POLICY UPDATE

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SUMMARIZES REGULATORY AND OTHER DEVELOPMENTS RELATED TO CLEAN TRANSPORTATION WORLDWIDE

Final regulations for the Inflation Reduction Act's Section 45V Clean Hydrogen Production Tax Credit

Andy Navarrete

The U.S. Department of the Treasury and the Internal Revenue Service released final regulations in January 2025 for the Clean Hydrogen Production Tax Credit under Section 45V of the Internal Revenue Code.[1] The Inflation Reduction Act of 2022, which established the Section 45V tax credits, requires that hydrogen be produced with life-cycle greenhouse gas (GHG) emissions, measured in terms of CO_2-equivalent (CO_2e), not greater than 4 kg for each 1 kg of hydrogen to receive the credits. Credit values depend on hydrogen life-cycle GHG emissions with four tiers of credits, up to a maximum of $3 for each kilogram of hydrogen (Table 1).

Proposed 45V regulations were released by the Treasury Department in December 2023.[2] We described this proposal and provided a general overview of the 45V clean hydrogen tax credit in an earlier ICCT policy update.[3] Here, we outline changes in the final regulation compared with the original proposal, focusing on changes to the calculation and accounting of hydrogen life-cycle emissions. We also describe additional guidance on the coordination of 45V with other credits.

www.theicct.org

communications@theicct.org

@theicct.org

1 Credit for Production of Clean Hydrogen and Energy Credit, 26 CFR Part 1 [TD 10023] RIN 1545-BQ97 § (2025), https://www.federalregister.gov/documents/2025/01/10/2024-31513/credit-for-production-of-clean-hydrogen-and-energy-credit.

2 Internal Revenue Service, U.S, Department of the Treasury, "Notice of Proposed Rulemaking: Section 45V Credit for Production of Clean Hydrogen; Section 48(a)(15) Election To Treat Clean Hydrogen Production Facilities as Energy Property," 2024, https://www.federalregister.gov/documents/2023/12/26/2023-28359/section-45v-credit-for-production-of-clean-hydrogen-section-48a15-election-to-treat-clean-hydrogen.

3 Yifan Ding, Chelsea Baldino, and Yuanrong Zhou, *Understanding the Proposed Guidance for the Inflation Reduction Act's Section 45V Clean Hydrogen Production Tax Credit* (International Council on Clean Transportation, 2024), https://theicct.org/publication/proposed-guidance-for-the-inflation-reduction-act-45v-clean-hydrogen-tax-credit-mar29/.

Table 1

Credit values under Section 45V of the Inflation Reduction Act

Life-cycle greenhouse gas emission requirements for each credit tier	Tax credit per kilogram of hydrogen produced by a facility that meets the prevailing wage and apprenticeship requirements
2.5 to 4 kg CO_2e /kg of hydrogen	$0.60
1.5 to less than 2.5 kg CO_2e /kg of hydrogen	$0.75
0.45 to less than 1.5 kg CO_2e /kg of hydrogen	$1.00
Less than 0.45 kg CO_2e /kg of hydrogen	$3.00

The final regulations include a number of changes and additional guidance regarding the determination of GHG emissions for well-to-gate hydrogen production. These include new rules for the use of the 45VH2-GREET model for determining life-cycle emissions and a discussion of pending and future model updates, updated rules for establishing eligibility for a provisional emission rate (PER), and updated rules for the life-cycle accounting of water-electrolysis and methane-derived hydrogen pathways.

45VH2-GREET MODEL

Under the proposed regulations, producers were required to use the most recent publicly available version of the 45VH2-GREET model to determine hydrogen life-cycle emissions and tax credit values for hydrogen produced in that year.[4] The final regulations include an exception to this rule that allows producers to instead use the most recent 45VH2-GREET model publicly available at the time of facility construction for the facility's entire 10-year credit window. Taxpayers choosing this option do not retain the option to use updated models in the future.

