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IRS REG-117631-23

STARS
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# STARS' Comments to IRS on Proposed Regulation: IRS REG-117631-23

The purpose of this letter is to provide the comments of STARS Technology Corporation (STARS) on the IRS Proposed Regulation on Clean Hydrogen rules, as published in the Federal Register Vol 88, No 245, pp 89220-89255, December 26, 2023.

STARS' comments are focused on the need to avoid delaying the inclusion of Clean Hydrogen produced from Biogas, Renewable Natural Gas (RNG) or other biomass feedstocks, especially those that provide the potential for the production of Carbon-Negative Hydrogen.

## Background on STARS

We are an original equipment manufacturer (OEM) of breakthrough, microchannel process technology – compact, process intensive, microchannel reactors, heat exchangers and separators – that are currently being demonstrated as a pilot plant in southern California. Producing ***clean, carbon-negative hydrogen from RNG, water and electricity***, STARS' ultra-compact chemical "skid" occupies just square meters.

STARS' objective over the next 2-3 years is to improve our system based on lessons-learned from our current pilot plant in southern California, with a new system designed to reduce costs through economies of hardware mass production.

If we are successful, we expect that STARS' Clean $H_2$ Generators can be deployed, on the existing natural gas grid for receipt of RNG through book-and-claim, at or in close proximity to various points where hydrogen is needed. We are also developing a compact, $CO_2$ capture module, that can be mass-produced and deployed with STARS' Clean $H_2$ Generators, to enable $CO_2$ sequestration and/or use for other purposes.

STARS is clearly a stakeholder in the establishment of IRS rules that enable clean hydrogen tax credits. We are very aware that delays in allowing tax credits for clean hydrogen from biomass-based feedstock will negatively affect the near-term economics and deployment opportunities for our systems and will therefore hamper market-based decisions that would support the use of clean hydrogen.

**Summary of our Argument**

A summary version of our argument is that there is an urgent need to address the ***Climate Crisis*** by allowing numerous hydrogen-production paths, including pathways based on the use of biomass feedstocks, including Biogas and RNG, to qualify for benefits of tax credits from the Inflation Reduction Act. The performance of GREET analyses to determine lifecycle carbon intensities is well understood and has been practiced by a number of organizations, including the California Air Resources Board which regularly determines the carbon-intensity of transportation fuels. As a result, there is little difference in difficulty in determine the carbon intensity for biomass paths than for natural gas paths.

Delaying the inclusion of hydrogen production pathways based on Biogas, RNG and other biomass feedstocks delays the opportunity to realize the benefits of carbon-negative hydrogen which can provide substantial near-term reductions in greenhouse gas emissions and offer removal of atmospheric $CO_2$ in meaningful quantities.

**Congressional Intent and the Need for Urgency**

The congressional intent in including hydrogen provisions in the Inflation Reduction Act (IRA; Public Law 117-169) and the Bipartisan Infrastructure Act (BIA; Public Law 117-58) is clearly to accelerate the reduction of Greenhouse Gas (GhG) emissions by enabling the production on clean hydrogen as an alternative for transportation, electricity generation, industrial and other applications. By encouraging the creation of a hydrogen business ecosystem, including hydrogen

hubs and the production of clean hydrogen – using renewable sources, nuclear power and fossil energy – with a clean hydrogen production tax credit for low-carbon hydrogen, Congress aimed to encourage reductions in USA-based GHG emissions.

The need for urgent actions is clear from a variety of reports from agencies like the International Energy Agency and the UN's International Panel on Climate Change, and the commitments from the USA and nearly all other countries to the 2015 Paris Agreement to limit the temperature effects global warming, as identified in Article 2 of the Paris Agreement, to no more than 2.0°C and, preferably, to no more than 1.5°C.

There is international agreement that the countries of the Earth must work together to sharply reduce GhG emissions, targeting the attainment of net-zero emissions by roughly the year 2050. *Overall, this requires annual reductions in GhG emissions of about 4% per year.*

The USA has been more successful than most countries in reducing GhG emissions over the last two decades. In the case of our electricity sector, reductions of over 30% have been achieved since our country's peak emission year of 2005, by shutting down over 300 coal-fired powerplants, replacing them with wind and solar power systems and carbon-lean, natural gas powerplants.

