FACT SHEET EUROPE

JUNE 2025

The economics and greenhouse gas emissions of renewable hydrogen and e-fuels imported in the European Union

BACKGROUND

As European Union (EU) Member States strive to reach economy-wide climate neutrality by 2050, renewable hydrogen and e-fuels will be critical to reducing emissions from hard-to-decarbonize sectors like aviation and maritime. Major EU transport policies, including the Renewable Energy Directive (RED) III, the ReFuelEU Aviation regulation, set transport-wide or sector-specific targets for the deployment of renewable synthetic fuels. EU policymakers have shown growing interest in importing renewable hydrogen and its derivatives, such as renewable ammonia and drop-in liquid e-fuels, from abroad to meet these aims.

THE ECONOMICS OF RENEWABLE HYDROGEN AND E-FUELS IMPORTS: A CASE STUDY OF BRAZIL AND EGYPT

Our latest study estimates the economic cost and emissions impacts of importing renewable hydrogen and e-fuels into the European Union.[1] We focus on Brazil and Egypt, which have announced long-term partnerships to produce and export hydrogen to European countries. We compare the cost of importing renewable hydrogen, in the form of ammonia, and e-fuels into the European Union from these two countries with the cost of sourcing these fuels from EU Member States.

KEY FINDINGS

Importing renewable hydrogen as ammonia may be more expensive than producing it within Europe due to the costs of ammonia conversion and reconversion. Previous studies generally agree that shipping hydrogen in the form of ammonia is relatively

1 The focus of this factsheet is on the cost of importing renewable hydrogen and its derivatives from Brazil and Egypt. In the study, we also assess what could happen if producers in these countries did not comply with EU additionality and temporal and geographic matching rules on sourcing renewable electricity from the grid for hydrogen production. We conduct a life-cycle assessment of the greenhouse gases associated with producing renewable hydrogen and e-fuels under two scenarios: one in which verification schemes ensure compliance with the EU rules and one in which such requirements are not met.

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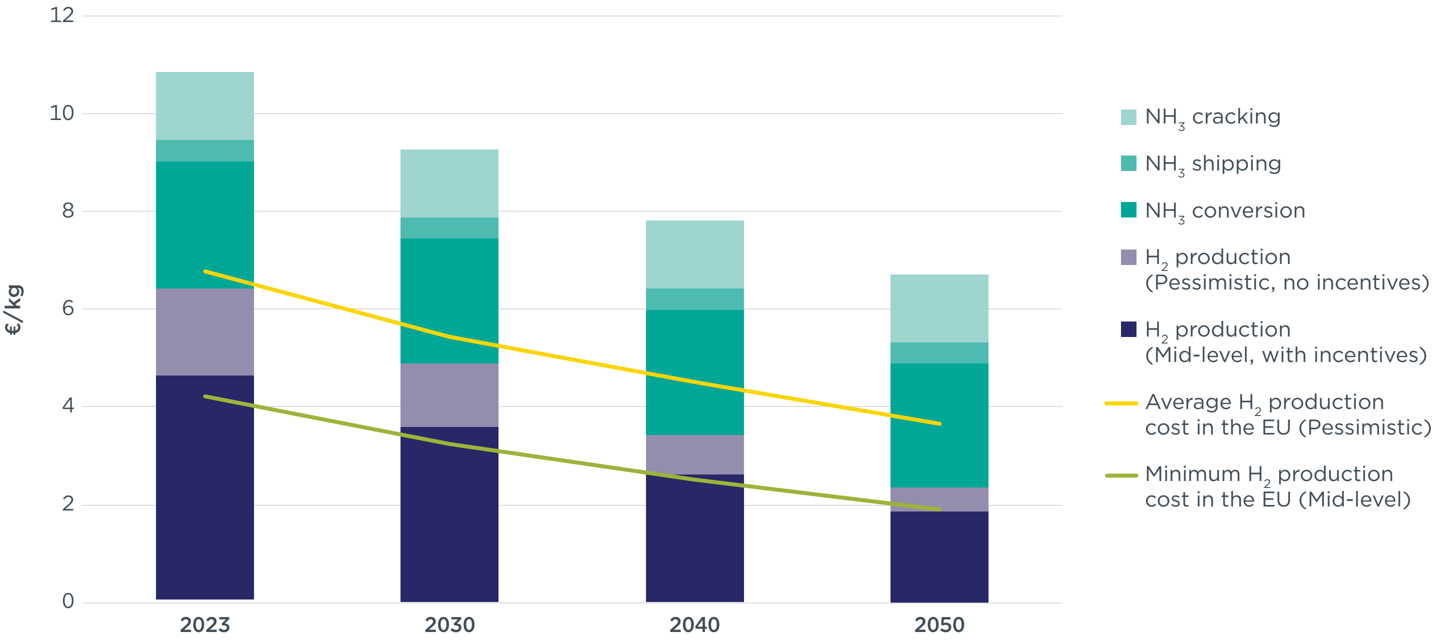
cost efficient compared with shipping it in the form of liquid hydrogen, especially over long distances. Renewable-abundant countries such as Brazil may produce renewable hydrogen at a lower cost than the European Union. Still, the costs of shipping—including converting hydrogen to ammonia, transporting it over a long distance, and then "cracking," or reconverting the ammonia back into hydrogen—can be as high as the production cost itself. The ammonia synthesis and cracking processes both are associated with hydrogen losses and need additional energy inputs, leading to a total efficiency for the two processes of only 50%.[2] Even in a scenario that assumes mid-level technology costs and current Brazilian government incentives that reduce the cost of financing for hydrogen producers, the cost of importing renewable hydrogen from Brazil in 2030 is nearly 50% higher than the ICCT's projected EU average in a pessimistic technology cost scenario (Figure 1).