The final regulations also discuss pending and future updates to 45VH2-GREET. The regulations anticipate the following future changes to the model:

- The inclusion of additional renewable natural gas (RNG) and coal mine methane feedstocks.
- The addition of hourly calculations of electrolytic hydrogen carbon intensities; this aligns with the hourly matching of electricity generation and hydrogen production beginning in 2030.
- Upstream methane leakage from natural gas infrastructure may change from a "background" value that cannot be adjusted to a "foreground" value. In the preamble to the final 45V regulations, the Treasury Department anticipates that better empirical data will allow hydrogen producers to calculate GHG emissions based on the upstream methane leakage rate specific to their supply chains. This data would become available with updated methane reporting requirements under the Environmental Protection Agency's Greenhouse Gas Reporting Program (GHGRP), which go into effect in 2025.[5] The Treasury also indicates that the initial

4 Argonne National Laboratory, 45VH2-GREET, Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET Model), computer software, updated January 2025, https://www.energy.gov/eere/greet.

5 Greenhouse Gas Reporting Rule: Revisions and Confidentiality Determinations for Petroleum and Natural Gas Systems. 40 CFR Part 89 FR 42062 (May 14, 2024). https://www.govinfo.gov/content/pkg/FR-2024-05-14/pdf/2024-08988.pdf.

background leakage rate in 45VH2-GREET may also be updated, but not until the option of inputting supply chain-specific leakage rates becomes available. Finally, the Treasury notes that if updated GHGRP rules for natural gas infrastructure are rescinded or revised, it will be necessary to maintain upstream methane leakage as a background value only.

Obtaining a provisional emissions rate

As noted in our previous policy update, a taxpayer may obtain the life-cycle GHG emissions rate of their hydrogen production through either the 45VH2-GREET model or by requesting a PER from the U.S. Department of Energy (DOE) for production pathways not included in 45VH2-GREET. The final regulations clarify that to receive a PER, applicants must complete a Class 3 front-end engineering and design study or similar indicator of project maturity. Hydrogen producers can also lock in the PER for all years of 45V crediting provided that the PER is received before facility construction begins. If the DOE issues the producer a PER after construction begins, producers must use the 45VH2-GREET emissions rate for their production pathway if that pathway is subsequently added to the model. Once the pathway is added, the producers can elect to lock in this initial 45VH2-GREET emissions rate for the remainder of the facility's crediting period.

HYDROGEN PRODUCED USING ELECTRICITY

The final regulation updates rules for the use of energy attribute certificates (EACs). These certificates are used to document that the electricity for hydrogen production came from specific lower-emission sources which meet incrementality, temporal matching, and deliverability requirements. We explain these rules below as well as how, in the absence of a qualifying EAC retirement, the carbon intensity of electrolytic hydrogen will be determined using the regional grid-average GHG emission rates established in 45VH2-GREET.

USE OF ENERGY ATTRIBUTE CERTIFICATES

The final regulations maintain the use of EACs as the sole means of establishing hydrogen production from specific lower-emission sources of electricity. For each unit of electricity claimed for hydrogen production, a corresponding EAC from that source—whether the electricity is grid-connected or generated "behind the meter" on site—must be retired so that it cannot be traded or sold to someone else. Table 2 outlines the minimum documentation requirements for 45V-eligible EACs. The final regulations clarify that distributed energy resources, such as rooftop solar installations, may generate EACs provided that incrementality, temporal matching, and deliverability requirements are met. For EACs sourced from electricity generators equipped with carbon capture and sequestration (CCS), the carbon intensity of the electricity input into 45VH2-GREET is determined by the annual carbon-capture rate reported either under Section 45Q, which gives tax credits for sequestering carbon emissions, or under the EPA's GHGRP program.

