Carbon Direct

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To the California Air Resources Board and associated staff:

We support the CARB's direction to further progress direct air capture (DAC) as a technology option to abate the greenhouse gas emissions of California fuels under the Low Carbon Fuel Standard (LCFS). This flexibility as a compliance option may reduce compliance costs, stimulate innovation and investment in climate technology, and position California as a global leader in reaching economy-wide, net-zero emissions targets. We welcome the opportunity to add our perspective to CARB's ongoing development related to DAC.

Direct air capture with storage (DACS) is a critical carbon removal technology for a net-zero world. This is recognized and substantiated in a large number of studies and deep decarbonization roadmaps, such as the IPCC's Sixth Assessment Report, the recent Lawrence Livermore National Laboratory's "Roads to Removal" report, and the European Union's communication of their 2040 climate target as well as their proposed path to climate neutrality by 2050.

Because DAC is in its early stages of operational and scale-up development, it is essential for the technology to mature and be available at the anticipated scale for later, deeper decarbonization. *Learning, knowledge sharing, data collection, and reporting are the immediate necessary steps before sound commercial and environmental regulation can be made*. Real data from operational pilots and facilities are essential. This is, in part, a key outcome of the US Department of Energy's Direct Air Capture Hub program, which includes pilot and small demonstration projects in California. In this context, CARB's decisions may prove precedent-setting not only for DAC in the US, but for other critical reduction and removal technologies and associated regulatory policies around the globe.

Carbon Direct agrees with most scholars and experts in the field: to provide material removal of CO_2 from the air and oceans, DAC facilities must operate on a net basis,

with high removal efficiencies, and with deduction of input energy emissions in their full product value chain. These must be substantiated by the use of low-carbon-intensity energy (heat and power) on a life-cycle basis. One proposed approach is “book and claim” power matching. This is where the annually averaged power used by DAC plants is matched with additional, location-based, renewable power. We are involved in ongoing discussions on the carbon credentials and impacts of these approaches, on both the power- and carbon-systems levels.

We would like to offer an addition or alternative to power matching as a way to substantiate carbon matching and integrity. Specifically, we hold that the current wish for “24/7” hourly matched power is not, at this time, technically nor commercially available at the quantity or quality needed for DAC matching loads. Additionally, quarterly power matching can be severely constrained or unavailable with the seasonal and episodic limits of variable renewable power (i.e., wind and solar, with or without batteries).

- To achieve true atmospheric neutrality, overall carbon neutrality of heat and power supply is a critical quality specification for DAC projects. However, time-matching of low-carbon generation and power demand (e.g. hourly power matching) is not the only way to demonstrate this and in some cases it may not be sufficient. Another approach is true carbon reduction accounting or "emissionality." This is the quantified, avoided emissions from the electricity generated by the low-carbon power supply minus the induced emissions from the electricity consumed by the facility, based on the respective hourly marginal emissions. This methodology can be applied regardless of the source of low-carbon electricity (nuclear, renewable, biopower, geothermal).
- The use of emissionality reporting[1] may provide the necessary confidence to market participants surrounding the carbon matching of electricity supply. Carbon matching of electricity could be used for DAC and other power-intensive projects, like green hydrogen production. This would provide time-shifted carbon matching which may be separate from hourly power matching.[2] Time-shifted matching can be location-based, with a wider or more narrow temporal and geographic definition. True carbon neutrality can be met with annual power averaging if the carbon avoided matches the carbon

[1] See the Resurety white paper, WattTime insight brief, and the report on UtilityDive for more information on emissonality.
[2] Though emissionality does not directly contribute to the development of firm, dispatchable, low-carbon power, it can catalyse their development as they can be included as “hourly” low-carbon power supplies, and with increasing renewables the amount of avoided emissions will decrease.

induced, and this is substantiated and quantified. Quarterly power matching would not improve emissions integrity further.

- *DAC facility operators could provide emissionality reporting to CARB through a transparent mechanism* (e.g., an annual book and claim methodology). Because emissionality is a maturing methodology, it would not be appropriate to include annual carbon matching as a requirement for DAC facilities until emissionality techniques are mature and this information is widely available. The lack of access to reliable, marginal emissions information for specific DAC plant technologies and low-carbon power generator locations remains a concern, and mandatory annual reporting would help.

Carbon Direct fully supports the development of firm, dispatchable, low-carbon power and power storage on the pathway toward a genuine 24/7, year-round, low-carbon power supply at capacity. Emissionality can be a "bridge" approach to catalyzing development and, as grids decarbonize further, may deliver more avoided emissions.

Thank you for the opportunity to provide feedback and your consideration.

Carbon Direct Inc. (Carbon Direct), helps organizations go from climate goal to climate action. Carbon Direct is a science-first organization that combines technology with deep expertise in climate science, data, and policy. We deliver actionable climate strategies and high-quality carbon dioxide removal (CDR) to decarbonize the global economy.

Carbon Direct has built a reputation as a trusted arbiter of high-quality strategy for carbon reduction, removal, and utilization throughout value chains, working with leading organizations. Our team of over 40 scientists includes thought leaders who actively contribute to the science of climate mitigation with novel assessment methodologies, providing public resources to facilitate action. Carbon Direct has applied its expertise to the completion of:

- Over 600 engineered, hybrid, and nature-based carbon credit project assessments, deep diligences for multi-year off-take agreements, and project co-design engagements;
- Over 150 unique emerging technology diligence reviews; and
- Deep technical diligence and de-risking engagements in improved forest management, reforestation, BECCS, and DAC, with commercial strategy support in collaboration with carbon credit developers to ensure that their products are best-in-class.