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United States Treasury Department
Internal Revenue Service
1111 Constitution Avenue Northwest
Washington, DC 20585

**Proposed 45V Production Tax Credit:**

**Comments and Feedback from GTI Energy**

To Whom It May Concern:

On behalf of GTI Energy, we respectfully submit the following comments to Department of the Treasury (Treasury Department) and the Internal Revenue Service (IRS)regarding the 45V Hydrogen Production Tax Credits, as added to the Code by §§ 13204 and 13704, respectively, of Public Law 117-169, 136 Stat. 1818 (August 16, 2022), commonly known as the Inflation Reduction Act of 2022 (IRA).

GTI Energy is a leading research and training organization that leverages the expertise of our trusted team of scientists, engineers, and industry partners to deliver impactful innovations needed for low-carbon, low-cost energy systems worldwide. We believe that incorporating clean hydrogen as an energy carrier can leverage the nation's existing energy infrastructure to achieve deep decarbonization of our economy and transition to a net-zero future. Hydrogen is flexible and able to draw on many pathways and energy sources for application. However, one of the missing factors for hydrogen is carbon intensity accounting as an enabler for market signals. Governments and organizations that have made ambitious climate pledges need an easy way to discover and compare low-carbon hydrogen solutions.

GTI Energy is working to answer that market need through several initiatives, most notably our partnership with S&P Global Commodity Insights, with technical support from the DOE's National Energy Technology Laboratory (NETL), to launch the Open Hydrogen Initiative in 2022. The Open Hydrogen Initiative (OHI) is an international coalition of over 30 participating organizations from industry, government, academia, coalition groups, and environmental NGOs with the mission of creating a harmonized methodology to vet the carbon intensity of hydrogen production at the facility level. In a bid for transparency and credibility, all the deliverables from OHI will be made open source and publicly available for integration and implementation across markets, corporate intelligence efforts, and policymaking. We hope that, through open learning and public-private collaboration, the OHI methodology can serve the Treasury Department, IRS, and the U.S. government more broadly in its efforts to implement the 45V Hydrogen Production Tax Credits.  Specifically, the OHI methodology will establish a globally accepted tool and corresponding set of protocols, giving market participants a consistent and credible framework for determining the carbon intensity of a given kilogram of hydrogen produced at a given facility.  The OHI methodology will be made open-source for use by any party.  To this end, OHI will stand ready to support 45V implementation as complementing source material for any future development of the Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET) model established by DOE's Argonne National Laboratory. The OHI team would welcome deeper collaboration with the US government on this topic. The feedback provided here is based on upon GTI Energy's deep understanding of GREET (especially the hydrogen production pathways in GREET – see hypec.gti.energy) and insights gained through engagement with industry and other stakeholders

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through OHI. **The feedback herein solely reflects the position of GTI Energy. NETL's role in the Open Hydrogen Initiative project does not represent or endorse the actions of the United States Government nor any agency thereof, expressed or implied, and does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions expressed by NETL and/or OHI do not necessarily state or reflect those of the United States Government or any agency thereof.**

We appreciate the opportunity to respond to this request for feedback pertaining to 45V. We would welcome the opportunity to further engage with the Treasury Department and the IRS as the agencies develop this important guidance. Thank you for your time and your consideration.

Sincerely,

GTI Energy – Energy Systems Centers of Excellence
Derek Wissmiller, Head of Energy Systems Centers of Excellence
Rosa Dominguez-Faus, Head of LCA Center of Excellence
Zane McDonald, Head of Open Hydrogen Initiative

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**(1) Clean Hydrogen**

**Section 45V provides a definition of the term "qualified clean hydrogen." What, if any, guidance is needed to clarify the definition of qualified clean hydrogen?**

**(a) Section 45V defines "lifecycle greenhouse gas emissions" to "only include emissions through the point of production (well-to-gate)." Which specific steps and emissions should be included within the well-to-gate system boundary for clean hydrogen production from various resources?**

See response to question (2).

