NOYES LAW CORPORATION
FUEL & CARBON LAW

September 28, 2023

Liane Randolph
Chair, California Air Resources Board

Steve Cliff
Executive Officer, California Air Resources Board

1001 I Street
Sacramento, CA 95814

*Comment submitted electronically*

**RE: Low-CI Power Coalition's Additional Comments on Low Carbon Fuel Standard Rulemaking – Determining the Optimal Temporal Period for Sourcing of Low-Carbon Intensity Power.**

Dear Chair Randolph and Executive Officer Cliff,

Our diverse group of low carbon fuel producers and developers including Blue Arrow, Fulcrum BioEnergy, H Cycle, Infinium, Velocys, and World Energy (collectively, the "Low-CI Power Coalition") appreciates the opportunity to offer comments on the Low Carbon Fuel Standard ("LCFS") rulemaking. As reflected in the attached Appendix 1, these leading-edge companies utilize a diverse range of low carbon feedstocks and advanced process technologies to produce the low carbon fuels of the future including electrofuels, renewable hydrogen, renewable diesel and naphtha, and sustainable aviation fuel. On June 6, 2023, this same group submitted detailed comments on the benefits of enabling the sourcing of low carbon intensity ("Low-CI") power under the LCFS program, and provided illustrative regulatory text (the "Low-CI Proposal" or "Proposal") for the California Air Resources Board's ("CARB") consideration.[1]

The purpose of these comments is to provide supplemental information in support of the Low-CI Power Coalition's proposal ("proposal") concerning the reporting and matching process for Low-CI power. As discussed in more detail below, a highly granular matching process for energy generation and demand (i.e., hourly) will considerably increase costs, render Low-CI power sourcing unworkable and forego achievable greenhouse gas ("GHG") emission reductions thereby stifling the fulfillment of California's short and long-term climate goals.

[1] See Low CI Power Coalition comment letter submitted by Noyes Law Corporation in LCFS Pre-Rulemkaing workshop (June 6, 2023), available at: https://ww2.arb.ca.gov/system/files/webform/public_comments/3666/Low%20CI%20Power%20ARB%20LCFS%20Comments%20w%20Appendices%206%20June%202023.pdf.

## Summary of this Comment

These comments focus on three key components of the LCFS rulemaking. The first key component focuses on the issue of temporal matching of Low-CI power generation with the power demand of the low carbon fuel production facility. This is a crucial topic to address given the increasing linkage opportunities emerging between the electrical power and the transportation fuel sectors. This linkage is attributable to the tremendous decarbonization opportunities that have opened up for renewable hydrogen, electrofuels, and advanced processing technologies capable of converting sustainable and scalable feedstocks like cellulosic materials into essential liquid fuels like sustainable aviation fuel.

Throughout the rulemaking process, the Low-CI Power Coalition has appreciated the opportunity to engage with CARB staff and LCFS stakeholders regarding the merits of the Low-CI Proposal, and also to study the analyses related to the necessary constituents for the production of Low-CI hydrogen. These analyses and position papers have been prepared to provide input to the California legislative process pertaining to the definition of "green hydrogen," and to the federal process relating to the establishment of a GHG lifecycle methodology to implement the various tiers of crediting pursuant to IRS Code Section 45V of the Inflation Reduction Act.

Informed by these analyses and discussions, the Low-CI Power Coalition has developed the Low CI Proposal's robust requirements for *additionality* and *deliverability* to further the fundamental LCFS program objective of decreasing GHG emissions.

The third key component of these comments focuses on the determination of the optimal temporal period for *matching* energy production and usage. This comment provides analysis to support our assertion that a temporal period of at least one calendar quarter is necessary to achieve the following goals: 1) real-world reductions in GHG emissions relative to grid power sourcing; 2) economic and practical viability for facilities to source Low-CI power and thereby minimize the use of fossil-based power; and 3) administrative feasibility within the LCFS program structure.

To this end, we would like to emphasize the following aspects of this Low-CI Proposal:

- The Proposal is intended to further reduce the overall CI associated with low carbon fuel demand in California thereby providing incremental GHG reductions per unit of fuel.
- The Low-CI Proposal would extend to all types of low carbon fuel production facilities including sustainable aviation fuel, biodiesel, electrofuels, ethanol, renewable hydrogen and renewable diesel.
- The Low-CI Proposal is detailed in proposed regulatory text (Appendix 3) with proposed changes to LCFS section 95488.8(h). The Low CI-Proposal does not propose any change to existing provisions for indirect accounting of Low-CI Electricity and Biomethane (LCFS section 95488.8(i)).

As a result of the substantial production incentives available to hydrogen on a sliding carbon intensity-based scale pursuant to Section 45V of the Inflation Reduction Act ("IRA"), there has been national attention on the development of a methodology for calculating the carbon intensity of hydrogen production. Due to the extensive analytical work that has been done to inform the 45V determination and also due to the complexity of this issue, this comment letter focuses primarily upon hydrogen as the example to support our analysis, but we note that the following analysis is offered on behalf of all low carbon fuels within the scope of the Low-CI Proposal.

## Background Summary

These comments and our prior comment respectfully recommends specific program refinements to enable the sourcing of Low-CI power under the LCFS program. Currently, the LCFS regulations contain unduly restrictive limitations that make it generally infeasible for low carbon fuel production facilities to source Low-CI power. Section 95488.8(h) creates strict limits on power sourcing unless expressly allowed elsewhere in the LCFS Regulation. CARB should consider amending this section because the power sourcing limitation has inadvertently limited the development and procurement of new, additional clean energy resources. For an extensive discussion on the infeasibility of behind-the-meter power sourcing, please see Fulcrum BioEnergy's comment detailing its efforts to source behind-the-meter Low-CI power for its Sierra Biofuels facility and the land availability, cost and regulatory hurdles Fulcrum encountered, included here as Appendix 2.[2]

The authorization of Low-CI power sourcing would counter this limitation and achieve additional GHG reductions by promoting the integration of new, additional clean energy resources. Our proposed regulatory text for this section is set forth in Appendix 3. As low carbon fuel production continues to expand to decarbonize and defossilize California's energy supply, adopting the Low-CI Proposal would create demand for new low carbon energy sources, rather than leading to increased demand for marginal system power, which is often comprised of fossil-fueled resources.

