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**Re: Comments on Air Resources Board Public Workshop on Potential Regulation Amendments to the Low Carbon Fuel Standard (October 14-15, 2020)**

Dear Rajinder,

Thank you for the opportunity to comment on the recent workshop on potential regulation amendments to the Low Carbon Fuel Standard (LCFS) of October 14-15, 2020. The undersigned represent a large and diverse array of energy producers, researchers, analysts, environmental NGOs, labor unions and power producers. We have a common interest in promoting solutions that can help California attain its mid-century climate goals. In this context, we offer comments below on considerations for Carbon Capture & Sequestration (CCS) under the LCFS as requested by staff.

**1. CCS as part of Innovative Crude projects**

Staff has requested comment on the following proposed revision to the Innovative Crude eligibility provisions from:

*“Carbon capture must take place onsite at the crude oil production and transport facilities”.*

to:

*Considering revising eligibility to state “Carbon capture must take place on equipment supplying steam, heat, or electricity (behind the meter) to crude oil production or transport facilities. The credit will be prorated based on the fraction of steam, heat, or electricity supplied to the crude oil production or transport facilities. Projects using CCS are subject to the provisions of section 95490.”*

The proposed revision does appear to provide some clarity in terms of specifying the location of the capture facility, and listing examples of the type of equipment that capture can be used on. The proposed revision allows for facilities that provide the crude production with energy and material inputs (steam, heat or electricity) that affect the carbon intensity of crude production to be located outside the strict legal boundary of the crude oil production and transport facilities. Thus, a plant that supplies such inputs behind the meter but is located adjacent to, but outside of, an oilfield’s legal fenceline, would rightly be eligible for credits.

However, the proposed revision does not allow for indirect accounting for material or energy inputs, and the ideal location for CCS may be other than that of the crude production and transport facilities. We fully appreciate that a rudimentary indirect accounting framework may create the possibility of resource shuffling, double counting, or risk not being additional, or raise eligibility questions for purchasing non-CCS power that is also not behind the meter at oil fields, but we believe that such issues can be resolved on a project-by-project basis, and we stand ready to discuss them with staff and devise a framework that is robust and credible.

In addition, the prorating credits (as proposed) to the fraction of steam, heat, or electricity supplied to the crude oil production or transport facilities creates a significant disincentive to facilities that would be eligible under this Innovative Crude provision for a number of reasons:

- Installing carbon capture at a gas-fired power plant or combined heat and power plant makes economic sense at capture levels that approach 100% of the total CO<sub>2</sub> emissions. Installing partial capture (equal to the portion that is supplied to the crude operations) may require less capital, but it wastes an opportunity for economies of scale, and condemns that facility to higher emissions and to supplying higher carbon products to “the grid”. Today’s carbon capture systems are not modular and, once fitted, a plant will operate at the lower capture rate for the remainder of its lifetime. The storage infrastructure such as transport and geologic storage sites can also be more economically utilized if CO<sub>2</sub> capture from each emitting source was maximized.
- Conversely, if CARB’s interpretation of the current regulation as it applies to a plant that supplies both an oil field and “the grid” is to assume that the overall facility CO<sub>2</sub> capture percentage is also the same as for the portion that supplies the oil field (e.g. for a power plant that captures 50% of its total CO<sub>2</sub> and supplies 50% of its power to an oil field behind the meter and 50% to the grid, the carbon intensity would be considered half that of the plant without CCS, as opposed to 100% carbon free for the portion that is supplied to the oil field and fully carbon emitting for the portion that supplies the grid), then this is an even larger disincentive, as it mandates full capture on the entire facility but only funds a portion of it through LCFS credit eligibility.
- The portion of the plant’s output that supplies “the grid” and not the crude facility may be regarded as outside the jurisdiction of the LCFS from a strict accounting standpoint. However, the Cap-and-Trade program, under which the plant would most likely have a compliance obligation for the emissions that correspond to its “grid” output, currently does not allow for CCS as a compliance mechanism. Nor does the Mandatory Greenhouse Gas Reporting Regulation (MRR) recognize CCS.<sup>1</sup> It should also be noted that grid electricity is in the scope of LCFS’s CA-GREET 3.0 model and a decarbonization of the overall grid will have a direct impact on the Carbon Intensity scores of all facilities utilizing grid power.

