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Commentary to 45V Notice of Proposed Rulemaking released 12.26.2023

From:
Mid-Atlantic Clean Hydrogen Hub (MACH2)

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Executive Summary

As leaders of a regional clean hydrogen Hub in the Mid-Atlantic (MACH2), we strongly support the Administration's efforts to advance clean energy and accelerate America's clean hydrogen industry. **We are believers in the goal of reaching net zero emissions by 2050 and that a robust clean hydrogen economy can greatly advance decarbonization objectives in hard-to-abate sectors, reducing criteria pollution emissions, and driving health benefits in the communities we represent.**

It is critical that the final guidance for qualification to the Clean Hydrogen Production Tax Credit under 45V NPRM unleash this potential by **making the economics of zero-emission hydrogen produced through electrolysis powered by renewable electricity or nuclear power at least on par with the current process of creating hydrogen from natural gas combusted through steam methane reforming**. The transition to truly zero-emission hydrogen depends upon a cost-effective transition from utilizing steam methane reformation to adopting electrolysis powered by zero-emission electricity as the preferred means of production.

To this end, we find the currently proposed rules for 45V NPRM - published by the Treasury Department last December – have areas that could be improved to prevent the above-mentioned aspirations from being placed at risk. While we support the need for time-matching, incrementality, and deliverability requirements to control induced grid emissions, we believe these should be phased in by 2030 to reflect the anticipated deployment timelines for utility-scale renewable energy sources, such as offshore and large solar projects that await interconnection in the PJM queue. We believe extensive developments in grid infrastructure and renewable electricity development need to happen before they are in place, and that a more realistic timeline and allowance of a small, reasonable percentage of existing nuclear and renewable electricity will prevent **Treasury from unwittingly jeopardizing the ecosystem of zero-emission hydrogen & Clean Hydrogen Hubs program and stunting future growth in the sector by significantly hurting the economics of electrolysis projects across the US in their nascent years**. This would hurt the development of a national electrolyzer industry and delay deep decarbonization in difficult to abate sectors. Failure to level the playing field for renewable and nuclear powered electrolyzers will encourage even greater use of natural gas fueled SMRs and lock in additional fossil fuel usage—and their corresponding greenhouse gas emissions—at the expense of zero-emitting Hydrogen.

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The below reflects MACH2's management team views. MACH2 project partners may have additional comments that may be submitted separately. MACH2 key concerns and areas for improvement within the proposed 45V NPRM are:

- **Incrementality Requirement:**
  - **Nuclear Energy:** 45V NPRM underutilizes the potential for a small percentage of existing nuclear power to support decarbonization in hard to abate sectors, and threatens to diminish the scope of hydrogen Hubs chosen by DOE. Only one new nuclear power plant reactor was started in the past 40 years in the US. The proposed exceptions via avoided retirement or upgrades are as well ill-suited for the idiosyncrasies of nuclear power generation in our country. Furthermore, the current timelines for deployment of advanced nuclear technologies are unlikely to bring significant new nuclear power online in the next five years. Nuclear power additionally provides a critical need for electrolysis hydrogen – stable, round-the-clock electricity availability. It is critical that at least a small percentage of existing nuclear generation be able to qualify for the full credit.

  - **Incrementality requirement exceptions - Formulaic Approach for clean generators:** The 2022 PJM Energy Transition report highlights renewable energy integration challenges, with significant expected curtailments in accelerated renewable scenarios. These challenges are compounded by the six-year queue for processing interconnection in PJM, which may be further exacerbated and delayed by the huge amount of renewable energy projects catalyzed by the incentives of the Inflation Reduction Act. The proposed 5% of hourly power generation exception is insufficient for an RTO like PJM, and unable to provide the ability to scale up in the future and mitigate the significant uncertainty for green hydrogen projects introduced by the above-mentioned factors. The proposed rules affect electrolytic hydrogen project's feasibility and economic viability, threatening the growth and development of the green and pink hydrogen sectors.

- **Time-matching Requirement:** The proposed hourly matching poses operational challenges for green and pink hydrogen production facilities, and will also entail a significant levelized cost of hydrogen (LCOH) premium in early stages of a nascent industry. Boston Consulting Group's analyses suggest an LCOH premium of 10-40% in certain PJM regions, while an E3 study indicates that hourly matching requirements could raise hydrogen production costs by up to 60% in our region, jeopardizing the economic viability of U.S.-produced green and pink hydrogen. It will be challenging for clean hydrogen producers would be able to secure end-users who are able to accept the resulting higher prices that these increases in costs require. This would prevent the clean hydrogen industry to kickoff at scale, and would make less efficient international electrolyzers more attractive than more efficient, but currently more expensive, domestic technology, hindering the growth of the US electrolyzer industry. Moreover, these strict rules would be detrimental to DOE's effort to set up Clean Hydrogen Hubs across the country, as more competitive blue or grey Hydrogen may capture demand that could have been transferred to green or pink hydrogen. This would not only jeopardize the growth of the Clean H2 industry across the US, but also a considerable amount of the $7

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billion of taxpayer money that the DOE has committed to awarded Clean Hydrogen Hubs across the country.

