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RE: Notice 2022-58 Request for Comments on Credits for Clean Hydrogen and Clean Fuel Production

Submitted via www.regulations.gov

NRDC (Natural Resources Defense Council) is an international nonprofit environmental organization with more than 3 million members and online activists. Since 1970, our lawyers, policy analysts, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Bozeman, MT, Beijing, and New Delhi.

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We are commenting on **.01 Credit for Production of Clean Hydrogen**. Our comments are applicable and in response to questions: **(1)(e) and (4)(c), 4(f) and 4(g)**.

They reflect very similar comments to our previous response to **Notice 2022-49 "Request for Comments on Certain Energy Generation Incentives - Hydrogen (IRC Section 45V)"** developed with RMI (Rocky Mountain Institute), with support from the Environmental Defense Fund, the Clean Air Task Force, and the Union of Concerned Scientists, and with further sign on from the League of Conservation Voters, Evergreen Action, Common Defense.

Our focus is to provide recommendations pertaining to IRS guidance concerning the **emissions accounting framework and methodology for calculating the greenhouse gas emissions of grid-connected electrolyzers.**

<u>Grid-Connected Electrolyzer Emissions Accounting Challenge – Overview</u>

- The 45V clean hydrogen production tax credit (PTC) in the Inflation Reduction Act (IRA) offers a generous subsidy for clean hydrogen production that meets a certain carbon intensity threshold, based on a lifecycle greenhouse gas (GHG) emissions analysis.
- The IRA directs the Department of Treasury to publish guidance and regulations to determine the carbon intensity of hydrogen projects.
- Many hydrogen producers will seek to use grid-connected electricity to power electrolyzers and produce hydrogen. Despite rapid decarbonization and clean energy deployment, the current grid makeup is roughly 60% fossil fuels and too carbon intensive to qualify.
- Given the importance of grid connection to support and scale clean hydrogen production, Congress tasked Treasury with developing guidance for a system to evaluate the carbon intensity of hydrogen using grid electricity for the purposes of receiving the 45V PTC.
- The political and economic pressure to implement a weak system will be substantial.
- Effective clean energy crediting systems with guardrails exist and can be integrated within the GREET model.

A weak framework could increase emissions by half a gigaton of carbon dioxide (CO2) over the lifetime of the credit while costing the taxpayer billions of dollars. This would be at odds with the legislative text and intent, result in disastrous climate consequences, and undermine confidence in the ambitious climate investments in the Inflation Reduction Act.

We recommend beginning with a stricter framework, and allowing additional robust compliance options over time:

- In preliminary guidance, we recommend Treasury use the DOE GREET model to qualify projects:
    - The GREET model uses the average carbon intensity of grid electricity. Producers of electrolytic hydrogen that use primarily on-site, zero-carbon electricity should immediately qualify. Emissions offsetting mechanisms (or "book-and-claim"

systems) should not be allowed, pending the development of appropriate guidance for such systems in the final guidance.

- In final guidance, the Treasury should **collaborate with DOE and a technical working group** to establish an effective framework for emissions accounting for hydrogen projects that seek to be grid connected and rely on a book-and-claim system to reduce their effective emissions; this framework could be integrated into GREET.

Leveraging the expertise of a range of stakeholders including academics, think tanks, environmental non-profits, hydrogen developers and clean energy attribute developers in a deliberate and transparent process will be of vital importance for Treasury and IRS to publish rigorous guidance that accords with Congressional intent.

Statutory Authority of the Treasury Department and the IRS

Congress defines "lifecycle greenhouse gas emissions" in the IRA as:

> the aggregate quantity of GHG emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes), as determined by the Administrator, related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer, where the mass values for all greenhouse gasses are adjusted to account for their relative global warming potential. *26 U.S.C. § 45V (c)(1)(A) (adopting the definition set forth in 42 U.S.C. § 7545(o)(1)(H)).*

The statute further defines the term to only include the well-to-gate GHG emissions of hydrogen projects as determined under the most recent "'GREET model' developed by Argonne National Laboratory, **or a successor model (as determined by the Secretary)**." *26 U.S.C. § 45V(c)(1)(B) (emphasis added).*

The Treasury Department and the IRS are directed to issue regulations or other guidance to carry out the purposes of section 45V, including for determining the lifecycle greenhouse gas emissions of hydrogen projects, by August 16, 2023. *Id*. at § 45V(f).