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<sup>1</sup> See relevant letter to the California Air Resources Board [here](#); and further analysis in a recent report by the Energy Futures Initiative and Stanford University [here](#).

A set of requirements that either drives partial CO<sub>2</sub> capture preferentially over full capture, or mandates full capture but only gives partial credit for its installation, does not serve California's ambitious decarbonization goals under SB32 and Executive Order B-55-18, its sectoral goals under SB100 to decarbonize its electricity grid while providing for firm or dispatchable capacity, or in fact the objective of the LCFS to reduce the carbon intensity of its transportation fuels.

The following modifications to the LCFS regulation could rectify this independently of amending the Cap-and-Trade regulation and MRR to incorporate CCS:

- Allowing a gas-fired plant that implements CCS and supplies electricity to a crude facility behind the meter to tie the remainder of its output that is supplied to the grid contractually to another crude production facility with Innovative Crude eligibility. This would be analogous to the book-and-claim mechanism that is currently allowed under the LCFS for electricity that supplies charging stations or electrolytic production that provides hydrogen for transportation uses.

or

- Allowing any gas-fired plant on California's electricity grid to implement CCS and use a similar book-and-claim arrangement with crude production facilities inside the State and be eligible for Innovative Crude credits. We estimate that oil production facilities in the State consume on the order of 1200MW of electricity, which is equivalent to approximately 3 million tons of CO<sub>2</sub> annually.

We feel that incorporating these items would be beneficial to initiating CCS projects that reduce the carbon intensity of California's fuels while supporting a resilient and reliable grid by supplying firm and dispatchable zero-carbon electricity while renewable generation is being scaled up even further.

This issue applies to the Refinery Investment Credit provisions as well, and solutions to address this issue for the Innovative Crude Pathway should be considered for adoption elsewhere in the LCFS as similar challenges are identified. CARB should therefore revisit similar requirements and their effects under the Refinery Investment Credit provisions, and also for Tier 2 pathways, with the overarching theme being to allow for capture installation to be economically feasible in the first place and also to maximize the possible CO<sub>2</sub> reductions at the facility in question.

## **2. Miscellaneous Innovative Crude changes**

The Air Resources Board is considering requiring "the innovative crude credit to be prorated in those oil fields that produce both oil and gas for export", and has solicited comments on this proposed change.

If the Board implements this requirement, we presume it will be based on production only from the zone subject to enhanced oil recovery by injection of CO<sub>2</sub> rather than based on production from the entire field in which this activity occurs. The ratio of gas to oil from a field producing from more than

one zone is different than the ratio from any zone individually, however. We further presume the proration will be based on the relative energy content of the oil and gas produced from the zone into which CO<sub>2</sub> is injected. We raise these concerns because the Board's approach to carbon intensity is field-based even though the carbon intensity of oil produced from different zones in the same field can vary substantially.

### **3. Executive Order N-79-20 and Implications for the CCS in the LCFS**

Staff solicited comments on the implications of the ZEV Executive Order on CCS and project eligibility.

In September 2020, Governor Newsom signed Executive Order (EO) N-79-20 stating that "It shall be a goal of the State that 100 percent of in-state sales of new passenger cars and trucks will be zero-emission by 2035. It shall be a further goal of the State that 100 percent of medium-and heavy-duty vehicles in the State be zero-emission by 2045 for all operations where feasible and by 2035 for drayage trucks."

The Governor's order directs the Air Resources Board to develop and propose regulations in pursuit of these goals. The order also directs the Governor's Office of Business and Economic Development, in consultation with a number of State agencies, including the Air Resources Board, and the private sector to develop a Zero-Emissions Vehicle Market Development Strategy by January 31, 2021 (to be updated every three years thereafter).

The order further directs the California Environmental Protection Agency and the California Natural Resources Agency, in consultation with other State, local and federal agencies, to expedite regulatory processes to repurpose and transition upstream and downstream oil production facilities, while supporting community participation, labor standards, and protection of public health, safety and the environment.