Figure 1
Cost of renewable hydrogen delivered from Brazil to the European Union



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E-diesel produced in any country will likely remain substantially more expensive than fossil diesel until 2030. Importing e-diesel from Egypt or Brazil could be about 20% cheaper than producing it in the European Union on average. Assuming mid-level electrolyzer costs and point-source carbon sourcing, we estimate that e-diesel produced via a direct connection between the electrolysis facility and renewable electricity facility, either imported from Brazil or produced within the European Union, likely not be lower than €2 per liter in 2030.[3] The 2023 wholesale diesel cost in the European Union (excluding taxes and carbon price) was €0.9 per liter. We note that our EU cost projections do not include government fiscal support or carbon pricing. With the implementation of the Emissions Trading System 2, the diesel price is projected to increase by less than €0.2 per liter in the near term if the carbon price is about €50 per tonne. Should the carbon price exceed €200 per tonne, the diesel price could increase

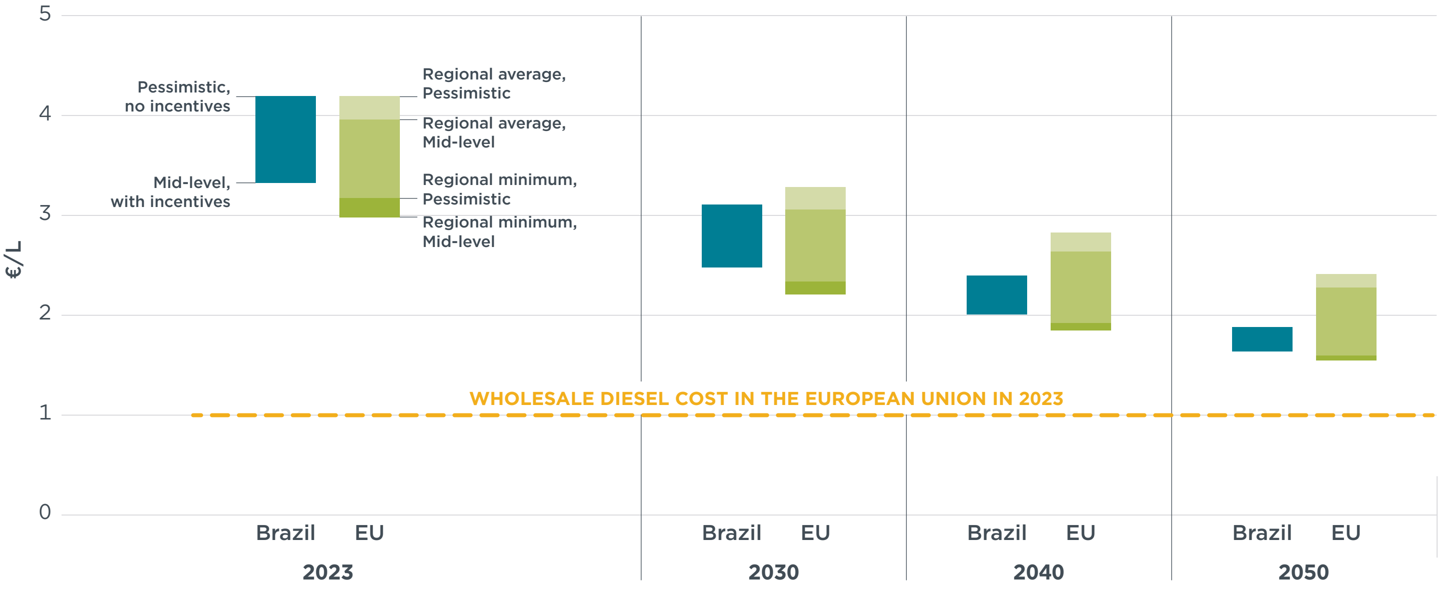
2 International Renewable Energy Agency, "Global Hydrogen Trade to Meet the 1.5°C Climate Goal: Green Hydrogen Cost and Potential," 2022, https://www.irena.org/publications/2022/May/Global-hydrogen-trade-Cost.