**(b)**

**(i) How should lifecycle greenhouse gas emissions be allocated to co-products from the clean hydrogen production process? For example, a clean hydrogen producer may valorize steam, electricity, elemental carbon, or oxygen produced alongside clean hydrogen.**

See response to question (1)(b)(ii).

**(ii) How should emissions be allocated to the co-products (for example, system expansion, energy-based approach, mass-based approach)?**

Co-product treatment can be done through displacement (e.g., substitution) or allocation (energy allocation, mass displacement, or market value). Each of these approaches can lead to very different results. There are advantages and disadvantages to each of these approaches – no single approach is universally favored. The approach used should be selected in a manner that (1) works most suitably for evaluating facility level analysis, and (2) is harmonized and consistent with stakeholder buy-in.

Choices made regarding co-product allocation can significantly impact results. For example, based on GREET (v2021) analysis of steam methane reforming (SMR), the following range of results can be attained for the carbon intensity of hydrogen production

- Displacement of steam coproduction → 11.20 kgCO2e/kgH2
- Energy allocation → 11.65 kgCO2e/kgH2
- Market allocation → 13.75 kgCO2e/kgH2

General comments regarding common co-product allocation methods are as follows:

- Energy allocation is simplest when all products are energy products.
- Mass displacement is often favorable to H2 under current default assumptions in GREET.
- Market value is the most uncertain as value ratios can change in time with market fluctuations.

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- In system expansion with displacement there's many assumptions about the emission factors of the product that is substituted. Options need to be offered based on stakeholder input.

**(iii) What considerations support the recommended approaches to these issues?**

No response.

**(c)**

**(i) How should lifecycle greenhouse gas emissions be allocated to clean hydrogen that is a by-product of industrial processes, such as in chlor-alkali production or petrochemical cracking?**

See response to question (1)(c)(ii).

**(ii) How is byproduct hydrogen from these processes typically handled (for example, venting, flaring, burning onsite for heat and power)?**

These are important methodological choices that can greatly influence emission results, as illustrated in Figure 1 below. Even when there is agreement on treatment methodology, certain assumptions can significantly impact the results. This is the case of choice of substituted product in a displacement methodology. Greater consistency in methodology is needed, as well as greater transparency. Stakeholder engagement is key.

In chlor-alkali processes, hydrogen is usually sold as chemical feed or as a fuel to produce steam or electricity. In this case, the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) framework recommends displacement since there is diversity in the products that can be substituted. For steam crackers, energy allocation is the method recommended though substitution is also possible. In steam crackers, co-product hydrogen is usually burned for heat in the facility. If this co-product hydrogen is sold into merchant markets, natural gas will need to be burned to produce heat to backfill for that hydrogen. If the steam cracker hydrogen is allocated by energy, it is ignoring this change in behavior and potential increase in net GHG emissions. There is a clear counterfactual, which justifies the substitution approach in the steam cracker case. There is no reason both cases should not be treated the same way. A transparent and consistent approach needs to be applied and clearly communicated.

