Response: Carbon Capture and Sequestration Concept Paper

May 25, 2017

On April 17th, 2017 California Air Resources Board released "Air Resources Board Carbon Capture and Sequestration Program Concept Paper" and followed-up with May 8th workshop. The Concept Paper's purpose is to layout the current vision of a Quantitative Method (QM) and permanence protocol for Low Carbon Fuel Standard (LCFS) and Cap-and-Trade for Carbon Capture and Sequestration (CCS). ARB has consistently stated the need for the inclusion of CCS in both LCFS and Cap-and-Trade to meet the states greenhouse gas (GHG) reduction goals.

ARB's accompanying background document lists sources of anthropogenic CO2 as "coal and natural gas power plants, ethanol plants, cement plants, refineries, and iron and steel plants." Most of these entities are regulated under California Cap–and–Trade program. It is Ethanol that stands out from this list for two reasons. First, California's in state demand of over 1.5 billion gallons of ethanol dwarfs California's in state production of less than 400 million gallons – thus nearly 75% of ethanol consumed by California is imported into the state either from foreign countries or from other states (this assumes that all instate California ethanol facilities are running at full rates and only serving California). The current domestic production capacity of ethanol is slightly over 15 billion gallons per year and is above current domestic demand needs; that means that few if any new plants will be built until domestic demand improves and the status quo of imports into California for the foreseeable future. Second, as over half the credits currently generated under the LCFS are generated by Ethanol that means the majority of the credits from ethanol needed for obligated parties to meet their targets are coming from out of state.

Specifically speaking of the LCFS, the scope of the program covers all transportation fuels in the state. CARBOB the de facto transportation fuel is made from refined oil and has among the highest CI ratings of the fuels covered by LCFS. Ethanol makes up approximately 10% of the transportation fuel by default as it is often blended into CARBOB to serve as an oxygenate and an octane booster, while serving to diminish the amount of petroleum needed in transportation fuels. Since CARBOB and by extension, through GHG life cycle analysis, oil is covered under LCFS and ethanol is covered under LCFS both could be the recipient of lower CI scores through CO2 enhance oil recovery. This, however, is not how the concept paper has designed the "project system boundary" for the Quantitative Method (QM). It states the following:

> *"Under the LCFS, staff plans to draw a system boundary that includes the substantial sources of emissions for CCS projects, essentially capture, compression, transport, and injection of CO2. Staff is considering a project system boundary that begins with generation and capture of CO2. Emissions upstream of CO2 generation would be assigned to the primary product causing those emissions. The project system boundary would end with injection operations. In the case of CO2 enhanced oil recovery (CO2-EOR) emissions associated with oil production would be considered part of the system boundary and be included in the accounting, for example by allocating in some proportion between oil production and CO2 capture. However combustion would not be included, since oil is a primary product and its combustion emissions would be accounted for separately to the extent it is used in California. CO2 that is recovered from produced oil and re-injected, transferred to another field, or emitted will be accounted for in the QM. Our current thinking is that CO2 transferred to another field would be considered emitted. Covered GHGs under the LCFS include CO2, N2O, CH4, CO, and VOCs; again, only CO2 will be considered for adjusted CI or credit."*

CARB has recognized the need, in its background paper, to use CO2 EOR as a stepping stone to broaden the knowledge base for engineering required to create pure sequestration projects and it also has recognized the need to utilized CCS projects to meet GHG reduction targets. The current design proposed for project system boundaries will fail to incentivize actions that will meet these stated goals. The passage above, taken from the concept paper, needs to consider the source of anthropogenic CO2 when calculating lifecycle emissions. Ethanol production facilities as referenced by the background paper released by CARB is one of the "'low hanging fruit'" for CO2 capture because of its relative purity compared to other sources. The domestic ethanol industry overall produces over 42 million metric tons of CO2 as a by-product of fermentation annually. Few ethanol plants currently capture CO2 for geological storage and the majority of the industries' fermentation CO2 is emitted. Therefore, it is vital that CARB incentivize behavior from these facilities that would result in geological storage of CO2. In order to accomplish this, CARB should consider project boundaries that would allow for credits back to the ethanol plant or allow for splitting the credit between the ethanol producer and the oil producer. The reason for this is pragmatic. Over 600 million barrels of oil are consumed by the state of California