Overall, the reduction in the USA's GhG emissions is averaging about 1% per year since 2005. However, given the current circumstance where the world is now approaching the 1.5°C limit, it is important that Federal agencies, including the IRS, act quickly to incentivize clean hydrogen and establish hydrogen hubs, which will help us reduce emissions from the transportation, commercial and industrial sectors, as directed by the Congress in the IRA and the BIA.

**The Relevance of Biogas, RNG and Other Biomass-Based Pathways to Clean Hydrogen**

It is now clear that biomass-based pathways to ***clean, carbon-negative hydrogen*** offer both cost advantages and the opportunity to remove GhG from the Earth's atmosphere. Recent assessments include:

The Princeton University-led study, "Net-Zero America – Potential Pathways, Infrastructure, and Impacts" (Final Report, October 29, 2021; https://acee.princeton.edu/acee-news/net-zero-america-report-release/).

The Princeton University-led study found that increased use of bioenergy is an important part of the USA's clean energy future, with expectations that bioenergy might represent 10-15%, or more, of the USA's future energy use. This includes carbon-negative hydrogen via BioEnergy with Carbon Capture and Storage/Sequestration (BECCS-$H_2$) pathways, which was identified to have the highest energy delivered per unit $CO_2$ captured among all biofuel options.

The DOE's "U.S. National Clean Hydrogen Strategy and Roadmap" (June 2023; https://www.hydrogen.energy.gov/library/roadmaps-vision/clean-hydrogen-strategy-roadmap).

This DOE report notes positive attributes of hydrogen, produced from biomass and waste feedstocks:

- *"Additional pathways to hydrogen production include biomass gasification with carbon capture and storage and SMR [Steam-Methane Reforming] or ATR [Auto-Thermal Reforming] using feedstocks such as biogas from organic landfill matter, sewage, or agricultural wastes in place of natural gas. These production methods have the potential to be low-carbon or carbon-negative depending on the feedstock."*

- *"When biomass pathways are coupled with CCS, their net emissions have the potential to be negative. For example, when the waste feedstock is diverted from landfills and instead used to make hydrogen, some of the methane generated by processing the waste is also diverted from the atmosphere and thermally converted to clean hydrogen (i.e., methane that would not otherwise have been flared, given regional best practices and regulations).*

The International Energy Agency (IEA) updated study, "Renewables 2023 – Analysis and Forecast to 2028" (https://www.iea.org/reports/renewables-2023).

This IEA report update includes a new chapter ("Special Section: Biogas and Biomethane"). In this chapter, the IEA notes that biogas is *"a ready-to-use technology that can help accelerate decarbonization in the short term"*, and that *"using biogas and biomethane helps build a circular economy around residue and waste valorisation contribute to rural development and creates employment."* The IEA report also notes programs in California, Oregon and Washington that incentivize biogas/biomethane capture and use for transportation, and references the IRA's *"hydrogen production tax credit that includes biogas as a feedstock for hydrogen production."*

The recent IEA report, "Net Zero Roadmap – A Global Pathway to Keep the 1.5°C Goal in Reach"(2023; ).

This IEA report acknowledges recent projections that global emissions of anthropogenic $CO_2$ (37 gigatonnes in 2022) are now expected to peak within the next few years, perhaps as soon as 2025. This is very good news in that it represents the accomplishment of one of the specific objectives of Section 1 of Article 4 of the Paris Agreement and starts us on the path of another: Attaining *a balance between anthropogenic GhG emissions and uptake by sinks*, potentially much sooner than anticipated in the Paris Agreement.[1]

The IEA report also notes that progress in *"Bending the Emissions Curve"* comes from momentum in *"small, modular, clean energy technologies"* including solar photovoltaics, heat pumps, batteries and electric vehicles.

The IEA report additionally discusses the *"comparative pace of the clean energy transition"* and the important role of accomplishing low costs through supply chains and economies of hardware mass production.

Finally, the IEA report recognizes the important of biomass/bioenergy and states that *"carbon capture, utilization and storage (CCUS) hydrogen and hydrogen-based fuels, and sustainable bioenergy are critical to achieve net zero emissions"* and that *"rapid progress [in these areas] is needed by 2030"*.