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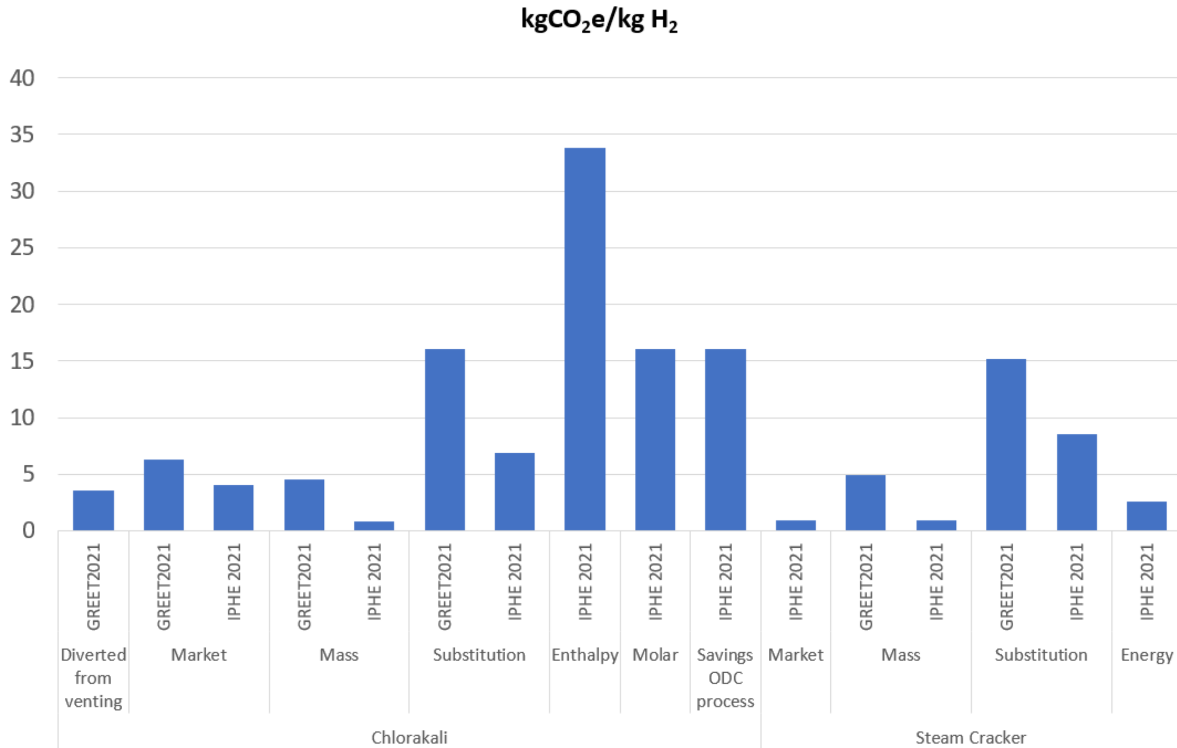
*Figure 1. Carbon Intensity (kgCO2e/kgH2) of hydrogen production as by-product of chlor-alkali and steam cracker processes, calculated under different methodologies in GREET2021 and as reported in IPHE document "Methodology for Determining the Greenhouse Gas Emissions Associated with the Production of Hydrogen".*




**(d) If a facility is producing qualified clean hydrogen during part of the taxable year, and also produces hydrogen that is not qualified clean hydrogen during other parts of the taxable year (for example, due to an emissions rate of greater than 4 kilograms of CO2-e per kilogram of hydrogen), should the facility be eligible to claim the § 45V credit only for the qualified clean hydrogen it produces, or should it be restricted from claiming the § 45V credit entirely for that taxable year?**

No response.

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**(e) How should qualified clean hydrogen production processes be required to verify the delivery of energy inputs that would be required to meet the estimated lifecycle greenhouse gas emissions rate as determined using the GREET model or other tools if used to supplement GREET?**

The 45V production tax credit should be linked to asset-specific characteristics of a given hydrogen production facility. That is, the overall carbon intensity assessment for a given hydrogen production facility should be based on the specific attributes of the source energy and feedstocks that are utilized by that hydrogen production facility, the operational parameters of the facility, and its upstream supply-chain, rather than average values for source energy and feedstocks in a given region.

The usage of dated literature and regional averages (both spatial and temporal averages) is insufficient for determining the carbon intensity of hydrogen production for a given facility. This is to say that there are very few values that are unlikely to vary meaningfully at a sub-regional level. If a facility pays a premium to source lower-carbon electricity or responsibly sourced natural gas, the model must factor this into the determination of the carbon intensity for the associated hydrogen production facility. Temporal granularity is also a very important parameter to capture in accounting for GHG emissions. The methodology proposed in the DOE draft CHPS guidance is far too tolerant of failing to capture this level of granularity.