Congressional Intent

Determining well-to-gate GHG emissions requires multiple frameworks to evaluate the various hydrogen project pathways. Emissions accounting is relatively simple for electrolyzer projects primarily and directly powered by a clean energy facility. However, it is complex for other types of projects, such as electrolyzers connected to the bulk power grid that primarily consume grid power. Congressional guidance offers important direction for how the the Treasury Department and the IRS should consider those grid-connected projects. Legislative history clarifies that grid-

connected electrolyzers that use grid power and procure clean energy attributes certificates (EACs) to offset their consumption are meant to be *eligible* for the PTC at the highest tiers.[1]

> Mr. CARPER: It is …my understanding of the intent of section 13204, is 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. Is that the chairman's understanding as well? Mr. WYDEN. Yes. Mr. CARPER. Thank you, Mr. Chairman. Additionally, I would like to clarify that the intent of section 13701 allows the Secretary to consider indirect book and claim factors that reduce effective greenhouse gas emissions to help determine whether the greenhouse gas rate of a qualified fuel cell property, which does not include facilities that produce electricity through combustion or gasification, is ''not greater than zero.'' Is that the chairman's understanding? Mr. WYDEN. Yes

168 Cong. Rec. S4165 (Aug. 6, 2022).[2]

However, not all clean EACs are made equal: any such book-and-claim system must "reduce **effective** greenhouse gas emissions." There are two major takeaways from this key requirement:

- "Reduce" assumes active changes to the grid to eliminate emissions. The producer cannot simply use accounting sleights of hand. The phrase suggests a producer must take an active role driving GHG reductions to offset emissions linked to grid-connected projects.
- "Effective greenhouse gas emission" refers to the system-wide impact of the project. Many accounting systems can "attribute" clean power to a project, but in practice increase system-wide emissions by increasing fossil fuel generation (we further discuss this dynamic in our policy recommendations). The statute and legislative history do not support weak or ineffective accounting systems that ignore the system-wide emissions impact of a new hydrogen project. The goal of this policy, as outlined above, is to reduce U.S. GHG emissions and incentivize clean hydrogen projects.

Congressional language allowing the Secretary to implement a "successor model" if needed, and issue regulations or other guidance to carry out the *purposes of section 45V* gives the Treasury Department and the IRS clear authority and the tools to implement the 45V tax credits in a manner that adheres to the statute and Congressional intent.

[1] We use energy attribute certificates (EACs) as an umbrella term that encompasses a range of potential grid electricity offsetting mechanisms, including Renewable Energy Credits (RECs), Clean Energy Credits, Zero Emission Credits (ZECs), and others.

[2] https://www.govinfo.gov/content/pkg/CREC-2022-08-06/pdf/CREC-2022-08-06-pt1-PgS4165-3.pdf, pages 1-2.

Policy Recommendations Consistent with Statutory Authority and Congressional intent

Our policy recommendations direct the Treasury Department and the IRS to adopt a two-step approach. The first step relies on the already-established GREET model, and the second step relies on a "successor model" and the issuance of new guidelines for determining the lifecycle GHG emissions of hydrogen projects, particularly grid-connected electrolyzer projects. As we discuss below, ensuring that a system **"reduces effective greenhouse gas emissions,"** per Congressional intent is complex and requires design and adoption of a rigorous and well-designed accounting framework. A "successor model" and/or new guidelines for determining lifecycle GHG reductions should be developed through deliberative engagement with experts and stakeholders and put in place to provide the necessary framework for grid-connected electrolyzers to qualify for 45V. Our recommendations outline the pillars and key elements of a system that "reduces effective greenhouse gas emissions."

We sum up our recommendations to the Treasury Department and the IRS as follows:

1. **Implement a two-step approach, committing to effective accounting pillars for grid-connected electrolyzers in any preliminary guidance:** The varying degrees of complexity that characterize hydrogen production pathways require a phased approach (described below), with the Treasury Department and the IRS committing to a rigorous emissions accounting system for grid-connected electrolyzers that leverages additionality, regionality, and granular temporal accounting for emissions impacts - critical components to an effective accounting system.
    a. **In preliminary guidance:** The Treasury Department and the IRS should accredit hydrogen projects that meet the 45V carbon intensity thresholds using the GREET model. Electrolyzers powered off-grid by zero carbon power should qualify. Initially, emissions linked to electrolyzers' consumption of grid electricity should also be calculated using the GREET model, but without any reliance on offsetting mechanisms (e.g., EACs). The Treasury Department and the IRS should also use this initial guidance opportunity to commit to rigorous principles of accounting to ensure grid-connected electrolyzer production is clean. This will provide certainty to developers and support the Treasury Department and the IRS process of establishing final guidance along the statutorily required timeline.
    b. **In final guidance:** With comprehensive support from the Department of Energy (DOE), Environmental Protection Agency (EPA), and Energy Information Administration (EIA), Treasury should develop and implement a rigorous emissions accounting system for grid-connected electrolyzers.

2. **Consider and assess two leading potential frameworks** we propose could ensure effective qualification of low emitting hydrogen projects and low grid emissions: 1) hourly-matched EACs with additionality and deliverability requirements, which is emerging as a leading framework for ensuring 24/7 carbon-free electricity, and 2)

locational-marginal emissions matching, an early concept worthy of further investigation. We recommend the Treasury Department and the IRS work with the DOE and EPA to evaluate those two potential accounting systems and develop a method that is practical to implement, provides certainty for producers, and rigorously enforces the legislated requirements.