The DOE/Lawrence Livermore National Laboratory (LLNL) study, "Roads to Removal: Options for Carbon Dioxide Removal in the United States" (December 2023; https://www.llnl.gov/article/50686/new-analysis-outlines-national-opportunities-remove-carbon-dioxide-gigaton-scale).

This DOE/LLNL report includes a chapter entitled "Biomass Carbon Removal and Storage" (BiCRS). Potential $H_2$ production pathways include but are not limited to land and wastewater biogas as well as RNG.

[1] Section 1 of Article 4 of the Paris Agreement states, with italics and underlining added: "In order to achieve the long-term temperature goal set out in Article 2, Parties aim *to reach global peaking of greenhouse gas emissions as soon as possible*, recognizing that peaking will take longer for developing country Parties, and *to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century*, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty."

In identifying Carbon-Negative Hydrogen as a potentially *"dominant BiCRS pathway"*, this chapter notes that *"BiCRS hydrogen has some advantages relative to electrolysis hydrogen, as it does not rely heavily on grid electricity and produces two products of value, decarbonized hydrogen and carbon-removal services."*

In addition, noting that the US DOE has put forward a projected need for 50 million tonnes $H_2$ per year by 2050, this chapter finds that BiCRS pathways *"can produce hydrogen at the scale of this projected need."*

**The Importance of Enabling and Accelerating the Clean Hydrogen Business Ecosystem with Support from the Clean Hydrogen Tax Incentives of the IRA**

The Clean Hydrogen Business Ecosystem requires the synergistic establishment of supply chains (manufacturers that produce clean hydrogen technologies, contractors that set up and deploy clean hydrogen technologies, and operators that will produce clean hydrogen and use clean hydrogen in transportation, commercial, and industrial market sectors).

Two conventional economic graphs are relevant for discussion. One is the conventional "s" curve for new technologies, which typically start out slowly but which experience more rapid growth (the steep part of the "s" curve) in part due to improving economies ("economies of scale" or "economies of hardware mass production").

The other graph is the conventional supply-demand graph, where the intersection of the supply and demand curves identifies the "equilibrium point" that defines both market adoption rates and prices. Here, shifts in the supply curve, such as are attained through economies of scale or economies of hardware mass production, also shift the intersection, "equilibrium point", accelerating deployments.

As with other clean energy technologies, including wind generators, solar photovoltaics and battery electric vehicles, the pace of acceleration depends greatly on the combinations of supply chains, economies of hardware mass production and economies of scale, *and government policies which encourage the marketplace by amplifying the natural economic feedback loops* which occur as costs fall (e.g., the "supply curve") and demand increases.

At this point, the deployment of clean hydrogen technology and infrastructure is growing slowly, aided for example by Pigouvian Subsidies (named for the 20th Century economist, Arthur Cecil Pigou) for fuel cell electric vehicles but hampered

by the fact that most hydrogen deployments require costly distributed infrastructure (for example, at filling stations and transit agencies).

With this in mind, the clean hydrogen tax provisions of the IRA are additional Pigouvian Subsidies (named after the 20th Century economist, Arthur Cecil Pigou) that can stimulate the establishment of supply chains by shifting the supply curve downward, therefore also shifting the equilibrium point in the direction of more rapid deployment.

For example, considering the current economics of hydrogen production and distribution, the $3/kg for the Clean Hydrogen Production Tax Credit established by the IRA is a substantial incentive that should work, in concert with other incentives like the $7500 tax credit for fuel cell electric vehicles, to substantially shift the Supply Curve for Clean Hydrogen production, therefore shifting the equilibrium point, and encouraging large private investment in hydrogen production infrastructure, including manufacturing plants for clean hydrogen generators and fuel cells. That is, the hydrogen production tax incentives are strong motivators for the accelerated development of the required Hydrogen Business Ecosystem and the adoption of clean hydrogen as an alternative to fossil fuels.

On the other hand, failure to rapidly put regulations in place for the hydrogen production tax incentives will delay both the development of the business ecosystem and the adoption of clean hydrogen.

Rather, the need to rapidly reduce fossil carbon emissions, during this decade and beyond, and the opportunity to produce *affordable, carbon-negative hydrogen from biomass-based feedstocks*, including RNG and biogas*, with provisions for $CO_2$ capture* (therefore reducing the GhG content of the atmosphere) demands the thorough implementation of the IRA's clean hydrogen production tax incentives as soon as possible.

