



444 Castro Street, Suite 710
Mountain View, CA 94041

August 5, 2022

Low Carbon Fuels Standard Program
California Air Resources Board
Sacramento, CA 95814

RE: Comments on LCFS Program Staff Presentation on July 7, 2022

To the LCFS Program:

H Cycle, LLC (“H Cycle”) appreciates the California Air Resources Board (“CARB”) moving forward with the informal rulemaking of the Low Carbon Fuel Standard Program (“LCFS Program”), the staff presentation regarding potential changes to the LCFS Program, as well as the opportunity to provide comments to this process. Below you will find our comments regarding LCFS Program changes proposed at the workshop, as well as our comments and recommendations pertaining to issues of primary importance to H Cycle, a leading company in the waste-to-hydrogen sector. We believe the following recommendations will benefit both the LCFS Program and California’s emerging low-carbon hydrogen sector.

About H Cycle

H Cycle is a developer of low-cost, low-carbon hydrogen production facilities that deploy a proven waste-to-hydrogen thermal conversion technology. H Cycle is currently developing multiple projects in California. Our solution can utilize a diverse composition of waste feedstocks (municipal solid waste, agricultural, forest) to produce valuable renewable hydrogen product, thereby reducing methane emissions from landfill disposal and achieving California’s waste diversion targets under Senate Bill 1383. The H Cycle process delivers low-carbon hydrogen that can be used as an energy source for decarbonizing hard-to-abate sectors such as low-carbon fuel refining and heavy-duty trucking. We are excited to work with CARB to deploy our solution and support the State in meeting its climate, sustainability and air quality goals.

Comments Summary

H Cycle appreciates the opportunity to provide input on the following LCFS Program changes. We hope that CARB will consider all these issues as it moves forward with the LCFS rulemaking, and establish sub-workshops to focus on these issues with input from stakeholders. H Cycle:

1. Supports CARB’s proposal to increase the carbon intensity requirement for 2030 and establish five-year interim targets between 2025 and 2045



444 Castro Street, Suite 710
Mountain View, CA 94041

2. Supports CARB's proposal for infrastructure crediting of Medium Heavy-Duty/Heavy Heavy-Duty ("MHD/HHD") refueling
3. Requests development of a new Tier 1 carbon intensity ("CI") calculator for hydrogen pathways that includes organic waste-to-hydrogen through thermal conversion, and provides crediting for landfill methane avoidance
4. Recommends that CARB extend the existing authorization of electricity book-and-claim accounting for hydrogen production beyond electrolysis to include hydrogen produced using non-fossil-based pathways

Chief among H Cycle's recommendations is for CARB to authorize indirect ("book-and-claim") accounting for low-carbon electricity used for hydrogen production from non-fossil-based technologies. We believe that limiting indirect accounting for low-carbon electricity to electrolysis, as is currently provided by Section 95488.8(i)(1) of the LCFS Regulation, fails to harness the substantial benefits that waste-to-hydrogen production and other innovative technologies can provide and stunts investment into and the growth of the low-CI hydrogen sector in California. More details on this recommendation are provided below.

Comments Detail and Background

Support for increasing the carbon intensity requirement for 2030 and establishing five-year interim targets between 2025 and 2045.

The Staff Presentation on July 7 makes clear that the LCFS Program is working well, achieving a 9.36% reduction since 2011 in the overall carbon intensity of vehicle fuels while diversifying the fuel pool, which is important to meeting all vehicle needs. While the LCFS Program's achievements are significant to date, the program can be further strengthened to help meet the state's 2030 and 2045 climate goals.

The Staff Presentation requested feedback on whether the 2030 target should be increased and proposes increasing the requirement to 25% or 30% in 2030. H Cycle strongly supports increasing the 2030 requirement, ideally targeting a 30% reduction by 2030. In our view, this would bring the Program in line with the requirements of Senate Bill 32 (40% carbon emission reduction by 2030) and will help achieve the state's goal of carbon neutrality by 2045.

The Staff Presentation also requested feedback on whether the ARB should set five-year interim targets out to 2045. H Cycle strongly supports this proposal for two reasons. First, achieving carbon neutrality by 2045 will not be possible without aggressive carbon reduction targets in the transportation sector, given that transportation is the largest source of greenhouse gas ("GHG") emissions in the state. Second, setting longer term targets will send the right market signal to innovators, entrepreneurs and the finance community. Constructing energy infrastructure



444 Castro Street, Suite 710
Mountain View, CA 94041

requires large amounts of capital deployment and long-term certainty, given the lengthy life of such assets. We believe the long-term targets will provide the longevity and dependability needed to efficiently develop and finance the infrastructure that California needs.

