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Treasury's Final Rules for the Clean Hydrogen Production Tax Credit: 45V

A Perspective Using Four Lenses

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About AzCaNE: The Center for an Arizona Carbon-Neutral Economy (AzCaNE) brings together a diverse group of stakeholders committed to fostering a carbon-neutral, thriving economy in Arizona and the desert southwest by 2050. Arizona's abundant solar energy resources offer substantial potential for low-carbon-intensity (low-CI) energy and low-CI molecular hydrogen (H_2) production, positioning the state as a national leader in these sectors.

Treasury's Rules for the Clean Hydrogen Production Tax Credit: 45V

This document outlines AzCaNE's perspective on Treasury's rules for the Clean Hydrogen Production Tax Credit (Section 45V), emphasizing the need for these incentives to promote the growth of the low-CI H_2 industry while ensuring long-term environmental integrity, energy security and resilience, economic feasibility, and social equity and justice.

1. Issue Overview

The Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA) incentivize low-CI H_2 production, end-use applications, and the development of connective infrastructure [1], [2]. The U.S. National Clean Hydrogen Strategy and Roadmap outlines initiatives to reduce low-CI H_2 costs, advance Regional Clean Hydrogen Hubs, accelerate deployment, and catalyze private sector investment [3]. These strategy elements support hard-to-abate sectors such as heavy industry, chemical manufacturing, heavy-duty transportation, and long-duration energy storage, aligning with global strategies including those from the International Energy Agency (IEA) and the Intergovernmental Panel on Climate Change (IPCC) [4], [5]. The goal is to propel the U.S. toward a carbon-neutral economy by 2050, necessitating ongoing reductions in carbon intensity (CI) and emissions across all sectors, with an emphasis on diversifying energy sources to bolster national energy security [6].

2. The Environmental, Economic, Security, and Social Lenses

The 45V production tax credit (PTC) in the IRA supports low-CI H_2 production in the U.S. by offering credits of up to $3 per kilogram, which can significantly offset today's $4.5 to $12 per kilogram delivered cost of low-CI H_2 [7]. Facilities that begin operation construction before January 1, 2028 and produce low-CI H_2 after December 31, 2022 can claim this credit for up to 10 years [8]. This incentive aims to reduce CI, drive innovation, and attract investment in low-CI H_2. While stakeholders across the low-CI H_2 industry, environmental groups, academia, the public, and governments agree on advancing low-CI technologies, they differ in their perspectives on the best ways to produce and use low-CI H_2 to reduce emissions of hard-to-abate sectors. We reflect on these varied viewpoints or "lenses," which shape policy perspectives on low-CI H_2 production and its role in achieving a carbon-neutral economy.

- **Environmental Lens:** Focuses on reducing emissions and preserving ecological integrity. This perspective calls for stringent rules to secure environmental benefits, even in the short term [9], [10].
- **Economic Lens:** Centers on cost-effectiveness and financial viability, balancing profitability with responsible use of capital. This view values the economic feasibility of low-CI H_2 projects and considers high compliance costs and operational demands that could limit industry growth and investment [11], [12].
- **Security and Resiliency Lens:** Highlights the need for a resilient, reliable energy system built on diverse resources, with low-CI H_2 playing a crucial role [6], [13]. This lens emphasizes integrating low-CI H_2 to provide long-duration energy storage solutions, ensuring reliability during seasonal fluctuations and periods with limited sunlight and wind, and thus supporting energy security and resiliency [6].

- **Social Lens:** Prioritizes human welfare, equity, and social justice, focusing on job creation, community well-being, and equitable access to low-CI benefits, especially for disadvantaged communities [12].

3. Treasury's Final 45V Rules

We now examine the requirements or "three pillars" employed by Treasury that production facilities must meet to receive 45V production tax credits.

