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Evidence Shows Three Pillars Remain Crucial for 45V Hydrogen Tax Credit to Protect Climate, Consumers, Industry

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SUMMARY

The Biden Administration signed the Inflation Reduction Act (IRA) into law in August 2022, which included the Section 45V Clean Hydrogen Production Tax Credit (45V). The United States Treasury Department issued draft rules for 45V in December 2023 but has yet to publish final rules. Treasury's draft rules require electrolyzers—which split hydrogen from water molecules—to use incremental, deliverable, hourly-matched clean electricity (the "three pillars") in their hydrogen production in order to earn the top $3-per-kilogram-hydrogen subsidy.

This research note summarizes real-world developments and analysis over the last two years, affirming **Treasury should finalize its proposed three-pillars framework ("strong 45V rules").** Strong rules are essential for cutting climate pollution, protecting consumers, and building a truly clean hydrogen industry able to succeed long term.

The stakes for our climate and economy are tremendous. In 2021, the U.S. was forecast to only reduce emissions 17 percent below 2005 levels by 2030, but it is now on track to cut climate pollution by 37 percent thanks to the IRA and subsequent federal policies; however, **weakened 45V rules could set back these efforts by 2 to 3 percentage points—equivalent to putting 48 million cars on the road**—making it far more difficult to reach the U.S. target of 50-52 percent emissions cuts by 2030. Weak rules could also raise wholesale electricity prices by 10 percent at a time when one-third of U.S. households had to forgo basic necessities to pay energy bills in 2023.

Weakening these rules will fraudulently qualify enough dirty electrolytic hydrogen production to surpass the U.S. Department of Energy's goal of producing 10 million metric tons (MMT) of "clean" hydrogen annually (equivalent to today's U.S. consumption of natural gas-based hydrogen). Examples of weakening 45V include allowing 5 to 10 percent of existing clean energy to qualify, exempting relicensed nuclear or hydroelectric power plants, easing hourly matching requirements (via pushing back compliance dates and/or grandfathering first-movers), or exempting states with clean energy or carbon cap mandates. Treasury can build flexibilities into its final rules, but they ought to protect 45V's integrity and support truly clean hydrogen production.

Strong 45V rules will still drive substantial growth in electrolytic hydrogen, but such rules ensure it will actually be clean. The rules may change *which* projects get built or what their designs look like—as this is necessary to shift from dirty to zero-carbon hydrogen production—but they will not meaningfully slow deployment.

- One group of companies stated its readiness to build more than 50 gigawatts (GW) of three-pillars-compliant electrolyzers in the U.S., capable of producing more than 6 MMT of truly clean hydrogen per year.
- More broadly, a range of developers have expressed a strong preference for the three pillars, acknowledging their necessity for building a durable industry and earning the trust of the public and buyers of hydrogen.

- A leading economy-wide modeling study from Evolved Energy Research finds comparable volumes of electrolytic hydrogen production (11 MMT annually by 2032) with and without the three pillars in place.
- A meta-analysis of studies assessing the costs of complying with the three pillars finds such projects are financially viable, with strong rules not being a barrier to development.

For more background and detail on this topic, please see:

- Our April 2023 paper on smart design principles for 45V;
- Our November 2023 memo on consumer cost impacts;
- Our February 2024 comments on how to design exemptions that target truly clean hydrogen; and
- Our March 2024 public testimony summarizing our policy recommendations.

CLIMATE

Rules that significantly weaken or remove the three pillars would build a hydrogen industry that worsens rather than reduces net climate pollution (i.e., after accounting for hydrogen's downstream use)—defeating the sole purpose of investing in hydrogen.

- Weakened rules could lead electrolytic hydrogen to emit enough net climate pollution to set the U.S. back by **2-3 percentage points**—or 100-200 MMT net carbon dioxide (CO_2) emissions per year—in its efforts to meet its 2030 Nationally Determined Contribution (NDC) of 50-52 percent emissions reductions by 2030 relative to 2005 levels. This would set back progress at a time when every policy tool is needed to meet this target.
- Weakened rules would essentially make 45V a fossil fuel subsidy to the tune of **$150-300 per ton of net CO_2 added to the atmosphere,** with a fiscal impact on the order of **$30 billion per year.**

Claims that strong 45V rules will slow "clean" hydrogen production are greenwashing, as they suggest that *any* electrolytic hydrogen production is "green" or "clean" without consideration of upstream emissions impacts.

- In general, electrolysis projects that do not satisfy the three pillars would drive climate pollution that is two to five times worse than how hydrogen is made today (via natural gas-based steam methane reformation) and as much as 100 times higher than 45V's mandated threshold for earning the top tax credit. These emissions rates are higher than what hydrogen could offset downstream across all end-uses (except potentially steelmaking).
- A wide range of studies affirm the three pillars are necessary to keep electrolyzers from inducing substantial net greenhouse gas emissions. The few studies suggesting the three pillars do not provide a meaningful emissions reduction benefit suffer from too narrow of an analytical scope (e.g., failing to account for structural changes to the power grid and economy over time, choosing to artificially constrain hydrogen production) and are "inappropriate for drawing comprehensive conclusions" about 45V policy design.
- Unlike other clean energy technologies, hydrogen can worsen net greenhouse gas emissions even after it displaces fossil fuels downstream. For example, an electric vehicle charged exclusively with electricity from a coal power plant would emit about as much climate pollution as a new gasoline vehicle; however, a fuel cell vehicle supplied with coal-powered electrolytic hydrogen would be more than three times more polluting.

