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February 26, 2024

Commissioner Daniel Werfel
Internal Revenue Service
CC:PA:LPD:PR (REG-117631-23)
Room 5203
P.O. Box 7604
Ben Franklin Station
Washington, DC 20044

Re: H Cycle Comments on the Internal Revenue Service's Notice of Proposed Rulemaking – Section 45V Credit for Production of Clean Hydrogen (REG-117631-23; 88 FR 89220)

Dear Commissioner Werfel:

Thank you and your team's tireless efforts to advance the Notice of Proposed Rulemaking (NPRM) regarding the "Section 45V Credit for Production of Clean Hydrogen; Section 48(a)(15) Election To Treat Clean Hydrogen Production Facilities as Energy Property" (hereinafter referred to as "45V Credit"). H Cycle values this opportunity to provide feedback to the Internal Revenue Service ("IRS") and U.S. Department of the Treasury ("Treasury").

Headquartered in Concord, California, H Cycle specializes in producing low-carbon hydrogen through our innovative waste processing system, effectively diverting municipal and organic waste from landfills. We commend your leadership and acknowledgement of clean hydrogen as a pragmatic and forward-looking component to America's energy future.

Congress passed the Inflation Reduction Act (IRA) to supercharge investment in a new generation of technologies including a specific intent to rapidly scale clean hydrogen production, transport, and use to speed the decarbonization of critical segments of the U.S. economy, create jobs, and enhance energy security. Along with the Bipartisan Infrastructure Law, Congress spoke clearly – the development and deployment of clean hydrogen will shape the nation's clean energy trajectory. Projections suggest that clean hydrogen adoption in the U.S. could yield a 10 percent reduction in economy-wide emissions and generate approximately 3.4 million jobs by 2050.[1] To harness these historic opportunities, industry and government must work in concert to achieve America's goal as a global clean hydrogen champion.

Companies are now deploying all types of clean hydrogen projects; however, where and when many of these investments will materialize remain uncertain, influenced in part by policy decisions. Despite the robust and commercial readiness of clean hydrogen technologies, they face stiff competition from cheaper and established fossil fuels. For instance, renewable hydrogen currently carries a price tag of approximately $7-10/kg, while fossil-based hydrogen is available for $2- 3/kg,

[1] *Road Map to a US Hydrogen Economy* at https://h2fcp.org/sites/default/files/Road-map-to-a-US-hydrogen-economy_Executive-Summary.pdf?_ga=2.64305190.867347766.1688755025-1708075037.1687979596 (Feb. 19, 2024).

depending on the region. Like any technology, economies of scale will play a pivotal role in driving down costs over time. As you rightly acknowledge, access to incentives such as the 45V Credit is crucial for leveling the playing field and kickstarting the scaling process.

As you finalize the 45V Credit rulemaking, we urge you to remain mindful of both Congressional intent and the Administration's overarching objectives, namely, enhancing energy security, fostering job creation, and decarbonizing the economy's most carbon-intensive sectors. Clean hydrogen incentives that include unworkable requirements will thwart these goals, shift clean hydrogen investments overseas, and undermine America's global leadership in clean hydrogen.

1) PER Should Account for Innovative Technologies

While not yet operating, H Cycle's technology can propel America's clean energy future, and the financing of our projects can be facilitated through the opportunity to petition for a Provisional Emissions Rate ("PER"), which gives investors confidence in the carbon intensity scoring methodology to be applied to 45V qualification. While we eagerly await further details on the PER process, expected April 1, 2024, we want to underscore key areas for the IRS and Treasury to consider for 45V Credit rule promulgation.

Regarding the PER process, we understand that renewable energy certificates ("RECs") and energy attribute certificates ("EACs") will be considered as the U.S. Department of Energy ("DOE") determines the provisional emissions rate. However, it is unclear how the DOE will make this determination for producers who have not made a full forward purchase.