Table 2

Documentation requirements for energy attribute certificates

Requirement	Details
Description of generation facility	Includes technology and feedstock used to generate the electricity
Amount and units of electricity	For example, electricity produced in units of megawatt hours
Commercial operation date of facility	Date that the facility entered commercial operation
Time of electricity generation	Before January 1, 2030: Calendar year After December 31, 2029*:* Date and hour including time zone
Other	Any other attributes required by 45VH2-GREET or a provisional emissions rate to determine electricity emissions
Installation date for carbon capture and sequestration equipment	When applicable
Project identification number or another assigned identifier	For example, project IDs used in the Western Renewable Energy Generation Information System

INCREMENTALITY

The final regulation maintains the requirement that qualifying EACs must come from facilities that began commercial operations no earlier than 36 months before the placed-in-service date of the hydrogen production facility. If an electricity generator installs CCS equipment, the 36-month period begins when the CCS equipment is placed in service. If generation capacity is uprated or increased at a facility, only the additional capacity is considered to have a new placed-in-service date. Electricity generators that have been shut down for at least 1 year can use a base of zero to determine uprated capacity, essentially resetting the placed-in-service date for the generation facility to the date operations resumed.

The final regulations also include two specific exemptions to EAC incrementality requirements, which were not part of the original proposed regulations: electricity produced in qualifying states and electricity produced by certain nuclear facilities. These are described in detail below.

Electricity produced in qualifying states

The 45V credit incrementality requirement aims to prevent existing clean electricity generation from being diverted to hydrogen production. This could result in the diverted electricity being replaced by fossil fuel powered generation, increasing overall emissions. In a preamble to the final regulation, the Treasury notes that some state policies are sufficient to prevent this outcome. Specifically, the Treasury finds that the combination of a legally binding emissions cap covering the power sector, along with policies supporting the continued deployment of clean electricity generation, should be sufficient to prevent induced emissions. The Treasury notes that the binding emissions cap is a primary safeguard for ensuring that overall GHG emissions will not increase, regardless of growing electricity demand. Emission targets for the electricity sector play a complementary role in ensuring that induced electricity-sector emissions are avoided, even in the context of a multi-sector GHG emissions cap. Thus, the final regulations specify that electricity-generating facilities located in states with qualifying policies are considered to satisfy the EAC incrementality requirement for hydrogen producers within that state, regardless of commercial operation date. This allows hydrogen producers to access a larger pool of low-carbon electricity generators.

To qualify, state policies must meet two requirements:

- *A qualifying standard for decarbonizing electricity*: The standard must include an electricity-sector target of 100% renewable or minimal-emitting ("zero or near-zero") generation in 2050 or earlier, with the policies in place to achieve this target.
- *A qualifying GHG cap program*: The program must restrict electricity-sector emissions by issuing a limited number of allowances or other compliance instruments. The price of allowances should not fall below $25 per metric ton of CO_2e, and the program must include measures to ensure that the overall cap cannot be exceeded for less than $90 per metric ton.

The final regulations note that the Treasury secretary, in consultation with DOE, has determined that California and Washington meet these requirements.

Electricity produced by certain nuclear facilities

Up to 200 megawatt-hours of electricity per operating hour may be considered incremental if the average annual revenue generated by the nuclear reactor was less than 4.375 cents per kilowatt-hour for any 2 years between 2017 and 2021. Nuclear facilities meeting these requirements must also obtain a binding contract to supply EACs to a hydrogen provider for at least 10 years to qualify for an exemption from the commercial operating date.

Other possible exemptions to the EAC incrementality requirement discussed the proposed regulations, such as allowing 5% of existing generators to qualify regardless of placed-in-service date, were not adopted in the final regulations.

TEMPORAL MATCHING

Starting in 2030, the final regulation requires that the electricity represented by an EAC is generated in the same hour that the electricity is used by the hydrogen production facility. Prior to January 1, 2030, the electricity tied to the EAC must only be produced in the same calendar year as the hydrogen production to qualify. This change delays the requirement for hourly matching by 2 years compared with the original proposal. EACs for electricity discharged from storage during the same hour as hydrogen production can also meet the temporal matching requirement provided that:

- The storage equipment is in the same grid region as the hydrogen production;
- Storage-related efficiency losses are taken into account when calculating the volume of EACs required; and
- The EACs document the energy attributes of the original generating facility and the temporal attributes of when the electricity is stored and discharged.