- **Deliverability Requirement:** With the recent withdrawal of multiple offshore wind projects that now must be rebid and PJM's six-year interconnection backlog, MACH2 is concerned about the availability of clean generation resources in our RTO over the next few years. The Natural Resources Defense Council's 2023 analysis on PJM projects a 22% gap in meeting the 2028 Renewable Portfolio Standards. This gap is exacerbated by a backlog in the interconnection queue of PJM, with over 202 GW of projects as of September 2022, and an eightfold increase in estimated costs for active projects since 2019. This situation signals a potentially considerable shortfall in renewable energy capacity and endangers the reliability and sustainability of the electricity supply, emphasizing the need for PJM to be able to seek renewable electricity supply from more regions.

While additional detail on concerns and proposals raised by the MACH2 partners can be found on the body of this letter, **MACH2 acknowledges the importance of controlling induced grid emissions, and aims to propose a common-sense ramp up of the stringency of requirements that will support that goal without hurting the early growth of the clean hydrogen economy across the nation** and jeopardizing the development of an industry that has the potential to decarbonize hard to abate sectors in our economy. While induced grid emissions may increase in the short term, MACH2 strongly believes that, by allowing green hydrogen projects some latitude to acquire renewable energy certificates in the years that additional renewable energy resources are brought online will accelerate the deployment and to move down the cost curve of electrolysis. Similarly, allowing a small percentage of existing nuclear plants to generate pink hydrogen will spur earlier zero-emission hydrogen production without adversely affecting efforts to decarbonize the grid and electrify the residential, commercial, and light-transportation sectors. This common-sense approach will catalyze earlier emissions reductions in hard-to-abate industrial, heavy-transportation, and agricultural sectors. As a co-benefit, this approach will also reduce criteria pollution emissions, benefiting local communities that have long suffered from environmental injustices, and creating healthier populations across the US.

The **key changes proposed by MACH2 are**:

- **Incrementality Requirement changes:**
  - **Nuclear Energy Exemption:** MACH2 proposes to exempt a small percentage of existing nuclear energy (10%) from the 45V incrementality rule, to avoid underutilizing nuclear plants in PJM, thereby supporting economically viable hydrogen production. We believe this recommendation is in line with Congress's intent when legislating on the IRA and IIJA to establish a US clean hydrogen economy, which explicitly called for a hydrogen hub with nuclear energy as the power source.

  - **Incrementality exceptions - Adaptation to Formulaic approach to address incrementality from existing clean generators:** While the data analysis conducted by Lawrence Berkeley National Laboratory and quoted in the NPRM considers

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national level data, a "one-size fits all" approach does not capture the nuanced distribution of renewable generation facilities across the country, particularly the extremely long interconnection backlog of PJM and the timelines for the offshore wind deployment, which represents the greatest opportunity for utility-scale zero-emission power close to the load centers of the east coast. We therefore **recommend a regionally tailored formulaic approach, allowing a minimum of 10% of hourly generation from existing clean generators** to meet incrementality requirements, as new renewables, such as offshore wind, are brought on at scale. This exception could be time-limited through 2030 to correspond with the deployment schedules of offshore wind and other utility scale renewable projects that will come online by the end of this decade. While the 2018 data suggest negative prices for 5% of the hours at national level, based on some certain, PJM could see a 16% curtailment rate by 2035, indicating significant challenges in renewable energy integration across the RTO.

- **Hourly Matching Delay:** MACH2 supports requiring hourly matching as renewables and storage capacity are brought online; however, it does not make sense to delay all green hydrogen facilities and electrolyzer deployment until such infrastructure is in place. As such, we recommend requiring the mandatory hourly matching starting in 2030 to align with the European Union's approach, including parameters for extension under specific conditions. This approach would support the clean hydrogen electrolysis industry growth by improving economic feasibility in early years and incent the accelerate deployment of additional renewables, while placing the US clean hydrogen's competitivity at par with Europe.

- **Deliverability regional expansion:** In limited cases where a green hydrogen project can demonstrate that insufficient renewable energy certificates are available at a reasonable price within the RTO/ISO where a project is being constructed (and additional renewables are being constructed), we recommend a minor, time-limited exemption to allow renewable electricity procurement to include adjacent neighboring RTO/ISO. For PJM, for example, this would be limited to NYISO, MISO and Southeast. This recommendation provides certainty and reliability for green hydrogen project developers to mitigate potential shortfall of renewable electricity and the long interconnection queues in PJM, as well as the potential for market manipulation through the hoarding of renewable energy certificates to constrain supply and artificially drive-up costs.

