E-FUEL IMPORTS FROM THE MENA REGION AS AN OPTION FOR DECARBONIZING EUROPE'S ENERGY SYSTEM

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Overview

In order to avoid the consequences of anthropogenic climate change and to comply with the decisions of the Paris Agreement 2015 [1], the European Union (EU) aims at becoming greenhouse-neutral by 2050 [2]. The European Commission's (EC) hydrogen strategy [3] attributes an important role to hydrogen in achieving this goal. In compliance with the net-zero target, the EC's long term-strategic vision implies hydrogen demands of about 1,655 TWh_{H2} to 2,175 TWh_{H2} [1] in Europe for energy conversion, industry, transport, residential and services by 2050 [4],[5]. The production of these hydrogen quantities must be covered by corresponding quantities of renewable electricity. Recognizing that the Middle East and North Africa (MENA) especially has beneficial solar power potentials, hydrogen could be imported from there.

Using results of the energy system model Enertile this conference paper analyzes the hydrogen generation potential in the MENA region and compares it to a domestic European hydrogen supply.

Methods

The energy system model *Enertile* is used to investigate the potential hydrogen generation potential in the MENA region. The optimization model combines a high level of temporal, spatial, and technical detail. It minimizes system cost to meet exogenously specified electricity demands and to provide hydrogen at predefined sales prices. The optimization includes both capacity expansion and unit dispatch of relevant infrastructures. The analysis is performed for a future de-fossilized MENA electricity system in 2050. In such a system, the electricity used for hydrogen generation is by definition renewable. To account for the high aridity in MENA, hydrogen production is limited to coastal regions in the chosen analysis framework.

Results

Figure 1 and Figure 2 show supply curves of electricity-based hydrogen from a European perspective. Domestic European hydrogen production is compared to possible imports from the MENA region including hydrogen transport cost. The European hydrogen production curves are taken from Lux and Pfluger (2020) [6].

Hydrogen import potentials from MENA increase steeply with rising hydrogen selling prices. Depending on the assumed weighted average cost of capital (WACC) and taking into account average hydrogen pipeline transport cost of 21 €/MWh, the supply of gaseous hydrogen from MENA in Europe could start above sales prices of 91 €/MWh (7% WACC) and 121 €/MWh (12% WACC). The comparison of hydrogen supplies to meet European demands in Figure 1 shows that MENA imports of hydrogen at equivalent capital cost (WACC of 7%) as in Europe are economically feasible compared to a domestic European production. The comparison of hydrogen supplies to meet European demands in Figure 2 shows that MENA imports of hydrogen at increased capital cost (WACC of 12%) compared to Europe might not be economically feasible.

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[1] This range of demands for hydrogen-based energy carriers (hydrogen, e-gas, e-liquid) is derived from the 1.5TECH scenario and the 1.5Life scenario of the EC's long-term strategy vision [4],[5]. It is assumed that e-gas is equivalent to synthetic methane and that e-liquids are equivalent to synthetic methanol. The stoichiometric ratios in the Sabatier reaction and methanol synthesis are used to derive the underlying hydrogen quantities.

