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Pathways for Low-Emission Hydrogen Supply to Europe: Modeling and Case Studies

Nima Farhang-Damghani
University of Technology Nuremberg (UTN), Nürnberg, Germany

Extended Abstract

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Abstract Summary

To achieve the European Union's (EU) 2050 climate neutrality target, fossil fuel-based energy must be partly replaced by low-emission carriers such as hydrogen. While green hydrogen supply will be limited in the near term, blue hydrogen can help bridge the gap, support import scale-up, and reduce greenhouse gas (GHG) emissions. We develop an optimization model to identify cost-minimizing transition pathways and apply it to Norway and Algeria – current fossil fuel exporters with hydrogen potential. The model compares import costs and GHG effects of shifting from natural gas to blue and green hydrogen under varying CO_2 prices, GHG leakage rates, technological learning, and policy frameworks. Results show that in low-leakage settings, blue hydrogen remains the least-cost option until 2050, while in high-leakage contexts with favorable green hydrogen conditions, it may lose its cost advantage by 2034. Competitiveness relative to natural gas depends strongly on CO_2 pricing and leakage. Excluding blue hydrogen early in low-leakage regions raises the cost of carbon abatement, whereas in high-leakage regions, earlier or direct transitions to green hydrogen are economically and environmentally preferable.

Presenting Author Biography