For companies like H Cycle, we hesitate to submit our electricity plans in the absence of a full forward purchase agreement. Instead, we request the IRS and DOE to consider allowing applicants to estimate their EAC characteristics to fulfill the provisional carbon intensity ("CI") score requirement. Under this approach, applicants would verify that the submitted EACs meet or exceed the estimated values for the PER to remain valid. Alternatively, we recommend that the IRS permit EAC applicants to seek the PER based on an estimated procurement level of compliant EACs. This method would place the responsibility on applicants to obtain sufficient EACs to validate the provisional CI score. By addressing the forward purchase obligation limitation at the time of PER application, this option would enable more renewable hydrogen projects to be developed and financed, especially as 45V-compliant EAC markets continue to mature.

2) 2023 45V GREET Model Hinders Important Feedstock Options and Technological Pathways

Numerous provisions outlined in the 45V Credit NPRM have a considerable effect on current and future opportunities for low carbon hydrogen production, notably impacting the options of the removal of feedstocks as delineated in earlier iterations of the 45V GREET model.

When the IRA was enacted, the legislation contemplated the choice of feedstocks and referenced the GREET model, which included a range of pathways from feedstock to fuel. An example of the pathways enumerated in the prior GREET model included municipal solid waste (MSW) to methane via anaerobic digestion, which can be processed in a steam methane reformer to yield hydrogen. These methodologies for greenhouse gas (GHG) calculations could then be applied to innovative production routes, like H Cycle's MSW-to-hydrogen technology.

However, the 2023 45V GREET calculator takes a retrograde step by excluding several pivotal feedstock options and technological pathways. Notably, while MSW was included in the 2022 GREET H2 Calculator and is present in the broader GREET framework, it is conspicuously absent in the 2023 version.

The DOE Argonne National Laboratory's December 2023 GREET report highlights the benefits of utilizing diverse feedstock options especially those pathways that use renewable natural gas (RNG) as a process fuel or feedstock.[2] The report summarizes that the life cycle assessment (LCA) results of RNG are subject to further revisions to address technical uncertainties, especially related to counterfactual scenario assumptions for wastes that are used for RNG production.[3] The counterfactual for new MSW to RNG projects is well understood and could be applied as a basis to H Cycle's technology to determine carbon intensity.

Importantly, no U.S. jurisdictions currently prohibit methane emissions from MSW, nor is avoided methane from alternative uses of MSW considered in the lifecycle carbon analysis as current structured in DOE life cycle analysis documentation. Given the pressing issue of landfill emissions, including MSW as a feedstock for hydrogen production will help reduce organic material landfilling and consequent methane emissions.

In light of these considerations, we urge the IRS, Treasury, and DOE to explore alternative pathways within the 2023 45V GREET model, specifically those leveraging MSW as a feedstock with the goal of producing low carbon intensity hydrogen.

3) Hourly-matching and Additionality Dismiss the Objectives of Clean Energy Generation

Regarding your request for comment at *(V)(C)*: immediately requiring a nascent industry to track electricity on an hourly basis and only with new, additional renewable power generation would be unprecedented and incongruent with the spatial and temporal variability of intermittent renewables.

According to the Department of Energy's *Pathways to Commercial Liftoff* report, this approach would necessitate up to 200 gigawatts of new renewables online by 2030 solely for hydrogen production – a scale roughly equivalent to all wind and solar generation ever built in the United States. Even studies commonly cited in support of additionality demonstrate minimal emissions benefits, especially in realistic and future grid scenarios.[4] Imposing disproportionate burdens and costs on a single industry for grid decarbonization would be counterproductive and have a chilling effect on domestic clean hydrogen projects.

[2] *See*, U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version GREET1_2023 (Dec. 2023).
[3] *See, Id.*
[4] Wilson Ricks et al, *Minimizing Emissions from Grid-based Hydrogen Production in the United States*, Environ. Res. Lett. 18 014025 *at* Figure 2 (Jan. 2023), *available:* https://iopscience.iop.org/article/10.1088/1748-9326/acacb5/meta.