3 Egypt does not have a carbon pricing system that meets EU's requirements on using point source CO2 for e-fuels production. As a result, the study only considered direct air capture (DAC) for e-fuels in Egypt, which results in significantly higher costs. For more information, please refer to the full report.

by about €0.5 per liter, reaching €1.4 per liter.[4] Thus, even when considering carbon pricing, we do not expect e-fuels to be cheaper than diesel in the near term. If CO_2 were to be sourced from direct air capture instead of a point-source, the e-diesel cost could be 20% higher than if it is sourced from a point-source.

Figure 2

Cost of e-diesel produced using CO_2 from point source delivered from Brazil to the European Union



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As we outline in a recent blog, several factors impact the cost estimates for renewable hydrogen and derivatives in the literature, including the cost of electricity, the cost and performance of electrolyzers, and the cost of financing the project.[5] **Our estimated renewable hydrogen and e-fuels production costs are within the range of existing studies.** The blue bars in Figures 3 and 4 represent the cost ranges from other studies, and the red bars represent our estimated costs for Brazil, Egypt, and the European Union based on different cost scenarios. At the higher end of the range in the literature, the production costs of renewable hydrogen and e-diesel could be over €4 per kilogram and €4 per liter, respectively, in 2050.[6] Under the most optimistic scenarios from other studies, renewable-rich countries like Brazil might be able to produce renewable hydrogen or e-diesel for less than €1 per kilogram or €1 per liter in 2050, which could be cost competitive with fossil diesel.[7] Reaching such cost parity would

4 Dennis Tol et al., “Techno-Economic Uptake Potential of Zeroemission Trucks in Europe,” 2022, https://www.agora-verkehrswende.de/fileadmin/Veranstaltungen/2022/Elektrische-Lkw/TNO_2022_R11862_Techno-economic_uptake_potential_of_zero-emission_trucks_in_Europe.pdf; Sasha Ranevska, “EU Carbon Market Will Cause Diesel Prices To Soar,” *Carbon Herald* (blog), July 1, 2024, https://carbonherald.com/eu-carbon-market-will-cause-diesel-prices-to-soar/; Lea Nesselhauf and Simon Müller, “The Carbon Price for Buildings and Road Transport,” 2025, https://www.agora-energiewende.org/publications/the-carbon-price-for-buildings-and-road-transport.

5 Andy Navarrete and Yuanrong Zhou, “The Price of Green Hydrogen: How and Why We Estimate Future Production Costs,” *ICCT Staff Blog* (blog), May 20, 2024, https://theicct.org/the-price-of-green-hydrogen-estimate-future-production-costs-may24/.