- **Other dimensions of 45V NPRM:**

    - **Hourly Carbon Intensity averaging:** The currently proposed regulation does not clarify whether Carbon Intensity (CI) will be calculated through annual or hourly averaging. MACH2 strongly encourages Treasury to provide transparency on this guidance, and that, in line with their requirements for hourly matching in power consumption, hourly CI averaging is implemented. This will allow producers that are planning to have grid power consumption as backup to secure the full PTC in the hours in which renewable energy is being consumed.

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- **45VH2 GREET Model Region granularity:** The GREET model's division into just the 10 NERC regions may not accurately reflect local grid specifics, impacting carbon intensity (CI) scores for projects using mixed renewable and grid electricity. MACH2 proposes to amend the 45VH2 GREET model to allow for more granular electricity source identification. This will enable projects to accurately reflect the rapidly expanding mix of renewable and grid electricity specific to their local grid, and support DOE in better assessing the CI score's impact from grid electricity use as backup or for auxiliary equipment.

A view of more detailed concerns and suggestions related to the dimensions covered above, as well as other dimensions of the NPRM – such as biomethane or verification requirements – can be found in the body of this letter. In addition, MACH2 has encouraged the project partners members of the Hub and its Subrecipients of DOE's Clean H2 Hubs award to submit their own commentary to better capture their individual positions.

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1 Incrementality Requirement

The MACH2 Hub is a green and pink Hydrogen Hub, as such, MACH2 would like to emphasize critical concerns with 45V proposed regulation's impact on nuclear hydrogen projects and the challenges faced by green hydrogen initiatives due to incrementality requirements and interconnection bottlenecks. MACH2 Hub advocates for regulatory adjustments to better support clean hydrogen production and develop a national clean H2 economy.

1.1 Challenges and concerns with proposed approach

1.1.1 Nuclear Energy Powered Hydrogen Production

The proposed 45V regulation, as it stands, diverges from Congress's original legislative intent by affecting existing nuclear plants' eligibility for hydrogen production credits. Per the Bi-Partisan Infrastructure Bill, which created the hydrogen Hubs, **it is stated that at least one Hub would use nuclear power as the source for hydrogen production.** The proposed regulation would significantly hinder this possibility as well as the success of all the hydrogen Hubs.

The proposed ruling on incrementality mandates the Commercial Operation Date (COD) of the electricity generating facility to be no more than 36 months prior to the hydrogen production facility's start date. When making the incrementality requirement applicable to nuclear energy, the Treasury seems to overlook that only one new nuclear power plant reactor was started in the past 40 years in the US[1]. This means essentially, that all but one nuclear power plant in the US fail to meet this criterion, and that the proposed regulation therefore explicitly excludes nuclear energy, impacting the eligibility of nearly all nuclear facilities for the proposed 45V credits, including those associated with our partner's projects.

This exclusion not only underutilizes the potential of nuclear power to support decarbonization in hard to abate sectors, but also threatens to diminish the scope of hydrogen Hubs chosen by the DOE, as two hydrogen Hubs, including MACH2, rely on existing nuclear facilities[2] within their proposed scope.

Furthermore, the exclusion of nuclear plants could significantly increase hydrogen production costs, impede industry growth, and delay decarbonization efforts in crucial, hard-to-abate sectors. The DOE estimates that excluding nuclear plants from Hydrogen production would imply needing to double the nation's renewable solar and wind sources to produce enough hydrogen to meet 2030 climate goals for transitioning industry to clean energy[3].

[1] The US gets its first new nuclear reactor after 40 years
[2] Mid-Atlantic coast and Midwest rely on nuclear to hydrogen
[3] Nuclear Newswire article

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While the proposed regulation proposes several exceptions to meet the incrementality requirement, these seem to not account for the specifics of nuclear power generation.

For instance, while preventing a facility's retirement could meet the criteria, the reality is that the federal policies introduced recently, including Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA) have effectively prevented the retirement of at least 22 nuclear reactors[4]. Moreover, the incrementality rules for Avoided Retirements specified in the 45V proposed regulation make it challenging to argue for the retirement eligibility of a nuclear plant.

MACH2 Hub producers that were planning on utilizing nuclear energy to power hydrogen production highlight that the only way they could meet this requirement is through upgrading a nuclear facility or through the 5% threshold of hourly generation for minimally emitting power generation sources proposed by the Treasury for the formulaic approach. However, upgrading a nuclear facility is a process fraught with uncertainty in both timing and economic viability, and, while the 5% limit is enough to get initial projects off the ground, it may prevent the further scaling up of the industry and carries significant risk of making pink hydrogen projects economically unfeasible, potentially leading to projects not moving forward, and thus resulting in a lost opportunity for the US hydrogen industry. We recommend a threshold of 10% of existing nuclear capacity.

1.1.2 Green Hydrogen

The incrementality requirement, particularly in regions like PJM, is poised to significantly elevate the costs associated with the production of clean hydrogen. These requirements, coupled with the current challenges of interconnection bottlenecks and delays of offshore wind deployment, not only threaten to delay the initiation and completion of green hydrogen projects but also pose a considerable risk to the overall growth of the industry. According to findings from the Lawrence Berkeley National Laboratory, the average duration for projects to navigate through interconnection queues before reaching completion in 2022 spanned an extensive five years[5]. This duration is significantly longer than the three-year timeline outlined in the draft.