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We believe that overly restrictive proposals for hourly matching, additionality, and deliverability have the potential to disrupt the delicate balance between fostering clean hydrogen growth and ensuring environmental integrity in this emerging market landscape.

H Cycle and our clean hydrogen industry partners appreciate your work advancing the 45V Credit. Our industry stands poised and fully committed to driving forward our shared objectives of enhancing energy security, fostering job creation, and accelerating decarbonization efforts. It is crucial for federal leaders to collaborate closely with their state counterparts to effectively stimulate the early growth of U.S. clean hydrogen while upholding the environmental integrity of the market.

In addition to the comments set forth above, please find additional information enclosed as **Appendix 1** – H Cycle's October 19, 2022, Comments on the DOE's Clean Hydrogen Production Standard Draft Guidance. We welcome additional opportunities to elaborate on how this Administration can foster innovation and advance America's clean hydrogen future.

Sincerely,

Brandon Cowart
CEO
H Cycle, LLC
www.hcycle.com

APPENDIX – H Cycle's Comments on DOE's Clean Hydrogen Production Standard Draft Guidance (Oct. 19, 2022)

APPENDIX 1

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October 19, 2022

Hydrogen and Fuel Cell Technologies Office
Office of Energy Efficiency & Renewable Energy
Department of Energy
Forrestal Building, 1000 Independence Avenue
Washington DC, 20585

Submitted via email to Cleanh2standard@ee.doe.gov

RE: Comments on U.S. Department of Energy Clean Hydrogen Production Standard (CHPS) Draft Guidance

Dear Hydrogen and Fuel Cell Technologies Office:

H Cycle, LLC ("H Cycle") appreciates the Department of Energy ("DOE") moving forward with the development of a Clean Hydrogen Production Standard ("CHPS"). Below you will find our comments and recommendations regarding the DOE's initial proposal and guidance for the CHPS. We believe the following recommendations will benefit the envisioned Hydrogen Hubs as part of the Bipartisan Infrastructure Law ("BIL"), the implementation of the Inflation Reduction Act's ("IRA") Hydrogen Production Tax Credit ("PTC") and the US hydrogen sector in general.

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 the Western United States. Our solution can utilize a diverse composition of waste biogenic feedstocks (post-separated municipal solid waste, agricultural residues, woody biomass from wildfire risk reduction projects) to produce a renewable hydrogen product, thereby reducing methane emissions from landfill and other disposal methods. 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, heavy-duty trucking and sustainable aviation. We are excited to work with the DOE to deploy our solution and support the nation in meeting its climate, sustainability and air quality goals.

Comment Scope

H Cycle appreciates the opportunity to provide comments regarding the following questions posed for stakeholder feedback, per the DOE's CHPS Draft Guidance Document.

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1. Point (b) under "Methodology" (section 2)

Use of some biogenic resources in hydrogen production, including waste products that would otherwise have been disposed of (e.g., municipal solid waste, animal waste), may under certain circumstances be calculated as having net zero or negative CO_2 emissions, especially given scenarios wherein biogenic waste stream-derived materials and/or processes would have likely resulted in large GHG emissions if not used for hydrogen production. What frameworks, analytic tools, or data sources can be used to quantify emissions and sequestration associated with these resources in a way that is consistent with the lifecycle definition in the IRA?

H Cycle provides in this letter a review of available frameworks that can be applied for hydrogen production from biogenic resources. H Cycle recommends the use of a simplified calculation approach accounting for methane avoidance, while accounting for biogenic CO_2 as net-neutral.

2. Point (c) under "Implementation" (section 3)

Should renewable energy credits, power purchase agreements, or other market structures be allowable in characterizing the intensity of electricity emissions for hydrogen production? Should any requirements be placed on these instruments if they are allowed to be accounted for as a source of clean electricity (e.g. restrictions on time of generation, time of use, or regional considerations)? What are the pros and cons of allowing different schemes? How should these instruments be structured (e.g. time of generation, time of use, or regional considerations) if they are allowed for use?