Considering the far-reaching implications of the 45V credits, it is critical that the Treasury implement a rigorous emissions accounting framework that ensures the emissions integrity of grid-connected electrolyzers. The generous 45V tax incentives significantly reduce cost impacts on grid-connected electrolyzers and bolster market lift-off. We encourage Treasury to work closely with DOE on utilizing the GREET model where appropriate and in developing the framework for a more suitable and rigorous system for grid-connected electrolyzers. By offering the largest subsidies for clean hydrogen in the world, IRA creates the imperative and opportunity for the U.S. to adopt a world-leading framework that, if replicated, can put the global hydrogen market on a sound course.

We offer our recommendations below and look forward to working with the Treasury and DOE over the coming months on designing a workable and robust system.

Emissions Accounting for Grid-Connected Projects is Complex and Requires Development of a Rigorous Framework

Various hydrogen projects and production pathways pose varying degrees of complexity with respect to accurately calculating their emissions footprint. For example, several types of hydrogen projects would rely on the DOE-developed GREET model, which is one of the specified tools in statute. Those projects include fossil-based hydrogen projects equipped with carbon capture and electrolyzers powered directly by "behind-the-meter" clean electricity.[3]

Emissions accounting becomes much more complex for other types of hydrogen projects, notably electrolyzers that are connected to the electricity grid and consume grid power. The GREET model is not scoped to evaluate market-based accounting models to ensure "effective" GHG emissions reductions, as outlined in the Senate colloquy expressing Congressional intent. The grid is a complex, dynamic system. To verify effective GHG emissions reductions, system-level modeling and granular grid emissions data are required. To date, the vast majority of existing market-based approaches (such as renewable energy credits) were designed to drive renewable generation, but do not verify system-wide emissions impacts. Therefore, a framework with expanded capabilities will be needed to establish a robust book-and-claim system for grid-connected projects, which can then be integrated with GREET. Implementing a successor model or a GREET-integrated emissions accounting framework will require rigor and careful consideration of various scenarios and their implications before greenlighting this generous tax credit to grid-connected electrolyzers. While there are many hydrogen pathways, our comments

[3] While GREET may be a suitable baseline tool to estimate those projects' emissions, other accounting considerations like requiring the accurate measurement of methane leakage in the case of fossil hydrogen projects are critical. Future comments will focus on this issue.

are focused on the grid-connected electrolytic hydrogen production pathway which will likely be one of the largest by volume.

There is a high risk that a weak book-and-claim accounting framework fails to "reduce effective greenhouse gas emissions." Conservative estimates show that a weak system could increase net emissions by nearly 500 million tonnes of CO2e.[4] We define such a failing framework as one that either inaccurately estimates the carbon intensity of grid-connected electrolyzers or attributes a carbon intensity that does not reflect the reality of their induced emissions on the grid.

The risks are twofold:

1. **Emissions increases on the grid:** Assuming DOE's recently proposed target for clean hydrogen production by 2030, 45V uptake could pay out more than $120 billion over the next 20 years.[5] Grid connection will likely be the easiest way for producers to seek qualification. Absent a robust system requiring them to effectively and demonstrably offset their grid power consumption, grid-connected electrolyzers can be up to *twice* as emissions intensive as hydrogen produced from natural gas. This is in direct conflict with statute Congressional intent. DOE's assessment finds projects that use any more than 15% grid power will not qualify for the tax credit at all due to the carbon intensity of the grid.[6] Weak accounting systems will keep dirty generators online and slow grid decarbonization, risking U.S. decarbonization efforts. A rigorous accounting system that supports power sector and industrial decarbonization in this decade is essential to achieve the goals of a 50-52% emissions reduction by 2030, a carbon-free electricity system by 2035, and a net-zero GHG economy by 2050.[7]
2. **Undermine confidence in hydrogen and the IRA as a climate solution:** High-profile accounting failures, in which taxpayer money is used to subsidize facilities that lead to significant net increases in grid emissions, would risk hydrogen's reputation and undermine the overall clean energy tax credit package. A weak emissions accounting system may lead to elimination or reform to the credit that damages the clean hydrogen

[4] This figure is based on preliminary analysis assuming electrolysis displaces SMR production and a conservative estimate based on DOE's projections of roughly 5 million metric tonnes (MMT) H2 production per year for ten years of the credit. One kg H2 production requires roughly 50 kWh electricity and according to the EPA eGRID2020 data, average grid intensity is roughly .3726 CO2e/kWh. Should weak accounting schemes allow grid-connected electrolyzers to qualify for the highest tiers of the credit, 5 MMT of hydrogen production receiving the PTC for 10 years could lead to roughly 1.02 gigatons of CO2e emissions. Under the assumption that this displaces SMR, the emissions would net out to roughly 0.42 gigatons CO2e.

[5] https://www.hydrogen.energy.gov/pdfs/clean-hydrogen-strategy-roadmap.pdf. This number is a rough estimate meant to illustrate the magnitude of the incentives and underscore the importance of ensuring that they are subsidizing truly "clean" hydrogen.