Finally, in reference to the LCFS or its stated objectives and targets, the order directs the Air Resources Board, in consultation with other State agencies, to develop and propose strategies to continue the State's current efforts to reduce the carbon intensity of fuels beyond 2030 with consideration of the full life cycle of carbon. We see CCS as consistent with, and important to, this goal.

#### *Fossil-fueled vehicles will remain on the road past 2035*

The Governor's order is aimed at reducing emissions from one of the largest and toughest-to-decarbonize contributors in the State: the transportation sector. The number of fossil-fueled vehicles on California roads presents a challenge to achieving this goal. However, even under the provisions of the EO, there will be a yet unknown transition period before all vehicles are free of emissions.

The EO does not prevent Californians from owning and operating passenger vehicles and trucks that run on gasoline or diesel after 2035. According to the Alliance of Automobile Manufacturers, the average California passenger car has a lifetime of over 11 years, and the California Department of Motor Vehicles

reported about 26 million registered automobiles in the State in 2019. If this ownership trend continues, conventional vehicles will remain on the road well through mid-century, and after California's 2045 carbon neutrality milestone. In addition, the carbon footprint of both electric and fuel-cell vehicles depends directly on the carbon intensity of the electricity used to charge them or produce their fuels.

To that effect, the EO explicitly recognizes the need to "continue the State's current efforts to reduce the carbon intensity of fuels beyond 2030 with consideration of the full life cycle of carbon". We view this as a direct endorsement of the LCFS or its stated objectives and targets, as well as the need to intensify the State's efforts to lower the carbon intensity of both its fossil transportation fuels and its electricity beyond 2030, and note that CCS can materially contribute to both of these objectives.

*CCS can lower the carbon intensity of both transportation fuels and electricity*

The LCFS' Innovative Crude, Refinery Investment Credit and Tier 2 pathway provisions where CCS is now eligible as of 2019 are instrumental to lowering the carbon intensity of the State's fossil transportation fuels, and are also the most important policy support mechanism for CCS deployment in the fuels sector. We are aware of five projects that are currently under development as a direct result of the LCFS and, in some cases, the federal 45Q CCS tax credit.

CCS, with its ability to capture virtually the entirety of the CO<sub>2</sub> from large point sources that are part of these fuels' production and transportation lifecycle can make a significant contribution to the lowering of their carbon intensity. We see both the technology and its eligibility under the LCFS as entirely consistent with EO N-79-20.

In addition, electricity production combined with carbon capture and sequestration provides a way to further reduce electric and fuel-cell vehicles' carbon footprint by providing electricity with a carbon footprint that ranges from very low to net-negative for direct use or for electrolytic or other conversion to low-carbon or carbon-free transportation fuels such as hydrogen. As has already been documented in the context of SB100, maintaining a small number of firm, dispatchable, zero-carbon generation assets on the grid can help meet the State's electricity decarbonization goals at much lower cost while maintaining grid resilience and stability.<sup>2</sup>

As such, we strongly support continued eligibility of CCS under the LCFS, and view it as entirely consistent with EO N-79-20.

#### **4. Eligibility conditions for Direct Air Capture projects**

Staff has solicited comments on the "[n]eed for additional eligibility conditions for DAC projects (location)." Direct air capture (DAC) is widely recognized as an important component to any effort to address greenhouse gas emissions that have already contributed to historically high atmospheric CO<sub>2</sub>

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<sup>2</sup> See E3, "Long-Run Resource Adequacy under Deep Decarbonization Pathways for California", 2019, available [here](#).

concentrations.<sup>3</sup> A recent report ‘Getting to Neutral’ by Lawrence Livermore National Laboratory and partners<sup>4</sup> identified the essential role of DAC technologies in meeting California’s carbon neutrality goal by 2045, as set forth by Executive Order B-55-18. Leadership shown by California in bringing DAC into the LCFS has significantly boosted the prospects of DAC transitioning from a nascent to commercially-ready technology at scale. This not only serves the State’s purposes, but will also have the important benefit of making the technology available for use by other jurisdictions. Staff has solicited comments on the location of DAC plants and their participation within the LCFS.

