Energy transition and the eco-social dilemma of (un-)sustainable Hydrogen: from the international scenario to the case of South Tyrol

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During the last decade, hydrogen resources and related systems for their production, storage, and utilization have been at the core of the international public and scientific debate, as well as central elements of national and European policy initiatives. Despite the political and scientific momentum behind the promotion of new hydrogen economies, caution and careful considerations are essential for understanding how such transitions are designed and implemented. This is particularly important in addressing ongoing injustices faced by marginalized and vulnerable populations, while simultaneously tackling energy security issues and environmental concerns (Demirbas, 2017; Cremonese et al., 2023). The transition to carbon-neutral futures through the consolidation of hydrogen economies is currently calling into question the necessity to navigate and understand at institutional, entrepreneurial, and research level, the intertwined complexity of relationships and mechanisms that in the social arena can curb, foster, and locally reshape and adapt such pathways (Batel and Devine-Wright, 2017). The analysis of human and social behaviors is therefore pivotal for retooling future sustainable energy scenarios. Accordingly, a social science approach appears increasingly relevant to support and address this effort by understanding the socio-technical systems within which hydrogen energy transitions are activated, mediated, or contested. The path to a global hydrogen economy is hence “not just a function of technical and economic factors” (Van de Graaf, 2020), but it is a complex process, embedded within a broader societal transitions. This article provides an overview of Europe's progress in the hydrogen sector and shares initial insights from the action-research project "HYDRO-Economia dell’Idrogeno e Mobilità Sostenibile. Analisi delle Ricadute Territoriali e Sociali nelle Province di Trento e Bolzano." The discussion focuses on the unique characteristics of South Tyrol's energy landscape as a socio-technical system. Using the Actor-Network Theory (ANT) approach, the analysis explores the interplay among various elements, both tangible and intangible, such as technology, regulations, user practices, markets, cultural meanings, and infrastructures. The study aims to identify diverse and sometimes conflicting imaginaries on the implementation of the local hydrogen economy and the "Hydrogen Valley South Tyrol" initiative, funded by the National Recovery and Resilience Plan (PNRR). It examines the potential opportunities and risks, as well as the strengths and weaknesses, perceived by different local groups, including enterprises, energy cooperatives, institutions, scientific and technical organizations, and environmental organizations.