[6] https://www.energy.gov/eere/fuelcells/articles/clean-hydrogen-production-standard

[7] https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/

industry far more in the long run than taking the time to develop an effective accounting system.

A Two-Step Approach is Necessary for Treasury to Develop a Robust Framework for Grid-Connected Projects

Emissions accounting is relatively simple for a range of projects, including electrolyzers that are directly powered by co-located, "behind-the-meter" renewable energy resources and are not connected to the electricity grid. The GREET model is generally a suitable tool for those projects. In contrast, emissions accounting is very complex for grid-connected electrolyzers that are mostly or wholly powered by the electricity grid and rely on mechanisms like EACs and power purchase agreements to offset their emissions. Designing a rigorous emissions accounting framework for grid-connected electrolyzers will take time to consider feedback, model impacts, and develop the systems necessary for implementation.

We therefore recommend that the Treasury adopt the following two-tiered implementation system commensurate with the varying degrees of complexity:

- In preliminary guidance and until a "successor" model and a new framework are finalized, we recommend the Treasury use the GREET Model, as delineated in statute, to qualify projects. Given the average carbon intensity of grid electricity, near-term usage of the GREET model means projects primarily relying on behind-the-meter clean electricity to power their electrolyzers will qualify for the PTC.
- In preparation for final guidance, the Treasury should collaborate with DOE, EPA, and other relevant agencies to evaluate concepts, feasibility, and frameworks for emissions accounting of hydrogen projects that seek to be primarily grid connected. We believe that this process can be completed in no more than 18 months and that engaging in a deliberate and transparent process to get those rules right is of vital importance.

Based on recent modeling, we recommend three design pillars that are all necessary for any rigorous emissions accounting framework for grid-connected electrolyzers. We also provide two potential emissions accounting frameworks that internalize the pillars and can robustly deliver "effective" emissions reductions. We look forward to working with both agencies over the coming months to finalize a rigorous system that would ensure that public funds subsidize truly clean hydrogen projects and that the 45V tax credits deliver on the statute and intent.

Criteria and Design Pillars

Practical Criteria

An emissions accounting framework for grid-connected electrolyzers should meet, at a minimum, the following criteria:

- Sufficient rigor and stringency to avoid emissions increases on the grid and deliver on the requirement to reduce effective GHG emissions;
- Implementability by the Treasury with supporting agencies, including DOE;

- Certainty and practicality for industry so as not to hinder the economics and market lift-off of grid-connected electrolytic hydrogen.

Guided by those criteria, we outline design pillars that should be embedded in any robust framework, as well as two potential frameworks for consideration. It is our assessment that both frameworks have the potential to adequately satisfy the three criteria and internalize the design pillars, based on our own analyses and meaningful consultation with a range of stakeholders including clean energy companies, hydrogen developers, academics, and peer environmental groups. We call on the Treasury, in conjunction with supporting agencies, to further assess the emissions impacts, cost, and operational implications of each after adequate socialization and engagement with a wide range of stakeholders including academics, grid operators, industry, and environmental groups.

Design Pillars

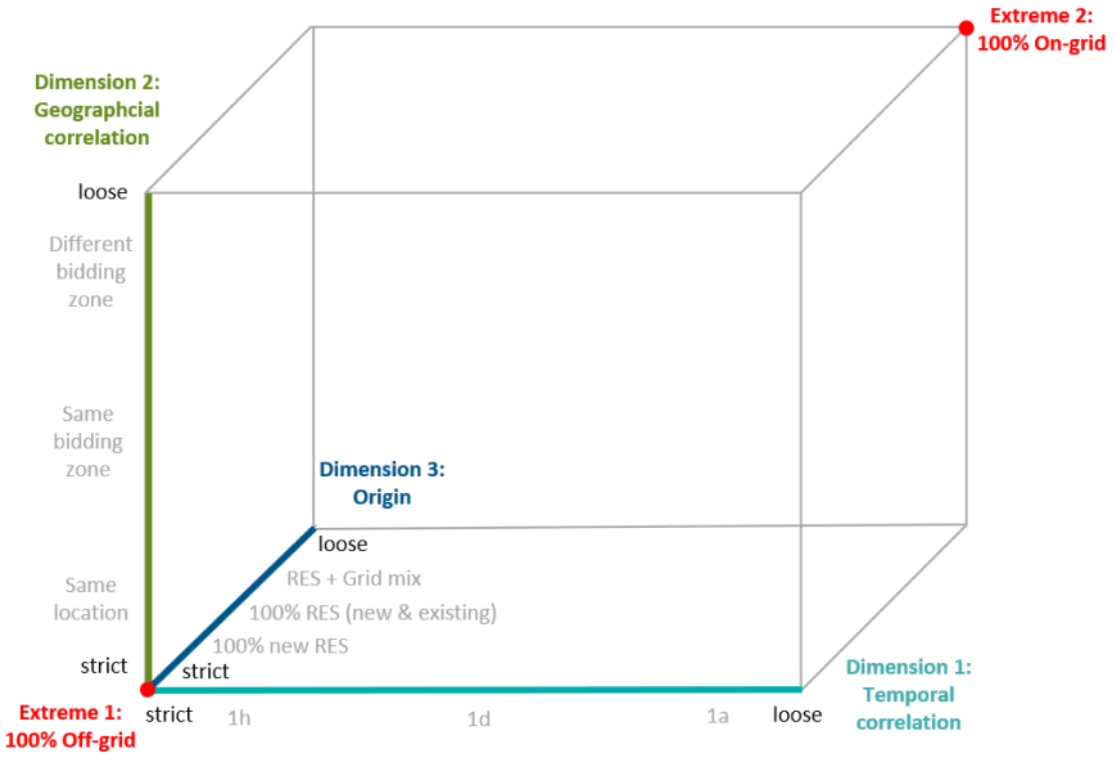
We identify three key pillars as fundamental to any emissions accounting scheme that rigorously accounts for the emissions of grid-connected electrolyzers:

1. Additionality
2. Regionality
3. Granular temporal accounting for emissions impact

The first three pillars are based on three variables for which the stringency can be adjusted. Using the visualization below, we think that a strict origin, accurate temporal assessment of emissions impact, and moderately strict geographical correlation are critical to ensuring truly low emitting grid-connected hydrogen production.[8]

[8] https://cadmus.eui.eu/bitstream/handle/1814/74850/RSC_WP_2022_44.pdf?sequence=1&isAllowed=y, page 10.

Figure 1. Regulatory dimensions



1. Strict additionality is fundamental; a system without additionality is a non-starter

Additionality is a key requirement to ensure that developers are offsetting the emissions of the new load from grid-connected electrolyzers. To offset emissions linked to new grid power consumption, electrolyzers must contract *new* clean generation to match this load. If electrolyzer loads are not paired with new clean generation, the grid will respond by ramping fossil generators to serve the new load. The effective GHG impact of fossil generators would make the facility in question ineligible for the 45V tax credit. Existing renewable generators are already meeting loads on the grid, such that attributing this clean energy to electrolyzers would merely shuffle its attribution and contribute to no real emissions reductions on the grid, delaying the decarbonization of other sectors. A recent study by Princeton University (undergoing peer review) estimates that absent additionality requirements, grid-connected hydrogen projects could have an emissions rate that is up to *5 times* the threshold that would make a project eligible for even the lowest tax credit.[9] Our estimates corroborate this finding: we estimate that absent additionality requirements, grid-connected electrolyzers could result in half a gigaton of carbon

[9] Wilson Ricks, Qingyu Xu and Jesse D. Jenkins, "Enabling grid-based hydrogen production with low embodied emissions in the United States," Andlinger Center for Energy and the Environment, Princeton University, October 2022, https://zenodo.org/record/7183516#.Y1a6cXbMJPY

emissions over the lifetime of the credit. Additionality is a necessary, but not sufficient, feature for any accounting standard that evaluates the system-wide emissions impacts of grid-connected electrolyzers and seeks to "reduce effective greenhouse gas emissions". Additional necessary criteria are outlined in the sections below.

Mechanisms to demonstrate additionality require further assessment. Treasury and DOE should evaluate a range of options and implement a rigorous framework. Considering the critical importance of additionality, the process of defining it and outlining the proper demonstration mechanisms should embed a high degree of transparency and stakeholder engagement. Options for consideration include but are not limited to: requirements for electrolyzers to sign power purchase agreements with *new* clean energy projects that come online within a set timeframe, financial tests that quantify the incremental impact of the hydrogen project on the clean energy project's economics (demonstrating that the project would not be financeable otherwise), proof clean generation would have otherwise been curtailed or at-risk of closure but for the new demand from electrolyzers, and other mechanisms.

The generous federal incentives on the table (IRA tax credits and DOE hub grants) can significantly reduce cost impacts linked to additionality requirements. In fact, as we note below, the Princeton and European University Institute studies estimate that a system that requires additionality and further embeds other strict criteria would impose only modest costs on electrolyzer projects. There are also a number of choices Treasury could make to increase the flexibility of the standard for a diversity of projects. Options include (and which the Treasury and DOE should further evaluate): allowing hydrogen projects to contract with repowered renewable energy projects (with the hydrogen project driving the repowering), providing a well-designed and time-bound grace period for project development and interconnection, and allowing curtailed clean power to qualify as additional (assuming that a robust framework is in place to verify that the clean power would indeed have otherwise been curtailed absent demand from the hydrogen project).

