


## ORIGINAL ARTICLE

# Foresighting Scenarios for Green Hydrogen in Portugal: Systematization of Potential Futures and Identification of Bottlenecks and Constraints

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## ABSTRACT

The use of green hydrogen has emerged as a promising avenue for facilitating the decarbonization of society. In this study, the potential futures of green hydrogen in Portugal, a key player in Europe's energy transition, are explored. Utilizing General Morphological Analysis combined with advanced clustering, the various political, social, and technological elements are analyzed to create a multifaceted view of the sector's future. This results in seven distinct scenario clusters, each offering unique insights into the challenges and opportunities for green hydrogen. The scenarios span a range of outcomes, from rapid growth fueled by strong policy support and technological advancements to more measured development due to economic or infrastructural hurdles. This study intends to provide stakeholders a deep understanding of the factors influencing green hydrogen's role in Portugal's push towards a sustainable energy landscape by 2030. These results provide a basis for the development of new projects and research directions, providing them with the necessary knowledge to make informed decisions. Moreover, this study will contribute to decision support by facilitating actions aimed at fostering the appropriate development of green hydrogen.

## 1 | Introduction

Green hydrogen is emerging as a critical component in the transition to sustainable energy systems worldwide. The global hydrogen market is anticipated to expand substantially, with projections indicating the creation of 1.7 to 2 million new jobs in the EU and UK by 2040 in the green molecule industry (Green Molecules: The Upcoming Revolution in the European Employment Market 2024). Green hydrogen's significance in achieving decarbonization goals is also recognized in the European Union (EU) Commission's Hydrogen Strategy, targeting at least 6 GW of renewable hydrogen electrolyzers in the EU by

2024 and 40 GW by 2030 (European Commission 2020). Plus, the recent EU's 2040 climate target of 90% lower greenhouse gas (GHG) emissions by 2040 relative to 1990, relies on 9 Mtoe of produced hydrogen in 2030, 76 Mtoe in 2040 and 185 Mtoe in 2050 (2040 Climate Target—European Commission, n.d.). Renewable hydrogen is a key energy vector for the future EU energy system, required to decarbonize hard-to-abate sectors and to produce e-fuels (2040 Climate Target—European Commission n.d.).

The “Green Hydrogen in Europe—A Regional Assessment” report and the “Are green and blue hydrogen competitive or