

Carbon Pricing for Green Hydrogen Adoption: Insights from a Firm-Production Model

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Extended Abstract

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Abstract Summary

The European Union (EU) has a commitment to reach climate neutrality by 2050, and hydrogen is identified as a key enabler of this transition. The EU focuses on the development of green hydrogen, which is projected to supply around 10% of the EU's total energy demand by 2050. Despite this target, the deployment of green hydrogen remains limited, mostly due to its high production costs relative to existing alternative technologies like renewables (wind and photovoltaic) and conventional (oil and natural gas). While policy instruments such as carbon pricing or cap-and-trade programs could improve the competitiveness of green hydrogen, it remains unclear how to design these instruments to make green hydrogen economically competitive with alternative technologies in industrial applications.

This paper uses an optimization-based approach to estimate the carbon price levels required for green hydrogen to become cost-competitive with alternative technologies. The model relies on a two-level constant elasticity of substitution (CES) production function and is calibrated using observed energy prices and consumption data to represent an industrial firm in Luxembourg. We simulate how firms adjust their energy input mix in response to different carbon price levels, allowing identification of the carbon price threshold at which green hydrogen becomes a substitute for alternative technologies.

The preliminary results indicate that the carbon price required for green hydrogen to become competitive ranges from 180€ to 3,000€ per ton of CO₂ depending on model specifications, such as production function (including Cobb-Douglas and nested CES) and the assumed substitution elasticities. Even the lower bound would require an increase over Sweden's current carbon price, which is already the highest at €138. This suggests that carbon pricing alone is unlikely to drive large scale adoption of green hydrogen under current cost conditions, highlighting the need for complementary measures (e.g., reducing hydrogen production costs or expanding hydrogen infrastructure).

Presenting Author Biography

Monica is a Doctoral Researcher at the Interdisciplinary Centre for Security, Reliability and Trust (SnT), working with the Digital Financial Services and Cross-Organisational Digital Transformations research group (FINATRAX). Monica holds a bachelor's degree and a master's degree from the University of Lorraine. Monica's academic interests centre on the interplay between energy economics, technological innovation, and sustainability.