MOLTEN

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SUBMITTED ELECTRONICALLY - February 26, 2024

Re: Treasury Department and IRS Request for Comments on Proposed Rule on Implementation of Section 45V Credit for Production of Clean Hydrogen; Section 48(a)(15) Election to Treat Clean Hydrogen Production Facilities as Energy Property, IRS-2023-0066.

Molten Industries is pleased to have the opportunity to provide comments in response to Treasury Department and Internal Revenue Service Request for Comments on Proposed Rule on Implementation of Section 45V Credit for Production of Clean Hydrogen; Section 48(a)(15) Election to Treat Clean Hydrogen Production Facilities as Energy Property, IRS-2023-0066.

Molten Industries is an Oakland, California-based startup with a goal to produce the lowest-cost, cleanest hydrogen on the planet. Molten's simple process cracks methane at white hot temperatures into hydrogen and synthetic graphite using renewable electricity, a technology called methane pyrolysis. High temperatures are achieved using electrical resistive heating, similar to a toaster oven. The process creates no carbon dioxide, instead producing hydrogen and a valuable synthetic graphite co-product that can be used in a variety of products, including lithium-ion batteries, steelmaking electrodes, refractories, concrete, paints, plastics, and tires. Molten's methane pyrolysis process has the potential to achieve well-to-gate lifecycle greenhouse gas emissions below 0.45 kg CO_2e/kg H_2.

Methane pyrolysis is an important clean hydrogen production technology for the United States. Molten Industries and other companies in the methane pyrolysis space have made important strides towards scaling the technology to deliver clean, low-cost hydrogen, with the potential to decarbonize sectors such as steel, fertilizers, shipping, and chemicals. Molten Industries' ability to produce a graphite co-product further advances critical energy priorities of the United States, including lithium-ion batteries that use graphite anodes.

While clean methods of hydrogen production exist – like water electrolysis – they rely on large amounts of renewable wind and solar energy. Methane pyrolysis has the potential to use five times less energy than water electrolysis per kilogram of hydrogen produced. Methane pyrolysis also overcomes challenges to hydrogen transport and storage by using methane as a hydrogen carrier, utilizing existing natural gas networks to produce hydrogen on-site.

Molten targets responsible methane feedstock procurement from certified low-emissions natural gas sources[1,2] and waste streams such as dairy farms, waste-water treatment plants, and landfills. When using renewable natural gas (RNG) from waste methane sources, Molten's process has the potential to even achieve carbon negative well-to-gate lifecycle emissions by sequestering carbon from methane as a solid. This can be achieved with a pure RNG feedstock or a blended feedstock of a small amount of RNG with natural gas.

[1] https://miq.org
[2] https://www.projectcanary.com

Summary of Comments:

- Methane pyrolysis should be included as a 45VH2-GREET pathway as soon as possible, given its commercial readiness and ability to provide low-cost, clean hydrogen.
- The methane loss rate should become foreground data in future releases of the 45VH2-GREET model, provided that certificates of Certified Natural Gas or Responsibly Sourced Gas are used with upstream emissions intensity verified by independent third parties.
- Graphite or carbon black co-products of clean hydrogen produced methane pyrolysis can easily be accounted for using the ISO 14044:2006.2 standard through the displacement method of emissions, and the 45VH2-GREET model should implement displaced emissions credits for carbon black and synthetic graphite, similar to existing steam, oxygen, and nitrogen displaced emissions credits.
- An energy allocation for co-products of clean hydrogen production by methane pyrolysis is not appropriate. This is because the primary co-products generated by methane pyrolysis hydrogen production, including synthetic graphite or carbon black, are not energy carriers.
- The 45VH2-GREET model should permit the use of the actual hydrogen outlet pressure for well-to-gate lifecycle greenhouse gas emission calculations, as long as the outlet pressure equals or exceeds the inlet pressure of the hydrogen-utilizing process. This adjustment would accommodate variations in outlet pressure based on specific industrial applications.
- The 45VH2-GREET model should permit and incentivize the use of high temperature hydrogen and credit for the export value in mmBtus of steam corresponding to the value in mmBtus of heating an equivalent amount of hydrogen from 25C to the high temperature of the hydrogen produced, up to a maximum of the temperature needed for the hydrogen's use at the gate.
- The counterfactual assumption in many RNG use cases today is venting, which we believe to create massive distortions in incentives and uses of RNG. Venting RNG should not be the standard practice today for any waste streams. Flaring is done at many locations where methane is created, and flaring should be the standard counterfactual assumption for RNG.