This pronounced and documented delay in new renewable electricity projects progressing from conception to realization introduces a layer of uncertainty for the development of green hydrogen initiatives. The lag in timelines for project approval and completion directly impact the operational and economic viability of green hydrogen production, as this delay in the availability of renewable electricity sources is likely to significantly hinder the planned expansion and scale-up of hydrogen production facilities. Such uncertainty may not only impede the strategic planning and investment decisions for these projects but also affect the broader objective of transitioning towards a more sustainable and low-carbon energy future. Overly restrictive conditions on renewable energy usage could strain limited resources, potentially leading to higher costs and impacting green hydrogen's economic viability and encourage the use of more-polluting natural gas fueled SMR technologies.

[4] How policy saved America's nuclear powered plants
[5] Lawrence Berkeley National Laboratory "Queued Up" study

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One MACH2 Hub producer partner raises that the lack of certainty in accessing qualifying electricity for clean hydrogen production through electrolysis over the lifetime of the project risks early projects not moving forward into the phase or Budget Period 1 of the Clean Hydrogen Hubs program.

While there are allowable exceptions, such as upgrading an existing facility to qualify. It's also important to recognize that existing facilities employing advanced low-emission technologies could face increased costs and complexity due to mandated upgrades in order to get the credit under 45V.

1.2 Proposed Adjustments

With consideration to the perspective of our partners, the MACH2 Hub proposes amendments for greater flexibility under 45V proposed guidance, including the effective exclusion of existing nuclear power under incrementality rules, and increasing curtailment rate under the formulaic approach for the proposed exceptions to the incrementality requirement. This flexibility would mitigate the above-shared risks by enhancing the economics and scalability of green hydrogen projects.

1.2.1 Exemption for nuclear energy under incrementality rules

MACH2 Hub advocates for a small exemption for existing nuclear-powered energy from the incrementality rule under 45V guidelines to ensure economic viability for clean hydrogen projects. The current proposed rule, which requires generation assets to be in service no more than 36 months before the hydrogen facility's commissioning, effectively excludes all but one existing nuclear plants, including MACH2 Partners. This exclusion would render the project economically unfeasible and hinder our partner’s ability to move forward. As such, we recommend that 10% of existing nuclear generation be allowed to qualify.

The very high capital cost and long lead times for permitting and construction of new nuclear power plants would yield higher hydrogen costs, making it harder to produce at prices attractive to end-users. This is particularly evident in the northeast and Mid-Atlantic regions as the price of electricity is more expensive than in many other regions of the country. An exemption for nuclear energy is crucial for the viability and progression of our partners’ project. An exemption also aligns with broader goals of developing a domestic clean hydrogen economy, as recognized by initiatives like the IRA and IIJA, emphasizing the urgent need for deploying clean hydrogen production powered by carbon-free sources.

The EU's approach offers a valuable comparison, granting nuclear energy an exemption for renewable hydrogen production. This policy also allows hydrogen fuel producers to consider electricity from the grid as "fully renewable" in areas with emission intensity lower than 18 grams per megajoule, facilitating the integration of nuclear energy into the renewable energy mix. This strategic exemption supports the transition to clean energy, demonstrating a practical pathway to include nuclear power in efforts to meet future hydrogen demand and emissions reduction targets,

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mirroring the necessity for similar considerations in the U.S. context[6]. This threshold eases the way for regions where nuclear energy forms a large part of the energy mix. Such an exemption would address the oversight, enabling existing nuclear plants to contribute to clean hydrogen production without facing unnecessary economic hurdles, thus supporting a broader, more inclusive strategy for clean energy development.

1.2.2 Formulaic approach to addressing incrementality from existing clean generators

The 2022 Energy Transition report by PJM underscores renewable energy integration challenges, with significant curtailments, notably in accelerated renewable scenarios, reaching 16% due to transmission bottlenecks[7]. The Inflation Reduction Act (IRA) is expected to further escalate these curtailment rates. Further, delays in the deployment of offshore wind will require green hydrogen producers intending to utilize offshore wind as a power source to acquire renewable energy certificates in the early years as this additional power comes online. This issue of deployment is not isolated to PJM; similar challenges are anticipated across the energy grid, including in Texas, where the US Energy Information Administration (EIA) predicts that by 2035, wind and solar curtailments within ERCOT could reach 13% and 19%, respectively[8]. We recognize the proposal for a national average curtailment rate of 5% but believe it overlooks the challenges hydrogen projects face, and prevents the industry from further scaling.

To address these challenges and support low carbon H2 ecosystem advancement, MACH2 proposes a regionally tailored formulaic approach which should factor in the above mentioned 16% curtailment rate in PJM.