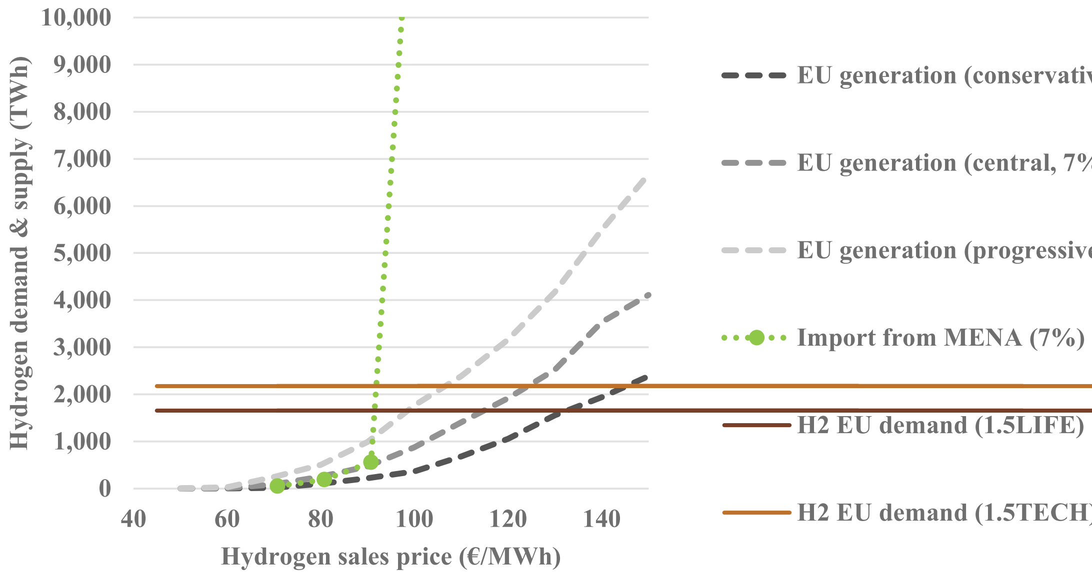

Figure 1 Different supply curves of electricity-based hydrogen to meet hydrogen demands implied by the long-term strategic vision of the EC [4],[5]. Domestic European hydrogen supply curves are taken from Lux & Pfluger (2020) [6]. The MENA import curve is calculated for gaseous transport via pipeline and with weighted average costs of capital of 7%.

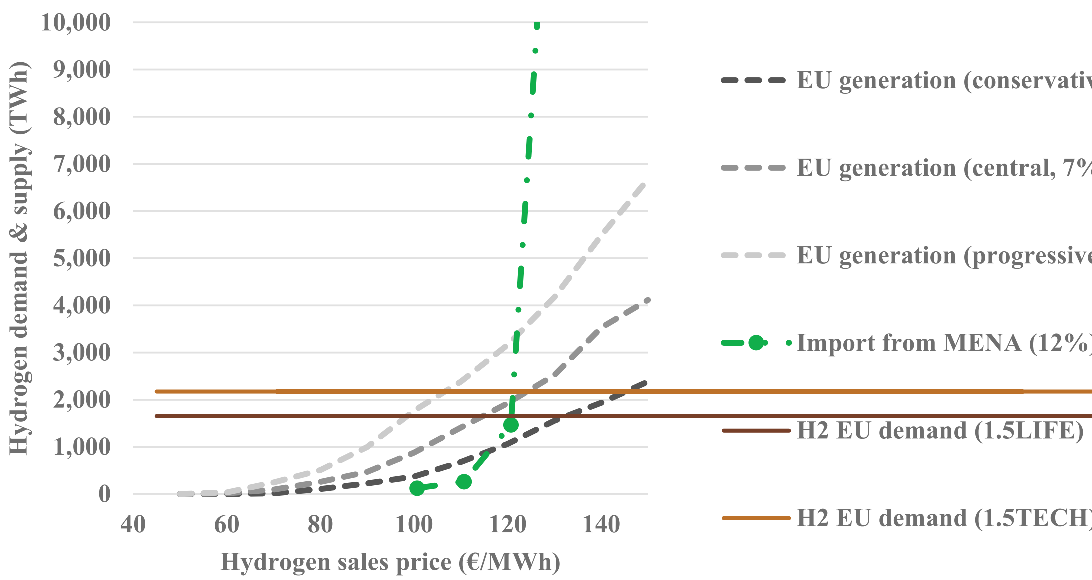

Figure 2 Different supply curves of electricity-based hydrogen to meet hydrogen demands implied by the long-term strategic vision of the EC [4],[5]. Domestic European hydrogen supply curves are taken from Lux & Pfluger (2020) [6]. The MENA import curve is calculated for gaseous transport via pipeline and with weighted average costs of capital of 12%.

Conclusions

Our results show that the MENA region is characterized by extensive and low-cost renewable power generation potentials exceeding electricity demands within MENA. These potentials can be used to produce electricity-based hydrogen for the export to Europe. However, compared to hydrogen production within Europe, the production in MENA might be subject to higher capital and transport costs. In order to answer the question whether hydrogen from MENA can contribute to the supply in Europe, these additional costs must be further examined.

References

[1] United Nations. Paris Agreement; 2015.

[2] European Commission. The European Green Deal. Brussels; 2019.

[3] European Commission. A hydrogen strategy for a climate-neutral Europe. Brussels; 2020.

[4] European Commission. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE, THE COMMITTEE OF THE REGIONS AND THE EUROPEAN INVESTMENT BANK COM(2018) 773: A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy; 2018.

[5] European Commission. In-depth analysis in support of the commission communication COM(2018) 773: A clean Planet for all - A European long-term strategic vision for a prosperous, modern, competitive and cimate neutral economy. Supplementary information; 2018.

[6] Lux B, Pfluger B. A supply curve of electricity-based hydrogen in a decarbonized European energy system in 2050. Applied Energy 2020;269:115011. doi:10.1016/j.apenergy.2020.115011.