DELIVERABILITY

As in the proposed regulations, the final regulations contain a deliverability provision. This provision generally requires that electricity represented by EACs be generated in the same grid region as the hydrogen production facility. If the balancing authorities of both the electricity generator and hydrogen producer are within the same grid region, the electricity is considered to be deliverable. The final regulation includes a table clarifying the balancing authorities and their corresponding regions for the purposes of the 45V credit. The list of authorities and regions can be found in the appendix of this paper.

The final rule also adds a provision for interregional electricity delivery. The deliverability requirement can be met by EACs from other grid regions provided that the electricity represented by the EAC has transmission rights from the generator location to the region where the hydrogen production facility is located. At a minimum, interregional electricity delivery must be demonstrated on an hour-to-hour basis with no direct counterbalancing reverse transactions.[6] Interregional EACs must also document the delivery. In the case of electricity imported from Canada or Mexico, a further attestation is required that the use or attributes of the electricity represented by the EAC are not being claimed for any other purpose.

HOURLY ACCOUNTING FOR CARBON INTENSITY

A significant change in the final regulation is a provision for determining 45V credit tiers on an hourly basis for electrolytic hydrogen production starting in 2030. Under hourly accounting, the carbon intensity for each kilogram of hydrogen is determined by matching the hours when the hydrogen was produced with the electricity from the corresponding EACs that were retired. To qualify for hourly emissions accounting, the average annual carbon intensity of all hydrogen produced at the facility must not exceed 4 kg CO_2e/kg. For any electricity used in hydrogen production without an hourly-matched EAC, the carbon intensity of electrolytic hydrogen will be determined using the regional grid-average GHG emissions rate established in 45VH2-GREET.

Table 3 shows how hourly accounting would apply in each of the grid regions to an electrolysis facility with 65% conversion efficiency. As shown, hydrogen producers connected to grids with lower carbon emissions need a smaller percentage of electricity use covered by EACs with zero carbon intensity than those connected to higher-emitting grids to stay below the annual eligibility threshold of 4 kg CO_2e/kg hydrogen (blue column). The last column in the table gives the maximum annual full load hours that a producer could run its electrolyzer in each region assuming that 4,380 hours, equivalent to 50% of the total hours in a year, were covered by EACs with a carbon intensity of zero.

6 A counterbalancing transaction would send an equivalent quantity of electricity in the opposite direction, meaning that the interregional electricity delivery tracked by the EAC would not impact the net flow of electricity in the transmission system

Table 3

Hourly accounting example in each grid region

45V grid region	Grid emission factor (kg CO_2e/kWh)	Carbon intensity of hydrogen produced with 100% grid electricity (kg CO_2e/kg)	Percentage of electricity needed from zero carbon emission EACs to stay below annual threshold	Maximum annual capacity factor assuming 4,380 hours of zero carbon intensity EACs
California	0.24	12.4	68%	74%
Delta	0.46	22.99	83%	61%
Florida	0.46	22.84	82%	61%
Mid-Atlantic	0.41	21.18	81%	62%
Midwest	0.58	29.93	87%	58%
Mountain	0.63	32.16	88%	57%
New England	0.32	16.29	75%	66%
New York	0.28	14.55	73%	69%
Northwest	0.162	8.39	52%	96%
Plains	0.475	24	83%	60%
Southeast	0.38	19.42	79%	63%
Southwest	0.4	20.5	80%	62%
Texas	0.4	20.65	81%	62%
Alaska	0.58	29.59	86%	58%
Hawaii	0.76	39.21	90%	56%

Notes: Example calculated using 45VH2-GREET for a low-temperature electrolysis facility with 65% efficiency of converting energy to hydrogen. The annual emissions threshold to qualify for credits is 4 kg CO_2e/kg hydrogen. The red, orange, yellow, and green shading in the table highlight the higher to lower values. The shading in the blue column reflects lower to higher percentages.