Loosening 45V rules will not merely trade a near-term emissions increase for a deeper long-term emissions cut.

- Studies find strong 45V rules will drive a comparable (and sometimes higher) level of electrolyzer deployment as weak 45V rules, meaning there is no clear deployment benefit (with accompanying lower costs due to learning curve dynamics) from loosening the rules.
- Unlike strong 45V rules, weak rules bring no incentive to innovate on flexibility, as electrolyzers would be able to easily procure qualifying energy attribute credits to run around-the-clock. This would bring the wrong (i.e.,

inflexible) electrolyzers down the cost curve, drive underinvestment in midstream infrastructure (e.g., hydrogen storage), and result in a higher prevalence of rigid business models (e.g., unable to adapt to potential variations in hydrogen supply)—making it much more difficult to eventually transition to truly clean and cost-effective electrolytic hydrogen production and achieve net emissions reductions.

Many proposed "compromise" exemptions to the three pillars would allow massive volumes of hydrogen to bypass these critical guardrails without justification. In other words, they wouldn't necessarily drive more electrolytic hydrogen production but would instead allow certain volumes of electrolytic hydrogen production to be dirty when they would otherwise be clean (under strong 45V rules). These giveaways can sound like small concessions but would have disastrous impacts for climate, with greenhouse gas emissions impacts exceeding that of today's natural gas-based hydrogen production (approximately 100 MMT CO_2 per year).

- Exempting 5-10 percent of all existing clean energy would allow approximately 1.7-3.4 MMT of electrolytic hydrogen production to be dirty; if this materialized, it would drive an estimated 34-136 MMT of CO_2 emissions and cost $5-10 billion per year.
  - Rhodium Group finds a 5 percent exemption could drive a net impact of up to 1,500 MMT CO_2 cumulatively through 2035.
  - Notably, analysis of power system dynamics shows this exemption would *not* result in electrolyzers using a meaningful share of clean energy that would otherwise go to waste, thus discrediting its intended purpose.
- Allowing relicensed nuclear and hydroelectric power plants to count as "incremental" would allow approximately 7 MMT of electrolytic hydrogen production to be dirty; if this materialized, it would drive an estimated 140-280 MMT of CO_2 emissions and cost $21 billion per year.
  - Rhodium Group finds nuclear and hydroelectric relicensing exemptions could drive net impacts of up to 360 MMT CO_2 and 165 MMT CO_2 cumulatively through 2035, respectively.
- Allowing all projects that commence construction before 2028 to use annual matching for the full 10-year lifetime of the tax credit (rather than requiring all projects to hourly match their operations with qualifying clean energy by 2028) would be similarly problematic.
  - Rhodium Group finds this could drive a net impact of up to 685 MMT CO_2 cumulatively through 2035.
  - Similarly, Princeton finds this could allow 69 MMT of total electrolytic hydrogen production to be dirty; if this materialized, it would drive an estimated 694 MMT of cumulative CO_2 emissions and cost $208 billion.
  - If the "commence construction" date is pushed to 2032, Princeton finds its impacts would rise to allowing 680 MMT of total electrolytic hydrogen production to be dirty, driving an estimated 2,266 MMT of CO_2 emissions at a cost of $227 billion.
- Exempting states with clean electricity standards would still subsidize dirty hydrogen production until states have actually achieved a near-100 percent clean energy system.
  - For example, a current target of 50 percent clean electricity would still allow electrolyzers to use fossil fuel power for half of their consumption, resulting in an emissions intensity at least as high as today's natural gas-based steam methane reformation hydrogen.
  - Such an exemption would also allow electrolyzers to use electricity from existing clean energy resources whose services are costly to replace (e.g., nuclear or hydroelectric facilities that can run when wind and solar are unavailable), thus raising clean electricity standard compliance costs borne in part by utility customers.

- Exempting states with carbon cap-and-trade systems would generally not result in clean hydrogen production.
  - For example, California's program unlocks additional (and eventually unlimited) emissions allowances when prices rise above certain thresholds; the value of 45V's top tax credit is 1.5 times as much as the program's current price ceiling, meaning projects could worsen pollution despite the ostensible carbon cap.
  - Princeton finds carbon cap-and-trade programs would have little impact on the emissions intensity of electrolytic hydrogen production, largely due to emissions "leakage" into states not covered by the cap.

CONSUMERS

Strong 45V rules will protect consumers from higher costs associated with rising electricity demand.