Lastly, H Cycle recommends that the Program expand the definition of obligated parties to intrastate aviation, rail and maritime applications, in order to further bolster the LCFS market, incentivize innovation and drive investment in California's clean transportation sector.

Support for infrastructure crediting of MHD/HHD refueling

The Staff Presentation proposed a design for MHD hydrogen refueling infrastructure ("HRI") to support the buildout of MHD/HHD refueling infrastructure in the state. H Cycle supports both the decision to develop such a program as well as the design elements proposed, including the 15-year crediting period.

The Staff Presentation requested feedback on whether to incorporate requirements for sites to be capable of both LD and MHD refueling. Based on H Cycle's own assessment and discussions with fuel dispensers in the state, we do not support the requirement to incorporate LD fueling in MHD stations. MHD fueling will require different equipment parameters (e.g. nozzle rates, storage capacities) and layouts, driven by filling behavior and ingress/egress considerations. Furthermore, delivered hydrogen pressure may also vary between the two, as it is possible to design a viable MHD station dispensing at 350 barg, whereas LD typically requires 700 barg.

Finally, H Cycle recommends that CARB consider how to leverage the HRI program to support investment in new renewable hydrogen supply projects, with an emphasis on promoting new production capacity and reducing reliance on existing steam methane reformers ("SMR") paired with biomethane credit procurement. For instance, the program could adjust the level of capacity crediting based on renewable hydrogen content or make receipt of capacity credits in the future contingent on increasing renewable content over the 15-year crediting period. Furthermore, the program could offer additional incentives for procuring hydrogen from new facilities, as opposed to utilizing existing SMR procuring biomethane credits.

Development of a new Tier 1 CI calculator for hydrogen pathways that includes organic waste-to-hydrogen through thermal conversion, and considers crediting such a pathway with landfill methane avoidance

H Cycle recommends the development of a new Tier 1 CI calculator for hydrogen pathways. We have observed that throughout the LCFS Program, the list of recognized hydrogen pathways is limited to those for SMR and electrolysis technologies. H Cycle's technology is a conversion solution for biogenic materials (organics and biomass) that produces low-carbon hydrogen



444 Castro Street, Suite 710
Mountain View, CA 94041

without being in the SMR or electrolysis categories. The lack of a Tier 1 calculator complicates our process for obtaining an LCFS pathway designation. Should CARB institute a Tier 1 calculator for hydrogen pathways, H Cycle urges CARB to consider the inclusion of biogenic feedstock conversion to hydrogen through thermal conversion pathways.

Similarly, the LCFS Tier 1 calculator provides landfill GHG avoidance credits for pathways diverting biogenic feedstock from alternative fates (e.g. dairy lagoon or landfilling) but this credit is only made available to anaerobic digestion (“AD”) pathways. H Cycle recommends the expansion of methane avoidance credits in the Tier 1 calculator to include approaches other than AD, such as thermal conversion.

Expanding the applicability of landfill GHG avoidance credits to thermal conversion enhances the fairness and consistency of the LCFS Program while providing a critically needed economic driver to develop landfill diversion technologies and projects beyond AD. Climate science is now very clear that reducing short-lived climate pollutants (“SLCP”) emissions is by far the most impactful step we can take to address climate change as it is one of very few measures that begins to cool the climate right away. As the Air Board’s *Short-Lived Climate Pollutant Reduction Strategy* states, “The science unequivocally underscores the need to immediately reduce emissions of short-lived climate pollutants (SLCPs).” The importance of harnessing organic waste is clearly recognized by CalRecycle’s recent report “Analysis of the Progress Toward the SB 1383 Organic Waste Reduction Goals” which:

- Highlights the scale of the challenge ahead of us (27 million tonnes per annum of organic waste must be diverted in a beneficial and cost-effective manner);
- Showcases the importance of novel approaches complimentary to conventional organic diversion methods (namely anaerobic digestion and composting); and
- Points to the promise of technologies like H Cycle’s that can handle a wide range of difficult waste streams in an environmentally friendly process.

H Cycle’s numerous commercial interactions with waste haulers across the state confirm the value proposition of thermal conversion pathways - namely the ability to handle a wide range of mixed organic material that are difficult to purify further (e.g. contain glass, textiles, metals) or that are not suitable conventional biological treatment (e.g. compost or anaerobic digestion). Such materials often have limited cost-competitive options besides landfilling.