- Some of our Hub partners propose modifying the 45V incrementality ruling to allow a minimum usage of 10% from existing zero-emitting generators, like wind and solar facilities operational before January 1, 2023, to meet the formulaic approach under the incrementality requirement, facilitating competitive economies of scale and sustainable levelized cost of hydrogen (LCOH) for end-users.

- Furthermore, our partners suggest allowing a minimum of 10% from existing nuclear power generation facilities, integrating this flexibility into the framework to support the broader adoption of clean energy solutions by increasing the availability of low carbon power to the hydrogen economy. This will also enable further scale of the clean hydrogen ecosystem, avoiding the proposed hydrogen Hubs to be one-of-a-kind projects and further enabling decarbonization in hard to abate sectors.

[6] RED 2 includes Nuclear
[7] 2022 Energy Transition Report by PJM
[8] EIA Texas grid curtailment rates

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2 Hourly Matching Requirement

Implementing an hourly matching requirement for clean electricity consumption starting 2028 under the proposed 45V guidelines presents significant challenges and will hurt economic feasibility of clean H2 projects during its nascent period, preventing a future in which clean H2 supports decarbonization in hard to abate sectors.

2.1 Challenges and concerns with proposed approach

They key challenges and concerns the MACH2 Hub would like to point out are:

- **Cost Implications of Hourly vs. Annual Matching**: The transition to hourly matching under the 45V guidelines significantly impacts the economics of hydrogen production. The requirement will lead to increased investment in storage and electrolyzer upsizing, raising the levelized cost of hydrogen for end-users. It will also pose significant operational challenges in running facilities. The Boston Consulting Group estimates a **10-40%** increase in electrolysis costs with the implementation of hourly matching.[9] Additionally, E3 performed an analysis by looking at 10 different scenarios in PJM and found hydrogen production costs under an hourly approach are 19% to 61% higher than under an annual approach with the same renewable generation portfolio[10]. This stark increase illustrates the financial strain placed on clean hydrogen projects, potentially jeopardizing their economic viability and federal investments planned by DOE for the clean H2 Hubs program. This increase in costs also potentially impacts the competitiveness of US-produced green hydrogen on the global market providing export opportunities to other countries. Preliminary findings from the Boston Consulting Group also suggest that this **increase in LCOH** could result in a decrease of approximately 1 million metric tons per annum (MTPA) in domestic demand for low-carbon hydrogen by 2030 due to these requirements (~25% of the potential overall demand)[11].

- **Electrolyzer Market Dynamics and Hydrogen Production Risks**: The stringent requirements of 45V could shift project priorities towards capital expenditure sensitivity due to decreased equipment utilization. Preliminary results from Boston Consulting Group suggest that hourly matching requirements could lead to an increase in PEM electrolyzer

[9] LCOE for 75/25 share of wind/solar in Delaware, CapEx $925/kW, OpEx 2.5% of CapEx, BCG analysis
[10] E3 Analysis of hourly & annual GHG emissions for H2 production (Energy & Environmental Economics, Inc.)
[11] Preliminary estimate based on LCOH increase in ERCOT, not factored in possibility of green H2 demand moving to blue.

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costs by 4-14% by 2030 relative to current forecasts[12]. This shift, together with the implied OpEx increases in producing green or pink H2 through electrolysis subject to hourly matching, might inadvertently favor less efficient, lower cost electrolyzers, from outside of the US, over more efficient U.S. alternatives. Such a trend could undermine the domestic green hydrogen industry by making clean hydrogen production via electrolysis economically unfeasible.
Additionally, the requirement of hourly matching availability means that hydrogen plants may often need to shut down or operate at barely breakeven level. This restricts the types of electrolysis technologies that are economically viable, as operating on electricity that doesn't meet the criteria will not be cost-effective. Such intermittent operation raises concerns about the reliability and safety of the equipment used for compressing and processing hydrogen post-production. This requirement could also render advanced electrolysis technologies, like solid-oxide electrolysis cells, impractical for use.

- **Regulatory and Financial Risks**: The complexity of achieving hourly matching, particularly for smaller grids or individual consumers, introduces significant regulatory and financial uncertainties. Most electric loads lack the necessary flexibility to adjust operations based on fluctuating weather conditions, leading to potential safety and operational challenges. This requirement could also create an unmanageable market for hourly REC products, complicating clean hydrogen production via electrolysis and making it economically unfeasible in scenarios where matching is not possible. The absence of an hourly EAC market, combined with the imposition of hourly matching requirements, is unlikely to catalyze market creation. The process to update REC tracking systems for hourly matching, in addition to the time needed to develop a liquid market for these instruments, presents a lengthy timeline. Moreover, without mandating all accounts within tracking systems to adopt hourly tracking, the voluntary uptake of hourly-matched EACs will be minimal. This will severely restrict supply and potentially lead to a price premium for these instruments. Compounding these challenges is the current impracticality of implementing hourly time-matching—synchronizing power consumption with generation on an hour-by-hour basis. This difficulty is exacerbated by the anticipated challenges in expanding the necessary power generation and transmission infrastructure by 2028. Consequently, by that year, all hydrogen projects aiming to fulfill this criterion would need to secure their power through PPAs specifically designed for hourly time-matching, rather than relying on general grid power.