To help incentivize the increased usage of both measured data and facility-specific data protocols should be adopted that outline best practices in data reporting, monitoring, verifying, tracking, and traceability. These protocols should be written in concert with the industry, mindful of existing reporting guidelines, emissions hotspots, and emissions blind spots.

Renewable energy credits, certified natural gas, power purchase agreements, and similar market structures should be allowed when characterizing the carbon intensity of feedstock energy for hydrogen production. The 45V carbon intensity evaluation methodology should be forward-looking and capable of accommodating information from these instruments. In general, greater transparency in GHG data quality, tracking, and traceability is needed throughout and across energy value chains, both domestically and globally, to establish clarity in GHG accounting frameworks to underpin low-carbon energy markets. However, care must be taken in providing guiderails on how the industry uses financial mechanisms to indicate decarbonization. Voluntary carbon markets, offsets, and some abatement programs are still maturing. This evolution should be taken into account when relying on these mechanisms to imply decarbonization, especially in how it relates to permanence, additionality, and fidelity.

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**(i) How might clean hydrogen production facilities verify the production of qualified clean hydrogen using other specific energy sources?**

See response to question (1)(e).

**(ii) What granularity of time matching (that is, annual, hourly, or other) of energy inputs used in the qualified clean hydrogen production process should be required?**

See response to question (1)(e).

**(2) Alignment with the Clean Hydrogen Production Standard. On September 22, 2022, the Department of Energy (DOE) released draft guidance for a Clean Hydrogen Production Standard (CHPS) developed to meet the requirements of § 40315 of the Infrastructure Investment and Jobs Act (IIJA), Public Law 117-58, 135 Stat. 429 (November 15, 2021). The CHPS draft guidance establishes a target lifecycle greenhouse gas emissions rate for clean hydrogen of no greater than 4.0 kilograms CO2-e per kilogram of hydrogen, which is the same lifecycle greenhouse gas emissions limit required by the § 45V credit. For purposes of the § 45V credit, what should be the definition or specific boundaries of the well-to-gate analysis?**

The definition of the well-to-gate system boundary for clean hydrogen production can greatly impact the results of the well-to-gate analysis. The draft CHPS guidance issued by the Department of Energy (DOE) is murky on the definition of LCA scope boundary, as highlighted in the following observations:

1. Figure 1 in the DOE draft CHPS guidance does not seem to include downstream hydrogen compression for transport. This is appropriate given this is a producer's tax credit. Additionally, the emissions from compression for transport and refueling station and refueling station cooling are not controlled by hydrogen producer and thus should be outside of scope for the CHPS.
2. However, footnote 11 on page 5 of the DOE draft CHPS guidance states "In the CHPS, the lifecycle target corresponds to a system boundary that terminates at the point at which hydrogen is delivered for end use." Thus, there is inconsistency between Figure 1 of the CHPS guidance, and footnote 11 on page 5.
3. The default calculations in GREET also include emissions associated with compression of hydrogen up to high pressures for hydrogen vehicle filling stations. Footnote 11 on page 5 of the DOE draft CHPS guidance appears to indicate that these emissions won't be included, however, it's not clear how this will be accomplished given that these emissions are embedded in GREET calculations.

Table 1 below defines five example cases for which the scope could be defined. The subsequent Tables 2-5 show the impact of these different boundary assumptions on the carbon intensity, as based on GREET (v2021) results. The carbon intensity varies considerably depending on the system boundary for the same technology under the same assumptions and operating conditions. The significance of the definition of the well-to-gate boundary on

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the carbon intensity is highlighted in the following observations, as based on the results in Tables 2-5.

