# *FORECASTING GLOBAL GREEN HYDROGEN AND HYDROGEN DERIVATIVES INTERNATIONAL TRADE BY 2030: A REGULATION-DRIVEN APPROACH TO PRICING AND MARKET DYNAMICS*

Emmanuel Grand, FTI Consulting, 10 rue de Bassano 75116 Paris, +33688408623 emmanuel.grand@fticonsulting.com
Keyvan Rucheton, FTI Consulting, 10 rue de Bassano 75116 Paris, +33652028250 keyvan.rucheton@fticonsulting.com
Luis Lopez, FTI Consulting, 10 rue de Bassano , 75116 Paris, luis.lopez@fticonsulting.com
Natalia Gmucova, FTI Consulting, 10 rue de Bassano 75116 Paris, natalia.gmucova@fticonsulting.com
Ruoyang Gu, FTI Consulting, 10 rue de Bassano 75116 Paris, ruoyang.gu@fticonsulting.com
Michel Farah, FTI Consulting, 10 rue de Bassano , 75116 Paris, michel.farah@fticonsulting.com

## Overview

Global warming necessitates urgent greenhouse gas reductions, and green hydrogen—produced with renewable electricity—offers a critical pathway to decarbonizing sectors that are challenging to electrify, such as heavy industry, shipping, and aviation. Its derivatives, including e-ammonia, e-methanol, ande-kerosene, extend its potential applications. With binding consumption targets set by 2030 in Europe and East-Asia, international markets for green hydrogen and its derivatives may be needed as domestic production could be insufficient or costly. However, transportation costs could significantly influence final prices. This paper develops a global market model to simulate trade flows and prices for green hydrogen and its derivatives in 2030. Using regulatory targets to quantify demand, project-level data for supply forecasts, and cost modelling for production and transport, the model identifies optimal trade routes and landed prices per country per derivative. It offers insights into competitiveness and the dynamics of international green hydrogen markets.

## Methods

In essence, we model the trade flows and prices for green hydrogen and its derivatives in 2030 by (i) quantifying the demand per derivative, (ii) forecasting available supply, (iii) establishing total production costs, and (iv) dispatching the energy carriers following a cost-minimization under constraint.

i) Demand is derived from binding consumption targets set by the EU (Renewable Energy Directive II/III, ReFuelEU Aviation, and FuelEU Maritime), Japan (Hydrogen Strategy), and South Korea (Hydrogen Economy Roadmap). These targets encompass specific mandates for green hydrogen, e-ammonia, e-and e-kerosene, converted into hydrogen-equivalent volumes. Countries without explicit mandates are assumed to rely on domestic production without significant participation in international trade.The end-use sectors considered for green hydrogen and its derivatives are maritime and aviation transports, industrial refining, (i.e. non-transport fuel refining), and chemicals.

ii) Supply forecasts are based on project-level data from the International Energy Agency and independent analyses. Probabilities of completion are applied to account for uncertainty in early-stage projects. Each project is categorized by its primary hydrogen derivative.

iii) For each supply project the total production cost is calculated. The cost of feedstock (electricity) is first calculated by estimating the levelized cost of electricity (LCOE) based on the project characteristic, including CAPEX, load factors, and country-specific weighted average cost of capital (WACC), and oversizing requirements relative to the electrolyser to optimise hourly-matching requirements. Second, the levelized cost of hydrogen (LCOH) is determined by integrating electrolyzer costs, optimal load factors, but also "hidden costs" such as linked to the balance of plant, compressors, contingency . Finally, we obtain our total production by incorporating additional operational expenses (OPEX) and annualized capital expenditures (CAPEX) associated with producing one kilogram of the hydrogen derivative for each supply project -- except for pure hydrogen where the additional cost is only due to the storage requirements.

iv) Transport costs for each route between supply and demand nodes were calculated based on distance and transport mode (e.g., specific chemical tankers, hydrogen pipelines). This includes any associated costs of exporting and receiving terminal infrastructures. An economic dispatch of the global market is conducted using a linear programming model, designed to minimise landed costs, satisfying global supply and demand equilibrium by 2030, and satisfying physical (e.g. availability of pipelines and ships) and contractual constraints.