## Published Analytical Support for Annual Matching of Power Sourcing and Fuel Demand

The most empirically grounded analysis in support of the optimal temporal matching period that we have identified was prepared by Energy+Environmental Economics ("E3"), a leading economic consultancy that is focused on the energy industry, with an emphasis on electricity and the clean energy transition. E3 was retained by the American Council on Renewable Energy ("ACORE") to prepare the report entitled Analysis of Hourly & Annual GHG Emissions ("E3's 45V Analysis"). E3 provides advisory services and energy systems modeling

[2] Fulcrum BioEnergy, Comment #54 for Public Workshop to Discuss Potential Changes to the Low Carbon Fuel Standard- 1st Workshop, submitted August 8, 2022, available at https://www.arb.ca.gov/lists/com-attach/61-lcfs-wkshp-jul22-ws-UWZTClc3UnQDYlAl.pdf.

to investor-owned utilities, public power agencies, project developers, energy consumers, regulators, grid operators, government agencies, and public interest advocacy groups across North America. CARB is highly familiar with E3 having retained the consultancy to do work for the agency on multiple projects as have other California agencies. For instance, CARB, the California Energy Commission, the California Public Utilities Commission, the California ISO, and the Governor's Office engaged E3 to evaluate the feasibility and cost of potential 2030 GHG targets.[3] The E3 Study Team for the section 45V scenario analysis included Arne Olson, Gregory Gangelhoff, and Anthony Fratto. ACORE is a 501(c)(3) national nonprofit organization that unites finance, policy and technology to accelerate the transition to a renewable energy economy.[4]

E3's 45V analysis focused on precisely the questions of the tradeoffs associated with various levels of temporal matching, including:

1. **How should we account for the carbon content of the electricity supply used to produce hydrogen?**
2. **Does annual matching result in more $CO_2$ emissions than hourly matching?**
3. **What are the cost implications of hourly matching requirements?**[5]

To answer these questions, E3 modeled modern, utility-scale wind and solar resources across a wide range of interconnected systems including the Electric Reliability Council of Texas ("ERCOT"), the Midcontinent Independent System Operator- North ("MISO-North"), the Southwest Power Pool ("SPP"), and the PJM Interconnection ("PJM").[6] E3 applied the following methodology across these diverse regions and interconnected power systems:

> *E3 compares the clean energy production requirement, carbon emissions in kgCO2e / kgH2, and cost of hydrogen production in $/kg under annual and hourly matching approaches for two scenarios:*
>
> ***1. Energy Match:***
>
> *For annual matching, a portfolio of wind and solar generation is procured in a quantity equal to the annual energy demand of the electrolyzer during hours when the marginal emissions rate of grid electricity is positive. For hourly matching, hydrogen production*

[3] See E3 website, "Projects & Case Studies," available at https://www.ethree.com/projects/

[4] See Energy+Environmental Economics website, "New Analysis Finds Annual Matching requirement for Hydrogen Production Will Not Raise Emissions and Will Avoid Cost Barriers," at https://acore.org/new-analysis-finds-annual-matching-requirement-for-hydrogen-production-will-not-raise-emissions-and-will-avoid-cost-barriers/

[5] E3, "Analysis of Hourly & Annual GHG Emissions, Accounting for Hydrogen Production," April 2023, available at https://www.ethree.com/wp-content/uploads/2023/04/2023.04.19_E3-ACORE_Report_vFF_20230421update.pdf

[6] Id. at p. 14.

*is restricted based on the hourly quantity of renewable generation available under the same portfolio.*

***2. Emissions Match With 0.45 kg CO2 Target**:*

*For annual matching, a sufficient quantity of wind and solar generation is procured to limit incremental emissions to 0.45 kg CO2e / kg H2, the maximum allowed under the IRA to qualify for the full 45V PTC. For hourly matching, hydrogen production is restricted based on the hourly quantity of renewable generation available under the same portfolio.*

*The analysis is repeated across clean generation mixes, markets, and time periods to capture a range of current and future grid dynamics. The analysis assumes a utility-scale, 500 MW electrolyzer with a 90% utilization rate under annual matching to maximize hydrogen production and 70% production efficiency.*[7]

E3's 45V Analysis focused on the incremental GHG emissions impacts of hydrogen when Low-CI power is supplied via power purchase agreement coupled with renewable energy certificates ("RECs"). E3 compared the GHG emissions impacts and other factors when energy generation is matched to hydrogen production on an annual versus hourly basis. Consistent with the robust *additionality* and *deliverability* requirements built into the Low-CI Proposal, E3's 45V Analysis, however, did not directly examine the issues of additionality and deliverability.

E3's 45V Analysis did, however, contain 40 scenarios that utilized 2025 or 2030 as the time period; power sourced from all wind, all solar, or various mixes of wind and solar; and ERCOT, MISO-North, PJM or SPP as the regional interconnection system. E3's 45V Analysis found that:

1. **In 25 of the 40 scenarios, $CO_2$ emissions are lower under the annual matching approach than under the hourly matching approach.**

2. **In 15 of the 40 scenarios, $CO_2$ emissions are higher under the annual matching approach than under the hourly matching approach.**[8]

3. **In all four power markets analyzed by E3, an hourly matching requirement with the same net CO2 emissions as an annual matching requirement produces higher hydrogen costs ranging from 61% in PJM, to 66% in SPP, to 102% in ERCOT, and 108% in MISO-North.**[9]

[7] Id. at p. 2.

[8] Id. at p. 3.

[9] Id. at p. 6-7

The following chart illustrates the specific scenarios and demonstrates that according to E3's 45V analysis, annual matching actually outperforms hourly matching in terms of overall GHG reduction achieved.[10]