annually, however less than 1/3rd of the barrels are from California oil fields. In addition, CO2 EOR suitable fields are in much smaller supply inside the state of California as in comparison to states like Kansas, New Mexico, Oklahoma and Texas. (See Figure 1) Oil from these EOR states make up less than 1% of Oil imported into the state. If these import ratios hold, true credit generation from innovative crude will be relatively small because instate production is limited and large quantities of oil are imported from foreign suppliers. Low carbon intensity ethanol on the other hand has a much greater opportunity to be supplied to California given its smaller volumes of imports into the state compared to oil and domestic ethanol's' proximity to EOR fields.

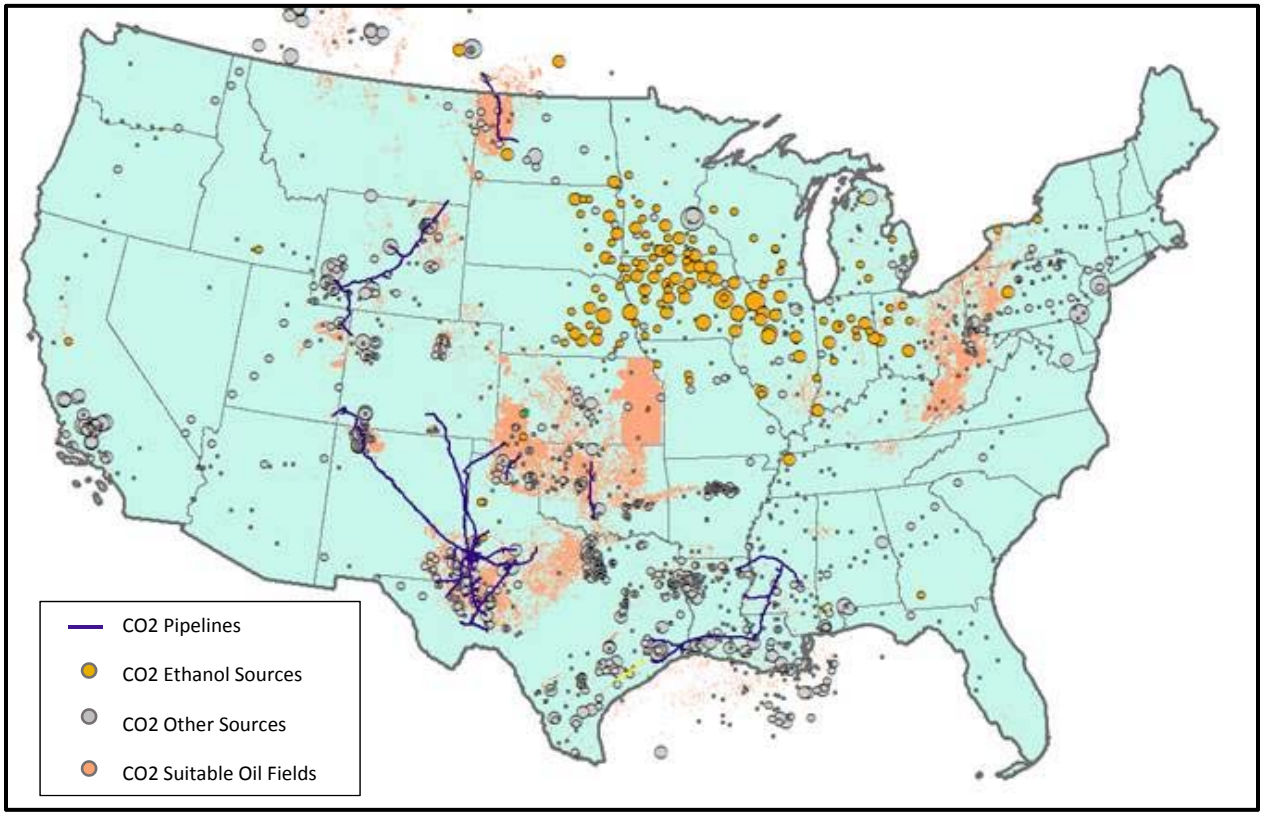

Figure 1 Map of CO2 sources against EOR suitable locations

For an ethanol producer delivering CO2 to an EOR company it is proposed that CO2 captured and sent across the blower to the compression facility be considered captured and sequestered for the purpose of the Quantitative Method (QM). Process compression energy and transport to the field and downhole of CO2 from the ethanol facility should count against the CI score of the barrel of oil produced. Both parties under the LCFS could have pathways filed with the agency and be reporting volumes imported into the state. As previously stated most EOR project physical barrels of oil will not be imported into California because of logistical hurdles and while ethanol logistics into the state can be physically defined and measured due to railcar transport from producers. Since both entities would have pathways into the state and both would be required to report import volumes there would be no risk of double counting CO2 credits from captured CO2 going into EOR. (See Figure 2, Figure 3) This would draw a system boundary around compression down to oil delivered into California for pathway construction and thereby increase CI scores for the Oil produced but maintain the overall GHG reduction for the two fuels combined. (See Figure 4) This pragmatic approach incentivizes the displacement of CO2 from natural sources with anthropogenic sources that would otherwise be emitted.

The EOR industry currently has billions of dollars invested into projects producing millions of barrels of crude. These projects will continue to run and produce oil with little regard for the source of the CO2 if there is no incentive to capture and use anthropogenic sources. The primary reason incentives are needed is because manmade sources of CO2 are often less reliable than a natural source due to economic conditions. Chemical plants, ethanol plants and other manmade CO2 sources are dependent on economics to continue operations. Often time, these economics are far removed from that of the oil producer.