- Typically, when new electricity demand connects to the grid, it puts upward pressure on electricity costs (all else equal) due to causing older, costlier, and less-efficient power plants to come online. This is because power grids are optimized to rely on their least-expensive generators for electricity at any given point in time.
- The three pillars ensure that subsidized electrolyzers will bring new, local, hourly-matched clean energy online in parallel with their development. These factors dampen (and can eliminate) power price impacts from their connection to the grid by offsetting their electricity demand with new clean energy in every hour.
- Three-pillars-compliant projects are likely to build more clean energy than they can use. This is because doing so helps them maximize hydrogen production in more hours (e.g., still achieving full output as wind speeds dip or the sun starts to set). Thus, strong 45V rules can even put downward pressure on power prices by sending extra low-cost clean energy to the grid.
- Over the long term, flexible electrolyzers (built as a result of strong 45V rules) will soak up excess clean energy when available and turn off when that energy is needed elsewhere on the grid. This behavior will help bring more cheap clean energy online (by providing a revenue source for otherwise-wasted excess energy) and mitigate price impacts from high demand days (by allowing low-cost energy to serve other customers).

By contrast, **real-world examples and modeling demonstrate that weak 45V rules risk raising wholesale electricity prices by on the order of 10 percent**—thereby worsening consumer energy bills. In general, electrolyzer projects developed under weak 45V rules would operate similarly to data centers and cryptomining (i.e., running around-the-clock). This means such projects can serve as instructive points of comparison—and that electrolyzers built under weak 45V rules would add to these harmful consumer impacts.

- A proposed data center project is seeking to connect directly to the Susquehanna nuclear power plant in Pennsylvania. American Electric Power and Exelon estimate this arrangement could shift as much as $140 million annually to state electricity customers.
- One study found that each GW of new electricity demand from cryptominers in Texas' power grid led to a wholesale power price increase of 2 percent. By comparison, 45V could spur tens to hundreds of GWs of new electrolysis demand across the country.
- Another study found "small businesses and households paid an extra $92 million and $204 million annually in Upstate [New York] because of increased electricity consumption from cryptominers."
- A third study assessed the impact of weak vs. strong 45V rules in California and Colorado, finding up to 10 percent increases in wholesale power prices.

INDUSTRY

Strong 45V rules will drive more domestic electrolyzer manufacturing and reduce dependence on Chinese imports. China leads the world in the production of lower-tech alkaline electrolyzers, which are cheap but

inflexible. By contrast, U.S. companies are leading the development of higher-tech electrolyzers—including proton exchange membrane (PEM) and more flexible alkaline electrolyzers—which have higher capital costs but are far more flexible.

- Weak rules make it easy for developers to run their electrolyzers around-the-clock, removing the need for flexibility. This will encourage developers to buy the cheapest electrolyzers on the market (i.e., from China's glut), thus ceding the domestic market.
- Strong rules require developers to hourly match their electrolyzers' operations with new clean energy, which will generally be variable wind and solar resources. This will drive greater investment in domestic PEM electrolyzer manufacturing and drive innovation on flexibility in other electrolyzer chemistries.

Strong 45V rules will align the U.S. with key trading partners in the European Union.

- The EU adopted the three-pillars framework for its clean hydrogen standard in June 2023. U.S. projects must meet these requirements in order to access the EU market.
- Strong rules would build toward a unified international standard, promoting the growth of truly clean hydrogen around the world and minimizing uncertainty (and thereby market friction) associated with the emissions intensity of hydrogen designated as "clean."

Strong 45V rules are necessary to grow an industry that can outlive the tax credit.

- Weak rules will allow developers to run electrolyzers around-the-clock. This will stifle deployment of flexible electrolyzers (and innovation on flexibility more broadly), bringing the wrong technologies down the cost curve. When 45V expires, these projects will be incapable of remaining profitable (even if all capital costs are paid off), as they will need to buy electricity at very cheap prices but will be unable to adjust their operations to exclusively capture these windows. This will result in stranded assets and lost jobs, or a tax credit extension that prolongs weak rules' climate emissions problem.
- Strong rules will drive developers to deploy flexible electrolyzers that match changes in wind and solar energy output. This will bring these technologies down the cost curve and encourage innovation on other flexible electrolyzer chemistries. When 45V expires, these projects will be capable of smoothly adjusting to the new paradigm, ramping up when power prices are cheap (and electricity is clean and abundant) and ramping down when power prices are expensive (and electricity is dirty or clean electricity is needed elsewhere). This will result in a robust, healthy industry that can outlive 45V.

Strong 45V rules do not threaten the success of the seven proposed U.S. hydrogen hubs and are critical to ensuring the hubs reduce net climate pollution.

- Analysis from RMI finds hydrogen hubs will have more than enough qualifying clean energy available to capture the full 45V tax credit for all of their proposed electrolytic hydrogen production.
- A study commissioned by the Washington Department of Commerce finds the three pillars will have a negligible impact on the volume of electrolytic hydrogen production (relative to no pillars). Washington is part of the proposed Pacific Northwest Hydrogen Hub.
- The U.S. Department of Energy's public estimates of the hubs' greenhouse gas emissions impact focus strictly on hydrogen's use downstream—they do *not* account for the upstream emissions impact of hydrogen's production. If the hubs' electrolytic hydrogen production projects do not satisfy the three pillars, it's likely the hubs will *increase* net climate pollution.