2. Regionality

Regionality establishes a geographical boundary within which both the clean energy project that the electrolyzer is relying on for EACs and the electrolyzer must be located. The boundary can range from "anywhere" (i.e., no restrictions), to the same grid, to the same RTO, to the same interconnection node. More flexibility increases the risks of increased emissions due to transmission constraints, while also providing access to areas with the best clean energy potential.[10] In some regions, tighter geographic boundaries can lead to greater emissions reductions. Transmission constraints can prevent procured renewable projects from delivering electricity into the region/grid where the electrolyzer is located; this could result in those procured renewable projects either simply displacing other renewable energy on their grid and/or displacing fossil resources resulting in emissions abatement that may not be proportionate to the electrolyzer's emissions. A lack of deliverability would therefore undermine the connection

[10] Wilson Ricks, Qingyu Xu and Jesse D. Jenkins, "Enabling grid-based hydrogen production with low embodied emissions in the United States"

between the emissions linked to the electricity consumed by the electrolyzer and the emissions abatement delivered by the procured clean energy projects.

It is critical that any emissions accounting framework incorporate relevant spatial variability in power system dynamics and grid congestion/constraints, and impose operational guardrails to ensure clean energy resources powering electrolyzer loads are located in a region that allows for an appropriate degree of electricity deliverability.

3. Granular Temporal Accounting

Temporal accounting refers to the degree of alignment between the times when the electrolyzer is consuming grid power for operation and times when procured clean energy projects are generating. Temporal accounting can be hourly (i.e., the electrolyzer only operates within the same hours the renewable project generates), daily, monthly, quarterly, annually, or unrestricted. The more granular the time period (i.e. hourly), the more assurance the government will have that hydrogen producers are effectively offsetting induced emissions from their grid-powered electrolyzers with clean energy operating in real time. As solar and wind generation increases on the grid, the daily variation of grid emissions increases - thus sub-daily measurements are required for accurate emissions accounting.

In contrast, annual accounting schemes entail loose correlation between electrolyzer load and clean energy generation and allow electrolyzers that drive significant increases in grid emissions to pass off as clean. The climate risk occurs when electrolyzers operate during times of high marginal grid emissions (e.g., at night when gas plants are running and renewable generation is low) and supplement their electricity consumption with annual EACs generated by clean energy facilities with low marginal emissions abatement (e.g., a new solar project in California that displaces other renewables and insufficiently displaces marginal gas plants). Annual accounting systems and systems that allow unbundled EACs are a non-starter due to their carbon emissions impacts.

This dynamic is illustrated in the Princeton study, which finds additionality coupled with only annual EAC matching is ineffective at reducing electrolyzer emissions and results in hydrogen sources with very high emissions (up to *5 times* higher than the tax credits *minimum* eligibility threshold) qualifying for the 45V credit.[11] This finding is corroborated by a recent study by the European University Institute which sees increased gas generation and associated net system emissions in the case of annual EAC matching schemes.[12] Such impacts directly contradict statute and Congressional intent.

Hourly matching is emerging as a critical instrument, offering the necessary emissions accounting rigor. For example, the Princeton study finds that requiring hydrogen producers to match their electricity consumption on an hourly basis with local clean generation can achieve

[11] Wilson Ricks, Qingyu Xu and Jesse D. Jenkins, "Enabling grid-based hydrogen production with low embodied emissions in the United States" (page 8)

[12] https://cadmus.eui.eu/bitstream/handle/1814/74850/RSC_WP_2022_44.pdf?sequence=1&isAllowed=y

effective emissions reductions needed to qualify for 45V.[13] This mechanism is also receiving increased support from a growing range of stakeholders. Leading organizations developing hourly EAC markets, like M-RETs, EnergyTag, and Singularity, are confident that a nationwide system could be implemented and enforceable in time for clean hydrogen project development, and in line with statutory requirements. Engagement with these stakeholders should be part of Treasury's evaluation process.

Two Potential Systems to Reduce Effective Emissions

We recommend two potential systems for consideration that internalize the above pillars and satisfy the three criteria relating to emissions accounting rigor, implementability by agencies, and reasonableness for industry. The following table provides an overview of both, followed by a description of the key elements of each.

1. Overview of key features of the 24/7 Carbon Free Electricity (CFE) and Marginal Emissions Accounting frameworks (compared with a weak Annual Accounting Framework Without Additionality)

The table below compares the core features of three different accounting schemes, two that could maximize emissions reduction through more stringent restrictions and one that could hinder effective emissions accounting because of its relative leniency. Schemes include:

- **Hourly matching of carbon free electricity** - a leading approach for ensuring that grid electricity is offset through timely procurement of clean energy sources.
- **Hourly marginal emissions accounting** - directly measures and offsets emissions from grid electricity.
- **Annual accounting without additionality** allows environmental attribute certificates produced at any time to offset the use of fossil-intensive grid electricity on an annual basis without requirements that any of the matched clean power be new. As discussed above, the third is a weak framework that risks subsidizing highly emitting hydrogen sources and is at odds with statute and Congressional intent; we add it here for comparison purposes.

A rigorous accounting scheme should incorporate our design pillars; Treasury, with support from DOE and other agencies, may adjust the stringencies of the criteria below as needed to accomplish this.