- **Inefficiencies and Unintended Consequences:** Isolating clean energy buyers from broader electricity markets could lead to suboptimal consumption decisions. For example, the need for flexible electrolyzers to operate during peak hours to meet contractual supply obligations, regardless of high market prices or carbon intensity, contradicts efforts to optimize energy consumption in response to grid conditions and could open the market to supply from gray or blue production.

[12] Loss in 1MTPA green H2 demand by 2030, based on 5MW electrolyzer CapEx. From “Estimating future costs of power-to-gas – a component-based approach for technological learning” DOI: 10.1016/j.ijhydene.2019.09.230

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- **Comparison of Emissions Reductions:** E3 did a study comparing annual matching to hourly matching across four regions, including PJM, through 10 different scenarios for each region. The analysis centered around a utility-scale, 500 MW electrolyzer operating with a 90% utilization rate under annual matching to optimize hydrogen production, and a 70% production efficiency[13]. The findings from E3's study challenge prevailing assumptions about the effectiveness of hourly matching in reducing greenhouse gas emissions. Contrary to expectations, the analysis revealed that annual matching does not necessarily lead to higher carbon emissions compared to hourly approaches and, in some cases, results in lower emissions.

  One key insight from the study is that with minor adjustments in the size and composition of the renewable energy portfolio to accommodate the electrolyzer' s demand, hydrogen production under an annual matching regime could achieve incremental emissions lower than 0.45 kg CO2/kg H2.

2.2 Proposed Adjustments

Phasing from annual to hourly matching by 2028 is a fair ambition, but it disregards pragmatic realities. This ambitious proposal should be questioned in its feasibility and the appropriate timeline, especially in light of the current technological and market preparedness. We believe that at a minimum these requirements should correspond to the 2030 timeline established by the European Union.

The move towards hourly matching introduces complexities, potentially fragmenting the market by requiring customized solutions for each consumer to meet supply obligations even when renewable power is not available to power electrolysis operations. In contrast, annual time-matching in the early years emerges as a pragmatic alternative, offering several advantages. Notably, it provides greater flexibility, which translates into higher electrolyzer utilization rates and a reduced levelized cost of hydrogen (LCOH). Given the nascent stage of electrolysis technology at commercial scale and the operational challenges posed by hourly matching, including the need for larger electrolyzers and the risk of underutilization, it becomes evident that a more gradual approach is warranted.

- Some Hub partners mention that time matching requirements are likely to present technological, operational and safety concerns from discontinued operations, preventing them from advancing in the development of the proposed projects. One partner, in particular, recommends that phase-in from annual matching to hourly matching is not to be allowed until 2040, with pathways to extensions where markets have not made the necessary changes and/or grids have not greened as anticipated.

- MACH2 acknowledges the need to control induced grid emissions, but it also important to point out that there will be significant cost increases that will hurt a nascent, high-potential industry, and that hourly tracking systems are currently immature. To allow for

[13] E3 Analysis of hourly & annual GHG emissions for H2 production (Energy & Environmental Economics, Inc.)

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sufficient time for the development and maturation of hourly tracking systems and to avoid the "kneecapping" in early stages of green hydrogen projects, MACH2 proposes delaying the start of mandatory hourly matching to 2030 with defined parameters for extending further or having regional exceptions until renewable power availability is solved.

- A delay to 2030 mirrors the European Union's approach, offering a comparable timeframe that has been internationally recognized as feasible for green hydrogen industry. This also ensures that developers can design electrolysis and clean energy projects with the future requirement of hourly matching in mind from the beginning, without the immediate pressure of implementation. By advocating for this delay, we underscore our commitment to a transition that is inclusive, sustainable, and economically sound, ensuring that the leap towards cleaner energy practices is both feasible and beneficial for all stakeholders involved.

3 Deliverability Requirement

3.1 Challenges and concerns with proposed approach

The challenges facing PJM Interconnection in integrating renewable energy and ensuring efficient hydrogen delivery are multifaceted. The restriction to source power exclusively within PJM is a significant concern, especially given the delay to connect renewable supply within PJM, and the need for additional transmission infrastructure within this system to distribute remotely produced renewable energy.

The reliance on the National Transmission Needs Study for regional definitions appears to constrain the potential for clean energy sourcing, neglecting scenarios where wind projects in areas like Wyoming could supply power to the Southwest, which would be beneficial for hydrogen production in those regions. California's example, a state designated as its own region yet sourcing much of its clean power externally, illustrates the complexities of regional dynamics and the supply-demand interplay. These factors are pivotal, potentially impacting the levelized cost of hydrogen, especially for projects reliant on Renewable Energy Certificates (RECs).

