# Supplementary Information 3 – Alternative scenarios

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Following the significant uncertainties regarding the future hydrogen demand, the potential trade access and a global converging policy determination regarding supporting renewables, we defined three alternative scenarios: the low demand, limited trade and non-converging WACC scenarios. In the following we describe the underlying paradigms and the results of each of these scenarios.

## The low demand scenario

The low demand scenario considers a 10-year delay in the demand ramp-up for clean hydrogen. This scenario considers decarbonisation of current hydrogen uses by 2030. The demand for clean hydrogen then remains at current 90 $MtH_{2eq}$ in 2030 and reaches 175 $MtH_{2eq}$ by 2040 and 406 $MtH_{2eq}$ by 2050. Therefore, the demand is about 48% less in 2030 and 33% less in 2050. **Figure SI3.1** below shows this clean hydrogen demand during the outlook period.

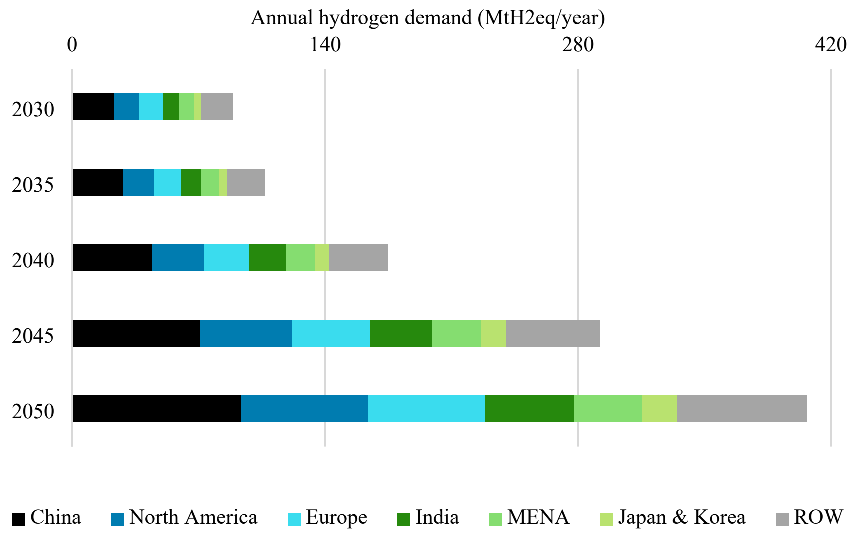


**Figure SI3.1.** Clean hydrogen demand evolution for the low-demand scenario between 2030 and 2050 by key regions of the study.

The delay in the demand ramp up puts green hydrogen in a more favourable position, as the ramp-up rates of renewable and electrolyser installations are less binding, and the cost advantage of green hydrogen is observed for lower demand values. clean hydrogen supply follows this lower demand, with green hydrogen representing 89% and 96.5% of the overall supply in 2030 and 2050 respectively. The remaining clean hydrogen demand is met by blue hydrogen (**Figure SI3.2**).

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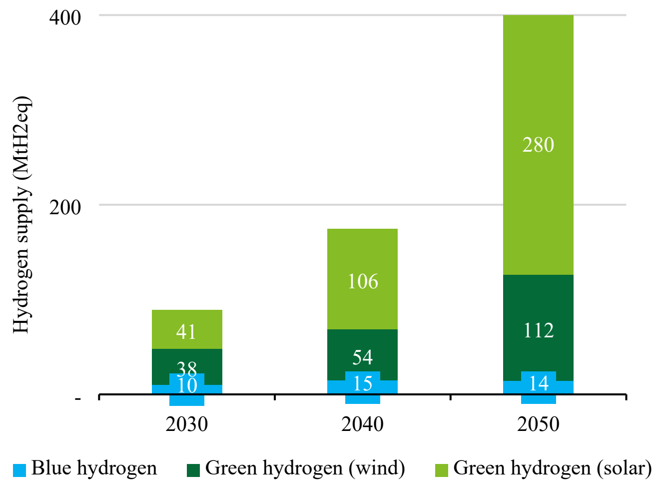


**Figure SI3.2.** Hydrogen supply mix for the low-demand scenario between 2030 and 2050.

The impact of this 10-year delay in demand is however smaller on the trade volumes in the long run. Although the trade volumes decrease, they still represent a robust share of nearly 15% of the demand, comparable to the 20% in the central scenario (59 $MtH_{2eq}$/year in 2050 - **Figure SI3.3**).