Below please find our comments in response to the Department of the Treasury and the IRS for public input on Proposed Rule on implementing 45V and 48(a)(15), with headings corresponding to the section name in the Proposed Rule.

Detailed Comments

<u>Section V. Procedures for Determining Lifecycle Greenhouse Gas Emissions Rates for Qualified Clean Hydrogen.</u>

1. ***Regarding foreground data in future version of GREET*** *- Treasury Department and the IRS seek comment on conditions, if any, under which the methane loss rate may in future releases become foreground data (such as certificates that verifiably demonstrate different methane loss rates for natural gas feedstocks, sometimes described as responsibly sourced natural gas).*

Incentivizing the production of hydrogen with a low carbon emission intensity is the primary objective of the 45V tax credit. There should be an incentive to reward clean hydrogen producers for purchasing low lifecycle greenhouse gas emissions Certified Natural Gas or Responsibly Sourced Gas over "normal" natural gas with higher emissions intensity when using methane pyrolysis and steam methane reforming with carbon capture and storage for hydrogen production. The hydrogen PTC and ITC vehicles are excellent methods of encouraging increased monitoring and verification of upstream methane emission intensity and promoting purchasing of low-emission methane.

The methane loss rate, or renewable natural gas (RNG) loss rate should become foreground data in future releases of the 45VH2-GREET model, provided that certificates of Certified Natural Gas or Responsibly Sourced Gas are used with upstream emissions intensity verified by independent third parties. Third party verification organizations such as MiQ (https://miq.org) and Project Canary (https://www.projectcanary.com) provide continuous upstream monitoring along the entire gas value chain and create certificates for natural gas that is <0.05% to <0.2% in methane intensity, depending on the certificate level. These certificates are widely used today and are ready to be added as foreground data to the 45VH2-GREET model.

Furthermore, it is good to see that blending of renewable natural gas (RNG) from dairy farms, waste-water treatment plants, and landfills with natural gas is included in the GREET model for methane feedstocks for hydrogen production via methane pyrolysis or steam methane reforming.

Methane pyrolysis has the potential to achieve well-to-gate lifecycle greenhouse gas emissions below 0.45 kg CO_2e/kg H_2. When using RNG or blends of RNG and certified natural gas, methane pyrolysis has the potential to achieve carbon-neutral or even carbon-negative clean hydrogen production.

2. ***Regarding co-product emission allocation in GREET*** *- The Treasury Department and the IRS seek comments on this approach, including whether alternative co-product accounting methods, such as physical allocation (for example, energy allocation or mass allocation) or allocation based on other characteristics, would better ensure well-to-gate carbon intensity of hydrogen production is accurately represented.*

As described in *Guidelines to Determine Well-to-Gate Greenhouse Gas (GHG) Emissions of Hydrogen Production Pathways using 45VH2–GREET* (GREET User Manual), the specific approach used in 45VH2-GREET 2023 for co-product accounting is "system expansion" (also known as the "displacement method"). This allocation method is aligned and described further in the International Organization for Standardization (ISO) 14044:2006.2. Graphite or carbon black co-products of clean hydrogen produced using a methane pyrolysis pathway can easily be accounted for using the ISO 14044:2006.2 standard through the displacement method of emissions, and the Department of Energy should implement displaced emissions of carbon black and synthetic graphite into the 45VH2-GREET model.

We suggest that the Department of Energy (DOE) offer specific guidance on GHG credit values associated with carbon black and synthetic graphite co-products when employing the system expansion method, similar to those for steam, nitrogen, and oxygen that are already included in the existing 45VH2-GREET 2023 model. Specific guidance should be added for primary methane pyrolysis co-products, including synthetic graphite and carbon black. For example, Argonne National Laboratory publishes a Battery GREET Module that already includes the GHG intensity of synthetic graphite. For carbon co-products, an upper limit on the amount of carbon black or synthetic graphite co-product that can be claimed for methane pyrolysis should correspond to the carbon to hydrogen ratio in the feed product (for methane this is a 3 to 1 mass ratio) to encourage efficient use of feedstock to produce hydrogen. This is similar to the existing guidance on steam for reformers.