***Figure 1. Incremental Emissions by Market and Renewable Mix, Annual Energy Match Scenario[1]***

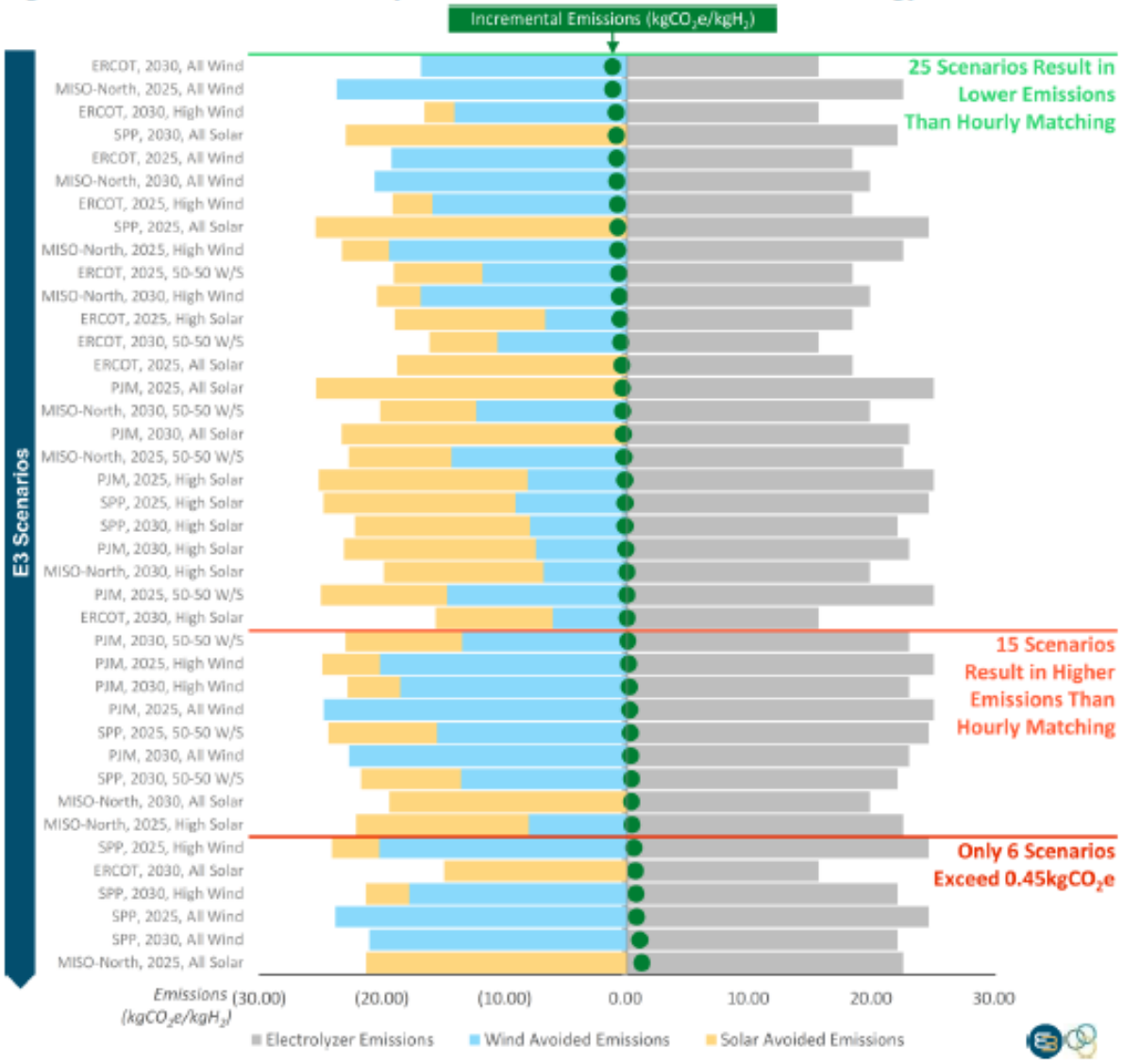


Figure 1 summarizes the emissions results under the Energy Match scenario. $CO_2$ emissions are lower under the annual matching approach than the hourly matching approach for 25 out of 40 scenarios, and less than the minimum value of 0.45 kg $CO_2e$ / kg $H_2$ for 34 out of 40 scenarios.

[10] Id. at p. 3.

## Jenkins et al Analysis of Hourly Matching

Based on our review, the primary published analysis in support of an hourly matching requirement has been developed by Professor Jesse Jenkins of Princeton University. The Jenkins methodology relies upon electricity system capacity expansion modeling, not actual grid mixes or historic information on power generation. This methodology is described in the environmental research letter entitled Minimizing emissions from grid-based hydrogen production in the United States ("Minimizing Emissions Analysis") as follows:

> *In this study we use the GenX electricity systems capacity expansion and economic dispatch model to evaluate the emissions impacts of subsidized hydrogen production via grid-connected electrolysis under a set of possible 45V PTC eligibility requirements [20, 26]. GenX optimizes electricity system investment, retirement, and operational decisions to maximize social welfare over a given planning horizon, subject to physical and policy constraints, and is configurable to allow for varying levels of spatial, temporal, and operational complexity. The model formulation is designed to replicate the investment and operational outcomes that would be observed undera well-functioning competitive electricity market or in a centrally-planned system. It is therefore suitable for exploring the impact of potential policy designs on long-run outcomes in the electricity sector.*[11]

In order to evaluate whether the conclusions reached in the Minimizing Emissions Analysis are valid, it is necessary to fully understand the underlying model and the assumptions that are embedded in it. Due to its lack of empirical data pertaining to how power markets actually behave in terms of power sourcing and cost, the Minimizing Emissions Analysis is of substantially less value in terms of informing policy design for California's LCFS. By comparison, E3's 45V Analysis relies on robust data set generated from several of the largest organized markets in the Country. By accounting for the existing dynamics in various power markets, the E3 analysis is a far better indication of how businesses would enter into power purchase agreements if indirect-accounting of Low-CI power were allowed for Tier 2 Pathway applications.

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[11] Wilson Ricks, Qingyu Xu and Jesse Jenkins, "Minimizing emissions from grid-based hydrogen production in the United States," January 2023, Environ. Res. Lett 18 (2023) available at https://iopscience.iop.org/article/10.1088/1748-9326/acacb5. Per footnote 20, the model is described in further detail in Xu, Q. & Jenkins, J.D., "Electricity System and Market Impacts of Time-based Attribute Trading and 24x7 Carbon-free Electricity Procurement, Zero-carbon Energy Systems Research and Optimization Laboratory," Princeton University, Princeton, NJ, 15 September 2022, available at https://zenodo.org/record/7082212.

Moreover, by basing the analysis on capacity expansion modeling without considering the actual mix of resources on the grid that would continue to operate under least-cost dispatch principles of the balancing authority or other organized market, the Jenkins analysis falls short by failing to account for the market exposure associated with over producing energy during certain hours. This risk would be borne by offtakers when they have to compete with other resources to sell excess power that cannot be matched. More specifically, the highly granular temporal matching analysis fails to recognize the market risk, collateral requirements, and practicality of overbuilding renewables to support increased renewable matching. Contracting for renewables in any volume generally requires collateral to mitigate the risk that power developers are exposed to when building new generation assets. For non-rated entities, this collateral requirement is substantial and could represent years' worth of Power Purchase Agreement (PPA) payments posted as upfront cash collateral. This additional capital expenditure layered on top of the capital expenditures necessary to develop an advanced low carbon fuel production facility reduces project returns and in turn, makes it hard for smaller offtakers to purchase a portion of the capacity from a renewable energy project. In other words, by optimizing the grid through capacity expansion modeling, the Jenkins analysis fails to recognize the market realities of increased collateral requirements, a larger capacity overbuild, and the costs associated with selling excess energy when prices are low. By contrast, as demonstrated by the E3 analysis, annual matching outperforms hourly matching both on carbon intensity reduction and cost. While more granular than an annual approach, quarterly matching smooths out market dynamics and significantly reduces the costs and risk associated with the Low-CI power sourcing by PPA.