- **Additionality (or Incrementality)** requires that only new renewable or low-CI sources supply energy to the production facility, with these sources coming online within three years of the low-CI H_2 production facility's commissioning.
- **Temporality (or Time-Matching)** requires hourly matching between renewable or low-CI energy sources and the H_2 production, with annual matching allowed through 2029 (and hourly matching required beginning January 1st, 2030) to determine the CI. Producers may use Energy Attribute Certificates (EACs) for this alignment instead of direct sourcing.
- **Regionality (or Deliverability)** mandates the renewable or low-CI electricity, direct or EAC, sources must originate from pre-defined local regions.

These pillars aim to limit both attributional and consequential emissions. **Attributional Emissions** refer to the greenhouse gas (GHG) emissions directly associated with a specific product or activity, including all emissions from the production process. **Consequential Emissions** consider the indirect effects on overall emissions across different sectors, by examining how a product or policy might displace other emissions or induce added emissions elsewhere [14].

The rules aim to lower economy-wide emissions without increasing the power sector's GHG emissions by displacing low-CI sources or adding fossil fuel capacity [14]. From an environmental perspective, the stringency of the rules is seen as essential for reducing emissions in both the near term and long term [10]. Conversely, an economic perspective raises concerns that overly stringent requirements might slow or halt low-CI H_2 projects, potentially hindering long term efforts capability to achieve a carbon-neutral economy [15]. These rules may inadvertently favor certain regions for low-CI H_2 production, discouraging development near end-users and increasing the need for long-distance transport [10], [11]. The economic viewpoint emphasizes that such delays in low-CI H_2 deployment could impede broader goals for timely reduction in economy-wide emissions, especially as the electric grid continues to lower its CI and overall GHG emissions [11], [16].

A security and resiliency lens favors less stringent rules to support rapid deployment of low-CI H_2 projects and enhance load management, diversifying the energy mix to strengthen long-term energy security. Similarly, a social lens might promote flexibility in the rules to ensure that low-CI H_2 production promotes equitable access to its benefits, including job creation, energy justice, active community engagement, clean air, and workforce development, while contributing to both environmental sustainability and economic growth.

4. AzCaNE Viewpoint on Treasury's 45V Rules

AzCaNE views Treasury's rules for low-CI H_2 PTC under the IRA, which emphasize additionality, temporality, and regionality, as overly and unnecessarily restrictive and lacking balance. These rules risk hindering the development of a national low-CI H_2 network [16], [17], a critical step toward achieving a carbon-neutral economy by 2050 [3], [10]. AzCaNE finds that such stringent requirements could create substantial barriers in regions like Arizona, strategically located between Texas and California [10], and would likely limit low-CI H_2 deployment, increase costs, and reduce efficiencies—outcomes counter to the original intent to

encourage market liftoff for this nascent industry [18]. Studies indicate that integrated emissions can be effectively managed with more moderate rules than those currently in place [10], [11], [17], [18], [19]. AzCaNE supports a more balanced approach that advances rapid market growth while maintaining effective emission controls, ensuring progress in lowering the emissions of hard-to-abate sectors, and aligning with the IRA's primary goals.

5. Potential Impacts of Treasury's 45V Rules

The PTC incentive aims to stimulate low-CI H_2 production, but the rules' complexity and stringency may hinder industry growth by increasing costs and slowing deployment. Addressing crucial challenges that these rules pose to low-CI H_2 production and their broader implications for achieving a carbon-neutral economy may be necessary to promote the sector's development.