*The need for DAC is stronger than ever but no projects have yet come online as a result of its inclusion in the program 2018*

When DAC was allowed to generate credits under the LCFS in the 2018 amendments, stakeholders in the field of carbon dioxide removal rightly praised CARB for its vision. CARB also rightly identified that the atmosphere is agnostic as to where the CO<sub>2</sub> is removed from, and opened eligibility under the LCFS to DAC plants located anywhere in the world.

Despite keen interest and ongoing efforts to deploy DAC projects under the LCFS though, their costs remain high, siting and financing poses special challenges (see below), and both the local and global need to deploy DAC are now stronger than in 2018. At this point therefore, we do not see any likelihood for DAC to generate excessive credits that would destabilize the LCFS market or compromise the ability of other technologies and pathways to benefit from the program, and continue to support worldwide DAC eligibility.

In fact, California’s decision will also serve to reduce the cost of DAC through technological learning. The Rhodium Group has estimated that, for the U.S. to reach net-zero emissions by 2045, between 560 and 1,850 million metric tons of CO<sub>2</sub> will need to be removed by DAC.<sup>5</sup> LLNL et al. estimated that a cumulative DAC capacity of approximately 15 million metric tons of CO<sub>2</sub> annually would need to be deployed to bring DAC costs to just below the \$200/ton CO<sub>2</sub> mark (which is representative of recent LCFS credit prices), and that the State would need at least 17 million tons of CO<sub>2</sub> removal through DAC annually by 2045 - and potentially a lot more, depending on progress on other carbon removal pathways - to meet its 2045 carbon neutrality goal.

For this technological learning to happen, continued support under the LCFS is critical.

*DAC still faces unique deployment, financing and scale-up challenges*

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<sup>3</sup> NOAA reports that the global average atmospheric carbon dioxide in 2019 was 409.8 parts per million, with a range of uncertainty of plus or minus 0.1 ppm. Carbon dioxide levels in 2019 were higher than at any point in at least the past 800,000 years. Between 2009-18, the growth rate in the concentration of CO<sub>2</sub> in the atmosphere has been 2.3 ppm per year.

<sup>4</sup> LLNL et al., “Getting to Neutral”, 2020. Available [here](#).

<sup>5</sup> Rhodium Group, “Capturing Leadership - Policies for the US to Advance Direct Air Capture Technology”, May 2019. Available [here](#).

Direct air capture technology has now been developed by a handful of leading players and is available commercially. But, to date, the largest operating DAC facilities are at the ~1000 tons CO<sub>2</sub>/yr scale, and a leap to the million-ton scale is needed to sufficiently demonstrate the technology in commercial markets to draw in private capital broadly.

Direct air capture facilities, like point-source carbon capture projects, are capital-intensive energy projects with long lead times. In order to successfully secure equity and debt to see the project through the engineering, construction, and commissioning phases, investors require a high degree of financial security. Unlike some other types of CCS project, the *primary* source of revenue for DAC facilities today rests on the generation and sale of LCFS credits. Therefore, for “Generation 1” DAC technology - that developed and available by Carbon Engineering, ClimeWorks and Global Thermostat - to successfully reach commercial markets, investors must have full confidence in its security within the LCFS program.

Maintaining the LCFS driver in place is therefore critical for DAC’s in-State and global success alike. And the LCFS by itself as it stands today may still not be enough.

*Locational flexibility is critical to DAC success*

Depending on the DAC technology in question, it is significantly more economical to deploy in locations that provide access to either zero-carbon energy resources, renewable electricity, or both. In addition, in order to sequester the captured carbon according to CARB’s CCS Protocol, proximity to excellent geologic storage sites is necessary.

For example, locations near California’s geothermal resources and within reach of Central Valley storage formations, as well as sites in rural West Texas that have operating geologic sequestration sites and access to low-cost zero-carbon and renewable energy make for favorable DAC sites. Given the need to scale up DAC and the current challenges faced by the technology, it is paramount that the odds be stacked in favor of its success, and the locational flexibility that CARB has allowed to date is extremely important. Restricting DAC project location to California only, for example, may risk delaying DAC technology commercialization and forcing the State to pay a higher cost for CO<sub>2</sub> removal as it approaches the 2045 milestone for carbon neutrality.