H Cycle strongly recommends the allowance of indirect accounting, or "book-and-claim", for hydrogen producers to claim zero-carbon electricity in the production of clean hydrogen. H Cycle details the rationale for this recommendation along with suggested parameters around this provision.

We hope that the DOE will consider our input and analysis as the Department pursues implementation. Further, we are hopeful these comments are the start of ongoing discussions. H Cycle encourages the Department to seek additional stakeholder input through issue-specific workshops and stakeholder roundtables.

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Comments Detail and Background

Comment 1: Use of Biogenic Waste Resources for Hydrogen Production

H Cycle commends the DOE for recognizing the value of biogenic waste resources for hydrogen production pathways. H Cycle firmly believes that the large quantities of this resource can play a pivotal role in the development of low-cost renewable hydrogen, and in doing so mitigate substantial GHG emissions resulting from conventional disposal routes (e.g. landfilling). H Cycle's comments in this section are focused on the available frameworks and data sources used to quantify the emissions avoidance associated with these pathways. The comments center on diversion of Municipal Solid Waste ("MSW") organic fractions from a base case of landfilling (referred to as "waste-to-hydrogen").

H Cycle has surveyed a variety of lifecycle methodologies to score the avoided emissions of landfilling in waste-to-hydrogen pathways, which we describe below, to serve as a resource for DOE's CHPS development efforts. The methodologies converge around a few central concepts but diverge in a number of ways from each other, resulting in differing carbon intensity scores. The central concepts underpinning these methodologies are:

(1) Carbon content in waste subcomponents (e.g. food, paper) – commonly referred to as Degradable Organic Carbon ("DOC"). This value ranges from 10% to 70% on a wet basis.
(2) Degradable fraction of carbon content – refers to the portion of carbon that undergoes degradation to landfill gas under anaerobic conditions. This value has a default value of 50% (as per the IPCC)[1], however several studies have attempted to derive this value for subcomponents resulting in a range as low as 20% to as high as 87%.
(3) Landfill gas capture efficiency – refers to the portion of landfill gas that is captured and routed to flare or for energy production. The IPCC assumes a default value of 20%[2], while other models utilize a range of 50% to 80% factoring for various landfill-specific factors (e.g. cover type, weather).[3]
(4) Landfill gas oxidation factor – refers to the portion of uncaptured methane that oxidizes in the soil cover. This factor ranges from 10 to 30%, with a typical default value of 10%.[3]
(5) Carbon balance approach – refers to how carbon emissions or sequestration is accounted for in determining the ultimate carbon intensity for a fuel product.

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[1] Hiraishi, J. Waste management - IPCC Chapter 5 Good Practice Guidance. Retrieved October 17, 2022, from https://www.ipcc.ch/site/assets/uploads/2018/03/5_Waste-1.pdf (Note: IPCC default is 0.77 excluding lignin)
[2] Bogner, J. (2007). Waste management - IPCC Chapter 10. Retrieved October 17, 2022, from https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg3-chapter10-1.pdf
[3] (2020) US EPA Documentation for Greenhouse Gas Emissions and Energy Factors Used in Waste Reduction Model (WaRM) – Management Practices Chapter. Retrieved October 17, 2022, from https://www.epa.gov/sites/default/files/2020-12/documents/warm_management_practices_v15_10-29-2020.pdf

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H Cycle has reviewed four methodologies in depth and outlines the key differences in point (5) (stated above as carbon balance approach), which is most pertinent to the development of a waste-to-hydrogen approach in the CHPS. Defining (5) correctly sets the baseline avoided emissions, upon which process energy and other emissions can be added to determine the complete lifecycle carbon intensity of hydrogen. The four methodologies reviewed are:

(1) The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies ("GREET") Model by Argonne National Laboratory
(2) California's Low Carbon Fuel Standard ("LCFS") Tier 1 Organic ("T1 OW") Waste Calculator
(3) Environmental Protection Agency ("EPA") Waste Reduction Model ("WaRM")
(4) Totality of Emissions ("TOE") approach utilized initially by CARB in the assessment of high solids anaerobic digestion ("HSAD")[4]

The table below showcases key differences in carbon accounting across the four methodologies.