Finally, as we model the trade flows between countries for each for each of the five products considered, we obtain a merit order curve of the production capacities, identifying those that are dispatched and those that are not given our demand level, and we establish a landed price per country, corresponding to the marginal landed cost satisfying the demand of the respective derivative within the demand node

## Results

The analysis estimates a total global demand of approximately 11.2 Mt of hydrogen equivalent (all carriers included) by 2030, primarily driven by the trade of pure hydrogen and ammonia. They represent 5.9 Mt and 3.8 Mt of hydrogen equivalent when methanol and e-kerosene amount to 0.5 Mt and 1.0 Mt respectively.

We show that Japan and South Korea are driving imports, especially for green hydrogen and e-ammonia (they account for 50% of total H2 demand from international trade). Indeed, Japan plans to consume 1 Mt of green hydrogen by 2030 for industrial and power generation end-uses, while South Korea plans to import 2 Mt of green hydrogen, of which 1.5 Mt for the power sector. In Europe, the refining and fertiliser industries drive the demand for hydrogen and ammonia, while the maritime and aviation industries drive the consumption of e-methanol and e-kerosene.

On the other hand, the projected global supply is expected to reach around 20 Mt hydrogen equivalent, depending on the successful realisation of planned projects, with hydrogen and ammonia accounting for the lion's share of the supply at 9.8 Mt and 7.4 Mt respectively. Thus, we find that for pure hydrogen and ammonia there is significant oversupply to be expected in 2030 and one of our main finding indicates that the EU's supply of pure hydrogen is expected to meet domestic demand and most ot the trade is expected to occur via pipelines.The Netherlands and Spain emerging as the largest suppliers and Germany as the largest consumer. However, additional imports from outside the EU will be necessary to satisfy the demand for ammonia and e-kerosene.

In addidition, this study highlights significant regional variations in production costs. Levelized costs of hydrogen are heavily influenced by renewable electricity costs and electrolyzer capital expenses, with renewable-rich regions such as Spain achieving substantially lower costs due to lower CAPEX costs at 845 $/kW (agains an world average around 1037 $/kW) . In addition we find that hidden costs like balance of plant or compressor impact significantly the LCOH, representing up to 25%. Intra-region disparity is also observed with LCOH ranging from 10.2 to 26.1 USD2030/kg in Germany and from 6.7 to 13.6 USD2030/kg in Spain (the spanish projects dispatched has an average LCOH of 7.1 USD2030/kg). Modelling the global trade flows for each carriers, we find that Australia is expected to export the most of pure Hydrogen and ammonia (mainly toward Japan and South Korea), Spain the most green methanol and Uruguay the most e-kerosene.

## Conclusions

This paper underscores the critical role of global trade flows in establishing competitive markets for green hydrogen and its derivatives by 2030. While supply may outpace demand under favorable conditions, transport costs and project completion uncertainties remain significant challenges. Policymakers and market participants can leverage the model as a benchmarking tool to assess trade-offs between production and transport costs.

Future research should explore demand destruction mechanisms when landed prices exceed local compliance penalties, as well as capacity constraints in the shipping fleet and their impact on transport costs during demand peaks.

## References


Brändle and al. (2021), Estimating long-term global supply costs for low-carbon hydrogen, *Appl. Energy*, 302, 117481

Schuler and al. (2024) A review of shipping cost projects for hydrogen-based energy carriers, *Hydrig. Energy,* 49, pp. 1497-1508

Pantaia (2021) Cost Figures for Freight Transport – final report

International Energy Agency (2024) Hydrogen Production and Infrastructure Projects Database,

International Renewable Energy Agency (2024), Renewable Power Generation Costs