HYDROGEN PRODUCED USING RENEWABLE NATURAL GAS OR FUGITIVE SOURCES OF METHANE

Conventional hydrogen production uses natural gas, a fossil fuel composed mostly of methane, as a primary feedstock. However, it is also possible to produce hydrogen from other methane sources. The final regulations provide guidance on GHG accounting for hydrogen produced with four alternative methane sources: landfills, wastewater treatment, coal mines, and animal-waste management. Specifically, the regulation specifies the "alternative fate" of each feedstock, or what the GHG emissions of the feedstock would have been in absence of the hydrogen production. This is an important consideration for determining overall life-cycle emissions. The regulations also stipulate that fugitive methane from oil and gas infrastructure receives the same life-cycle analysis as conventional natural gas. Table 3 summarizes these provisions. Note that "first productive use" provisions considered in the proposed regulations, designed to ensure alternative methane is not diverted from its current use, were not adopted in the final regulations.

Table 3

Life-cycle assumptions for alternative methane sources

Methane source	Alternative fate	Notes
Landfills	Capture and flaring	
Wastewater	Capture and flaring	
Coal mines	Capture and flaring	Does not include methane removed from virgin coal seams
Animal waste	National business-as-usual management of animal waste resulting in a carbon intensity score of -51 g CO_2e/MJ for biogas before upgrading to renewable natural gas	Determination of carbon intensity outlined in a 2025 Department of Energy report[a]
Oil and gas infrastructure fugitive emissions	Productive use	Carbon intensity matches conventional natural gas

[a] U.S. Department of Energy, *A Generic Counterfactual Greenhouse Gas Emission Factor for Life-Cycle Assessment of Manure-Derived Biogas and Renewable Natural Gas*, January 2025, https://www.energy.gov/sites/default/files/2025-01/generic-counterfactual-greenhouse-gas-emission-factor-for-life-cycle-assessment-of-manure-derived-biogas-and-renewable-natural-gas_010225.pdf.

The final regulation also states that hydrogen production from distinct primary feedstocks must be treated separately for the purposes of determining 45V credit amounts and values. This eliminates the possibility of assessing credit values based on an average carbon intensity for hydrogen derived from a blend of feedstocks with different emission profiles. Instead, if a producer is using multiple feedstocks, the producer is required to separately calculate hydrogen volumes and credit values for each feedstock. The final regulations also clarify that switching primary feedstocks from conventional natural gas to a lower carbon-intensity source of methane does not establish a new placed-in-service date for the purposes of establishing a new 10-year window for 45V eligibility at existing hydrogen production facilities.

GAS EACS

The final regulations state that because a suitable gas EAC book-and-claim accounting system is not yet in place, a minimum 2-year window is needed for an appropriate tracking system to be developed and subsequently evaluated by the Treasury; the final regulations state that the Secretary of the Treasury will determine, no earlier than January 1, 2027, whether a suitable gas EAC book-and-claim system has been developed. Until this determination is made, the use of book-and-claim accounting for RNG and coal mine methane will not be allowed, and the use of alternative methane feedstocks can only be established by the exclusive physical delivery of the gas to the hydrogen production facility.

Once developed, the book-and-claim system for gas EACs can be used to establish the use of RNG and coal mine methane for hydrogen production facilities without requiring the hydrogen producers to physically source the gas. This system will allow the environmental attributes of RNG and coal mine methane to be traded and retired by hydrogen producers while receiving fossil natural gas from a shared pipeline network. The regulation establishes deliverability and temporal matching requirements distinct from those required of electricity EACs. Specifically, gas EACs must be matched with hydrogen production on a monthly basis. To establish deliverability, the RNG or

coal mine methane must be injected into a regional pipeline network shared with the hydrogen producer, but the contiguous United States is treated as a single region.

