

THE GEOPOLITICS OF HYDROGEN – THREE QUANTITATIVE-QUALITATIVE SCENARIOS

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Overview

The paper outlines the emerging geopolitics of the developing global market for hydrogen. It uses a scenario approach to highlight the uncertainty of concrete developments in the future hydrogen market and the various paths that emerge from Europe's energy crisis and its decision to decouple from Russia. We present three scenarios that link international relations with energy economics and focus on Europe's role and the shifts in the global order. While the first scenario, "Hydrogen Realignment", illustrates a shift of geopolitical power towards China, the Gulf, and East Africa, the scenario "Hydrogen (In)Dependence" describes the consequences of unresolved dependencies in Europe's cleantech value chains. Finally, the scenario "Hydrogen imperialism" presents a world in which pipeline dependencies make the EU turn Africa into a militarised hydrogen playground, in which it trades energy exports against stabilising autocratic regimes. We analyse the main takeaways of each scenario for hydrogen policy and the implications for the political economy of infrastructures. For this, we quantify the scenarios with the newly developed Global Hydrogen Model that represents global hydrogen and derivative flows by pipeline and other carriers until 2050.

Methods

The paper combines qualitative scenario generation and interpretation (i.e. strategic foresight) with a numerical partial equilibrium model (see Ansari & Holz, 2019, for the general approach).

First, in a series of workshops with diverse stakeholders, we generated 3+1 scenarios of the global hydrogen market ramp-up and its geopolitical implications. The workshops used various structured analytic techniques to define assumptions, drivers, projections, and—eventually—raw scenarios, that we continued to refine through additional desk research and plausibility checks (see also Bazilian et al, 2020, for this process).

In a second step, we use the newly developed Global Hydrogen Model, which is a partial equilibrium model with endogenous production, consumption, transport flows, and investment into production and transport capacities. It extends a well-established and prominent modelling framework that has been used in the Global Gas Model (Egging et al, 2010; Egging & Holz, 2019), the oil market model Oilmod (Ansari, 2017), and the multi-fuel model Multimod (Ansari & Holz, 2019). We translate key parameters from the three qualitative storylines into assumptions for the numerical model to quantify the pathways.

In a third and iterative step, we check storylines and numeral results for consistency and adjust the assumptions if both accordingly.

Results

Our study develops three extreme yet plausible scenarios of the hydrogen market-ramp up in addition to a reference scenario. All scenarios consist of a dedicated, global storyline and regional quantifications of key parameters (production, consumption, and investment in each modelled region as well as global trade flows through pipelines and ships).

"Hydrogen Realignment" describes a world in which the EU has mainly given in to degrowth policies, while China and other Indo-Pacific actors have taken over hydrogen and major parts of the global industry.

"Hydrogen (In)Dependence" foresees a world in which, by 2040, the EU has built a largely self-reliant system of hydrogen production—it has, in fact, become the only actor that uses hydrogen as a means of decarbonisation—, but remaining dependencies in the hydrogen value chain create erode the EU's political autonomy.

Lastly, “Hydrogen Imperialism” envisions a world in which hydrogen hegemony share technology leadership and enforce strictly bilateral export regimes vis-à-vis subservient countries, in which a regime-stabilisation-for-hydrogen bargain is established.

Conclusions

Aside from the quantification of pathways and their associated implications for policy and industry, our research provides insight into the levers and drivers of different challenges associated with the ramp-up of the hydrogen economy.

From a European perspective, for instance, the three scenarios prove that (i) an insufficient production of the energy-intensive industry, (ii) strategy gaps regarding a holistic political vision for the entire value chain (and not just the upstream sector), and (iii) excessive pipeline-bound, bilateral trade regimes create adverse consequences. We formulate a number of policy recommendations to synchronise goals of energy economics, energy policy, sustainable development, and geostrategic aspects.

Moreover, the study proves a vital way forward in enriching the current status quo of energy scenarios by showcasing an example of scenarios that not only bridge between the qualitative and the quantitative world but also between energy economics and international relations/political science.

References

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