- **Constrained Project Viability:** Although the three pillars promote environmental responsible practices, strict reliability requirements can sharply increase production costs, potentially making many projects financially unviable except in regions with superior conditions of both solar and wind resources [20], [21].
- **Reliance on Off-Grid Facilities:** By restricting grid dependency and aiming to reduce transmission losses, the rules may push low-CI H_2 production facilities toward off-grid, dedicated renewable sources. However, this reliance would be sub-optimal limiting system advantages and capacity factors, increasing costs, and reducing efficiency, especially if costly energy storage becomes necessary to maintain reliability and cost effectiveness [10], [21].
- **Loss of Grid Service Opportunities:** Off-grid renewable energy dedicated to low-CI H_2 production lowers CI but eliminates opportunities for ancillary grid services, such as demand response during peak times [10], [22]. Without such grid services, balancing supply and demand becomes costlier [22], particularly in regions like Arizona, where extreme temperatures, high solar adoption, and variable demand, call for extensive infrastructure [23], [24].
- **Low-Capacity Factors:** Strict rules align low-CI H_2 production with renewable availability, enhancing environmental integrity [10]. However, this intermittent operation reduces flexibility, productivity, and efficiency [10], [19]. Studies show that requiring hourly matching with renewable sources can significantly increase costs due to efficiency losses or extensive energy storage needs, underscoring the importance of balancing rules with operational practicalities [11], [18].
- **Complex Verification Process:** Although thorough verification is essential for transparency and trust, the rules could impose substantial administrative costs for lifecycle GHG emissions assessment [25] that may delay financing of projects [15]. Tracking hourly matching requires new systems that may be challenging to establish by 2030, complicating project financing compared to the more streamlined processes in the EU [17].
- **Regulatory Uncertainty:** Ambiguity around timelines and criteria introduced uncertainty, which caused delays in the sector development and progress toward environmental, economic, social, and security goals [20], [25].
- **Transmission Losses:** While localized production reduces transmission losses [14], the deliverability requirement raises concerns about securing recently added zero carbon resources for low-CI H_2 production [11]. The use of Energy Attribute Certificates (EACs) under the 45V rules can certify renewable energy use without necessitating long-distance electricity transmission [11].

- **Regional Concentration:** The framework may geographically concentrate low-CI H_2 production, favoring regions with both abundant solar and wind resources [10], [11]. This concentration could slow competition, create market disparities, and necessitate costly long distance transport to bring all regions towards a carbon-neutral economy [10], [11].
- **Competitive Disadvantages:** High compliance costs and regulatory complexity may drive stakeholders to regions with more favorable regulatory landscapes, such as Europe, potentially weakening U.S. competitiveness [16], [25], [26].

6. Advancing a Balanced Approach to 45V Rule Implementation

Addressing diverse perspectives requires a balanced evaluation of the rules, focusing on their impact on low-CI H_2's viability in hard-to-abate sectors and on carbon-neutral opportunities potentially lost by overly stringent rules. High costs and infrastructure demands highlight the need to incentivize this sector, and easing constraints may not necessarily lead to unacceptable emissions increases, as some have claimed [11]. Analyses of strict hourly matching suggest it does not consistently lower attributional emissions compared to annual matching [11], [17], [19].

The widely-cited study by Ricks et al. [14] finds that hourly matching lowers emissions only when cost-effective low-CI electricity is available—often requiring overbuilding of low-CI power sources, which raises costs [27] and can waste resources. However, modeling the complex dynamics between deployment levels, costs, system effects, and emissions remains challenging [14], [18], [27]. These findings highlight the need for on-going policy monitoring and potential adjustments (course corrections) to mitigate emissions impacts [18], [27]. Recent studies recommend annual matching to avoid significant cost and operational barriers while achieving environmental goals [11], [17], [18], [19]. Investigations indicate that stringent additionality and temporality requirements may not significantly reduce GHG emissions, yet they increase costs and reduce efficiency, likely slowing or even halting deployment in many regions [11], [15], [16], [17], [18], [19], [27]. These heightened costs risk negating the PTC's benefits, stalling industry progress, and undermining efforts to foster a sustainable and secure energy future [17].

7. Paths for Low-Carbon-Intensity H_2 Production Incentives

The three-pillar approach to low-CI H_2 imposes requirements that are more stringent than those for low-CI energy technologies such as the tax credits for battery electric vehicles (BEVs), raising concerns about equity [20], [28]. While BEVs initially relied on a carbon intensive grid energy, they have also driven growth in renewable energy to meet emission reduction goals [29]. If the PTC for low-CI H_2 prevents its use of grid power due to strict requirements, these incentives risk being undermined, creating barriers to lowering the emissions of hard-to-abate sectors that cannot rely on electrification [17]. The European Union's more balanced approach to low-CI H_2 regulation and its experiences offer a model that the U.S. could consider, supporting industry growth and enhancing energy security through a diverse and resilient energy mix [16], [17].