Finally, supporting thermal conversion approaches to biogenic feedstocks is a critical strategy for California to deploy at scale due to the imperative of carbon removal. The seminal report on methods by which California can achieve carbon neutrality was developed by Lawrence Berkeley National Laboratories.¹ The “Getting to Neutral” report concluded that “gasifying biomass to make hydrogen fuel and CO₂ has the largest promise for CO₂ removal at the lowest cost and aligns



444 Castro Street, Suite 710
Mountain View, CA 94041

with the State’s goals on renewable hydrogen.”¹ It also found that the potential climate benefit (captured carbon plus avoided emissions) from the strategy is equivalent to 126.5 million tons of CO₂ per year, at a weighted average cost of \$29.77/ton. This potential climate benefit is more than the greenhouse gas (“GHG”) emissions from every car on California’s roads today at costs equivalent to current prices in California’s Cap-and-Trade program. Based on the LBNL analysis, renewable hydrogen from biomass and organics is one of the three pillars of carbon neutrality for California and might represent the single most promising climate strategy in California.

Extending book-and-claim accounting for low-carbon intensity electricity for hydrogen production beyond electrolysis to include non-fossil technologies

H Cycle strongly recommends that the LCFS Program allow the indirect (“book-and-claim”) accounting for the low-carbon electricity required for low-CI hydrogen production via methods beyond electrolysis, particularly methods involving recognized conversion pathways for biogenic/non-fossil feedstocks.

Under existing regulations for hydrogen as a transportation fuel or used in the production of transportation fuel (e.g. in refining), indirect accounting (i.e. renewable energy power purchase agreements, renewable energy certificate purchases) for low-carbon electricity is only allowed for the production of hydrogen through electrolysis. In scenarios where such indirect accounting is not allowed, the environmental attributes of low-carbon electricity can only be captured by a non-electrolysis hydrogen facility if there is a direct connection from the generation source to the facility (i.e., behind-the-meter). For low-CI hydrogen facilities, just like for electrolysis facilities, there are many considerations that will affect where to site a hydrogen production facility. Site selection criteria often necessitate separating the hydrogen production facility from a renewable electricity generation site. Hydrogen production may require closer proximity to biogenic feedstocks and/or hydrogen offtakers, rather than a source of renewable electricity, in order to minimize costs, transportation emissions and other potential impacts.

H Cycle believes that this is an artificial distinction that is inconsistent with California’s GHG policy objectives and hydrogen’s potential. Given that California has an abundance of waste feedstocks including biomass from forest treatment, agriculture residues and municipal solid waste that can be used to produce transportation fuels using advanced technologies, it is essential for the LCFS Program to enable low-carbon hydrogen production solutions beyond electrolysis that can

¹ 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. 5, available at https://www.gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf.



444 Castro Street, Suite 710
Mountain View, CA 94041

benefit from flexibly contracted low-carbon electricity supply. This imperative is strengthened by Governor Newsom’s recent letter to Chair Randolph emphasizing that “state agencies plan for an energy transition that avoids the need for any new natural gas plants to meet our long-term energy goals while ensuring reliability and meeting growing demand for electricity.”²

The Governor’s letter also called out the importance of zero-carbon, clean energy sources including hydrogen to achieve this future and requested that “CARB evaluate and consider an increase in the stringency of the Low Carbon Fuel Standard and to work with relevant agencies to accelerate refinery transitions away from petroleum to the production of clean fuels.”³ For the LCFS Program to play its optimal role in decarbonizing and phasing out fossil fuels, it must include pathways for biogenic feedstocks that can achieve similar or better (i.e., negative carbon) emission outcomes than electrolysis. Such an approach simultaneously advances state goals to dramatically reduce short-lived climate pollutants, enable waste and forest management, minimize agricultural burning and achieve other climate priorities.

We strongly believe thermal conversion pathways to hydrogen should be considered a low-CI solution in the same light as electrolysis in the eyes of the Program – both can achieve greater levels of decarbonization through low-carbon electricity procurement. Furthermore, lifting the existing book-and-claim restriction will help grow not only the clean hydrogen industry but also the suppliers of zero-carbon power. As the levelized cost of renewable technologies such as wind and solar continues to fall, the LCFS Program should not limit the benefits of sourcing renewable electricity to any one specific hydrogen production technology.

Conclusion

H Cycle thanks the California Air Resources Board for its consideration of our input regarding the Staff Presentation on the potential changes to the LCFS Program. Please do not hesitate to contact us if any further input or clarification would be helpful. We look forward to continuing to support the Program and providing input towards its success.

Sincerely,

A handwritten signature in black ink, appearing to read 'Karim Ibrik', is written over a horizontal line.

Karim Ibrik
Chief Technology Officer

² Governor Gavin Newsom Letter of July 22, 2022, to CARB Chair Liane Randolph, at page 3, available at <https://www.gov.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf?emrc=1054d6>

³ Id. at p. 3, 4.