Emissions Accounting for the Hydrogen Production Tax Credit

KEY GAPS IN THE 45VH2-GREET MODEL

What is the GREET model?

The Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) model is used to determine the lifecycle emissions of various energy sources, expressed as carbon equivalent emissions, and creates the framework for many monetary and market incentives related to energy production. In some cases, the values, assumptions, and calculations within each GREET model have the power to allow dubiously credible fuels to be classified as clean energy and benefit from supportive tax credits and fuel standards. Developed by the US Department of Energy's Argonne National Laboratory and first released in 1995, the GREET model has been updated and developed for specific uses, including a version tailored to the 45V Hydrogen Production Tax Credit labeled 45VH2-GREET. (See also *Understanding the 45V Clean Hydrogen Production Tax Credit: Requirements, Exceptions, and Project Impacts*, here.)

Why is 45VH2-GREET important?

An updated 45VH2-GREET was released in January 2025 to accompany the final 45V guidance released by the US Treasury Department, and while it contains some changes that may provide stronger protections against faulty carbon counting, some concerning aspects of this model remain. The calculations performed through 45VH2-GREET will determine 1) if a hydrogen production facility is eligible for the 45V Tax Credit and 2) which credit tier the facility will qualify for, based on the calculation of a carbon intensity value. The GREET model will be updated annually, although facilities can "lock-in" a specific GREET model for emissions calculations at the time of construction of the facility for use over the duration of the tax credit (10 years).

What does 45VH2-GREET calculate?

The 45VH2-GREET model calculates carbon dioxide equivalent emissions for the methane, carbon dioxide, and nitrous oxides produced during hydrogen production and does so on a 100-year global warming potential scale. Notably, hydrogen emissions are not included in the 45VH2-GREET calculations despite hydrogen being an extremely potent indirect greenhouse gas. Hydrogen extends the life of methane in the atmosphere and increases concentrations of ozone and stratospheric water vapor, leading to 100 times more warming than carbon dioxide in the first 10 years of its atmospheric lifetime. This small molecule is extremely prone to leakage, making it imperative that fugitive hydrogen emissions are calculated in any greenhouse gas lifecycle assessment of hydrogen production.

What parts of the production process does 45VH2-GREET cover?

The final 45V guidance defines the system boundary for hydrogen production as well-to-gate, meaning that the lifecycle assessment of greenhouse gas emissions will only address emissions "through the point of production," instead of a well-to-grave model, which would calculate emissions through the end use of the fuel. Given this boundary, 45VH2-GREET does not account for emissions that could result from the liquefaction, storage, or transportation of hydrogen in its calculations, which could lead to an underestimation of lifetime emissions from hydrogen production and use.

How does 45VH2-GREET treat upstream methane emissions?

The 45VH2-GREET lifecycle assessment relies both on set assumptions that remain consistent and other inputs from the facility claiming the credit. One fixed assumption is the upstream methane emissions of natural gas that result from the production of blue hydrogen with carbon capture and storage (CCS). Upstream emissions of natural gas production in this case are assumed to be 0.9 percent of the methane

used by the hydrogen production facility, despite current evidence pointing to numbers almost three times that level. Fugitive methane rates, the amount of methane that inevitably leaks during extraction and transportation, vary greatly depending on where the methane is sourced, with some basins reaching leakage rates as high as 5.2 percent. Undercounting this harmful source of emissions could allow hydrogen production facilities that use fossil fuels, such as in blue hydrogen production, to be eligible for a higher tier of the tax credit.

What updates were made to 45VH2-GREET's treatment of RNG?

RENEWABLE NATURAL GAS (RNG) LEAKAGE RATES

Renewable Natural Gas (RNG) is a methane-based fuel that is made from processed and purified biogas. The assumed rate of RNG leakage throughout its production and purification process in this most recent 45VH2-GREET model increased from 2 percent to 2.8 percent, although studies have shown this may still be an underestimation .

RNG COUNTERFACTUAL SCENARIOS

Counterfactual scenarios refer to the practice of considering how the biogas would have been treated had it not been diverted and purified into RNG. The counterfactual scenarios typically factor in "avoided emissions" and in the past have assumed that biogas would have been vented into the atmosphere if it were not used for RNG. These scenarios frequently lead to RNG obtaining negative carbon intensity values despite being comprised of mainly methane, a potent greenhouse gas that leaks into the atmosphere and traps heat. Using RNG with a negative or near negative carbon intensity value in hydrogen production could lead to a more lucrative tax tier for that facility.

These counterfactual scenarios shown in Table 1 were updated in the most recent 45VH2-GREET release.

While these updates are a step in the right direction when compared to previous iterations of GREET that assumed venting of biogas as the counterfactual, leading to a much more negative carbon intensity value, they still result in a negative or near negative carbon intensity value. The accuracy of negative carbon intensity values for alternative fuels has been called into question and could potentially incentivize methane production in the long term, increasing emissions overall and potentially halting waste management methods that decrease methane production.

TABLE 1 45VH2-GREET Counterfactuals

Fuel	Updated counterfactual	Carbon intensity value (gCO_2e/MMBtu)
RNG from landfill gas	Flaring (incomplete combustion)	1.065
RNG from wastewater sludge at treatment plants	55% of gas used to heat digester, 44% of gas flared, 1% of gas leaked into the atmosphere	−31.2
RNG from animal manure	Weighted average emissions from manure management practices used in the US	−33.011

Source: US Department of Energy

So, how accurate is 45VH2-GREET?

Given the complexity of calculating lifecycle emissions for specific technologies and fuel production, models like GREET cannot endeavor to produce fully accurate emissions calculations for each facility but can only yield approximations. Having the most accurate approximation possible is crucial to ensure that hydrogen production doesn't do more harm than good, and the current 45VH2-GREET model may fall short of that goal.

In order to produce a more accurate calculation of the global warming effects of hydrogen production, an updated GREET model should:

- Include hydrogen as an indirect greenhouse gas
- Increase the upstream methane emission assumption for natural gas
- Eliminate negative carbon intensity values for methane-based fuels
- Expand the system boundary to include storage, transportation, and end use of the fuel

Without these changes, 45VH2-GREET will undercount the true effect of hydrogen production facilities' emissions on global warming and allow them to claim tax credits that are intended to support truly clean hydrogen production.

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To learn more about other harms associated with hydrogen's production and use, visit www.cleanegroup.org/initiatives/hydrogen.