GREEN HYDROGEN FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

The current interest in green hydrogen is largely motivated by the necessity to decarbonize our economy, but investments in this energy carrier can jeopardize aligning the ongoing energy transition with the economic, environmental, and social dimensions of sustainable development. Yet, the global green hydrogen value chain has the potential to act as a key driver in promoting these three sustainability dimensions. In this work, we investigate the alignment of the green hydrogen value chain with the dimensions of sustainable development. Most articles exploring the relationship between green hydrogen and the SDGs primarily focus on only one specific segment of the value chain or on the use of hydrogen in one single sector. We propose the Value Chain Assessment (VCA) methodology using the 2030 Agenda as an underlying framework. Our methodological approach strategically divides the value chain into distinct segments and can be applied either partially or in its entirety to other value chains, encompassing various types of energy carriers, feedstocks or low-carbon technologies, such as green ammonia or Carbon Capture and Storage (CCS). Specifically, we categorize green hydrogen into three key segments: production, transportation, and end-use. By disaggregating this value chain, we obtain insight into the multiple sustainable development dimensions of the adoption of green hydrogen. Our methodology consists of five steps that together enable better understanding of the complexity of the complete hydrogen value chain and inspecting all 17 SDGs and their 169 targets for each segment of the chain.

After an extensive and deep literature review as step 1, we map the influences (direct, indirect or no influence / still unknown and; green flag or red flag) of the deployment of green hydrogen on the three segments of its value chain (step 2 and 3). Figure 1 summarizes the main outcome of our analysis in which we assessed the extent to which the segments of the green hydrogen value chain influence sustainable development in terms of the 169 targets of the 17 SDGs. We find at least one segment of the green hydrogen value chain that the SDG is influenced by (either directly or indirectly), altogether involving 61 out of the 169 SDG targets. Across the overall count of segments that have an influence on a SDG target (149 in total, with, in principle, 507 possible influences), there are about four times as many indirect influences (119) as direct ones (30), particularly the SDGs 4, 8, and 17. Figure 2, we classify 86 influences as being positive (14 direct and 72 indirect), while the remaining 63 influences are negative (16 direct and 47 indirect). The high number of negative influences highlights a substantial misalignment between segments of the green hydrogen value chain and aspects of sustainable development, which prompts concerns regarding the deployment of green hydrogen.

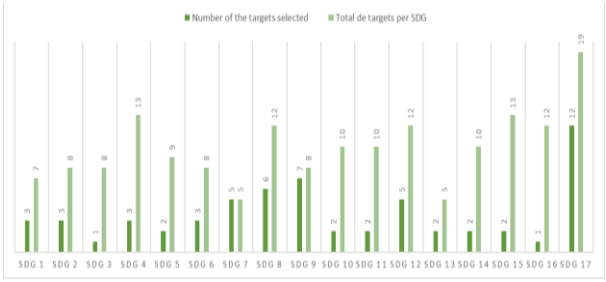

Fig. 1 – Total number of the direct and indirect influences of the green hydrogen value chain on each SDG.

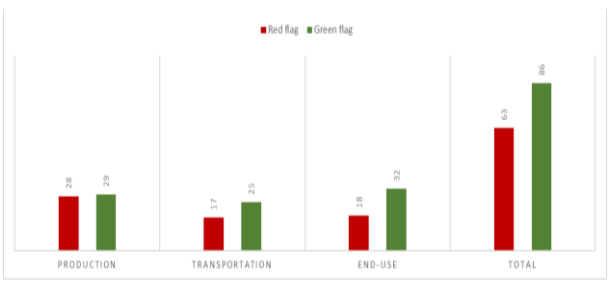

Fig. 2 – Number of green and red flags in the green hydrogen value chain per segment on 169 SDG targets.

The dimensions of temporality (step 4) contribute to improving our comprehension of the complexity of the green hydrogen value chain by analyzing the progress of the given SDG target in the short- (≤ 2030) or medium- to long-term (> 2030). In Figure 3, in the short-term 20% of the influences are direct and 80% are indirect, while in the medium- to long-term 15% are direct and 85% indirect. Whereas positive effects represent the majority in the short-term (66% positive and 34% negative), negative influences become more evident in the medium- to long-term (33% positive and 67% negative) to the deployment of the green hydrogen value chain. We apply the reciprocal interdependence as step 5, which provides the opportunity to identify the interconnections of each pair of segments of the green hydrogen value chain in meeting SDGs across different geographic scales, with a particular focus on local development. In the green hydrogen value chain, 12 targets require the reciprocal interdependence of three pairs of segments for progress towards the corresponding SDG. SDGs 7 and 8 include the highest number of targets with reciprocal interdependence between all three pairs of segments, while SDGs 9 and 12 present the highest number of targets with reciprocal interdependence between only one or two pairs of segments. SDGs 7, 8, 9, and 12 jointly constitute some of the most urgent challenges confronting the development of the green hydrogen value chain, which we think requires immediate action.

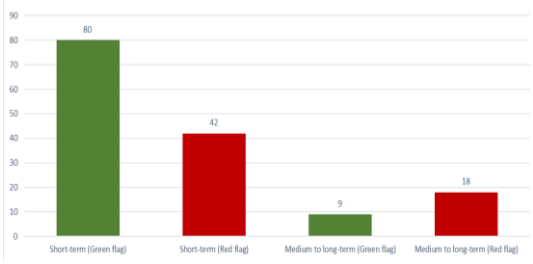

Fig. 3 – Total number of red and green flags across the dimensions of temporality in the green hydrogen value chain segments.

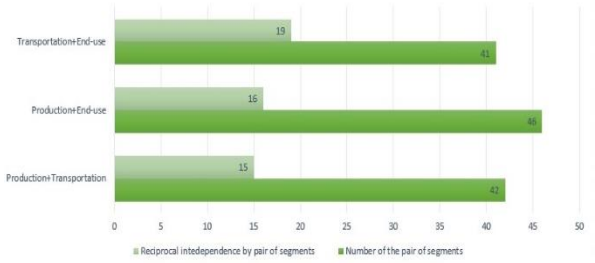

Fig. 4 – Number of the reciprocal interdependence by each pair of segments of the green hydrogen value chain.

After analyzing these results, a framework was developed as a strategic blueprint for fostering sustainable growth of the green hydrogen value chain. This framework provides a clear direction, interconnects steps, and assists stakeholders in understanding how to maximize the impact of the green hydrogen value chain on the SDGs. The findings also suggest that there are common alignments across the three sustainable dimensions, necessitating coordination and collaboration throughout the entire value chain to meet the SDGs effectively.