Method	Avoided Landfill Emissions	Waste-to-Hydrogen Emissions
GREET	Accounts for leaked methane and biogenic CO_2 resulting from any combustion; does not include CO_2 emitted from the landfill; accounts for some carbon sequestration assumed in landfills for the non-degradable fraction of carbon.(1)	Accounts for leaked methane and biogenic + fossil(2) CO_2 resulting from any combustion; accounts for some carbon sequestration in digestate, compost, or otherwise.
LCFS T1 OW	Primarily non-CO_2 emissions (mainly methane); does not account for carbon sequestration assumed in landfills for the non-degradable fraction of carbon.	Primarily non-CO_2 emissions (mainly methane); does not account for carbon sequestration in digestate, compost, or otherwise.
EPA WaRM	Primarily non-CO_2 emissions (mainly methane); accounts for some carbon sequestration assumed in landfills for the non-degradable fraction of carbon.(3)	Primarily non-CO_2 emissions (mainly methane); accounts for fossil CO2 emissions; accounts for some carbon sequestration in digestate, compost, or otherwise.
TOE	All GHG emissions, including biogenic CO_2.(4)	All GHG emissions, including biogenic CO_2.

[4] Staff Report (2014), Low Carbon Fuel Standard (LCFS) Pathway for the Production of Biomethane from High Solids Anaerobic Digestion (HSAD) of Organic (Food and Green) Wastes, California Air Resources Board

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- Note 1: This approach assumes non-degradable fraction of carbon in waste is stored in the landfill and is accounted for as permanent storage.
- Note 2: Fossil carbon is primarily found in plastics in waste; plastic is assumed to be wholly non-degradable and is therefore stored permanently in a landfill, whereas in a waste-to-hydrogen pathway the plastic is ultimately converted to CO_2.
- Note 3: The EPA WaRM's approach aligns with the GHG Inventory method and is commonly referred to as the "Carbon Neutral" approach, where biogenic CO_2 is simply disregarded from the carbon accounting calculations as it is assumed to be recaptured by biogenic sources. This assumption holds if waste is produced from sustainably sourced biogenic materials (e.g. sustainably-managed farmed forests as opposed to deforestation).
- Note 4: The TOE approach compares the positive emissions (CO_2, CH_4, or otherwise) from landfilling and a waste-to-hydrogen pathway, without accounting for "negative" emissions resulting from potential sequestration of carbon in landfill or otherwise. This approach is in-line with ISO 14040 in that the net GHG emissions correspond to the difference between the system and reference system.

Furthermore, it should be noted that GREET and LCFS T1 OW only showcase their methodology for Renewable Natural Gas ("RNG") production from Anaerobic Digestion ("AD"). Nonetheless, this can be readily adapted to waste-to-hydrogen processes, such as thermal conversion (gasification, pyrolysis) and other approaches.

H Cycle recommends the use of a model that accounts for biogenic CO_2 emissions as net-zero with additional crediting provided to diversion pathways for avoided non-biogenic CO_2 emissions. This approach is utilized by CARB's T1 OW calculator, and is essentially a simplified approach that accounts for avoided non-CO_2 emissions only. If a more comprehensive approach is required, H Cycle recommends the use of the EPA WaRM and TOE approaches for waste-to-hydrogen pathways, as they best represent the lifecycle of a waste-to-hydrogen pathway and are aligned with other internationally sound methods, namely IPCC GHG Inventory Protocol and ISO 14040. H Cycle recommends that the emissions factors and other factors used in GREET be applied to the carbon balancing approach of these two methods. Using these approaches, when coupled with organics-rich waste, it is quite reasonable to expect a net-zero or lower carbon intensity for the product hydrogen.

