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Opportunities and drivers for green hydrogen production from renewable energy: Constructing of a causal loop diagram from stakeholders perspective in Iceland.

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Green hydrogen produced through electrolysis using renewable energy has the potential to decarbonize many sectors by replacing fossil fuels. Although production is currently marginal, green hydrogen projects are initiated and assessed all around the globe, ranging from small energy systems to large-scale production units. Previous studies have identified a wide range of key stakeholders that influence the diffusion of green hydrogen technologies. However, an understanding of the overall complexity of the emerging hydrogen sector regarding techno-economic, social, and environmental aspects is needed. The main objective of this study is to provide a depiction of an emerging sustainable technology sector by integrating various stakeholders' perspectives. Based on this mapping key mechanisms that foster or hinder the production of green hydrogen will be identified. To perform our study, we chose a green hydrogen production project at the Hellisheiði geothermal power plant (Iceland) to construct a causal loop diagram (CLD) of the Icelandic green hydrogen production sector. Seven semi-structured interviews and one e-mail interview were conducted with relevant stakeholders. The National Innovation System was taken as a conceptual model in order to encourage the participants to answer in a systemic manner. Variables and causal links were then extracted from the interview transcripts using a coding process adapted from the literature. An overall CLD was constructed, showing the dynamic complexity of the system. The results show that mobility and export are the main sources for enhanced demand. Since most power companies in Iceland are state owned, green hydrogen supply comes mainly from energy companies, and strongly depends on political support. The importance of civil society, especially concerning the topics of nature protection and climate awareness, is also depicted. Additionally, a range of social, technical, and economical factors are identified, as well as their impact on the system's behavior. The diagram allows for comprehension of stakeholders' expectations and concerns with their potential consequences on the diffusion on green hydrogen technologies. The use of system dynamics and causal loop modelling provides a comprehensive view on the problem and helps to address issues that could be overlooked without it. Some of these causal chains could potentially lead to policy failure if not addressed early enough. The findings can be used to enhance cooperation between stakeholders and guide decision-making processes.