## Low-CI Power Proposal Overview

In support of California's short and long-term climate goals, CARB should create additional flexibility for the sourcing of Low-CI power set forth in Section 95488.8(h). In particular, CARB should allow for review of new Low-CI power sources that are contracted by fuel pathway holders and delivered via the grid. In exchange for this flexibility, the fuel pathway holder would be required to submit documentation as part of a Tier 2 Application process that it has contracted for one or more new Low-CI power sources under a power purchase agreement ("PPA") or ownership agreement. The contract or ownership agreement would need to meet certain threshold requirements discussed below and be subject to CARB review and approval. If approved, the fuel pathway holder would have two unique carbon intensity scores for its project: one using the Low-CI power source and another based on grid average carbon intensity for the region where the fuel production facility is located. During the quarterly reporting process, the fuel pathway holder would align its energy use with the production of energy from the Low-CI power source(s). Any energy use that cannot be aligned with production from the Low-CI power source(s) would be reported under the grid average CI score. The power sourcing would also be subject to annual reporting and verification. We have designed the proposal to leverage existing LCFS processes and minimize the time needed to ensure that Low-CI power sourcing meets CARB's program requirements. We have also designed this proposal to ensure that all aspects of

the LCFS program adhere to CARB's priorities for real, additional, verifiable and enforceable emission reductions.

The Low-CI Power Proposal is designed to protect the environmental integrity of the LCFS, while at the same time maintaining administrative feasibility for both CARB and fuel producers. It is important to acknowledge that under the status quo, when a new, low carbon fuel production process comes online, the utility that serves the fuel load will plan for that incremental energy demand consistent with that utility's planning requirements. In many parts of the country, incremental energy demand will be served by existing grid resources, which are typically fossil fuel resources. By creating intentional new demand for additional Low-CI generating capacity that would not otherwise be planned or procured by the utility, the Low-CI Proposal would achieve real, additional and verifiable greenhouse gas emission reductions.

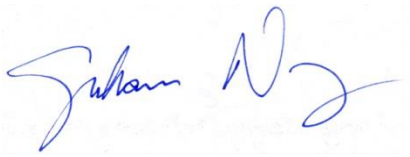
To realize these environmental benefits, Section 95488.8(h) must be modified in a way that is feasible and cost effective relative to the incremental credit value associated with a lower carbon intensity score. Managing energy purchases under a PPA and matching those purchases with the electricity load of a fuel production facility can add considerable complexity and risk to the process of planning the fuel production process and entering into the PPA. By allowing fuel pathway holders to report fuel transactions under two carbon intensity scores (i.e., one based on grid average and one based on Low-CI power), fuel pathway holders will be able to better manage quarterly variation in load and energy production. Moreover, by reporting on a quarterly basis, CARB will ensure that there is a direct correlation between energy usage and generation.

Under this Proposal, the energy usage reported by fuel pathway holder would still be reported on a monthly basis without attributing the power source in that month. In the quarterly fuel transaction reporting, the fuel pathway holder would determine how much Low-CI power it can match with each of its fuel sources, up to the total monthly energy demand that was reported by fuel. The fuel pathway holder would then use metered data from the Low-CI power source to determine how much Low-CI power it could match to the total quarterly energy used for process energy for the quarter. Any unmatched energy would be reported at the grid average CI for the fuel pathway. As part of its annual reporting requirements, the fuel pathway holder would also account for any RECs (or functionally equivalent certificates used in international systems) that have been generated by the Low-CI power source. The fuel pathway holder would demonstrate that the RECs have not been used for other renewable energy or carbon-based programs, such as the Renewable Portfolio Standard. The quarterly matching and annual reporting process is modeled after the existing LCFS reporting practices for Low-CI incremental EV charging and electrolytic hydrogen production.

## Conclusion

The Low-CI Power Coalition appreciates CARB's consideration of the Low-CI Power Proposal. As discussed above, the Low-CI Proposal for recognized qualifying grid-sourced Low-CI power with an approved Tier 2 fuel pathway would result in additional GHG emission reductions driven by the LCFS program. The technical analyses discussed and summarized herein make clear that hourly matching is not necessary to ensure the environmental performance and would instead be counterproductive to the goal of reducing GHG emissions. Simply put, hourly matching would make the Low-CI Proposal unworkable. We believe a quarterly matching approach is administratively feasible and will preserve the environmental integrity of the LCFS program. We look forward to working with CARB to further tailor and ultimately implement this proposal through the upcoming LCFS rulemaking.

Sincerely,



Graham Noyes
Noyes Law Corporation

# APPENDIX 1

Low-CI Power Coalition member companies:

**Blue Arrow** is the exclusive technology licensee in Mexico, Brazil and elsewhere of Fulcrum Bioenergy, Inc. Blue Arrow's and Fulcrum's plants combine multiple proven and established industrial processes into a patented system that converts waste into zero-carbon synthesis crude. The syncrude is then upgraded at a refinery to zero-sulfur SAF.

**Fulcrum BioEnergy** is a clean energy company pioneering the creation of renewable, drop-in transportation fuels from landfill waste, and is currently commissioning a facility in Reno, Nevada.

**H Cycle** is a developer, owner and operator of clean hydrogen production facilities that deploy a proven waste-to-hydrogen thermal conversion technology, redirecting municipal waste and organic waste before it reaches landfills.

**Infinium** is an electrofuels provider on a mission to decarbonize the world. Electrofuels are a new class of synthetic fuels made using renewable power-derived green hydrogen and waste carbon dioxide that would be otherwise emitted to the atmosphere. Infinium electrofuels can be dropped into existing trucks, planes and ships, significantly reducing harmful carbon dioxide emissions compared to fossil-based fuels.

**Velocys** is an international Sustainable Aviation Fuel (SAF) technology company with offices in the US and UK. Velocys' technology enables the conversion of various cellulosic feedstocks, including woody biomass residues and municipal solid waste, into low or negative carbon intensity transportation fuels. Velocys broadly offers its technology to the marketplace, and is developing the Bayou Fuels project in Natchez, MS as a commercial reference plant. Velocys has secured offtake commitments for 100% of the SAF from Southwest Airlines and IAG (parent of British Airways) with plans to supply this fuel for uplift in California.

**World Energy** is a low-carbon solutions provider focused on helping the world's leading companies make their net-zero commitments real. Our solutions Include sustainable aviation fuel, renewable diesel, and renewable naphtha, with plans to create renewable propane and green hydrogen.

August 7, 2022

Cheryl Laskowski
Branch Chief, Transportation
California Air Resources Board
P.O. Box 2815

Sacramento, CA 95812

RE: Recommended LCFS Rulemaking Issue- Enabling Low Carbon Intensity Power Sourcing by Fuel Production Facilities

(Comment submitted electronically via https://www.arb.ca.gov/lispub/comm/iframe_bcsubform.php?listname=lcfs-wkshp-jul22-ws&comm_period=1 )

Dear Dr. Laskowski,

I am writing to recommend that the California Air Resources Board ("CARB") address the topic of low carbon intensity power ("Low-CI Power") sourcing in the upcoming series of Low Carbon Fuel Standard ("LCFS") public workshops to discuss potential LCFS regulatory revisions. Specifically, I am recommending that CARB authorize the sourcing of Low-CI Power via power purchase agreement ("PPA") for low carbon fuel production facilities. For these facilities, sourcing Low-CI Power can be highly impactful to the fuel pathway's total carbon intensity ("CI") score, particularly for processes such as those that Fulcrum utilizes which are capable of breaking down waste feedstocks. Due to the issue's importance, Fulcrum has been communicating with CARB staff and management on this issue for several years, and has previously submitted similar comments to CARB in communications of June 10, 2020, and again on February 1, 2022.