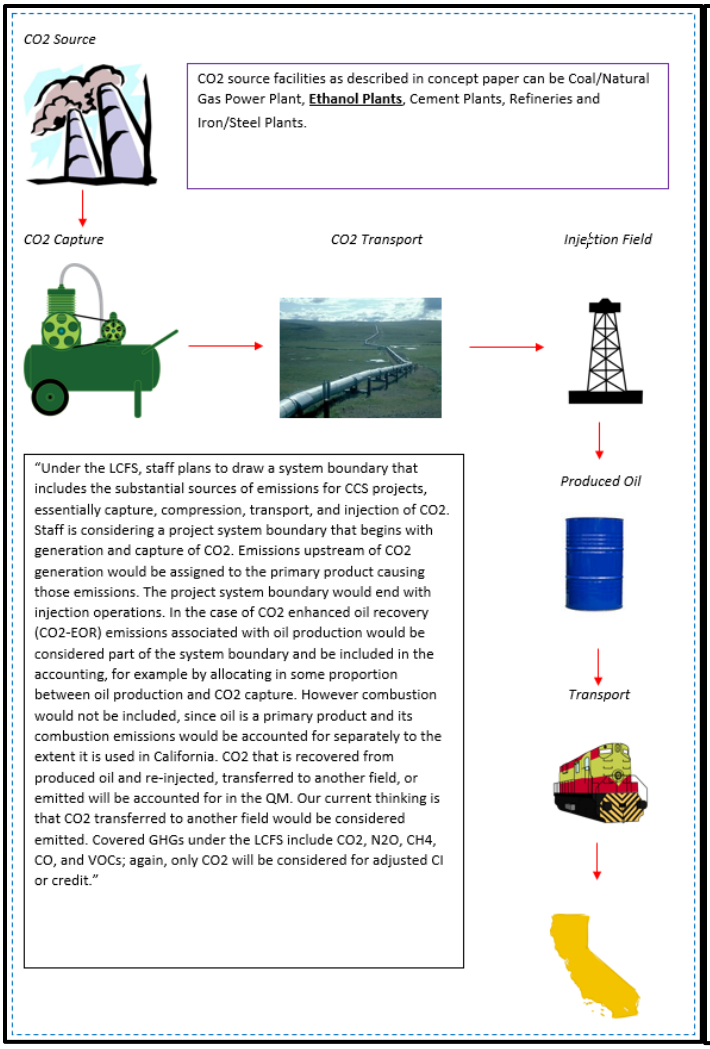

Figure 2 Innovative Crude Pathway as Laid out in CCS Concept Paper

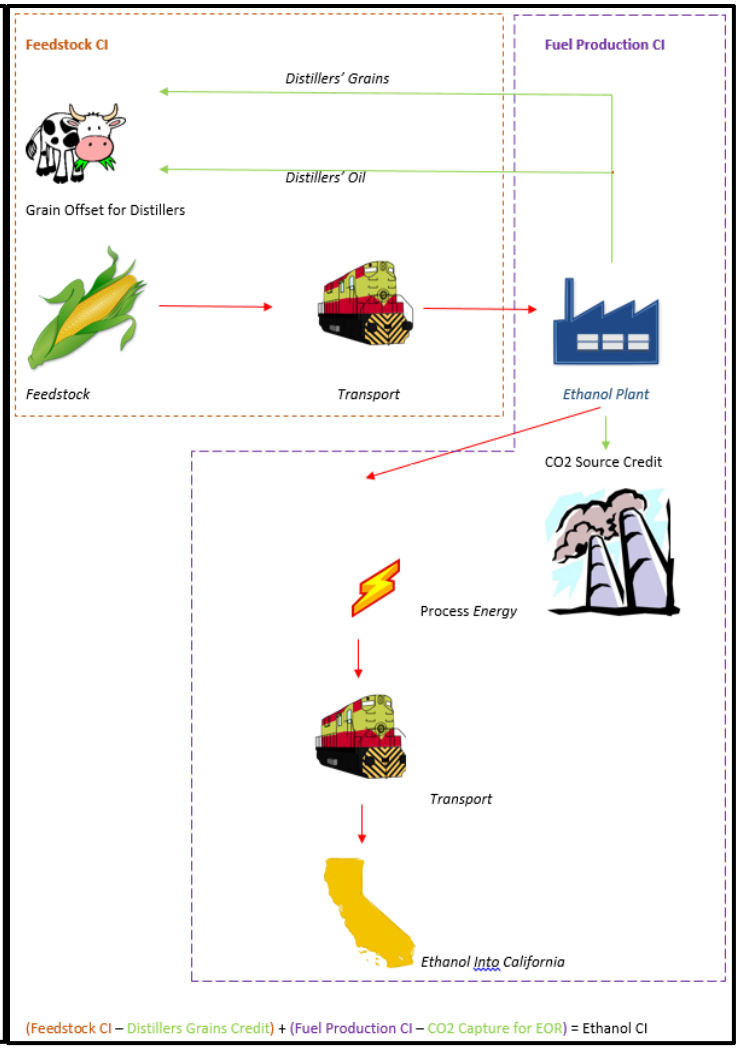

Figure 3 Proposed Ethanol Pathway moving CO2 credit to Ethanol

A secondary point of concern within system boundary proposal stems from staff's current thinking that CO2 transferred from one field to another should be considered emitted. This assumption is overstating the impact of such activities in the EOR sector. CO2 will be produced from oil production wells as a course of business for the oil producer. This CO2 must be separated from the hydrocarbons so that the hydrocarbons can be sold. The separated CO2 is reinjected. Recycle can dramatically reduce the cost of operations of the field. Staff has already acknowledged that CO2 injection into EOR will result in "incidental storage" and therefore a mass balance can be calculated for the CO2 from recycle versus CO2 from new purchases. As any volumes that may be recycled and sent to another field would still be captured and injected into that field, it is not emitted into the atmosphere and continues to function as a GHG reduction. Staff has also acknowledged in its concept paper and background paper that no significant leakage of CO2 has ever been detected in the 40 years of EOR operations. This is because any leakage would also mean loss of oil, since a primary goal of the oil producer is to protect its reserves; it is unlikely that any producer operating in the EOR space would inject into a formation that would result in a form of significant leakage. Staff should take into consideration that the primary goal of the producer naturally guards against emissions of CO2.

Another consideration for staff that is implied, is that the transportation pipelines currently in use to CO2 EOR are in itself a form of storage. The capacity of these pipeline is mostly utilized by natural source CO2 because the reliability of anthropogenic CO2 in the quantities necessary are not up to the levels required. That means that the pipelines are filled with co-mingled CO2 from both manmade and natural sources and chemically indistinguishable. Staff should take action to make the mix of these volumes favor anthropogenic sources over natural ones.