In the context of clean hydrogen production through the methane pyrolysis pathway, energy allocation is not appropriate. This is because the primary co-products generated by methane pyrolysis hydrogen production, including synthetic graphite or carbon black, are not energy carriers.

3. ***Comments regarding GREET – hydrogen outlet pressure***

As described in Guidelines to Determine Well-to-Gate Greenhouse Gas (GHG) Emissions of Hydrogen Production Pathways using 45VH2–GREET (GREET User Manual), "45VH2-GREET 2023 evaluates well-to-gate GHG emissions of hydrogen production using a functional unit of one kilogram (kg) of 100% hydrogen at a pressure of 300 psia (i.e. 20 bar). It is important to note that, while different facilities may vary with regard to the pressure and/or purity of the gas (i.e., mol% of hydrogen in the product stream), a consistent functional unit is necessary to evaluate well-to-gate emissions associated with hydrogen production by different facilities on a consistent and transparent basis."

While we acknowledge the rationale behind standardizing hydrogen outlet pressure at 300 psia for consistency and transparency, it's worth considering scenarios like certain applications in steel plants. For example, direct reduced iron plants for producing iron from iron ore operate anywhere from < 1 barg (MIDREX)[3] to 6 barg (HYL-Tenova).[4] In these cases, low-pressure hydrogen is adequate without the need for elevation to higher pressures using excessive electricity. We propose that future releases of the GREET model permit the use of the actual hydrogen outlet pressure for well-to-gate lifecycle greenhouse gas emission calculations, as long as the outlet pressure equals or exceeds the inlet pressure of the hydrogen-utilizing process. This adjustment would accommodate variations in outlet pressure based on specific industrial applications.

4. ***Comments regarding GREET – high temperature hydrogen vs. steam***

[3] https://www.midrex.com/tech-article/midrex-combination-plant-designed-for-changing-market-conditions/

[4] https://tenova.com/sites/default/files/2021-09/2007-ENERGIRON-Direct-Reduction-Technology-Economical-Flexible-Environmentally-Friendly.pdf

As described in Guidelines to Determine Well-to-Gate Greenhouse Gas (GHG) Emissions of Hydrogen Production Pathways using 45VH2–GREET (GREET User Manual), 45VH2-GREET 2023 allows users to account for steam as a co-product. However, for certain applications, high temperature hydrogen can be used directly in industrial processes such as in direct reduced iron production**.** For example, a direct reduced iron shaft furnace operates at 800-1200C, requiring that hydrogen be pre-heated before injection into the furnace to temperatures of >600C and ideally as high as 800-1000C.[5] The current ruling incentivizes cooling the hydrogen to create steam to maximize the tax credit, and then re-heating the hydrogen using the steam that was just created from cooling the hydrogen. This does not make sense and would result in energy loss. We propose that future releases of the GREET model permit and incentivize the use of high temperature hydrogen and credit for the export value in mmBtus of steam corresponding to the value in mmBtus of heating an equivalent amount of hydrogen from 25C to the high temperature of the hydrogen produced, up to a maximum of the temperature needed for the hydrogen's use at the gate.

5. ***Comments regarding Provisional Emissions Rate determination –*** *The Treasury Department and the IRS seek comments on appropriate indicators of project readiness that should be in place before an applicant requests an emissions value to ensure that requests correspond to hydrogen production facilities with significant commercial interest, and standards against which these indicators could be measured.*

Indication of a Provisional Emissions Rate and eligibility of any clean hydrogen production facility will be required for almost any project to inform a final investment decision. Therefore, the requirement that a FEED study be complete prior to requesting a Provisional Emissions Rate from the DOE has the potential to significantly delay projects, which will sit in a waiting line at the DOE between FEED and FID.

It makes more sense for a PER determination to be undertaken by the DOE at the same time as a FEED study, provided that there is:

1. A completed pre-FEED or feasibility study with project cost estimates and project site location;
2. Sufficient data from a similar existing project to complete a PER study (e.g., data from an existing commercial plant or data from a pilot or demo plant trial with measured and third party verified mass and energy balances); and
3. Sufficient hydrogen offtake interest in the form of conditional, non-binding offtake agreements or Memorandums of Understanding.