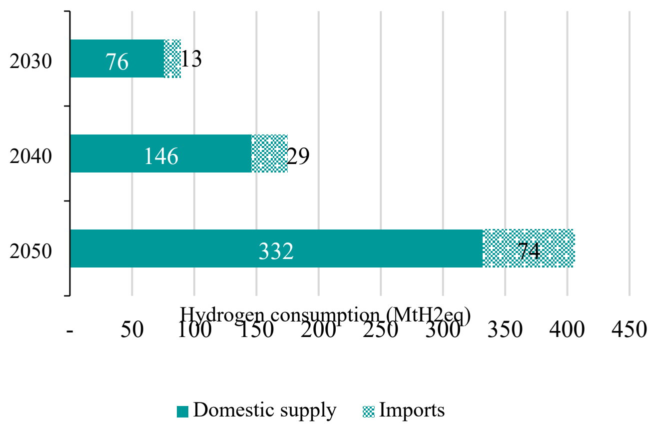


**Figure SI3.3.** The share of domestic production and trade of hydrogen in the low-demand scenario between 2030 and 2050.

## The limited trade scenario

This sensitivity scenario considers limited trade volumes to a fourth of them in the central scenario. Therefore, the trade in 2030 and 2050 cannot exceed 7.5 $MtH_{2eq}$/year and 27 $MtH_{2eq}$/year respectively. In this scenario, the clean hydrogen supply is still dominated by green hydrogen: 74% in 2030 and 85% in 2050. However, in such a scenario, some regions cannot produce the required hydrogen consumption and they can't import either. Therefore, this scenario is associated with unmet clean hydrogen demand that reaches as high as 39 $MtH_{2eq}$ in 2050 (**Figure SI3.4**).

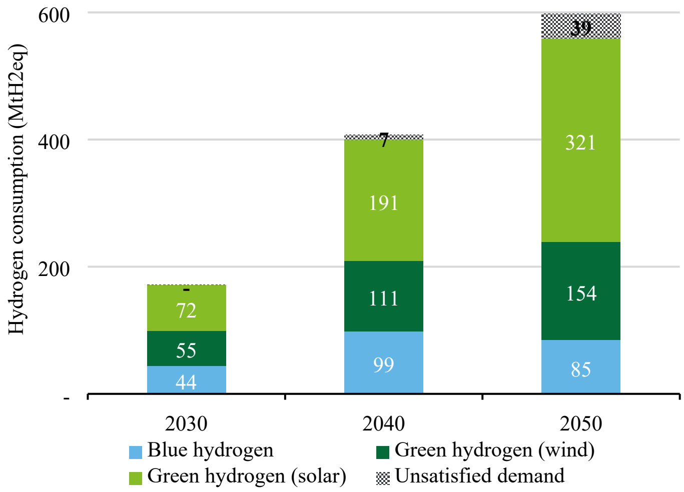


**Figure SI3.4.** Clean hydrogen supply in the limited trade scenario between 2030 and 2050.

Such a scenario is associated with significant extra costs. On the one hand, the cost of hydrogen supply is much higher in regions with lower renewable endowments. On the other hand, the cost of unmet demand as a lost opportunity cost is added to the overall costs (**Figure SI3.5**). In this scenario, the extra cost of limiting trade to a fourth of it reaches as high as \$350 bn/year (i.e., 25% of the global clean hydrogen market value in the central scenario in 2050)[d].