It is expected that at some point other jurisdictions will follow California’s climate leadership and policy advancements, that other markets will evolve to include DAC similarly to the California LCFS. Such discussions are under way in New York, Washington, British Columbia, and Ottawa about carbon intensity fuel regulations and their inclusion of carbon capture and DAC. But until concrete action is taken elsewhere and there are multiple markets that can support commercial DAC facilities, California’s LCFS is of critical importance.

Lastly, DAC projects require large quantities of electricity, which must come from clean sources if they are not to affect the net carbon intensity - and thus LCFS credit generation - of the facility. Due to both the large power demand and the large physical size of DAC facilities, it may not always prove possible to co-locate a DAC facility and a corresponding renewable electricity facility side-by-side and “behind the

meter”. We encourage CARB to continue to evaluate rules that ensure that DAC facilities are sourcing clean, additional renewable electricity but to explore other methods of assurance in addition to a “behind the meter” requirement.

## **5. Amending the CCS Protocol**

Staff has solicited feedback on areas for additional clarity and potential modifications to the CCS Protocol. Since becoming effective in 2019, the Protocol has already generated significant interest from the project developer and lender community both inside and outside of California, though no projects have yet been certified under the program and several implementation challenges are cited repeatedly. We believe that a small number of technically sound improvements to the Protocol would both enhance the environmental integrity of the program and facilitate additional credit generation potential.

Given the short timeframe for California to achieve its low carbon objectives and the lengthy time horizons for planning, permitting and implementing CCS projects, we encourage CARB to include CCS protocol revisions in its planned LCFS rulemakings as soon as possible or to explore other avenues for amendment, or clarification through guidance. Timely changes to the Protocol would avoid limiting the potential for CCS to contribute to a lower carbon future for California in the long term.

Over the past several months, we have identified a range of topics within the CCS protocol that would be worth revising, and stand ready to communicate the details of these to staff. High priority topics include:

### *Third party review*

The Protocol requires third-party review of both plans and as-built projects, which is essential for quality control and public trust. However, some of the details of the third-party review program around eligibility and competencies have created difficulties in assembling independent teams with appropriate expertise. In particular, requiring a professional geologist and engineer to certify legal and financial aspects of a project goes against those professionals’ ethical code of conduct and is clearly outside their area of expertise. Adjustments could be made to the requirements for third-party reviewers so that their competencies more closely match Protocol requirements and need for credibility and transparency.

### *Prohibition of penetration into the storage complex*

The Protocol prohibits penetrations of other wellbores into the storage complex, but that situation is often legally impossible to enforce because of property law. California and most, if not all, oil and gas producing states have rules and regulations designed to ensure that penetrations are effectively controlled at all times, all usable-quality water zones are isolated and sealed off to effectively prevent contamination or harm, and all formations, potential flow zones, and zones with corrosive formation fluids are isolated and sealed off to prevent vertical migration of fluids, including gases. This protects the integrity of the storage complex including the confining layers. In some cases, a storage complex may have multiple confining layers providing redundant protection against the release of stored CO<sub>2</sub> from a project. The Protocol could be revised to accommodate this eventuality in a safe and protective manner



that does not compromise the storage complex and confining layer or layers or increase the risk of CO<sub>2</sub> leakage.

#### *Post-injection obligations*

The Protocol requires operators to monitor the sequestration site for one hundred years with methods that may not adequately demonstrate storage security or permanence. This requirement could be modified to allow more definitive demonstration of secure geologic storage in less time, enhancing environmental integrity while reducing ongoing obligations on project developers that do not contribute to reducing risk.

#### *Buffer account contributions*

The Protocol requires an 8-17% contribution of credits into a buffer account to protect against CO<sub>2</sub> leakage, but based on the information in the previous rulemaking it is not clear how the various portions of this contribution were scientifically supported or how they are tied to project risk or the risk of leakage. Additionally, there are also much more economically efficient means to protect against CO<sub>2</sub> leakage. We understand that building a buffer into the system is essential for environmental integrity and public trust, but it could be done in a pooled manner that more accurately maps to specific project risks, with significant positive impacts to project economics.