COORDINATION OF 45V WITH OTHER CREDITS

The regulations clarify that 45V eligibility is not impacted if producers of electrolysis hydrogen use electricity from CCS-equipped facilities claiming 45Q carbon sequestration credits. Conversely, it appears that producers of hydrogen-derived liquid fuels such as e-fuels will not be allowed to claim both the 45V credit and the Section 45Z Clean Fuel Production Credit for clean fuels. While the final 45V regulations decline to provide guidance on this issue, the recently proposed 45Z regulations prohibit stacking of 45V and 45Z credits in a single interdependent fuel-production line.[7]

7 Internal Revenue Service, U.S, Department of the Treasury, "Section 45Z Clean Fuel Production Credit; Request for Public Comments," Notice 2025-10 § (2025), https://www.irs.gov/pub/irs-drop/n-25-10.pdf.

APPENDIX

Table A1

Balancing authorities and corresponding 45V grid regions

Balancing authority	Grid region
Balancing Authority of Northern California	California
California Independent System Operator	California
Imperial Irrigation District	California
Los Angeles Department of Water and Power	California
Turlock Irrigation District	California
Midcontinent Independent System Operator: South	Delta
Duke Energy Florida Inc	Florida
Florida Municipal Power Pool	Florida
Florida Power & Light Company	Florida
Gainesville Regional Utilities	Florida
Homestead (City of)	Florida
JEA	Florida
New Smyrna Beach Utilities Commission	Florida
Reedy Creek Improvement District	Florida
Seminole Electric Cooperative Inc	Florida
Tallahassee (City of)	Florida
Tampa Electric Company	Florida
East Kentucky Power Cooperative Inc	Mid-Atlantic
LG&E and KU Services Co	Mid-Atlantic
Ohio Valley Electric Corp	Mid-Atlantic
PJM Interconnection	Mid-Atlantic
Associated Electric Cooperative Inc.	Midwest
Electric Energy, Inc.	Midwest
Gridliance Heartland	Midwest
Midcontinent Independent System Operator: North and Central	Midwest
NaturEner Power Watch LLC (GWA)	Mountain
NaturEner Wind Watch LLC	Mountain
Nevada Power Co	Mountain
Northwestern Energy	Mountain
PacifiCorp East	Mountain
Public Service Company of Colorado	Mountain
Western Area Power Administration Rocky Mountain	Mountain
Western Area Power Administration Upper Great Plains	Mountain
ISO New England	New England
Northern Maine Independent System Administrator	New England

Balancing authority	Grid region
New York Independent System Operator	New York
Avangrid	Northwest
Avista Corporation	Northwest
Bonneville Power Administration	Northwest
Gridforce Energy Management LLC	Northwest
Idaho Power	Northwest
PacifiCorp West	Northwest
Portland General Electric	Northwest
Public Utility District No. 1 of Chelan County	Northwest
Public Utility District No. 1 of Douglas County	Northwest
Public Utility District No. 2 of Grant County	Northwest
Puget Sound Energy	Northwest
Seattle City Light	Northwest
Tacoma Power	Northwest
Southwest Power Pool	Plains
Southwestern Power Administration	Plains
Alcoa Power Generating Inc, Yadkin Division	Southeast
Duke Energy Carolinas LLC	Southeast
Duke Energy Progress East	Southeast
Duke Energy Progress West	Southeast
PowerSouth Energy Cooperative	Southeast
South Carolina Electric & Gas Company	Southeast
South Carolina Public Service Authority	Southeast
Southeastern Power Administration (Southern)	Southeast
Southern Company	Southeast
Tennessee Valley Authority	Southeast
Arizona Public Service Co	Southwest
Arlington Valley LLC	Southwest
El Paso Electric	Southwest
Gila River Power LLC	Southwest
Griffith Energy LLC	Southwest
New Harquahala Generating Company LLC	Southwest
Public Service Company of New Mexico	Southwest
Salt River Project	Southwest
Tucson Electric Power	Southwest
Western Area Power Administration: Desert Southwest Region	Southwest
Electric Reliability Council of Texas Inc. (Balancing Authority)	Texas

www.theicct.org

communications@theicct.org

@theicct.org

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