While our LCFS requested change is unchanged from our prior letters, the necessity of authorizing more flexibility for low carbon fuel production facilities has now been fully demonstrated by:

1. The priorities identified and analysis contained in CARB's Draft 2022 Scoping Plan Update ("Draft Scoping Plan"), and
2. Governor Newsom's recent letter to CARB Chair Randolph regarding new goals and actions to accelerate California's climate goals.

To facilitate efficient review and a complete record, this comment is organized in the following manner:

1. (New) Summary of the crucial determinations made by the Governor and CARB
2. (New) Update on the commissioning of Fulcrum's facility, the first commercial scale municipal solid waste (MSW) to fuel gasification facility preparing to supply fuel to the California market
3. (Previously Submitted) Discussion of Fulcrum's long-term struggle to develop qualifying Low-CI Power and examination of why CARB's carbon neutrality goal necessitates the ability to source Low-CI Power via PPA.

**CARB's DRAFT SCOPING PLAN ESTABLISHES THAT TO ACHIEVE CARBON NEUTRALITY BY 2045, CARB MUST AUTHORIZE THE USE OF LOW-CI POWER BY LOW CARBON FACILITIES THAT WILL OTHERWISE BE FORCED TO UTILIZE FOSSIL FUELS FOR HEAT AND PROCESS ENERGY**

As stated in the Executive Summary:

*"The 2022 Scoping Plan, once final, will be a major milestone, laying out how the fifth largest economy in the world can get to carbon neutrality by 2045 or earlier. This is the first Scoping Plan that adds carbon neutrality as a science-based guide and touchstone beyond statutorily established emission reduction targets. It identifies a technologically feasible, cost-effective and equity-focused path to achieve carbon neutrality by 2045, or earlier, while also assessing the progress the state is making toward reducing its greenhouse gas (GHG) emissions by at least 40 percent below 1990 levels by 2030, as called for in SB 32 and laid out in the 2017 Scoping Plan."*[12]

The Transportation sector remains the primary source of GHG emissions in California. The Draft Scoping Plan provides a detailed examination of the sector and contains CARB's Strategies for Achieving Success. The section begins by clearly recognizing the tremendous challenge of transitioning away from liquid fossil fuel reliance:

*"The transportation sector has long relied on liquid petroleum fuels as the primary energy source for internal combustion engine (ICE) vehicles, including cars, trucks, locomotives, marine equipment, and aircraft. Combustion of fossil fuels in vehicles emits significant amounts of GHGs, criteria pollutants, and toxic air contaminants. In 2019, the transportation sector accounted for over 50 percent of statewide GHG emissions and thus was by far the single largest sector source of carbon pollution in the state. In addition, the transportation sector accounted for over 75 percent of statewide NOx emissions and the vast majority of particulate matter emissions, 30 percent of which was toxic diesel particulate matter. (…)"*[13]

To achieve transformation in fuels, the Draft Scoping Plan recognizes three crucial realities:

*"Transitioning away from ICE vehicles is part of the solution, but we must ensure that an adequate supply of zero-carbon alternative fuel is available to power these vehicles."*

*(…)*

*"The Low Carbon Fuel Standard is the primary mechanism for transforming California's transportation fuel pool with low-carbon alternatives and has fostered a growing alternative fuel market."*

*(…)*

[12] California Air Resources Board, Draft 2022 Scoping Plan Update (May 10, 2022), at p. 0 of Executive Summary, available at https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf

[13] *Id*. at p. 147 (footnotes omitted).

*"California must use the best available science to ensure that raw materials used to produce transportation fuels do not incentivize feedstocks with little to no GHG reductions from a life cycle perspective."* [14]

CARB's analysis in the Draft Scoping Plan recognizes that the LCFS is the most powerful policy tool that California has in the transportation sector, that internal combustion ("ICE") vehicles will persist on California's roads beyond 2045, and that to meet carbon neutrality California must tap into fuels made from zero or carbon negative feedstocks. As discussed in a subsequent section of the comment letter, **Fulcrum is doing its level best to be the first zero carbon liquid fuel provider to deliver the zero or subzero CARB fuel that California must have**. However, like all facilities capable of producing liquid fuels from the most promising and abundant second generation feedstocks identified in the Getting to Neutral Report,[15] Fulcrum's gasification process is energy intensive. Thus, while Fulcrum's MSW feedstock is recognized by CARB as carbon negative, Fulcrum's energy use causes the total CI of the pathway to be significantly carbon positive.

As the first gasification facility that will utilize MSW to produce liquid transportation fuels for the California market, Fulcrum is a real-world test case regarding whether California's LCFS can stimulate sufficient demand for zero carbon fuels to enable the full substitution of zero carbon fuels for liquid petroleum fuels by 2045. Unfortunately, Fulcrum's experience reveals that the LCFS contains a critical design flaw in not enabling such a facility to source zero carbon energy.

The need to integrate practically feasible, zero carbon energy sourcing flexibility into the LCFS is further reinforced by Governor Newsom's recent establishment of new goals and actions that he requested be integrated into the final Scoping Plan. In the section entitled, "Moving Away from Fossil Fuels," the Governor stated,

> *"We must look for greater opportunities to reduce our dependence on fossil fuels to achieve our air quality and climate targets, including in our electricity and transportation sectors. To urgently move away from fossil fuels, and accounting for actions that are underway to preserve reliability and accelerate deployment of clean energy,* ***I am requesting that state agencies plan for an energy transition that avoids the need for new natural gas plants to***

[14] Id. at 152-154.

[15] Sarah E. Baker, Joshuah K. Stolaroff, George Peridas, Simon H. Pang, Hannah M. Goldstein, Felicia R. Lucci, Wenqin Li, Eric W. Slessarev, Jennifer Pett-Ridge, Frederick J. Ryerson, Jeff L. Wagoner, Whitney Kirkendall, Roger D. Aines, Daniel L. Sanchez, Bodie Cabiyo, Joffre Baker, Sean McCoy, Sam Uden, Ron Runnebaum, Jennifer Wilcox, Peter C. Psarras, Hélène Pilorgé, Noah McQueen, Daniel Maynard, Colin McCormick, Getting to Neutral: Options for Negative Carbon Emissions in California, January, 2020, Lawrence Livermore National Laboratory, LLNL-TR-796100, at p. 29, available at https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf (footnotes omitted, hereafter "Getting to Neutral Report"). The Getting to Neutral Report identifies woody biomass from forest treatments, agricultural residues, and MSW as the most promising second generation feedstocks that are abundant and zero carbon.

