock Weathering and Mineralization along with Nature-based removal protocols.

In addition to the database, cCarbon has published a suite of market intelligence reports analyzing the state of the CDR sector and its various segments. These reports could serve as useful reference materials for public agencies exploring sector dynamics and deployment trends. Key publications include:

- White Paper on Investing in CDR: <https://www.ccarbon.info/insight/investing-in-carbon-dioxide-removals-cdr/>
- State of the Sector – Investment in Carbon Removals: <https://www.ccarbon.info/insight/carbon-dioxide-removal-series-state-of-the-sector-investment-in-carbon-removals-august-2025/>
- Market Compass – Direct Air Capture: <https://www.ccarbon.info/insight/direct-air-capture-market-compass-july-2025/>
- Market Compass – Bioenergy with Carbon Capture and Storage: <https://www.ccarbon.info/insight/carbon-dioxide-removal-series-bioenergy-with-carbon-capture-and-storage-market-compass-august-2025/>
- Market Compass – Biomass Carbon Removal and Storage: <https://www.ccarbon.info/insight/carbon-dioxide-removal-series-biomass-carbon-removal-and-storage-market-compass-august-2025/>
- Market Compass – Enhanced Weathering and Mineralization : <https://www.ccarbon.info/insight/carbon-dioxide-removal-series-enhanced-weathering-and-mineralization-market-compass-august-2025/>
- Market Compass – Marine Carbon Removal: <https://www.ccarbon.info/insight/carbon-dioxide-removal-series-marine-carbon-removal-market-compass-august-2025/>
- Market Compass – Afforestation, Reforestation, and Revegetation: <https://www.ccarbon.info/insight/carbon-dioxide-removal-series-afforestation-reforestation-and-revegetation-arr-market-compass-august-2025/>
- Market Compass – Soil Carbon Removal: <https://www.ccarbon.info/insight/carbon-dioxide-removal-series-soil-carbon-removal-market-compass-august-2025/>

Conclusion

cKinetics' cCarbon research team would be glad to provide additional research to support CARB's efforts to implement SB 905. It is imperative to integrate CCUS and CDR into existing compliance mechanisms along with new financial incentives modeled on proven frameworks.

We welcome continued engagement and are available to provide additional analysis or clarification as needed.

Sincerely,

Pawan Mehra
Managing Director