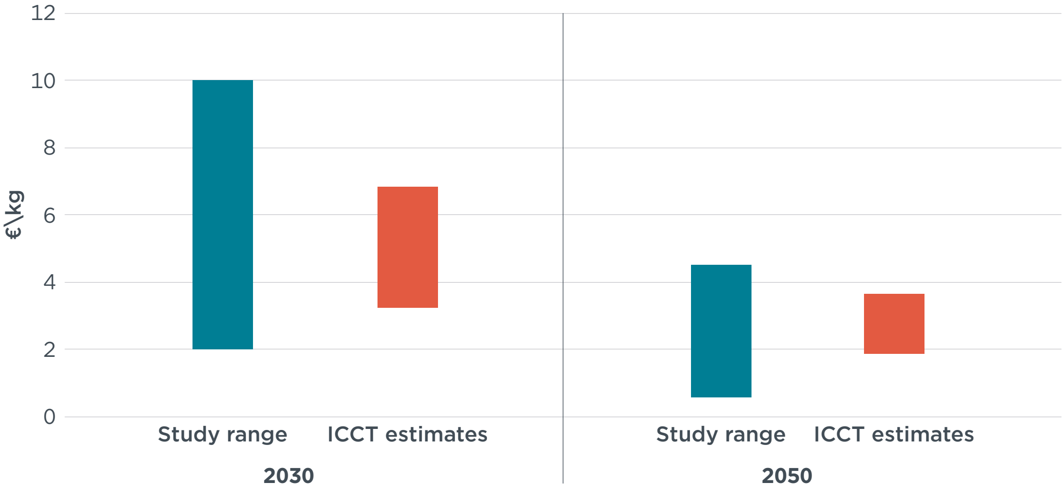
6 Viola Becattini, Paolo Gabrielli, and Marco Mazzotti, “Role of Carbon Capture, Storage, and Utilization to Enable a Net-Zero-CO2-Emissions Aviation Sector,” *Industrial & Engineering Chemistry Research* 60, no. 18 (May 12, 2021): 6848–62, https://doi.org/10.1021/acs.iecr.0c05392; Andres Gonzalez-Garay et al., “Unravelling the Potential of Sustainable Aviation Fuels to Decarbonise the Aviation Sector,” *Energy & Environmental Science* 15, no. 8 (August 11, 2022): 3291–3309, https://doi.org/10.1039/D1EE03437E.

7 International Renewable Energy Agency, “Global Hydrogen Trade to Meet the 1.5°C Climate Goal”; Nesrine Souissi, *E-Diesel in the Shipping Sector: Prospects and Challenges*, OIES Paper 30 (Oxford: The Oxford Institute for Energy Studies, 2024).

require substantial advancements and cost reductions across all major production technologies, including renewable electricity generation, water electrolysis, e-fuel synthesis, and carbon capture. At this early stage of renewable hydrogen and e-fuels production, it is unclear whether all of these technologies could achieve significant breakthroughs.

Figure 3

Estimated renewable hydrogen production cost compared with existing studies[8]