***meet our long-term energy goals while ensuring reliability and meeting growing demand for electricity."***[16]

Thus Governor Newsom is calling upon CARB to do everything possible not just to reduce liquid petroleum use but also gaseous fossil fuel use. For facilities like Fulcrum's that cannot site solar or wind at their facility location, the facility must source energy from the grid which will create continued demand for fossil natural gas. As described by this comment letter, Fulcrum has gone to great lengths to comply with the current LCFS regulatory requirement for Low-CI Power sourcing. Unfortunately, the siting difficulties and capital costs associated with establishing large scale renewable power generation coupled with the regulatory regimes that govern power sourcing where Fulcrum is planning on building production facilities create additional significant barriers to comply with CARB's Low-CI Power requirements. As a result, under the current version of the LCFS regulation, Fulcrum may have no other option but to source and utilize substantial electrical power from fossil-based electric grids and thereby release unnecessary $CO_2$ into the atmosphere during the production of low carbon fuels and undercutting California's carbon neutral goal.

By adding Low-CI Power sourcing flexibility for all low carbon fuel production facilities, CARB would decrease demand for fossil power, increase demand for Low-CI Power, and speed fulfillment of California's aggressive decarbonization and petroleum reduction goals. This topic therefore warrants CARB's consideration.

## Fulcrum's Next Generation Biofuel Processing Technology

Fulcrum is the parent company of Fulcrum Sierra BioFuels, LLC ("Sierra BioFuels"). Sierra BioFuels owns and operates a commercial scale low carbon fuel production facility comprised of a Feedstock Processing Facility and a biorefinery (together the "Sierra BioFuels Plant"). The Feedstock Processing Facility has been operational since 2017 and is located adjacent to the Lockwood Regional Landfill in Storey County, Nevada. The Feedstock Processing Facility receives MSW that would otherwise be landfilled. A sophisticated feedstock processing system shreds, screens, and sorts the MSW producing a MSW-derived feedstock. The resulting products from the Feedstock Processing Facility include the MSW-derived feedstock and recoverable materials with market value (e.g. ferrous and nonferrous metals and high value plastics).

The biorefinery is fully constructed and is located approximately 20 miles east of Reno in the Tahoe-Reno Industrial Center. The biorefinery is now undergoing commissioning and expected to achieve first production in the late summer or early fall of 2022. The biorefinery will ultimately have the capability to convert the MSW–derived feedstock into very low carbon diesel fuel, jet fuel, and bio-crude using a three-step process comprised of steam reforming, Fischer-Tropsch ("FT") synthesis, and hydroprocessing. Initially, the biorefinery will produce bio-crude which will be co-processed at a conventional refinery into finished fuels.

[16] Governor Gavin Newsom Letter of July 22, 2022, to CARB Chair Liane Randolph, at page 2, available at https://www.gov.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf?emrc=1054d6 (emphasis in original).

Fulcrum is also in the development stage of comparable facilities, including Fulcrum Centerpoint in Gary, Indiana. Centerpoint will have triple the production capacity of the Sierra BioFuels Plant, with an estimated annual output of over 30 million gallons. Two Feedstock Processing Facilities will divert 700,000 annual tons of MSW from the Greater Chicago area prior to conversion into low carbon fuels at the biorefinery. This project is in advanced development with operations targeted to start in 2025. Fulcrum plans to build an additional 12+ similar plants across the United States.

## Current LCFS Requirements Pertaining to Low-CI Power

The controlling general rule regarding Low-CI Power for fuel pathways is found in §95488.8, titled "Fuel Pathway Application Requirements Applying to All Classifications." Section 95488.8(h) provides that a fuel pathway applicant cannot indirectly source Low CI power via PPA or other means. In order to effectively source Low CI power for LCFS fuel pathway purposes, the generation equipment must be: "directly connected through a dedicated line to a facility such that the generation and the load are both physically located on the customer side of the utility meter" per the requirement of §95488.8(h)(1)(B).

The full text of this provision relating to Low-CI Power is as follows:

> *(h) Renewable or Low-CI Process Energy. Unless expressly provided elsewhere in this subarticle, indirect accounting mechanisms for renewable or low-CI process energy, such as the use of renewable energy certificates, cannot be used to reduce CI. In order to qualify as a low-CI process energy source, energy from that source must be directly consumed in the production process as described in (1) and (2) below:*
>
> *(1) Low-CI electricity must be supplied from generation equipment under the control of the pathway applicant. Such electricity must be able to demonstrate:*
>
> *(A) Any renewable energy certificates or other environmental attributes associated with the energy are not produced, or are retired and not claimed under any other program with the exception of the federal RFS, and the market-based compliance mechanism set forth in title 17, California Code of Regulations Chapter 1, Subchapter 10, article 5 (commencing with section 95800).*
>
> *(B) The generation equipment is directly connected through a dedicated line to a facility such that the generation and the load are both physically located on the customer side of the utility meter. The generation source may be grid-tied, but a dedicated connection must exist between the source and load.*
>
> *(C) The facility's load is sufficient to match the amount of low-CI electricity claimed using a monthly balancing period.*
>
> *(…)*

Lessons Learned through Fulcrum's Efforts to Source Low CI Power

Fulcrum is committed to using Low-CI power throughout its portfolio; however, current LCFS Low-CI Power sourcing requirements are challenging for even greenfield facilities to implement, and as a result are likely to result in sub-optimal outcomes than more flexible approaches.

The requirement for a dedicated connection behind the utility meter between the Low-CI power generation source and the biorefinery is particularly difficult. The impediment that is most difficult to overcome is securing a suitable site for Low-CI Power generation in the immediate vicinity of a suitable site for a biorefinery. Fulcrum biorefineries convert Separated MSW into fuels. In order to best source this waste stream, Fulcrum's preferred sites are near cities and populations that generate large volumes of trash. These areas are typically land constrained and lack the open spaces required for Low-CI Power (e.g., 200+ acres for a sufficient solar farm). Thus for Fulcrum, the LCFS behind the meter requirement consistently results in either the Low-CI Power generating facility or the biorefinery being sub-optimally located. In addition, imposing the requirement of co-developing a dedicated renewable power source on an advanced biorefinery dramatically increases capital cost and adds another element of risk to project development.

In addition to these substantial impediments, even in circumstances where a dedicated behind-the-meter connection is physically possible, utility regulations may preclude a biorefinery from having a behind-the-meter connection and being a retail utility customer at the same time. While not being connected to the grid is an option, this would require large amounts of storage infrastructure that would render the entire project uneconomical.