PJM's struggle is highlighted by the Natural Resources Defense Council's 2023 analysis, which projects a 22% gap in meeting the 2028 Renewable Portfolio Standards despite plans to add 1,000 MW of renewable projects annually[14]. This gap is exacerbated by a backlog in the interconnection queue, with over 202 GW of projects as of September 2022, and an eightfold increase in estimated costs for active projects since 2019, as noted by the Lawrence Berkeley National Laboratory[15]. Furthermore, the PJM 2023 Energy Transition report highlights a concerning forecast for the energy sector, indicating that by 2030, the decommissioning of traditional thermal power generation

[14] WAITING GAME: HOW THE INTERCONNECTION QUEUE THREATENS RENEWABLE DEVELOPMENT IN PJM
[15] Interconnection Cost Analysis in the PJM Territory

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facilities could surpass the introduction of new renewable electricity sources by a significant margin of 10 GW[16]. It is also important to note that the report was released before recent announcements of offshore wind project cancelations[17].

This situation signals a potentially considerable shortfall in renewable energy capacity and endangers the reliability and sustainability of the electricity supply, emphasizing the urgency for PJM to be able to seek renewable electricity supply from more regions.

3.2 Proposed Adjustments

MACH2 Hub advocates for a strategic adjustment to PJM's renewable electricity sourcing strategy, specifically for cases where insufficient reasonably priced renewable electricity certificates or power purchase agreements are available to include adjacent regions based on National Transmission Needs Study such as the Southeast, Midwest ISO, and New York ISO. By allowing sourcing from adjacent RTO in the Deliverability requirement, in limited cases where REC supply within the RTO is insufficient, the proposed rules would not delay critical electrolysis projects, which is crucial for meeting the region's decarbonization goals and supporting the development and financing of green hydrogen projects. This expanded sourcing approach aims to address the renewable energy shortfall projected in PJM's Energy Transition Report, ensuring a more reliable and sustainable energy supply. It reflects a pragmatic step towards overcoming current operational challenges, fostering a more integrated and efficient regional energy market. This initiative underlines the importance of adapting regulatory frameworks to better reflect the dynamics of regional energy flows and market realities, promoting a smoother transition to a low-carbon economy.

4 45VH2 GREET Model

Our partners propose specific amendments to the 45VH2 GREET model to enhance its applicability for clean energy projects, emphasizing the need for a stable model version pre-final investment decision (FID) to prevent economic uncertainties caused by future updates. This approach aims to ensure that projects maintain their eligibility for production tax credits without the risk of being impacted by changes in the GREET model or other emissions verification method set forth by DOE in the future, offering a more predictable and secure framework for project planning and investment in renewable energy.

In addition, MACH2 partners have found the model has limited flexibility for users to customize the input data with operator's project specified information, which might have a larger impact on the life-cycle carbon intensity calculation. The Hub's specific areas for concern and proposed adjustments are:

[16] 2023 Energy Transition Report by PJM`
[17] Two off-shore wind projects cancelled by Orsted in New Jersey

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Clarity on Carbon Intensity calculations

- **Challenges and concerns:** The 45V NPRM provides no clear guidance on whether the CI to qualify for the Production Tax Credit will be calculated on an annual or hourly average. As some partners plan their operations partially with EACs for hours with renewable generation and with grid power without EACs for other hours, this distinction is crucial, as it will determine their eligibility for the PTC during the hours in which renewable power is being consumed to power H2 production. A yearly average may take producers outside of the range to secure the $3/ Kg H2 full PTC, instead of obtaining it for the applicable hours.

- **Proposed amendments:** We strongly encourage Treasury to provide transparency on this guidance, and, that, in line with their requirements for hourly matching in power consumption, hourly CI averaging is implemented. Hydrogen producers should be able to produce hydrogen with varying carbon intensities throughout the taxable year to optimize operations, accommodate customer requirements, and adjust to input availability, price, and quality. This, for instance, will allow producers that are planning to have grid power consumption backup to secure the full PTC in the hours in which renewable energy is being consumed.

Electricity Source Granularity:

- **Challenges and concerns:** The current GREET model's division of electricity sources into 10 NERC regions lacks specificity to local grids, potentially affecting the carbon intensity (CI) score accuracy for projects using a mix of renewable (via PPAs) and grid electricity. This is particularly relevant for facilities that rely predominantly on renewable energy but still utilize a small percentage of grid electricity for auxiliary equipment.

- **Proposed amendments:** Our partners propose to amend the GREET model to allow for more granular electricity source identification, enabling projects to more accurately reflect the mix of renewable and grid electricity specific to their local grid (this will be incredibly important as offshore wind significantly decarbonizes the PJM grid). This would help in better assessing the CI score's impact from electricity use for auxiliary equipment.