8. Conclusion

A more nuanced approach for Treasury's 45V rules can help mitigate risks to achieving the intended goals by considering environmental, economic, security, and social lenses. The current rules risk prioritizing near-term environmental concerns about grid emissions, potentially overlooking economic, social, security, and resiliency factors critical to developing sustainable energy solutions for hard-to-abate sectors and reducing long-term emissions. Adjusting the rules to support a broader set of priorities could better promote technology deployment, economic growth, energy security, and job creation, all while aligning with our carbon-neutrality by 2050 objectives. Our recommendations seek to harmonize these rules with global

standards of flexibility and innovation, ensuring the U.S. remains competitive in the low-CI H_2 market. A balanced approach fosters a carbon-neutral future that is economically viable and socially inclusive, advancing a sustainable and equitable economy for the 21st century [11], [17].

9. Recommendations

AzCaNE underscores that the effectiveness of the 45V tax credit in driving low-CI H_2 production relies on thoughtful implementation. We would have recommended a balanced approach that addresses environmental integrity, economic viability, social equity, and energy security and resiliency. These strategies aim to align robust tax incentives with practical measures essential for the sustainable growth of the low-CI H_2 industry nationwide.

- **Grandfathering Early Movers:** Support for projects initiated before the end of 2027 by allowing annual matching, expanded deliverability regions, and the use of existing renewable sources, with tax credits limited to the first 100 metric tons per day per plant. This approach would incentivize and reward early movers, who take on greater risk and higher investment costs, fostering growth across the sector [20], [30], [31].
- **Transition Period from Annual to Hourly Matching:** Implement a phased transition to hourly matching, beginning with annual matching for all production prior to January 1, 2030, and for the first year of production until 2032. This flexibility would have provided industry and utilities time to adapt, supporting growth and competitiveness while keeping emissions impacts within reasonable bounds [17], [18].
- **Adjusting Regionality Requirements:** Modify regionality requirements to reflect unique energy landscapes, allowing more flexibility in sourcing zero-carbon electricity, such as within a balancing region, while managing impacts on consequential emissions [10].
- **Clarification on Renewable Natural Gas (RNG) Use:** Establish clear guidelines for RNG use within the 45V framework, addressing deliverability, additionality, book and claim accounting, and eligibility issues [16], [32]. This clarity is essential for regions like Arizona, where gas peaking plants will continue to play a crucial role [33], supporting a more inclusive low-CI energy certification approach using EACs [32], [34].
- **Responsible use of Natural Gas:** To enhance the tax credit's effectiveness and encourage best practices, base eligibility on individual performance rather than industry-wide average methane leakage rates. This approach, emphasizing measurement and verification for superior methane management, would motivate companies to adopt best in class practices, reduce methane emissions, and drive continuous improvement across the sector [35]. Moving away from an average-based approach can prevent underperforming companies from aiming only for minimal standards while recognizing those committed to rigorous methane control [36]. We also suggest incorporating third-party certification of responsibly sourced natural gas, using established frameworks like the MiQ Standard to verify low-emission practices. Such certification improves transparency, enhances accountability, and provides robust assessments of methane emissions and other environmental, social, and governance (ESG) metrics [37], [38].

