

Consumer Cost Impacts of 45V Rules

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November 2023

Consumer advocates sent a [letter](#) to the White House and U.S. Treasury Department with concerns that weak Treasury guidelines implementing the 45V hydrogen production tax credit will negatively impact consumers.

They recommend the 45V credit rules for *all* electrolytic hydrogen projects – both grid-connected and behind-the-meter projects – strictly adhere to three pillars of additionality, deliverability, and hourly matching to not only ensure proper emissions accounting but also protect consumers.

A study¹ by Princeton University's ZERO Lab supports their concerns and indicates that without these three pillars, power prices could increase by 8 percent in California and 10 percent in Colorado. Similarly, a European study from TU Berlin² found a staggering 43 percent increase in power prices due to weak hydrogen production rules. The complexity of how electricity markets respond to intricate policy choices, however, can often make such studies appear enigmatic.

This memo simplifies and explains dynamics behind these studies for policymakers. We review how electricity markets produce prices and describe the essential mechanisms behind consumer impacts of loosening the three.

TOPLINE SUMMARY

- Electrolyzers are large electricity users, so expanding their use without corresponding new clean generation will push electricity markets to call on more expensive generators, raising wholesale electricity prices.
- Crypto mining is a useful comparison. In Texas, prices rose 2 percent with every gigawatt (GW) of crypto energy demand. New York customers paid \$300 million additional annual energy costs from crypto demand.
- Meeting clean hydrogen goals will require even more electricity than crypto mining³: **It's reasonable to expect double digit percentage increases in electricity prices without an additionality requirement for electrolyzers.**

BACKGROUND: CONSUMER ELECTRICITY COSTS AND WHOLESALE PRICE FORMATION

¹ Ricks, Wilson, Qingyu Xu, and Jesse D. Jenkins. "Minimizing emissions from grid-based hydrogen production in the United States." *Environmental Research Letters* 18, no. 1 (2023): 014025.

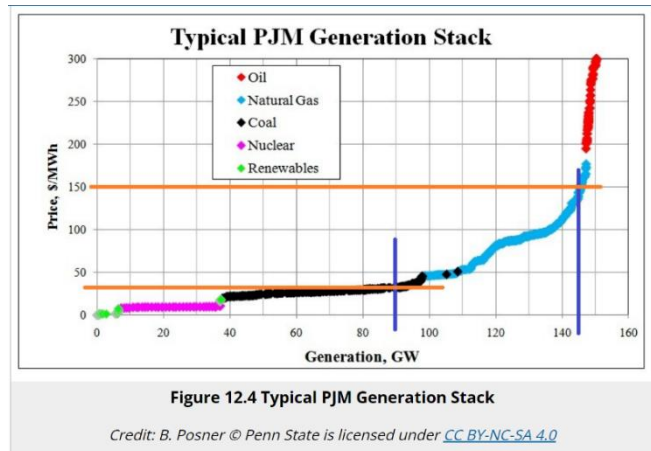
² Zeyen, E., I. Riepin, and T. Brown. "Hourly versus annually matched renewable supply for electrolytic hydrogen." Zenodo, Dec (2022).

³ A Feb 2022 White House fact sheet estimates crypto-assets consume up to 0.9% to 1.7% of total U.S. electricity usage -- meeting the DOE's 10 MMT per year clean hydrogen goal with electrolysis would use 12% of current usage.

Organized wholesale markets (covering approximately two-thirds of Americans) show how different policies affect electric supply and demand and thus generation costs for consumers. The real-time prices in these markets largely determine the cost of wholesale power in consumer's monthly bills.

Marginal pricing is the backbone of wholesale markets. The power price is dictated by the marginal generation costs required to meet demand in a given time interval. This classic figure displays a generation supply curve interacting with demand. As the vertical demand curve moves (blue lines) different prices ensue (orange lines).