H2 Pathways & Electrolyzer Technology Categorization:

- **Challenges and concerns:** The GREET model's recent simplification into two broad categories of electrolyzers (low and high temperature) removes the granularity needed to accurately account for the specific power consumption differences between technologies like Proton Exchange Membrane (PEM) electrolyzers and other low temperature electrolyzers. This generalization could inaccurately impact the CI score, especially concerning auxiliary equipment powered by grid electricity. Overall, the current 45VH2 GREET Model excludes a range of clean hydrogen pathways and feedstocks that add barriers to project financing for those producers. A clear example of this is that the previous GREET model had available a

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selection of different RNG production processes and feedstocks, including animal waste, biogas from food waste, and biogas from wastewater sludge. The proposed new 45VH2-GREET model no longer includes all of the production options, and seems to only allow for landfill gas

- **Proposed amendments:** Our partners propose to reintroduce detailed categorization for electrolyzer technologies in the GREET model to capture the nuanced differences in power consumption and CI scores. This specificity is crucial for accurately representing the environmental impact and eligibility for tax credits, particularly as newer electrolyzer technologies come into and grow in the market – such as SOEC or AEM. Moreover, our partners recommend that other RNG processes and H2 pathways are included in the model, since they continue to provide the same environmental and lifetime carbon intensity benefits. This will incentivize as many options as possible for achieving technology neutral greenhouse gas emission reductions.

5 Verification Requirements

MACH2 partners provide some observations and recommendations on verification requirements:

5.1 Co-location of Renewable and Hydrogen production system:

- **Challenges and Observations:** MACH2 partners point out the verification requirements that would be required even when the electrical source for hydrogen production is co-located with the production systems themselves. This verification provides unnecessary costs and complexities, undermining the process's efficiency and cost-effectiveness.

- **Proposed Amendments:** To address this, MACH2 suggests an amendment to exempt co-located hydrogen production systems from the verification requirement. This amendment would streamline operations by acknowledging the transparency of using on-site generated electricity, thus eliminating the redundant costs and administrative hurdles associated with proving the renewable credentials of the electricity used. It would also incentivize on-site renewable generation and additionality.

6 Biomethane (Renewable Natural Gas)

MACH2 Hub advocates for allowing biomethane (RNG) and continuation of the book and claim system to reduce emissions that are too often flared or directly released into the atmosphere.

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6.1 Biomethane / RNG Supply

- **Challenges and Concerns:** The current guidelines aim to mitigate the risk of entities generating additional biogas solely for the 45V credit, imposing limitations to ensure biomethane/RNG supplies are not created just for this incentive. These restrictions are set to prevent an unsustainable spike in biomethane/RNG production that surpasses historical growth rates, potentially distorting the market and environmental intentions of the 45V credit.

- **Proposed Amendments:** MACH2 Hub agrees with treasury's goal of ensuring that biomethane/NRG supplies are not just created to qualify for the 45V incentive but, suggests removing supply constraints on biomethane/RNG production to allow for its natural growth, emphasizing the untapped potential within the U.S. to reduce emissions by utilizing biomethane that is too often flared.

    - Currently, less than 10% of the U.S.'s municipal wastewater treatment plants harness biogas, and only 2% upgrade it to biomethane/RNG. With only 225 of 1,641 municipal landfills capturing biogas for mostly electricity generation and just 28 producing biomethane/RNG, there's considerable scope for growth[18].

    - While the current rule already suggests verifying the initial productive use of biomethane/RNG in hydrogen production, MACH2 recommends maintaining flexibility by monitoring waste volumes and using historical waste data to estimate potential increases in waste due to population growth. This method can indicate whether biomethane/RNG growth is unusual, aiming to encourage the biomethane/RNG sector development without limiting its potential. Biomethane/RNG, potentially the cleanest fuel with a carbon intensity as low as -283gCO2e/MJ[19], plays a critical role in advancing sustainability goals and supporting the U.S.'s net-zero ambitions by developing a hydrogen ecosystem.

6.2 Biomethane (RNG) CI in 45VH2 GREET model

- **Challenges and Concerns:** MACH2 partners find that only considering national average CIs misrepresents the efforts across the industry in reducing carbon intensity for biomethane production processes.

- **Proposed amendments:** MACH2 partners propose that actual upstream carbon intensity levels are recognized and allowed, rather than applying a national average carbon intensity value based on the model. In general, the natural gas industry is taking many steps to reduce methane emissions throughout the value chain, including the application of new sensors and monitoring technologies, and enhanced leak detection and repair. The US Federal

[18] RNG Potential
[19] RNG Carbon Intensity

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Government is encouraging these efforts, including through the Inflation Reduction Act's Methane Emission Reduction Program, and the EPA's proposed New Source Performance Standards for Oil and Gas Industry. The initiatives are allowing a higher degree of accuracy, and incentivizing efforts for achieving greater methane emission reductions. It is inconsistent and counter-productive for the GREET model and the 45V rulemaking to not allow for inputting actual upstream carbon intensities. The rulemaking should encourage, and the model should be flexible enough to capture, unique upstream carbon intensities to further incentivize these upstream methane emission reductions.