[13] Wilson Ricks, Qingyu Xu and Jesse D. Jenkins, "Enabling grid-based hydrogen production with low embodied emissions in the United States"

	24/7 Carbon Free Electricity (CFE)	Hourly Marginal Emissions Accounting	Annual matching without additionality (For Comparison)
Additionality	Requires additionality.	Requires additionality.	No additionality requirements.
Regionality	Narrow regional boundaries. The tighter the regional boundaries, the greater the emissions reductions and deep grid decarbonization. However, tighter regionality can also increase costs.	Does not require regionality. Relaxed regional restrictions can create efficiency, allowing clean energy to be built in the dirtiest grids, while hydrogen projects are built within cleaner grids. Narrower regional boundaries can support deliverability of new clean energy.	No regionality requirements.
Temporal Matching	Hourly matching.	Flexibility in the granularity of these measurements. Hourly measurement of both induced CO2 from electrolyzer operation and avoided CO2 from CFE generation is reasonable and should be considered.	Annual matching.
Variable Measured	Hourly grid electricity consumption is measured and offset.	Hourly marginal emissions induced by grid electricity consumption are measured and offset.	Average grid electricity consumption is measured and offset.

Impact	Good: Deep decarbonization in tighter geographical areas. Investment in emerging clean technologies and solutions are incentivized. Largely ensures clean hydrogen production.	Good: Carbon emissions are fully offset. Hydrogen projects are encouraged to be built in areas with robust clean energy and curtailed renewables. New clean energy is built in dirtiest grids to offset marginal emissions most efficiently.	Bad: EACs are transferred to hydrogen projects from already existing clean resources, diverting clean energy away from other grid uses. Fossil fuel generation often steps in to meet overall load and emissions increase.

2. 24/7 Carbon Free Electricity (CFE)

The 24/7 CFE approach requires that electrolyzer load be matched with *additional* clean electricity supply on an *hourly* basis throughout the year, with tight regionality requirements. This system would embed all three pillars outlined above – strict additionality, granular temporal matching, and tight regionality.

An hourly matching system would also be commensurate with emerging policy and market dynamics, which bolster its practicality. On December 8, 2021, President Biden signed Executive Order 14057 on Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability which sets out the goal of powering federal facilities with 100% carbon-free electricity by 2030, including 50% on a 24/7 basis.[14] In addition, corporate procurement preferences are gravitating towards hourly matching mechanisms with some of the largest corporations and energy users like Google and Microsoft committing to 24/7 carbon free energy. The 45V tax credits and those policy and market developments could therefore be mutually reinforcing and accelerate the wide scale adoption of 24/7 CFE systems.[15]

A 24/7 CFE approach may add a degree of costs and complexity to hydrogen projects. Should a hydrogen producer seek to operate for long hours, they would need to ensure that they procure sufficient clean power to offset their total load at every hour. Such a system would require diverse clean energy resources, including hybrid renewable portfolios (e.g., solar + wind + storage) and possibly, some technologies that are not fully commercialized (e.g., enhanced geothermal). This could make some projects less economically efficient than a pure emissions-based approach like marginal emissions accounting (which we discuss below). However, new studies are concluding that the added costs linked to a 24/7 system can be modest. The Princeton study estimates that 100% hourly REC matching requirements would add between $0 and

[14] https://www.federalregister.gov/documents/2021/12/13/2021-27114/catalyzing-clean-energy-industries-and-jobs-through-federal-sustainability

[15] Google's 24/7 carbon-free energy goal set to achieve by 2030; Microsoft 100/100/0 goal to run 100% of the time on energy with 0 emissions by 2030.; Eurelectric gathers EU suppliers and buyers in its 24/7 Hub to drive demand.

$1/kg$H_2$ to the levelized cost of hydrogen, largely owing to the generous IRA tax subsidies for both clean hydrogen and renewable energy projects. In addition, a recent joint letter to the European Commission penned by a coalition of environmental organizations, think tanks and industry amplifies this point, citing recent findings that an hourly matching system would result in minor cost impacts and a range of benefits.[16]

A 24/7 CFE approach would also encourage investments in emerging clean energy technologies and solutions that will be required for full grid decarbonization, such as enhanced geothermal, battery storage, and other clean firm technologies. Further, hourly load matching would encourage flexible electrolyzer operations, fluctuating in lockstep with the generation profile of the procured carbon-free electricity. This flexibility to ramp up operations when renewables are abundant and ramp down otherwise is projected to be a valuable asset for a future grid with very high shares of renewable penetration, bolstering reliability and reducing system-wide costs.[17]

3. Marginal emissions accounting

Unlike 24/7 CFE which focuses on offsetting project *loads* with clean electricity as a proxy for emissions, marginal emissions accounting focuses on directly offsetting *emissions*. This approach calculates the emissions intensity of the grid where electrolyzer demand occurs (using the marginal grid emissions rate) and requires procurement of clean energy at a location and time that reduces emissions by an equal amount (also using the marginal emissions rate at that location).[18]

Marginal emissions accounting systems do not require a strict regional requirement in the same way as 24/7 CFE, because the emissions themselves are being measured and offset. 24/7 CFE uses clean electricity as an emissions proxy, making deliverability an important component of this system. Marginal emissions accounting can be slightly more efficient by allowing developers to invest in clean projects where it offsets their induced emissions at the lowest price.