## Don't Let the Perfect be the Enemy of the Good

Throughout the Federal Register publication, we observed multiple items where the possibly of negative consequences are discussed, and this has filtered itself strongly into the proposed regulation. For example, concern that clean electricity for water-electrolysis might shift power from clean electricity generators with the possible consequence that additional fossil fuels might then be used for power generation.

As a result, the proposed regulation would not allow the clean hydrogen tax incentives for hydrogen production when the electricity would come from a clean electricity generator that began operation more than three years before the clean hydrogen production facility begins operation.

However, this does not truly consider the continued use of fossil fuels that would be displaced by the development of affordable, clean hydrogen as an alternative. It likewise does not consider the deployment of additional clean electricity generators as we continue to reduce greenhouse emissions from the electrical sector. Or the advantage of hydrogen as an energy storage option, that appears to have better economics than batteries, to backup intermittent electricity production from wind and solar systems.

Currently, there is substantial concern that continued deployment of clean, intermittent electricity production will cause periods where clean electricity generation exceeds electricity demand. It should be clear, however, that the development of a mature, hydrogen business ecosystem will present options where hydrogen, produced from electricity and/or biomass, can be the backup that supports additional solar and wind systems.

An analogous concern about biomass-based hydrogen appears in the report, that development and deployment may lead to greater waste production (that can be used as feedstock). However, this concern should be offset by both the urgency of our need to reduce GhG emissions and the advantage, in our economy, of producing a financial incentive to produce bio-energy and bio-fuels, including hydrogen, that provide additional revenue to our agricultural sector. And by the previously-referenced LLNL report ("Roads to Removal…") that asserts that biomass-based pathways can produce the projected demand for clean, affordable hydrogen while simultaneously removing GhG from the atmosphere.

Thus, we assert that the proposed regulation is too hesitant in its effort to authorize the IRA's clean hydrogen tax incentives over fears that, if we succeed in establishing an effective Clean Hydrogen Business Ecosystem, and substantially reduce GhG emissions, other problems might also have to be solved.

Surely, ***the Climate Crisis is a large enough problem*** that we should act aggressively to accept the clean hydrogen tax incentives, including the allowance for biogas, RNG and other biomass-based feedstocks ***that were mandated by Congress*** while we also monitor for possible foreseen and unforeseen consequences.

Given the fact that, as expressed earlier in this writeup, there is already substantial proven capability to apply the GREET methodology to determine the carbon-intensity of hydrogen from biomass-based resources, including biogas and RNG, we believe that there is no reason to avoid including these pathways in the current rulemaking.

**Finally, as if that wasn't enough…**

There is at least one additional significant reason to not delay the inclusion of biomass-based pathways in the clean hydrogen production tax provisions: The current climate state of affairs, including recent warming and wildfires, is causing serious reactions in the public.

Aggressive actions to reduce GhG emissions, including the inclusion of biomass-based pathways to clean hydrogen in the present rulemaking effort, can help the nation accelerate our use of fossil fuels, gain greater control over atmospheric GhG levels and reduce "climate anxiety".

More specifically, an impression is growing that we are failing to get the GhG content of the atmosphere under control. For young adults and teenagers, this manifests for many as a sense of impending doom. This negatively affects mental health and, for some, leads to decisions not to go to college, not to marry and have children, etc, especially if manifestations of impending doom are becoming apparent and will continue to grow over the next few decades.

For some others, this additionally creates an impression that there's no sense in trying to reduce GhG emissions. If we're doomed anyway, we might as well continue to burn fossil fuels.

With biomass-based pathways including RNG and biogas, which are near-term, "low-hanging fruit", included in the present rulemaking, we can more aggressively produce clean hydrogen, including carbon-negative hydrogen, with $CO_2$ sequestration and the removal of $CO_2$ from the atmosphere.

And by proving our ability to make serious progress, including the accomplishment of actual reductions in atmospheric $CO_2$ levels within a few decades, we provide *hope for the future*; and we recover from climate anxiety.

Sincerely,

Robert S Wegeng, President & CTO
STARS Technology Corporation

"That's one small step for a man…"