If DOE and the IRS believe that these requirements are not stringent enough to prevent unreasonable requests for PERs, then the IRS should implement a required maximum timeline for a PER after a request is provided to DOE that demonstrates a completed FEED study. We would suggest that such a timeline not exceed 3 months.

<u>Section IX. Renewable Natural Gas and Fugitive Sources of Methane</u>

6. ***Comments regarding "first productive use" of the relevant renewable natural gas***.

[5] Modeling the First Hydrogen Direct Reduction Pilot Reactor for Ironmaking in the USA Using Finite Element Analysis and Its Validation Using Pilot Plant Trial Data https://www.mdpi.com/2227-9717/11/12/3346

The current proposed rules on RNG as a feedstock should align with the corresponding proposed clean electricity rules. For example, the proposed rules for RNG define “first productive use” of the relevant methane as the time when a producer of the gas first begins using or selling it for productive use in the same taxable year as (or after) the relevant hydrogen production facility was placed in service, while additionality for clean electricity is defined as sources that are placed into service within 36 months prior to the relevant hydrogen production facility.

We propose defining the "first productive use" of the relevant renewable natural gas based on the first Commercial Operation Date (COD) that falls within a period no longer than 36 months before the relevant hydrogen production facility is placed in service.

7. ***Comments regarding limited additional production of waste RNG***

   (8) To limit the additional production of waste, should the final regulations limit eligibility to methane sources that existed as of a certain date or waste or waste streams that were produced before a certain date, such as the date that the IRA was enacted?

Final regulations should not limit eligibility to methane sources that existed as of a certain date. This would disincentivize capture of methane emissions from new waste sources that are very likely to continue to occur through growth such as new landfills, increasing the size of existing landfills, new waste-water treatment plants, and new farms.

We propose allowing new RNG methane and waste stream sources to anticipate new landfills or farms in the United States, and to anticipate increases in size of existing landfills, waste-water treatment plants, and farms within the United States. Our objective is to capture and utilize these methane emissions rather than releasing them into the environment, and we believe that such initiatives should be incentivized.

8. ***Comments regarding RNG geographic and temporal deliverability***

   (9) Are geographic or temporal deliverability requirements needed to reflect and reduce the risk of indirect emissions effects from biogas and RNG or fugitive methane use in the hydrogen production process? If so, what should these requirements be and are electronic tracking systems able to capture these details?

The natural gas grid in the United States can be treated similarly to the electric grid. We propose that similar requirements to temporal and geographic deliverability be imposed on RNG as those imposed on clean electricity.

9. ***Comments regarding counterfactual assumptions for lifecycle GHG emissions for hydrogen with RNG***

   (11) What counterfactual assumptions and data should be used to assess the lifecycle GHG emissions of hydrogen production pathways that rely on RNG? Is venting an appropriate counterfactual assumption for some pathways? If not, what other factors should be considered?

The counterfactual assumption in many RNG use cases today is venting, which creates significant distortions in incentives and uses of RNG. Venting RNG should not be the standard practice today for any waste streams. Flaring is done at many locations where methane is created, and perfect flaring should be the standard counterfactual assumption for RNG.

This is extremely important for avoiding the creation of highly carbon-negative use cases that still emit large amounts of CO_2, while only using a small blend of RNG with large amounts of natural gas.

For example, let's assume a steam methane reforming unit produces about 10 kg of CO_2 from direct emissions for reforming and natural gas firing per kg of H_2 (10 chosen for simplicity). This requires roughly 3.65 kg methane per kg H_2. Methane has a global warming potential of about 30 kg CO_2e/kg methane if vented, and let's assume that if flared it is completely transformed to water and CO_2 (perfect combustion). The flaring counterfactual would result in about 2.75 kg CO_2 per kg methane. Therefore, if using RNG with a venting counterfactual, a credit would be applied of -109.5 kg CO_2e/kg H2, making the H_2 from SMR with RNG very carbon negative. However, using RNG for SMR with a flaring counterfactual would result in a credit of -10 kg CO_2e/kg H_2, resulting in a near net-zero process. This encourages more responsible behavior across upstream RNG sourcing as well and eliminates perverse incentives to "pump up" baseline emissions intensities for RNG sources prior to being used for credits.