Critiques and Limitations

There are outstanding questions with this approach. Data availability and methods for calculating marginal emissions rates are currently limited and require approximations. Different methods would need to be evaluated for accuracy and consistency, though there are systems already in place and being developed that could serve as a starting point, including the EPA's AVoided Emissions and geneRation Tool (AVERT).[19] This challenge may be alleviated by the directive included in the Infrastructure Investment and Jobs Act requiring the Energy Information Administration to collect and publish estimated marginal emissions rates for different balancing

[16] https://bellona.org/news/renewable-energy/2022-10-bellona-signs-letter-forthe-european-commission-to-decide-on-rfnbo-delegated-act-to-enable-informed-debate-and-vote-in-the-european-parliament-and-council; https://cadmus.eui.eu/bitstream/handle/1814/74850/RSC_WP_2022_44.pdf?sequence=1&isAllowed=y

[17] https://www.utilitydive.com/news/how-utilities-harness-green-hydrogen-productions-flexibility/626096/

[18] This approach is described in greater detail here: https://www.watttime.org/news/insight-brief-accounting-for-impact/

[19] https://www.epa.gov/avert

authorities and nodes.[20] However, this process is in early stages and unclear when that data would be available at the scale needed for this system.

Additionally, marginal emissions accounting can introduce uncertainty for hydrogen project developers and financiers concerning the emissions intensity of a hydrogen project as the carbon intensity of the grid changes, and with it both the marginal emissions impact of the hydrogen producer and the procured clean energy change. For example, if a hydrogen producer enters into a power purchase agreement with a solar facility on a dirty grid such that it avoids significant emissions in the near-term, the producer will need some type of certainty that they can count on those (or comparable) avoided emissions for a specific amount of time. As the grid changes, the offsetting clean energy project will lose emissions value, developers will be required to build a new clean energy project or risk losing eligibility for the tax credit.

Developers will need to model future marginal emissions rates and induced emissions offsets, which may inject additional risk and cost.

Comparing the 24/7 and Marginal Emissions Accounting Frameworks

The following table compares the two frameworks based on cost efficiency, implementability, and effectiveness at incentivizing useful technologies and solutions.

	24/7 Carbon Free Electricity (CFE)	Marginal Emissions Accounting
Cost-efficient emissions reductions	More expensive in some locations with lesser access to carbon free sources	More cost-efficient in the short-term, costs may increase over time
Producer incentives aligned with system-wide emissions reductions	Supports project-specific and grid decarbonization	Supports system-wide decarbonization, could increase emissions locally
Tracking and data required	Hourly clean energy generation data	Hourly marginal grid emissions rates

[20] https://www.watttime.org/app/uploads/2022/05/WattTime-HowWattTimeGaugesAndIteratesOnMOERAlgorithmQuality-vFinal-202205.pdf

Certainty for projects developers and industry	Requires forecasting and flexible loads. Provides fairly robust certainty for developers.	Marginal emissions impacts and reductions will change over project lifetime, leading to less certainty for developers.
Provides near-term incentives for technologies and solutions that will be useful in long-term grid decarbonization	Yes	Yes, but only if buyers plan ahead for performance and avoided emissions impacts of procured CFE over the long term

Conclusion

The proposed framework must reduce effective GHG emissions to comply with the language and intent of the legislation. To comply with Congressional intent, **Treasury should adopt a two-step approach and publish:**

- Immediate guidance: the GREET model is the tool prescribed for all hydrogen production pathways. Grid-connected electrolyzers may employ GREET but are not allowed to rely on emissions offsetting mechanisms, pending final guidance. The Treasury Department and the IRS should also commit to rigorous principles of accounting to ensure grid-connected electrolyzer operations are clean. This will provide certainty to developers and support the Treasury Department and the IRS process of establishing final guidance along the statutorily required timeline.

- Near-term and final guidance: Treasury should work with DOE and EPA to develop and enforce a robust book-and-claim system incorporating the three pillars of additionality, regionality, and granular temporality for grid-connected electrolyzers.

This will provide near-term direction while allowing time to grapple with the complexity of a grid-connected accounting system. While a two-step approach may require more time and capacity upfront, it will be critical to deliver on Congressional intent and prevent high emitting projects from qualifying for this generous tax credit, creating a climate and reputational disaster.

A large and growing coalition of energy experts, hydrogen developers, granular EAC market developers, and environmental nonprofits have been collaborating on these ideas and could serve as an initial task force that the Treasury Department, the IRS and DOE can convene and lean on to develop a rigorous and practical emissions accounting framework.

We look forward to working with the Treasury and supporting agencies on this critical issue.

Sincerely,

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