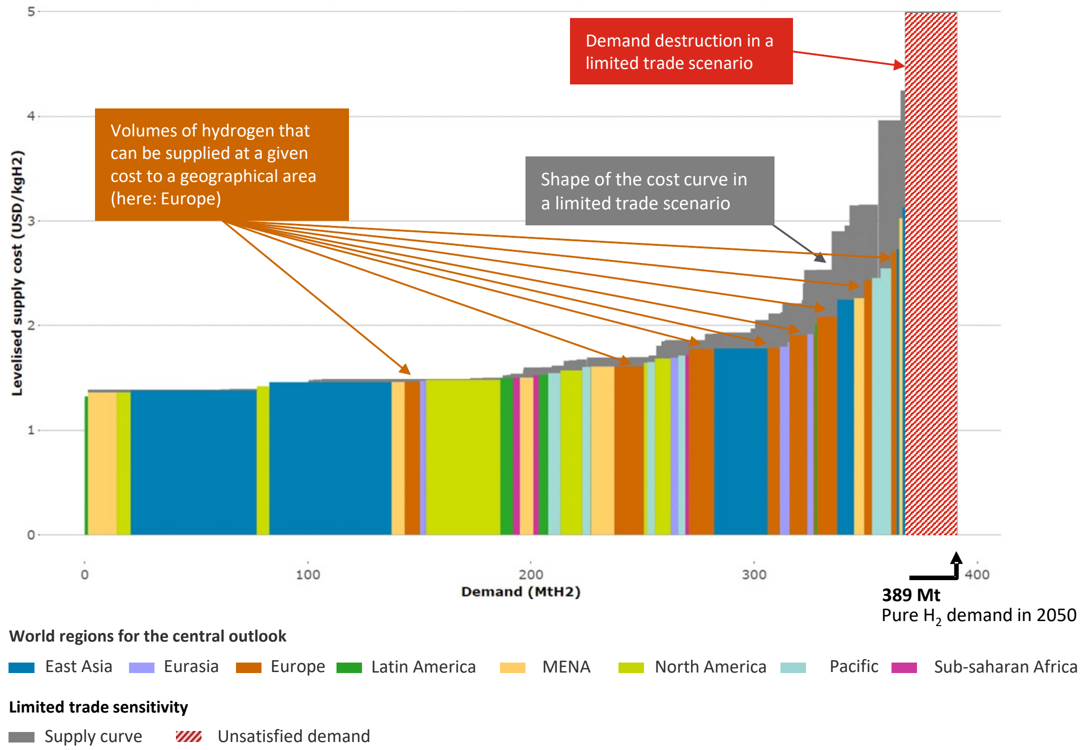


**Figure SI3.5.** Global hydrogen supply curve in 2050 for the limited trade scenario. The grey area represents the supply curve in the limited trade scenario, and the hashed red line represent the unmet demand in this scenario.

[d] The residual demand (i.e., the demand which could not be satisfied domestically due to limited trade) is priced at the highest supply cost obtained (about \$5 USD/kg$H_2$). The area between the optimal and trade-constrained supply curves (including satisfied demand) materialises the additional system cost.

## The non-converging WACC scenario

This scenario considers current WACC values as constant WACC values through 2050 in each considered country. Therefore, green hydrogen as a capital-intensive technology becomes more expensive than the case with converging and decreasing WACC considered in our central scenario. While the share of blue hydrogen in the clean hydrogen supply mix increases in this scenario, green hydrogen remains the majority hydrogen supply option with 104 $MtH_{2eq}$ of supply in 2030 and 446 $MtH_{2eq}$ of supply in 2050, representing 60% and 75% of the mix respectively (**Figure SI3.6**). The trade levels in this scenario at the same levels as the central scenario: 34 $MtH_{2eq}$ in 2030 and 111 $MtH_{2eq}$ in 2050.

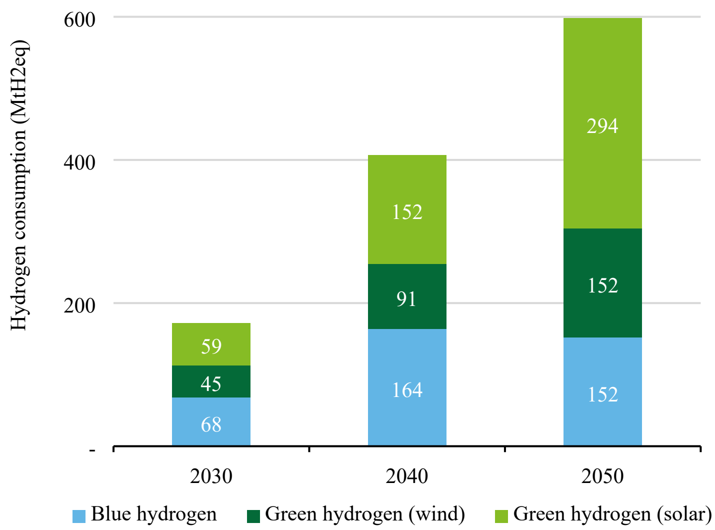


**Figure SI3.6.** Clean hydrogen supply for the non-converging WACC scenario from 2030 to 2050.