1. For an electrolysis facility driven by solar PV electricity, carbon intensity values can range from less than 0.45 kgCO2e/kgH2 ($3.00/kgH2 credit) to greater than 4.0 kgCO2e/kgH2 (no credit), depending on the well-to-gate boundary case considered (see Tables 2 and 3)
2. For a steam methane reforming facility using US average grid electricity and achieving a CO2 capture rate of 100% (e.g. theoretical maximum capture rate), carbon intensity values can range from 2.18 kgCO2e/kgH2 ($0.75/kgH2 credit) to greater than 4.0 kgCO2e/kgH2 (no credit), depending on the well-to-gate boundary case considered (see Table 4).
3. For a biomass gasification facility using US average grid electricity, carbon intensity values can range from 1.53 kgCO2e/kgH2 ($0.75/kgH2 credit) to greater than 4.0 kgCO2e/kgH2 (no credit), depending on the well-to-gate boundary case considered (see Table 5)

The results in Table 3 point to an important methodological issue to be raised with regard to the GREET model. GREET performs calculations assuming the same electricity source for all steps of the process. For example, the electricity used for hydrogen production is the same electricity used for downstream hydrogen transportation. In real world implementation, the electricity used for hydrogen production (such as a solar), is very likely to be different than the electricity used for downstream hydrogen transportation (such as the US grid mix). This has meaningful impact on the results (see Table 2 versus Table 3 below). GREET is not currently capable of readily performing such calculations to apply different electricity sources (and corresponding carbon intensities) in different sections of the well-to-gate analysis. This methodological issue is also true of other energy carriers in GREET as well, such as natural gas.

Regarding definition of the well-to-gate analysis boundary, our views are as follows:

- While we find the DOE draft CHPS guidance to be murky regarding the definition of the boundary of the well-to-gate analysis, our best interpretation is that DOE is recommending that a boundary consistent with Case 2 be used (see Table 1). We disagree with this recommendation, as emissions associated with downstream transportation of hydrogen should not be included. Hydrogen producers are likely to be a separate business entity from midstream hydrogen transporters, and as such, hydrogen *production* standards and tax credits should be solely applied to the *producer* of the hydrogen, not the transporter of the hydrogen.
- The Open Hydrogen Initiative has conducted extensive stakeholder engagement via our industry coalition over the last 9 months. Feedback from stakeholders suggests infrastructure emissions should be included where it contributes meaningful to a levelized carbon intensity and where it is practical to include. Please review the delta between Case 3 and Case 4 in Tables 2 & 3 for an example.

As the DOE works to develop methodologies that are both practical and credible, we would welcome DOE's active engagement with industry-forward coalitions like the Open Hydrogen

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Initiative. In general, a final decision on the boundary of the well-to-gate analysis should be made with transparency, openness, and collaboration with stakeholders.

*Table 1. Possible cases for defining the boundary of the well-to-gate analysis.*

| | Upstream of Hydrogen Plant | | | Hydrogen Plant | Downstream of Hydrogen Plant | |
|---|---|---|---|---|---|---|
| | Construction of Infrastructure and Equipment | Production of Energy Feedstocks | Transportation of Energy Feedstocks to Hydrogen Production Facilities | Production of Hydrogen | Transportation of Hydrogen to Refueling Stations | Compression for Refueling of Hydrogen Vehicles |
| Case 1 | Not Included | **Included** | **Included** | **Included** | Not Included | Not Included |
| Case 2 | Not Included | **Included** | **Included** | **Included** | **Included** | Not Included |
| Case 3 | Not Included | **Included** | **Included** | **Included** | **Included** | **Included** |
| Case 4 | **Included** | **Included** | **Included** | **Included** | **Included** | **Included** |
| Case 5 | **Included** | **Included** | **Included** | **Included** | Not Included | Not Included |

*Table 2. Electrolysis carbon intensity (kgCO2e/kgH2) for different electricity sources. Results based on GREET (version excel 2021).*

| Electricity Source Upstream of Hydrogen Plant | Electricity Source for Hydrogen Plant | Electricity Source Downstream of Hydrogen Plant | Case 1 | Case 2 | Case 3 | Case 4 |
|---|---|---|---|---|---|---|
| US Grid Mix | US Grid Mix | US Grid Mix | 21.94 | 22.43 | 23.93 | 24.29 |
| Solar Only | Solar Only | Solar Only | 0.00 | 0.00 | 0.00 | 2.51 |
| Wind Only | Wind Only | Wind Only | 0.00 | 0.00 | 0.00 | 0.33 |
| Nuclear Only | Nuclear Only | Nuclear Only | 0.10 | 0.11 | 0.11 | 0.14 |