The alternative of building the Low-CI Power project at a distance from the biorefinery and then transmitting the Low-CI Power to the biorefinery is also fraught with difficulties. Unless there is pre-existing electric transmission infrastructure, building new transmission lines is prohibitively expensive and lengthy, assuming the right-of-way exists and permits can be obtained. Even in the rare case when transmission infrastructure exists, local electric power regulations may prevent the biorefinery from using transmission lines. For example, the biorefinery may have to purchase all other power in the wholesale market which would require a wholesale power permit. These permits depend on factors outside of the control of the applicant, such as the availability of sufficient transmission capability and subject projects to uncertainty, costs, and lengthy delay.

California Policy Requires Decarbonization of the Transportation Sector

Pursuant to SB 32 and AB 197, California must reduce its GHG emissions 40% below 1990 levels by 2030 necessitating dramatic GHG reductions compared to current policies. Transportation emissions are the dominant GHG emissions source, constituting 41% of California's total GHG emissions of 424.1 $MMTCO_2e$.[17] Transportation GHG emissions have

[17] Air Resources Board, Public Workshop on the Transportation Sector to Inform Development of the 2030 Target Scoping Plan Update, September 14, 2016,

clearly emerged as the most difficult sector to decarbonize with transportation's rising from 35% of California's GHG emissions in 2015 to 41% in 2017.[18]

Pursuant to Governor Brown's Executive Order B-55-18, California has a statewide goal to achieve carbon neutrality as soon as possible, and no later than 2045, and to achieve and maintain net negative emissions thereafter in addition to statewide targets of reducing GHG emissions including SB 32 and AB 197.[19] In addition, the Executive Order provides that, "The California Air Resources Board shall work with relevant state agencies to ensure future Scoping Plans identify and recommend measures to achieve the carbon neutrality goal."

To identify negative emissions pathways that physically remove $CO_2$ from the atmosphere and that can enable California to meet its goal of achieving carbon neutrality by 2045, the Lawrence Livermore National Laboratory developed a recently published report entited, Getting to Neutral, Options for Negative Carbon Emissions in California ("Getting to Neutral Report"). Within the acknowledgments section of the Getting to Neutral Report, the technical information supplied by Jim Macias and Flyn van Ewijk of Fulcrum were recognized. The report identified the conversion of waste biomass to fuels, such as the conversion of Separated MSW to liquid fuels by Fulcrum, as one of the three primary pillars for California to reach 125 million tons of negative emissions annually. The Getting to Neutral Report estimates the total quantity of MSW available in California annually to be 13M bone dry tons, and determines there to be no incremental collection cost due to the existing waste collection system.[20] The "Gasification with Fischer-Tropsch Synthesis to Liquid Fuels" section of the report references a single facility:

> *"Within the state of California, this general type of biomass-to-liquid-fuels process has been developed by Fulcrum BioEnergy, based in Pleasanton. At their Sierra Biofuels plant, located in Storey County, NV, (estimated to begin operation in 2020), 175,000 tons per year of prepared feedstock (prepared from Municipal Solid Waste) will be gasified and then converted into a synthetic crude oil via Fischer-Tropsch synthesis. The gasification system is from ThermoChem Recovery International. Once fully operational, the plant will produce 11 million gallons of synthetic crude oil per year that will be processed by Marathon Petroleum into transportation fuel. The resultant liquid fuels will have a lifecycle emissions reduction of approximately 80% compared to their fossil counterparts."*[21]

The Getting to Neutral Report notes, however, that the cost of transporting CO2 combined with the limited availability of sequestration sites around the states are factors that limit the actual amount of negative emissions that can be achieved from biomass sources.[22] To address this concern, it is imperative that CARB facilitate the use of Low-CI Power by cutting edge biorefineries such as Fulcrum's in order to meet the state's carbon neutrality goals.

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https://www.arb.ca.gov/cc/scopingplan/meetings/091316/FINAL%20Scoping%20Plan%20Transport%20Workshop.pdf (last viewed September 19, 2016), at slide 11 and 14.

[18] Presentation of Executive Officer Richard Corey, slide entitled "Transportation Remains a Key Focus," presented at Argus Biofuels & Carbon Markets Summit, October 22, 2019, at slide 11.

[19] Executive Order B-55-18, available at https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf

[20] Getting to Neutral Report, at p. 29 (footnotes omitted).

[21] Id. at 53.

[22] Id. at 69.

To further enable California to fulfill the goal of carbon neutrality by 2045 established by Governor Brown's Executive Order B-55-18, the California Legislature approved the Budget Act of 2019 (AB 74) that funded two studies, administered by the California Environmental Protection Agency, to: 1) identify strategies to reduce emissions from transportation energy use, and 2) identify strategies to manage the decline in fossil fuel production and associated emissions in parallel with reductions in demand. The study to reduce emissions from transportation use was conducted by the University of California Institute of Transportation Studies ("ITS") at four campuses, UC Davis, UC Berkeley, UC Irvine, and UCLA.

The resulting ITS report is entitled, "Driving California's Transportation Emissions to Zero."[23] While California leads the nation in electrifying transportation, the primary strategy developed in the report still recognized the reality that forcing all internal combustion engines off the road by 2045 is not feasible. As a result, the Driving California's Transportation Emissions to Zero report concluded that to achieve carbon neutrality it was necessary for California to make a complete transition by 2045 from petroleum-based gasoline to bio-based gasoline including ethanol blends as is illustrated in the following chart.

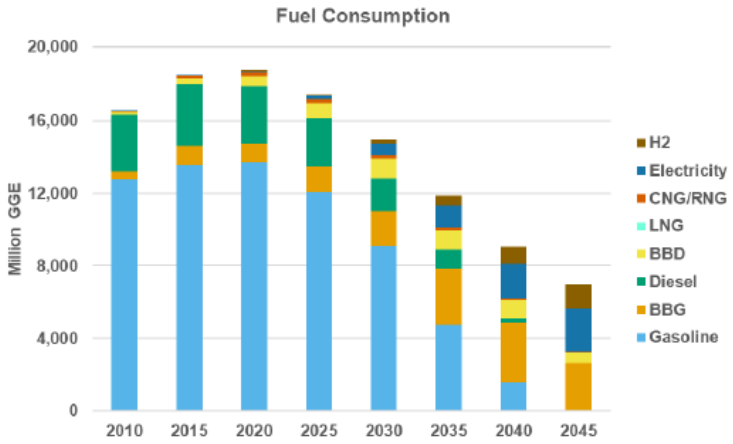


Figure EX-2. $CO_2$ emissions and fuel consumption projections in the LC1 scenario. The near-zero $CO_2$ emissions target is reached by 2045, with nearly all fossil fuels replaced by electricity, hydrogen, and biofuels at that date. (MMT, million metric tonnes; SAF, sustainable aviation fuel; H2, hydrogen; CNG/RNG, compressed natural gas/renewable natural gas; LNG, liquefied natural gas; BBD, bio-based diesel, including biodiesel and renewable diesel; BBG, bio-based gasoline, including ethanol blends and drop-in gasoline replacement fuels)

Driving California's Transportation Emissions to Zero

In order to enable the displacement of fossil fuels with bio-based gasoline and bio-based diesel fuel, it is essential that California facilitate the rapid expansion of next generation fuel facilities that utilize plentiful and Low-CI feedstocks, such as the Separated MSW feedstock that Fulcrum's facilities utilize.