Figure 12.4 is somewhat dated as far as marginal fossil costs (many natural gas units now have cheaper marginal costs than coal units and oil generation is less common) but it still captures features present in every supply curve seen today:



- Generation marginal costs are ordered from low to high: Increased demand always leads to higher prices. Lower demand reduces prices. Zero-carbon generation sits on the left side of the curve. Removing zero-carbon supply increases clearing prices, while adding zero-carbon generation does the opposite. Adding or removing this generation has functionally the same impact as removing or adding demand.
- The supply curve slope tends to increase with increasing demand, which means adding demand has more effect on prices when prices are already high than when they are low. Adding more demand (or removing zero-carbon generation) has accelerating impacts on price increases. Removing more demand (or adding zero-carbon generation) has diminishing returns on reducing prices.

Over time, major market changes from new electrolyzer demand and related supply contracts will cause investors to react. The generation mix will change in ways that moderate price effects we describe below. However, investment in new resources will be slow (likely to take at least one or two years) and unless the new demand and new clean generation are perfectly matched you can always expect long-term price effects.

WITHOUT ADDITIONALITY, DELIVERABILITY AND HOURLY MATCHING NEW ELECTROLYZER DEMAND LEADS TO HIGHER PRICES

From the electricity market's perspective, using **existing** clean generation to power new electrolyzers creates new demand with no new supply (or if they are co-located with existing clean power withdrawn from the grid, reduced supply with no change in demand). Load increase from new electrolyzers will increase price irrespective of any existing agreements with clean generators.

If existing clean generation provides power for electrolysis only during intervals with the lowest prices, consumer impacts could be limited. Unfortunately, this scenario is unlikely for now, as the large capital costs of electrolyzers means they need to run as much as possible (at least two thirds of the time). An electrolyzer seeking to qualify for 45¢ by matching with existing zero-carbon generation would likely target a portfolio closer to baseload, such as a nuclear plant, where the shift in demand will mimic cryptomining in Texas and New York. **One recent Texas**

A&M study⁴ found that for every new G) of extra load from cryptominers in the Texas grid, wholesale power prices increased 2 percent. Another study⁵ found “*small businesses and households paid an extra \$92 million and \$204 million annually in Upstate NY because of increased electricity consumption from cryptominers.*” **We expect to see tens to hundreds of new GWs of electrolyzer demand with plans to qualify for 45V tax credit.**

Once additionality is enforced the price increasing effects of electrolyzer demand would cancel out with the price decreasing effects of new supply. However, if we ignore deliverability and hourly matching, consumer prices can still increase.

For instance, if 45V standards permit annual matching, an electrolyzer would operate 24/7 while the matching clean generation is concentrated during specific periods. In a system flush with new variable renewables, the times of highest renewable production will mostly line up with the times of lowest prices. The increasing slope of the supply curve noted above means that offsetting price suppression effects of the clean generation will not be enough to balance the steady price increases due to the steady use of electrolyzers without hourly matching. Furthermore, an electrolyzer meeting an hourly-matching requirement will tend to over-procure new renewables to increase the odds of clean generation being available at any given time. If they sell off the extra, even more cost benefits from hourly matching will accrue to consumer. The logic for deliverability and wholesale price impacts is very similar.

Without clearly additional clean generation, along with the other two pillars, it is not surprising that models in the ZERO Lab and TU Berlin studies expect double-digit percentage increases in wholesale electricity prices.

Loosening more than one pillar can have compounding effects. For example, loosening both additionality and hourly matching means all electrolyzers will impact the market like a cryptomining load (or worse as they may not chose to operate flexibly at all) with no market price mitigation from the “matching” but pre-existing clean generation.

CONCLUSION

Adverse effects of relaxed 45V rules will have a pronounced and stacking impact on consumer bills in the initial years of a project. Enforcing the three pillars of additionality, deliverability and hourly matching for all 45V-eligible electrolytic hydrogen projects – both grid-connected and behind-the-meter – will reduce greenhouse gas emissions, reduce price pressures today, and ensure a future where electrolyzers trained to be flexible will operate sustainably. Only with the right policies will electrolyzer deployment benefit both emissions and consumer prices.

⁴ Lee, Jangho, Lily Wu, and Andrew E. Dessler. "A quantification of how much crypto-miners are driving up the wholesale cost of energy in Texas." arXiv preprint arXiv:2302.02221 (2023).

⁵ Benetton, Matteo, Giovanni Compiani, and Adair Morse. When cryptomining comes to town: High electricity-use spillovers to the local economy. No. w31312. National Bureau of Economic Research, 2023.