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*Table 3. Electrolysis carbon intensity (kgCO2e/kgH2) for different electricity sources for upstream and at hydrogen plant and US grid mix for downstream of hydrogen plant. This is likely to be a realistic scenario given that it is not likely that 100% renewable energy could be used for downstream hydrogen transportation. Results are based on GREET (version excel 2021) and GTI Energy calculations that are consistent with GREET LCA methodology. These GTI Energy calculations were performed because GREET is not capable of evaluating two different electricity sources for different portions of the overall hydrogen production pathway (see discussion under Table 1 above).*

| Electricity Source Upstream of Hydrogen Plant | Electricity Source for Hydrogen Plant | Electricity Source Downstream of Hydrogen Plant | Case 1 | Case 2 | Case 3 | Case 4 |
|---|---|---|---|---|---|---|
| US Mix | US Mix | US Grid Mix | 21.94 | 22.43 | 23.93 | 24.29 |
| Solar Only | Solar Only | US Grid Mix | 0.00 | 0.49 | 1.99 | 4.50 |
| Wind Only | Wind Only | US Grid Mix | 0.00 | 0.49 | 1.99 | 2.32 |
| Nuclear Only | Nuclear Only | US Grid Mix | 0.10 | 0.59 | 2.09 | 2.11 |

*Table 4. Steam methane reforming carbon intensity (kgCO2e/kgH2) for different carbon capture rates and electricity sources. Results based on GREET (version excel 2021).*

| Carbon Capture Rate | Electricity Source | Case 1 | Case 2 | Case 3 | Case 4 |
|---|---|---|---|---|---|
| 85% | US Grid Mix | 3.50 | 3.99 | 5.47 | 5.71 |
| 100% | US Grid Mix | 2.18 | 2.67 | 4.16 | 4.39 |
| 85% | Wind | 2.83 | 2.83 | 2.83 | 3.05 |
| 100% | Wind | 1.44 | 1.44 | 1.44 | 1.67 |

*Table 5. Biomass gasification carbon intensity (kgCO2e/kgH2) for different electricity sources. Results based on GREET (version excel 2021).*

| Carbon Capture Rate | Electricity Source | Case 1 | Case 2 | Case 3 | Case 4 |
|---|---|---|---|---|---|
| 0% | US Grid Mix | 1.53 | 2.02 | 3.52 | 4.32 |
| 0% | Wind | 1.26 | 1.26 | 1.26 | 2.07 |

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**(3) Provisional Emissions Rate.**
**For hydrogen production processes for which a lifecycle greenhouse gas emissions rate has not been determined for purposes of § 45V, a taxpayer may file a petition with the Secretary for determination of the lifecycle greenhouse gas emissions rate of the hydrogen the taxpayer produces.**

**(a) At what stage in the production process should a taxpayer be able to file such a petition for a provisional emissions rate?**

No response

**(b) What criteria should be considered by the Secretary in making a determination regarding the provisional emissions rate?**

No response

**(4) Recordkeeping and Reporting**

**(a) What documentation or substantiation do taxpayers maintain or could they create to demonstrate the lifecycle greenhouse gas emissions rate resulting from a clean hydrogen production process?**

No response

**(b) What technologies or methodologies should be required for monitoring the lifecycle greenhouse gas emissions rate resulting from the clean hydrogen production process?**

No response

**(c) What technologies or accounting systems should be required for taxpayers to demonstrate sources of electricity supply?**

No response

**(d) What procedures or standards should be required to verify the production (including lifecycle greenhouse gas emissions), sale and/or use of clean hydrogen for the § 45V credit, § 45 credit, and § 48 credit?**