## Recommended Revision to LCFS to Enable Low-CI Power Sourcing

Fulcrum proposes the following modification of §95488.8(h) to enable Low-CI Power sourcing by low carbon fuel production facilities.

[23] Institute of Transportation Studies, "Driving California's Transportation Emissions to Zero," (April 2021), available at https://escholarship.org/uc/item/3np3p2t0

**§ 95488.8. Fuel Pathway Application Requirements Applying to All Classifications.**

(…)

(h) *Renewable or Low-CI Process Energy.* Unless expressly provided elsewhere in this subarticle, indirect accounting mechanisms for renewable or low-CI process energy, such as the use of renewable energy certificates, cannot be used to reduce CI. In order to qualify as a low-CI process energy source, energy from that source must be directly consumed in the production process as described in (1) and (2) below:

(1) Low-CI electricity must be supplied from generation equipment under the control of the pathway applicant or subject to a firm power purchase agreement (PPA) from generating equipment within the same balancing authority as the facility. Such electricity must be able to demonstrate:

(A) Any renewable energy certificates or other environmental attributes associated with the energy are not produced, or are retired and not claimed under any other program with the exception of the federal RFS, and the market-based compliance mechanism set forth in title 17, California Code of Regulations Chapter 1, Subchapter 10, article 5 (commencing with section 95800).

~~(B) The generation equipment is directly connected through a dedicated line to a facility such that the generation and the load are both physically located on the customer side of the utility meter. The generation source may be grid-tied, but a dedicated connection must exist between the source and load.~~

(B) The facility's load is sufficient to match the amount of low-CI electricity claimed using a monthly balancing period.

(…)

## Conclusion

By implementing this proposed change to enable Low-CI Power sourcing by facilities via power purchase agreement, CARB would facilitate the achievement of California's GHG and petroleum reduction goals.

Thank you for your consideration of our input. We would welcome the opportunity to provide any further information that would be value to ARB on this subject.

Sincerely,

Benny Wong

Fulcrum BioEnergy, Inc.

Cc: Staff Air Pollution Specialist Jacob Englander

Industrial Strategies Division Chief Matthew Botill

Deputy Executive Officer Rajinder Sahota

# APPENDIX 3

LCFS Regulation §95488.8 provisions from 2020 CARB Version- Marked

**§ 95488.8. Fuel Pathway Application Requirements Applying to All Classifications.**

(…)

(h) *Renewable or Low-CI Process Energy.* Unless expressly provided elsewhere in this subarticle, indirect accounting mechanisms for renewable or low-CI process energy, such as the use of renewable energy certificates, cannot be used to reduce CI. In order to qualify as a low-CI process energy source, energy from that source must be ~~directly consumed in~~**supplied to** the production process as described in (1),~~ and~~ (2)**, (3), or (4)** below:

(1) ***Direct Electrical Connection.*** Low-CI electricity must be supplied from generation equipment under the control of the pathway applicant. Such electricity must be able to demonstrate:

(A) Any renewable energy certificates or other environmental attributes associated with the energy are not produced, or are retired and not claimed under any other program with the exception of the federal RFS, and the market-based compliance mechanism set forth in title 17, California Code of Regulations Chapter 1, Subchapter 10, article 5 (commencing with section 95800).

(B) The generation equipment is directly connected through a dedicated line to a facility such that the generation and the load are both physically located on the customer side of the utility meter. The generation source may be grid-tied, but a dedicated connection must exist between the source and load.

(C) The facility's load is sufficient to match the amount of low-CI electricity claimed using a ~~**monthly**~~ **quarterly** balancing period.

(2) ***Physical Supply.*** Biogas or biomethane must be physically supplied directly to the production facility. The applicant must submit the attestation set forth below in section 95488.8(i)(2)(C)2.

(3) ***Thermal Supply.*** Solar steam or heat generation must be physically supplied directly to the production facility, and any environmental attributes associated

with the energy are not produced, or are retired and not claimed under any other program with the exception of the federal RFS, and the market-based compliance mechanism set forth in title 17, California Code of Regulations Chapter 1, Subchapter 10, article 5 (commencing with section 95800).

**(4)** ***Approved Power Purchase Agreement.*** **Through the Tier 2 application process, a pathway applicant may seek Executive Officer approval for the sourcing of Low-CI electricity for all or a portion of a facility's electricity demands.**

**(A)** ***Low-CI Electricity Supplied via Power Purchase Agreement.*** **The Executive Officer may determine whether the sourcing of Low-CI Electricity via Power Purchase Agreement or ownership agreement qualifies as a Low-CI process energy source for a specific facility provided the conditions set forth below are met:**

**(1) Additionality.**

**a. The facility providing Low-CI Electricity (or portion thereof) is not accounted for or otherwise contracted with another buyer and has not been included in the resource plan of the utility serving retail electricity in the balancing authority or other organized market where the facility is interconnected and delivered.**

**b. The commercial online date of the facility providing Low-CI Electricity (or portion thereof) occurs after the execution date of the Power Purchase Agreement or ownership agreement.**

**c. The environmental attributes of the Low-CI Electricity (or portion thereof), howsoever defined, including but not limited to all greenhouse gas attributes, renewable energy certificates, or similar rights, attributes and products that are associated with Low-CI Electricity reported by the fuel pathway holder cannot be contracted, sold or transferred to any other buyer except the fuel pathway holder or its designee.**

**(2) Quarterly Matching of Low-CI Electricity. Low-CI Electricity must be reconciled with process energy in the Quarterly Fuel Transaction Report. Process energy must also be reported on a monthly basis. If the sum of the process energy for the quarter exceeds the Low-CI Electricity available for reconciliation in Quarterly Fuel Transaction Report, the difference must be**

**reported at the Grid-Average-CI Score for the balancing authority where the fuel production facility is located.**

**(3) Direct Delivery. The Low-CI Electricity source has a first point of interconnection in the same balancing authority area or other interconnected electrical system where the fuel production process is located or is scheduled, pseudo-tied or dynamically transferred from the Low-CI Electricity to the balancing authority or other electrical system where the fuel production facility is located.**