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Water availability and water usage solutions for electrolysis in hydrogen production

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ABSTRACT

Europe is committed to a new growth strategy with no net greenhouse gases emissions by 2050, where hydrogen has a clear role to play. Portugal's strategy for H_2 sets public policies promoting an industry focused on the hydrogen value chain. Considering the production of green hydrogen from renewable sources is key, water electrolysis becomes a priority, and with it, the need to assess the suitability of water sources, which is determined by both quantitative and qualitative factors. This work presents a new approach to assess the suitability of water sources for hydrogen production via water electrolysis by applying a Sustainable Value Methodology for decision-making support, combining economic, environmental and social criteria. The approach is applied to two different sites in Portugal: a semi-urban location on the Atlantic coast (site A) and a rural area far from the coast (site B). For both sites, water sources are evaluated regarding water availability, quality, transport options, abstraction costs, treatment needs and regulation (including environmental constraints) and social acceptance. The resulting sustainable value indicator, aggregator of different levels of information, enables a relative quantitative comparison of the performance of different water sources for electrolysis and the involved costs. It is found that the public grid water is the most suited source of water for electrolysis due to lower risk of supply, lower costs and avoids complex permitting processes. Likewise, seawater and wastewater treatment plant effluent (only in site A) showed to be possible water sources where the factors most affecting suitability are transport costs for water and waste disposal from water treatment.

1. Introduction

Europe is committed to a new growth strategy that will transform the Union into a modern, resource-efficient and competitive economy, aiming for carbon neutrality by 2050 (European Commission, 2018) and for decoupling economic growth from resource use. The European Green Deal is the plan for a sustainable economy in Europe (European Commission, 2019).

In 2020, after the adoption of the European Industrial Strategy, a plan for a future-ready economy, and of proposal of a Circular Economy Action Plan focusing on sustainable resource use, the EU also adopted the strategies on energy system integration (European Commission, 2020a) and on hydrogen (European Commission, 2020b) to pave the way towards a fully decarbonised, more efficient and interconnected energy sector. As stated by the IEA (2019), this is a critical time for hydrogen, which is today enjoying unprecedented momentum. The world should not miss this unique chance to make hydrogen an important part of our clean and secure energy future (Fatih Birol in IEA, 2019). The EU hydrogen strategy foresees at least 6 GW of renewable hydrogen electrolysers deployed up to 2024, producing up to 1 million tonnes of H_2.

Cycles of expectations followed by disillusion are associated to H_2 technologies (Staffell et al., 2019). On the production side, hydrogen can be produced from different sources, namely fossil fuels, biomass, and water electrolysis powered with electricity, naturally with different degrees of impact on the environment (Partidário et al., 2019). For H_2 to make a significant contribution towards the clean energy transition, it needs to be adopted in sectors where it is almost completely absent, such as transport, buildings, and power generation (IEA, 2019).

According to Blank and Molloy (2020), roughly 96% of H_2 produced

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