No response

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**(e) If a taxpayer serves as both the clean hydrogen producer and the clean hydrogen user, rather than selling to an intermediary third party, what verification process should be put in place (for example, amount of clean hydrogen utilized and guarantee of emissions or use of clean electricity) to demonstrate that the production of clean hydrogen meets the requirements for the § 45V credit?**

No response

**(f) Should indirect book accounting factors that reduce a taxpayer's effective greenhouse gas emissions (also known as a book and claim system), including, but not limited to, renewable energy credits, power purchase agreements, renewable thermal credits, or biogas credits be considered when calculating the § 45V credit?**

No response

**(g) If indirect book accounting factors that reduce a taxpayer's effective greenhouse gas emissions, such as zero-emission credits or power purchase agreements for clean energy, are considered in calculating the § 45V credit, what considerations (such as time, location, and vintage) should be included in determining the greenhouse gas emissions rate of these book accounting factors?**

No response

(5) Unrelated Parties

**(a) What certifications, professional licenses, or other qualifications, if any, should be required for an unrelated party to verify the production and sale or use of clean hydrogen for the § 45V credit, § 45 credit, and § 48 credit?**

No response

**(b) What criteria or procedures, if any, should the Treasury Department and the IRS establish to avoid conflicts of interest and ensure the independence and rigor of verification by unrelated parties?**

No response

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**(c) What existing industry standards, if any, should the Treasury Department and the IRS consider for the verification of production and sale or use of clean hydrogen for the § 45V credit, § 45 credit, and § 48 credit?**

No response

**(6) Coordinating Rules**

**(a) Application of certain § 45 rules.**

**(i) Section 45V(d)(3) includes a reduction for the § 45V credit when tax-exempt bonds are used in the financing of the facility using rules similar to the rule under § 45(b)(3)). What, if any, additional guidance would be helpful in determining how to calculate this reduction?**

No response

**(ii) Section 45V(d)(1) states that the rules for facilities owned by more than one taxpayer are similar to the rules of § 45(e)(3). How should production from a qualified facility with more than one person holding an ownership interest be allocated?**

No response

**(b) Coordination with § 48.**

**(i) What factors should the Treasury Department and the IRS consider when providing guidance on the key definitions and procedures that will be used to administer the election to treat clean hydrogen production facilities as energy property for purposes of the § 48 credit?**

No response

**(ii) What factors should the Treasury Department and the IRS consider when providing guidance on whether a facility is "designed and reasonably expected to produce qualified clean hydrogen?"**

No response

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**(c) Coordination with § 45Q. Are there any circumstances in which a single facility with multiple unrelated process trains could qualify for both the § 45V credit and the § 45Q credit notwithstanding the prohibition in § 45V(d)(2) preventing any § 45V credit with respect to any qualified clean hydrogen produced at a facility that includes carbon capture equipment for which a § 45Q credit has been allowed to any taxpayer?**

No response

**(7) Please provide comments on any other topics related to § 45V credit that may require guidance.**

Proper implementation of the 45V credit requires highly transparent, collaboratively developed methodologies for carbon intensity assessment. Importantly, these methodologies need to assess carbon intensity at the asset/facility level. Usage of pathway level averages, regional averages, and literature values should be minimized, being replaced with measured, real-time values whenever possible. We also recommend broad sector-level engagement in the development of these methodologies, ensuring that practical, real-world experience is brought to bear. A focus on asset-level operational characteristics and broad sector-level engagement in development will help avoid delayed reactions and the associated catastrophic climate impacts associated with emissions oversights, recently highlighted by fugitive methane emissions.