10. Comparing Proposed vs. Final Treasury Rules to AzCaNE's Recommendations

In January 2025, the Internal Revenue Service (IRS) and Treasury released final rules regarding the Production Tax Credit (PTC)[39]. These final rules maintained the original "three pillars" while allowing certain flexibility and expanded pathways that diverge from the proposed rules in meaningful ways. Under prior

law, a facility could qualify for 45V as long as construction began before January 1st, 2033—shown either by physical work of a significant nature or by incurring at least 5% of total project cost with continuity—and the credit would be available for qualified low-CI H_2 for 10 years starting on the placed-in-service date. The final 45V regulations added a beginning-of-construction safe harbor solely to lock in the GREET model version and, for what constitutes "begin construction" (including the 5% safe harbor and physical-work test), direct taxpayers to Notice 2022-61 [40] and the guidance under §§45, 45Q, and 48[1] [39].

Public Law No. 119-21 (2025) § 70511 enacted by Congress in mid-2025 amended the PTC's eligibility requirements[2]. This legislative amendment replaces the prior 2033 timeline for project qualification, now ending the credit for projects for which construction begins after December 31st, 2027. This shortens the begin-construction eligibility window by five years, creating a significant shift for low-CI H_2 producers' timelines, but does not modify any other standards or thresholds [41].

A. Grandfathering Early Movers

- **Final Treasury Rule:** The final rules did not adopt any special flexibility or grandfathering for early low-CI H_2 production projects. Early movers remain subject without exemptions.
- **Alignment with AzCaNE's Recommendations**: This change did not align with AzCaNE's recommendation to incentivize and reward early adopters.

B. Transition Period from Annual to Hourly Matching

- **Final Treasury Rule:** The final rules delay the hourly matching requirement until 2030. Importantly, producers do not lose the full credit if some production hours exceed an emissions threshold. Instead, as long as the annual average lifecycle emissions remain at or below 4 kg CO_2e per kg H_2, low-CI H_2 produced at ≤ 0.45 kg CO_2e/kg H_2 earns 100% of the credit; > 0.45–≤ 1.5 kg earns 33.4%; > 1.5–≤ 2.5 kg earns 25%; > 2.5–≤ 4 kg earns 20%; and no credit for hours with emissions > 4 kg[3] [42]. This structure rewards lower-CI operation in real time and encourages incremental improvements without penalizing variability.
- **Alignment with AzCaNE's Recommendations**: The start date initially aligned with AzCaNE's recommendation for a phased transition and two-year delay. However, because the statutory begin-construction cutoff is Dec. 31, 2027, projects that start later do not qualify for §45V regardless of annual vs. hourly matching [41]. Additionally, Treasury did not adopt AzCaNE's additional recommendation to allow each new low-CI H_2 production facility to use annual matching in its first operating year through 2032.

C. Adjusting Regionality Requirements:

- **Final Treasury Rule:** The rule retains DOE's regional boundaries and the core deliverability requirement that producers must source EACs from electricity generated in the same DOE-defined grid region as their low-CI H_2 production facility. It adds limited flexibility – producers may source EACs from another region provided they satisfy all the following conditions:

[1] See the discussion and regulatory text at § 1.45V-4(b)(2) and the parallel § 1.48-15(d)(5) labeled "Beginning of construction safe harbor."

[2] *See* 26 U.S.C. § 45V(c)(3)(C) (as amended by Pub. L. No. 119-21, § 70511, 119th Cong. (2025))

[3] See 26 U.S.C. § 45V(b)(2) (applicable percentage tiers based on lifecycle GHG emissions rate); see also 26 C.F.R. § 1.45V-4(a)(2) and Examples 1–2 at § 1.45V-4(a)(3) for the hourly-accounting election and tiered credit calculation.

- The producer, its counterparty, or their scheduling agent must hold transmission rights from the generator's interconnection point to the hydrogen producer's balancing authority area, and must schedule, dispatch, and settle the associated generation for delivery within that area.
- The producer must demonstrate that cross-region electricity delivery occurs on an hourly basis, record them in an hourly EAC registry, verify them using NERC E-tags or an equivalent electronic transmission log, and ensure that no counter-balancing reverse transactions offset the delivery.
- If the electricity comes from Mexico or Canada, the generator must provide an attestation confirming that no other party has claimed the associated attributes.