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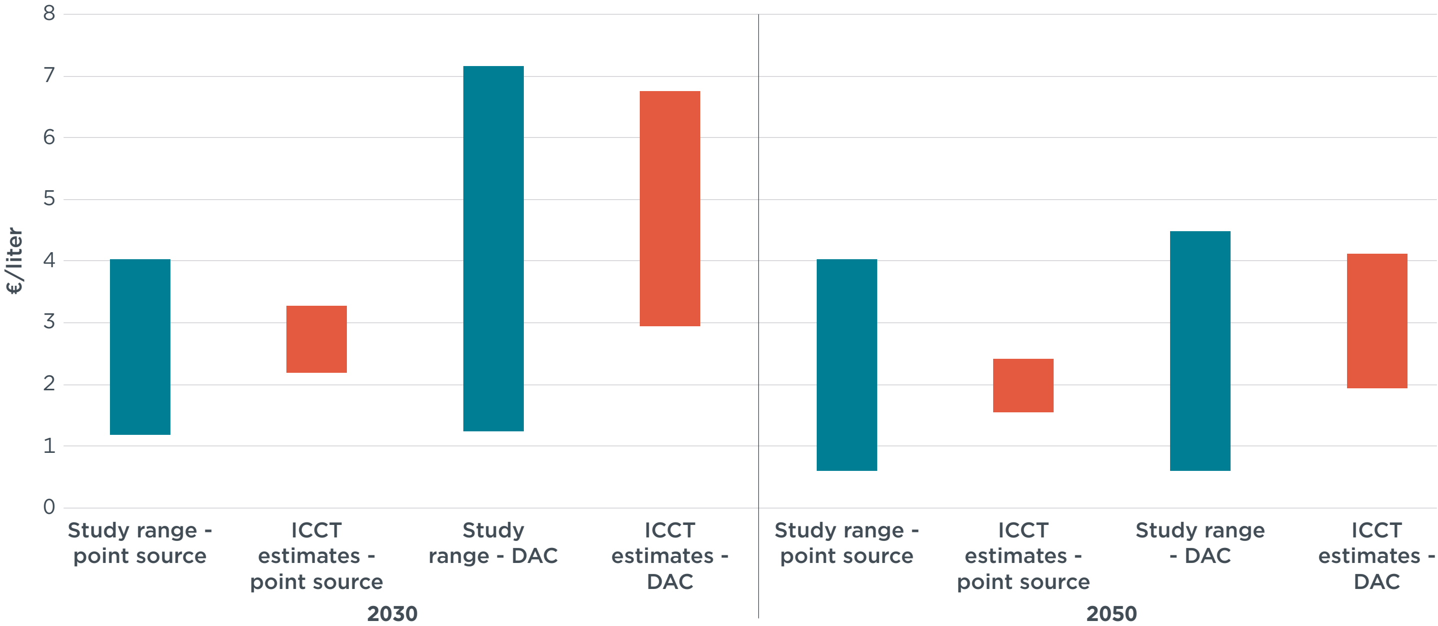
8 International Renewable Energy Agency, "Global Hydrogen Trade to Meet the 1.5°C Climate Goal"; International Energy Agency, "Global Hydrogen Review 2024," IEA, October 2, 2024, https://www.iea.org/reports/global-hydrogen-review-2024; Oeko-Institut, Agora Energiewende, and Agora Industry, "PTX Business Opportunity Analyser, Version 2.0," 2024, https://www.agora-energiewende.org/data-tools/ptx-business-opportunity-analyser-1; Alba Soler et al., "E-Fuels: A Techno-Economic Assessment of European Domestic Production and Imports towards 2050 – Update" (Brussels: Concawe, 2024), https://www.concawe.eu/publication/e-fuels-a-techno-economic-assessment-of-european-domestic-production-and-imports-towards-2050-update/.

Figure 4

Estimated e-diesel production cost compared with existing studies[9]



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9 Becattini, Gabrielli, and Mazzotti, "Role of Carbon Capture, Storage, and Utilization to Enable a Net-Zero-CO_2-Emissions Aviation Sector"; Selma Brynolf et al., "Review of Electrofuel Feasibility—Prospects for Road, Ocean, and Air Transport," *Progress in Energy* 4, no. 4 (August 2022): 042007, https://doi.org/10.1088/2516-1083/ac8097; Gonzalez-Garay et al., "Unravelling the Potential of Sustainable Aviation Fuels to Decarbonise the Aviation Sector"; Maria Grahn et al., "Review of Electrofuel Feasibility—Cost and Environmental Impact," *Progress in Energy* 4, no. 3 (June 2022): 032010, https://doi.org/10.1088/2516-1083/ac7937; International Energy Agency, "The Role of E-Fuels in Decarbonising Transport" (Paris, 2024), https://www.iea.org/reports/the-role-of-e-fuels-in-decarbonising-transport; Oeko-Institut, Agora Energiewende, and Agora Industry, "PTX Business Opportunity Analyser, Version 2.0"; Project SkyPower, "Accelerating the Take-off for e-SAF in Europe," 2024, https://project-skypower.org/sites/default/files/2024-10/Project%20SkyPower%20Insights%20Report%20Oct%202024_final.pdf; Soler et al., "E-Fuels"; Souissi, *E-Diesel in the Shipping Sector*; Stefan Bube et al., "Cost Analysis of Kerosene Production from Power-Based Syngas via the Fischer-Tropsch and Methanol Pathway," *Fuel* 384 (March 15, 2025): 133901, https://doi.org/10.1016/j.fuel.2024.133901.

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