We believe the following questions need to be addressed, and have not been adequately covered in the DOE draft CHPS guidance

1. Will a given hydrogen production facility be able to calculate its carbon intensity based on facility-specific measurements of its energy consumption (e.g. electricity, natural gas, biomass) per unit of hydrogen produced? This is a fundamental parameter impacting the hydrogen production facilities' carbon intensity.
2. Will a given hydrogen production facility employing carbon capture be able to calculate its carbon intensity based on facility-specific measurements of its carbon capture rate? This is a fundamental parameter impacting the hydrogen production facilities' carbon intensity.
3. Will a given hydrogen production facility be able to calculate its carbon intensity based on facility-specific characterization of its specific energy and feedstock sources? That is, if responsibly sourced gas or biomass, or low-carbon grid electricity is purchased, will the hydrogen production facility be able to use values specific to where it gets its energy and feedstock from in its calculations? These are fundamental parameters impacting the hydrogen production facilities carbon intensity.
4. Will the GREET excel version or GREET NET be used? There are differences in functionality between these two tools.
5. In our feedback, we have stressed the need for asset specific information, rather than average and/or representative values. To further highlight this point, consider the following. GREET version 2022 was just released on October 11, 2022. The GREET

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version 2022 results for the carbon intensity of hydrogen production differ from the GREET version 2021 results for several pathways and/or technologies. These differences are presumably the result of changes in default average and/or represented values embedded within GREET. It is not clear whether these default values can be readily accessed by a GREET user. Further, if they are readily accessible, it is not clear whether a user will be allowed to adjust these values as relevant for evaluation a given hydrogen production facility. The DOE draft CHPS guidance does not provide sufficient clarity on these topics. Further, the guidance does not provide clarity as to the process for which changes in such default values would be defined, approved, and implemented into GREET.

6. The inclusion of fugitive hydrogen as an indirect GHG could send some production facilities above the 4 kgCO2e/kgH2 benchmark. Our understanding of the magnitude of fugitive hydrogen emissions and their associated impacts on global warming are sure to evolve over the coming years. This highlights the need for the CHPS implementation framework to be defined with relevant structures and processes to facilitate evolution in methodology and approach to accommodate new technologies and knowledge. The guidance does not speak to these issues.
7. Will embedded emissions (e.g., emissions associated with construction of infrastructure and equipment) be included in the analysis? If so, specifically what infrastructure emissions will be included and what infrastructure emissions will be omitted?
8. Generally, we believe that the system boundary for emissions calculations should stop at the plant gate with a functional unit of hydrogen (predefined temperature, purity, and pressure), excluding post-production processing that goes beyond this functional unit (like liquefaction or additional compression). This allows for improved like-to-like comparison, assists with hydrogen market formation through more consistent spot-market structures, and avoid penalizing producers for extraordinary delivered-state configurations required by hydrogen consumers.
9. Will the emissions from energy use for CO2 injection and leakage from geologic storage be included in GREET? GREET2021 seems to include only emissions from the CO2 capture alone, not the injection energy emissions, or CO2 leakage over time.
10. Will any Carbon Capture and Utilization (CCU) cases be considered by the CHPS. How will the CHPS account for the emissions savings and recycling in cases where the CO2 is captured and utilized?
11. GREET does not currently include a comprehensive set of hydrogen production pathways. For example, GREET does not include pathways for methane pyrolysis, partial oxidation (POX), and autothermal reforming (ATR), all technologies for which commercial plants are in operation or being developed. How will these technologies be evaluated?
12. Will the carbon intensity evaluation methodology under 45V and CHPS account for variability in data quality and confidence? The reliability and representativeness of real-time measured data far outweighs that of industry-average or literature data. The CHPS should include a framework to 1) attribute a confidence interval based on the net quality of data used for asset-level calculations, and 2) use this confidence

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interval as an incentive for the industry to gravitate towards the usage of real-world measured data vs relying on literature and average values.

13. The DOE draft CHPS guidance is not clear on the greenhouse gases that will be evaluated beyond $CO_2$ and $CH_4$. In particular, CHPS should provide guidance on accounting of fugitive hydrogen and $N_2O$.
14. The DOE draft CHPS guidance is not clear on whether a 100-year or 20-year horizon will be used to underscore the calculation of global warming potentials (GWP), nor does it specify the GWP values that will be used or the source that will be used for definition of those GWP values.