#### *Definition of brine*

The Protocol defines brine as waters with 100 g/L of total dissolved solids, or 100,000 mg/L. Most sources define brine as waters with 10 g/L or 10,000 mg/L TDS. The Protocol calls for no migration of brine, which effectively allows migration of waters with between 10,000 mg/L and 100,000 mg/L outside the storage complex, which is likely not CARB's intended result. A modification of the brine definition would be appropriate to ensure the protection of groundwater resources.

In addition to these priority topics, we have identified potential areas for modification in injection pressure limits, corrosion monitoring frequency, corrective action for wells within the surface projection of the storage complex but that do not penetrate the storage complex, and well construction details for existing facilities. We have also identified technical fixes which can improve the clarity and certainty for project developers to begin to review and consider potential CCS projects.

## **6. Direct Air Capture advance credits**

On October 15<sup>th</sup>, a number of proposals were offered for stakeholder comment. Among those proposals was a presentation by Oxy titled "Advancing Credits for DAC." Under this proposal, DAC projects may generate credits after meeting a number of CARB requirements, including submitting and gaining application approval and meeting a financial assurance demonstration. Once approved, capacity credits are generated while the direct air capture project is constructed. Capacity credits are dedicated to the California market and would then be restored to the LCFS over the DAC facility's operating life.

We recommend that CARB consider this proposal and begin work drafting a regulatory approach for the following reasons:

- Shifting LCFS credit generation to the construction phase will result in more DAC projects being developed and enable California to meet its climate goals more rapidly. DAC addresses ambient CO<sub>2</sub> concentrations in the atmosphere. As NOAA reports, in 2019, CO<sub>2</sub> concentrations in the atmosphere were 409 ppm, higher than at any point in the last 800,000 years. The unusually elevated CO<sub>2</sub> concentrations in the atmosphere are the result of anthropogenic emissions, largely experienced during the industrial age. DAC permanently captures and sequesters CO<sub>2</sub> from the atmosphere. Unlike CO<sub>2</sub> captured at the source, DAC will reduce CO<sub>2</sub> that has already been emitted and is currently contributing to global warming.
- Shifting LCFS credit generation to the construction phase will help drive investment resulting in more DAC projects being built. The current capital cost for construction coupled with the construction time is an impediment to the deployment of DAC at scale. Developers expect that a DAC project will take three to four years to approve, site and construct. To attract private investment to make DAC projects a reality, the proposal shifts credit generation forward during construction. This will increase the likelihood that DAC projects can be realized with a corresponding benefit to the ambient CO<sub>2</sub> concentrations in the atmosphere.
- Shifting LCFS credit generation earlier to the construction phase will allow for more favorable financing conditions for DAC projects. The costs for removing a ton of CO<sub>2</sub> from the atmosphere using DAC remains greater than the maximum value of a LCFS credit. As these and other projects reach commercialization, costs for DAC deployment will come down, incentivizing more DAC projects with corresponding benefits for California's climate goals.
- Shifting LCFS credit generation to the construction phase will result in more DAC projects that will provide continuing benefits for California's programs to address climate change beyond the transportation sector. Even after California completes its transition from fossil fuels, elevated CO<sub>2</sub> concentrations in the atmosphere will remain. DAC will directly address these elevated CO<sub>2</sub> concentrations after efforts to transition away from fossil fuels are completed.
- Credits advanced will be dedicated to the California LCFS marketplace. This will provide stability and further cost controls for the California LCFS market place and ensure credits are available well into the future even while other states and regions adopt programs similar to California's.
- Credits will be financially assured by DAC Projects in a manner similar to the existing mechanisms relied on by the CCS Protocol. This will provide important financial security for the California LCFS market.

Finally, we believe that many of the same challenges associated with DAC projects are applicable more broadly to CCS projects and would propose that if CARB decides to pursue this approach that advanced credits be given to all CCUS projects in the construction phase as opposed to just DAC projects.

Respectfully submitted,

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