H Cycle offers additional clarifying comments regarding waste-to-hydrogen's value proposition and the criticality of enabling the nascent hydrogen sector:

(1) Waste-to-hydrogen should encompass gasification in addition to AD – From the research conducted at Lawrence Livermore National Laboratories ("LLNL") the "*Getting to Neutral*" authors conclude that a significant fraction of the California's renewable gas potential is

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found in cellulosic and lignocellulosic waste. These wastes are not suitable for anaerobic digestion and are ideally suited for thermal conversion processes; it is estimated that 85% of the state's bio-energy potential lies in such wastes.[5]

Additionally, gasification is a net generator of energy, multiplying the impact renewable power can have on decarbonization goals. Gasification takes advantage of the inherent energetic value of organic materials, extracting their energy as low carbon molecules (such as hydrogen). The process energy input to operate the process are a small fraction of the final product's energy. For instance, gasification can utilize 1 kWh of clean power to produce 2 kWh of hydrogen energy, whereas electrolysis utilizes 1 kWh of clean power to produce 0.6 kWh of hydrogen energy. The benefits from an energy efficiency standpoint will ultimately help advance President Biden's "Plan for Climate Change and Environmental Justice" by lessening the need for over-building renewable energy production and transmission in order to produce the renewable hydrogen that the decarbonized economy of the future will require.

(2) Pairing Waste-to-Hydrogen with Carbon Capture and Storage ("CCS") is a powerful strategy – Bioenergy coupled with CCS ("BECCS") is a vital carbon dioxide removal ("CDR") option. When paired with CCS, gasification offers the additional benefit of offering one of the most economic and significant carbon dioxide removal strategies, which will be needed to achieve carbon neutrality in the US, as identified by the DOE's Energy Earthshot and Carbon Negative Shot Initiatives. For instance, the LLNL report (*"Getting to Neutral"*) determined that BECCS can provide the majority of the carbon-negative emissions needed by California to reach carbon neutrality by 2045, stating (pg. 5): "Gasifying biomass to make hydrogen fuel and CO_2 has the largest promise for CO_2 removal at the lowest cost and aligns with the State's goals on renewable hydrogen."

(3) Landfill methane collection efficiency is uncertain, yet the lifecycle of waste-to-hydrogen is highly sensitive to this parameter – Landfill collection efficiency is perhaps the single most important variable in determining the carbon intensity of any waste-derived fuel. Unfortunately, the parameter is widely varying in the literature, with some studies showcasing a collection efficiency as low as 20% (compared to a typical base value of 75%).[6]

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[5] 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 .
[6] Giordano, Charles. Top-down and Bottom-up Landfill Methane Emissions Estimates: A Comparative Study of the European Union and the United States. Budapest, Department of Environmental Sciences and Policy of Central European University, 2020.

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Recently, NASA's Jet Propulsion Laboratory and other highly credible data sources have provided real-world monitoring data, rather than outdated estimates of landfill methane emissions. NASA's monitoring data makes clear that landfill emissions are higher – in some case, significantly higher – than previously believed.[7] Furthermore, similar work is being conducted by CalRecycle and CARB, showcasing the large range in leakage rates, leakage of non-CH4 emissions such as Volatile Organic Compounds and Nitrous Oxide, and highlighting the discrepancy with the modeling approaches utilized.[8] Using the latest estimates on collection efficiency will make the carbon intensity analysis more accurate, by basing it on actual data rather than decades-old estimates, and will accelerate the diversion of organic waste from landfills and provide the necessary incentive to produce low-cost renewable hydrogen from organic waste today.