- **Alignment with AzCaNE's Recommendations:** This modification partially reflects AzCaNE's recommendation to ease regional constraints. However, the allowed flexibility to source from qualifying regions remains narrower than broader market structures like the Western Energy Imbalance Market, which spans multiple balancing authorities across several states[4].

D. Clarification on Renewable Natural Gas Use

- **Final Treasury Rule:** Treasury removed the proposed "first productive use" ban, so previously captured or combusted methane can now qualify. The final rules also expanded the list of eligible renewable-methane sources beyond landfill gas to include gas from wastewater-treatment, animal-manure digesters, coal-mine methane, and other fugitive methane sources[5]. For each source type, the rules assign an "alternative-fate" baseline in the 45VH2-GREET (Greenhouse gases, Regulated Emissions, and Energy use in Technologies model to calculate lifecycle emissions). The rule allows for physical blending, but to avoid diluting the carbon intensity, it counts as RNG only gas backed by retired gas-attribute certificates and treats any uncertified portion of the blend as fossil gas at the default carbon intensity[6]. Deliverability requires that the gas EAC must cover RNG or coal-mine methane injected anywhere on the contiguous-U.S. pipeline grid (treated as one region); producers in Alaska, Hawaii, or a U.S. territory must buy EACs for gas injected in that same local region. Temporal matching is monthly: the EAC's injection month must be the same month the low-CI H_2 plant uses the gas. Treasury did introduce a "book-and-claim" accounting mechanism, but it cannot begin until the Secretary certifies a suitable registry which cannot occur before January 1, 2027, until then producers must prove direct, exclusive delivery or other physical delivery that precludes double counting[7].
- **Alignment with AzCaNE's Recommendations**: This clarification closely aligns with AzCaNE's recommendation for clear guidelines on RNG use.

E. Responsible Use of Natural Gas

[4] See 26 C.F.R. § 1.45V-4(d)(3)(iii)(A)-(B) (defining the core deliverability rule and the conditions for inter-regional EAC use)

[5] See 26 C.F.R. § 1.45V-4(f)(2)(iii)(B)–(E) (expanded RNG sources; "first-productive-use" ban removed).

[6] See 26 C.F.R. § 1.45V-4(f)(2)(i) and (f)(3)(ii)–(vi) (source-specific "alternative-fate" baselines in 45VH2-GREET) and § 1.45V-4(f)(4)(i) (blended uncertificated gas treated as fossil).

[7] See 26 C.F.R. § 1.45V-4(f)(4)(iii)(A)–(B) (monthly temporal matching and pipeline-deliverability rule); § 1.45V-4(f)(4)(ii) (book-and-claim deferred until registry certified).

- **Final Treasury Rule:** Treasury retains the default 45VH2-GREET model assumptions for upstream methane leakage but establishes a future pathway to use verified project-specific emissions data. Producers may use this option once EPA finalizes and implements its updated GHGRP reporting standards and Argonne integrates those standards into the GREET model.
- **Alignment with AzCaNE's Recommendations**: The final rules partially align with AzCaNE's recommendation by creating a future pathway for project-specific methane leakage data in future GREET updates once EPA's updated reporting systems are in place. However, they continue to rely on default national averages in the near term and do not adopt AzCaNE's call for immediate performance-based eligibility or recognition of third-party certifications like MiQ.

11. Takeaway

While the two-year extension for annual matching, modest adjustments to regionality requirements, and clarified RNG provisions ease some of the most stringent aspects of the original proposed rules, the final rules still impose significant constraints. They do not grandfather early movers, they maintain strict regional matching requirements, and they delay the use of project specific leakage rates. Compounding these regulatory hurdles, Pub. L. No. 119-21 (2025) § 70511 cut the eligibility window short by requiring construction to begin before January 1, 2028 rather than 2033, accelerating project timelines by five years without altering other §45V standards. As a result, the final 45V rules risk overly restricting low-CI H_2 producers, slowing deployment in regions like Arizona, and falling short of AzCaNE's recommendation for more balanced and flexible implementation rules.

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