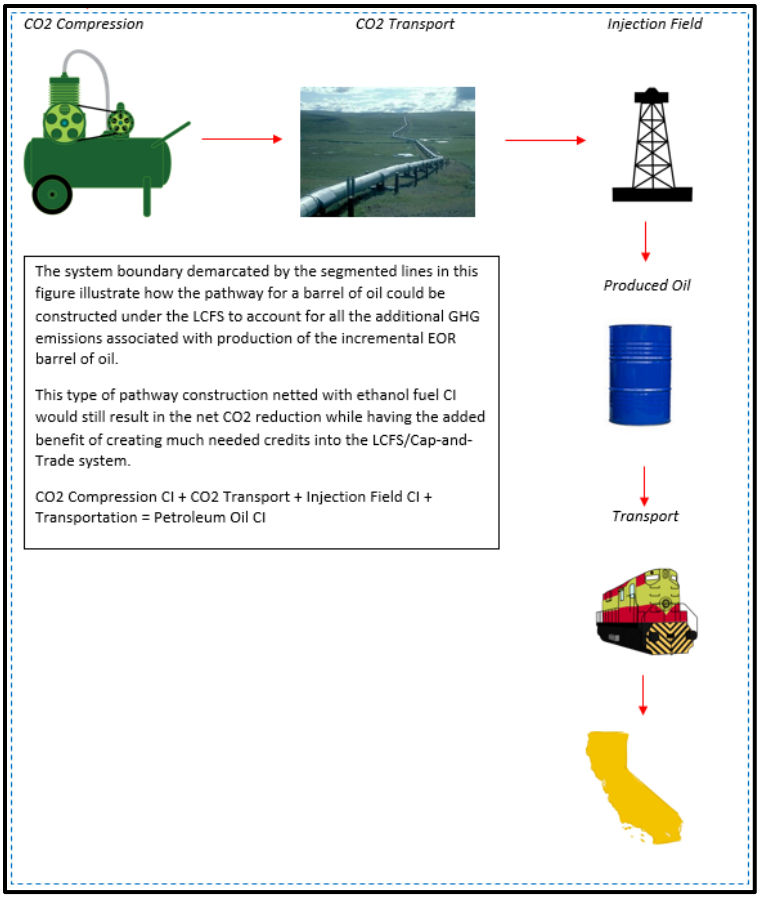

Figure 4 Crude Pathway removing credit for CO2 Capture while associating process energy

Under the Permanence Protocol, staff has expounded design principles that could be a disincentive to furthering anthropogenic CO2 utilization in EOR fields. The following requirement is likely to be a major roadblock for most EOR projects.

> *"Similar to the QM concept, the permanence protocol would include different provisions based on whether the project is utilizing CO2-EOR as the sequestration reservoir versus injecting into depleted oil and gas reservoirs or saline reservoirs. Again, a risk-based site analysis as well as most post-injection requirements for depleted oil and gas reservoirs or saline reservoirs would likely be similar. In addition, depleted oil and gas reservoirs would not be able to be put back into production; and CO2-EOR fields would not be able to be put back into production post-closure."*

Staff must make clear what the term "depleted" means in this passage. CO2 EOR projects exist because wells that had been depleted of primary oil through traditional means were reopened when new technology came into play that made recovery of additional barrels possible and economical. As stated by many of the source documents that are reference by staff, estimates of original oil in place after CO2 EOR operations have ceased can be as much as 50% of the original oil. If staff were to attempt to force a permanent closure of the field after CO2 EOR they effectively trap those barrels permanently. Technology in oil recovery continues to evolve and grow and future technology could cause these fields to become viable again for production. Without the ability to re-access these wells or sell the mineral rights of the proven unrecoverable barrels (because the field is permanently closed by ARB) oil producers will be hesitant to participate in the program.

It is also necessary for staff to determine appropriate monitoring time-frames for post injection periods of a project field. The cost of continued monitoring after the field ceases operations could become detrimental to projects as EOR companies must take those additional cost into account when planning the economics of the proposed EOR play.

Staff could propose or champion certain techniques in plugging wells that would result in sufficient assurance that CO2 will remain in the formation and thereby lesson the timeframes needed for monitoring.

ARB's GHG reduction goals into 2030 is both commendable and ambitious. CCS is an invaluable tool that should be utilized to effectively meet these goals. Staff must continue to create a program that is both robust enough to be applicable in changing economic environments, as well as, one that promotes accountability.