Comment 2: Renewable Power Procurement Instruments

H Cycle strongly supports the allowance of "indirect accounting", such as through renewable energy credit ("REC") purchases, power purchase agreements or energy procurement through community choice aggregation, in order for hydrogen producers to claim zero-carbon electricity feedstock in the calculation of hydrogen lifecycle carbon emissions. H Cycle defines indirect accounting (also referred to as book-and-claim or virtual electricity supply arrangements) as the chain-of-custody model in which decoupled environmental attributes (such as RECs) are used to represent the ownership and transfer of zero-carbon electricity without regard to physical traceability. We view indirect accounting as critical to rapidly scaling clean hydrogen production in the United States and meeting the DOE's Hydrogen Shot target of $1.00 per kilogram levelized cost of hydrogen ("LCOH") this decade. We discuss our rationale below, as well as key parameters we believe should be considered as part of this allowance.

Hydrogen molecules are significantly more difficult to move than electrons. Electricity today takes advantage of a vast network of transmission and distribution lines that can easily flow power across thousands of miles. There is no analogous infrastructure network for the transportation and distribution of hydrogen. Moreover, hydrogen is the lightest known molecule in the universe, and is extremely difficult to move without tube trailers or pipelines that are specifically designed to prevent hydrogen leakage. Hydrogen production facilities should therefore be located as close to end-use customers as possible, such as adjacent to industrial complexes or urban heavy-duty transmission corridors.

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[7] NASA. A third of California methane traced to a few super-emitters. NASA. Retrieved September 8, 2022, from https://www.jpl.nasa.gov/news/a-third-of-california-methane-traced-to-a-few-super-emitters

[8] California Polytechnic State University Prepared for CARB, Estimation and Comparison of Methane, Nitrous Oxide, and Trace Volatile Organic Compound Emissions and Gas Collection System Efficiencies in California Landfills, 2020, from https://ww2.arb.ca.gov/sites/default/files/2020-12/CalPoly_LFG_Study_03-30-20.pdf

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By allowing indirect accounting, hydrogen producers can take advantage of zero-carbon electricity while avoiding the siting constraints associated with constructing co-located wind and solar generation. Without indirect accounting, hydrogen producers would be limited to building dedicated renewable energy facilities “behind the meter” to production facilities to claim zero-carbon electricity. Current renewable electricity sources such as wind and solar require a significant amount of land and make siting hydrogen production close to demand centers extremely challenging if not impossible. While developing dedicated transmission lines to deliver renewable power to hydrogen producers from afar is possible, this would add material development and construction cost and increase the ultimate LCOH; as well as take years of permitting to accomplish.

Indirect accounting is also critical to offering hydrogen producers the lowest possible levelized cost of electricity. Today’s wind and solar projects take advantage of ever-increasing scale to offer competitive electricity prices to the market. This scale advantage disappears if hydrogen producers are forced to develop smaller dedicated behind-the-meter generation in order to claim zero-carbon electricity. A better solution would be to dissociate the physical location of hydrogen production from wind and solar generation, thereby allowing for a lower LCOH via electricity prices supported by economies of scale.

It should also be noted that the producers of clean hydrogen may not have the expertise or risk appetite to develop wind and solar generation alone. As the hydrogen sector is currently in its infancy, producers tend to focus more on de-risking hydrogen production technologies and developing the infrastructure to deliver their product to customers. Producers are unlikely to possess the knowledge, bandwidth or desire to simultaneously pursue wind and solar project development. This risk is better allocated to the many established renewable energy development companies across the country, who can leverage decades of experience and favorable financing terms to deliver zero-carbon electricity at highly competitive prices. Indirect accounting therefore serves to assign project risk to the appropriate entities, instead of compounding an untenable cost burden and project risk on the hydrogen producer.

Importantly, H Cycle’s recommendation on indirect accounting has been affirmed by a prior colloquy on August 6, 2022 in US Senate floor debate regarding Section 13204 (Clean Hydrogen) of the *Inflation Reduction Act* between Senator Tom Carper of Delaware and Senator Ron Wyden of Oregon. In the colloquy, Senator Carper mentions that it is his understanding that “in determining ‘lifecycle greenhouse gas emissions' for this section, the Secretary shall recognize and incorporate indirect book accounting factors, also known as a book and claim system, that reduce effective greenhouse gas emissions, which includes, but is not limited to, renewable energy credits, renewable thermal credits, renewable identification numbers, or biogas credits”;

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to which Senator Wyden concurs.[9] The clarification by the Senators on the intension to allow indirect accounting for purposes of the *Inflation Reduction Act's* clean hydrogen sections is a key marker in support of book-and-claim as part of the CHPS.

H Cycle generally supports the most flexible parameters concerning the indirect accounting principles. In this way, US legislators ensure the fastest deployment of clean hydrogen production and reduction of LCOH to the DOE's $1.00 per kilogram target. These parameters are discussed below.

We strongly urge the Department to limit any requirements on time-matching electricity production and usage to a period no shorter than 30 days. In other words, the number of megawatt-hours of electricity used to produce clean hydrogen should only need to match the number of megawatt-hours purchased at the end of each month. Any settlement period shorter than one month (e.g. hourly or daily) would impose a difficult parameter for producers to overcome in the procurement of renewable electricity – such a provision may for instance require the installation of batteries in order to more consistently deliver zero-carbon power, increasing the cost of power and ultimate LCOH. We therefore recommend a 30 day (or longer) settlement period to promote the most competitive prices of renewable energy for clean hydrogen producers.

We further recommend the Department of Energy avoid any additionality provisions that would require hydrogen producers to source zero-carbon electricity from new renewable generation; in other words, hydrogen producers should be able to contract for zero-carbon electricity with existing generators. Given the momentum of renewable generation build-out across the US, as well as the policy tailwinds offered to renewable energy developers in the *Inflation Reduction Act,* we see little risk in hydrogen producers "cannibalizing" existing renewable electrons from the grid. There are many existing wind and solar assets that operate on a merchant basis – these projects offer a quick and simple contracting opportunity for hydrogen producers to claim zero-carbon electricity, thereby accelerating the deployment of clean hydrogen production in the country. H Cycle moreover suggests that any proof of additionality be limited to requiring the retirement of RECs by or on behalf of the hydrogen producer. This measure would ensure that green attributes are not double counted by the producer and other entities seeking to utilize such credits, such as electric utilities. Requiring producers to retire RECs would also increase the demand for these green attributes, sending a positive market signal to renewable energy developers to increase the supply of wind and solar generation assets on the grid.

Lastly, H Cycle recommends that any indirect accounting provision require electricity to be sourced from a generator within the same or adjacent balancing authority as the hydrogen

[9] Congressional Record Volume 168, Number 133 (Saturday, August 6, 2022), Senate, pgs. S4165-S4195, from https://www.govinfo.gov/content/pkg/CREC-2022-08-06/html/CREC-2022-08-06-pt1-PgS4165-3.htm

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producer. This ensures a "wires-to-wires" connection on the grid that supports the virtual supply arrangement.

H Cycle recognizes the Department's need to continue strengthening the clean hydrogen production industry – we welcome the opportunity to collaborate further with the Department to refine the development of indirect accounting regulation.

Conclusion

H Cycle appreciates the opportunity to offer feedback and recommendations in response to the DOE's request for guidance regarding the Clean Hydrogen Production Standard. We hope that our comments regarding a) the production of clean hydrogen using biogenic resources, and b) the allowance of indirect accounting in the procurement of zero-carbon electricity for clean hydrogen production, are taken into consideration as part of DOE's ongoing efforts to foster a robust clean hydrogen economy in the United States. H Cycle looks forward to continuing engagement with the DOE on the CHPS; we are available at your convenience to discuss our comments in further detail.

Sincerely,

Karim Ibrik
Chief Technology Officer