Paper 318-24

Sustainable Mobility in Rural Landscapes: The Role of Hydrogen in Rural Transportation Evolution

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Abstract

Despite the focus on urban centers, rural areas present unique challenges and opportunities for implementing sustainable mobility solutions, particularly in developing countries and regions undergoing economic transition. Through an analysis of current trends, challenges, and future directions, we explore the integration of hydrogen technologies in rural transportation systems.

Our findings underscore the importance of innovative models and good practices in technology applications, including demand-sensitive transport and shared mobility, to facilitate social inclusion and environmental sustainability in rural mobility. The paper aims to contribute to the discourse on sustainable rural transportation by highlighting the need for comprehensive research, policy development, and the adoption of hydrogen technologies to address the unique mobility needs of rural communities.

Introduction

Global sustainable mobility models seek, among others, the use of transport with low or zero emissions, and the world's research focuses on the search for biofuels, the use and storage of hydrogen, and new technologies in electrical storage.

With the global momentum in hydrogen projects growing by 35% from May 2022 to January 2023, bringing total large-scale projects to over 1,000, the role of hydrogen in sustainable mobility is more prominent than ever. This increase reflects a surge in direct investment to $320 billion by 2030, marking significant progress in hydrogen infrastructure development for mobility, including over 1,000 refueling stations now operational worldwide. North America is charging ahead, driven by new incentives under the Inflation Reduction Act, accounting for 70% of committed clean hydrogen production.

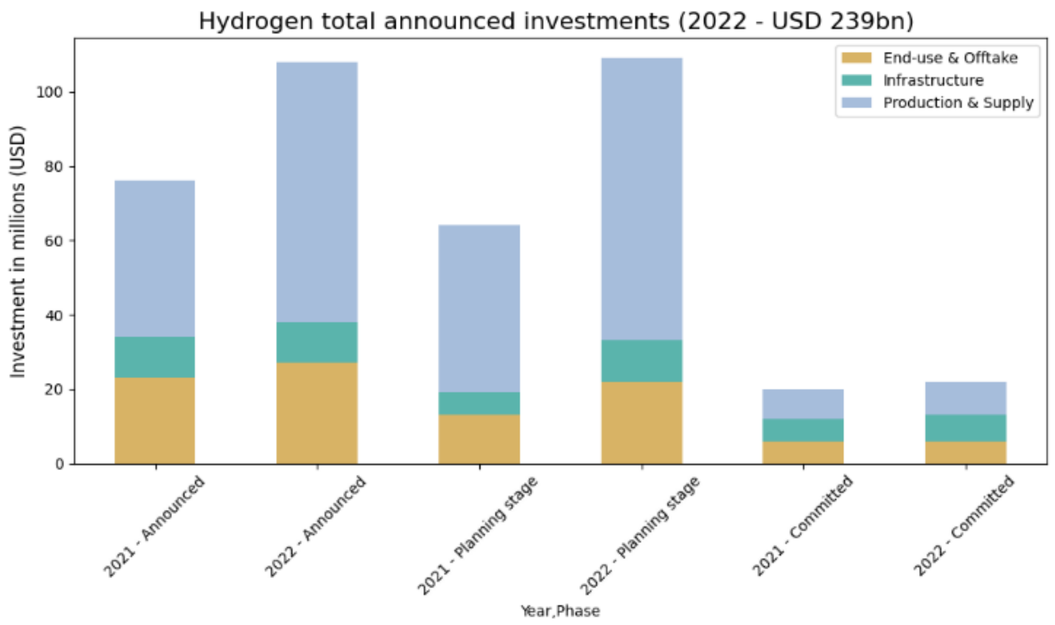

Fig.1. The distribution of hydrogen investment across different project phases. Announced, Planning, and Committed—for the years 2021 and 2022.

Sustainable Mobility in Rural Applications

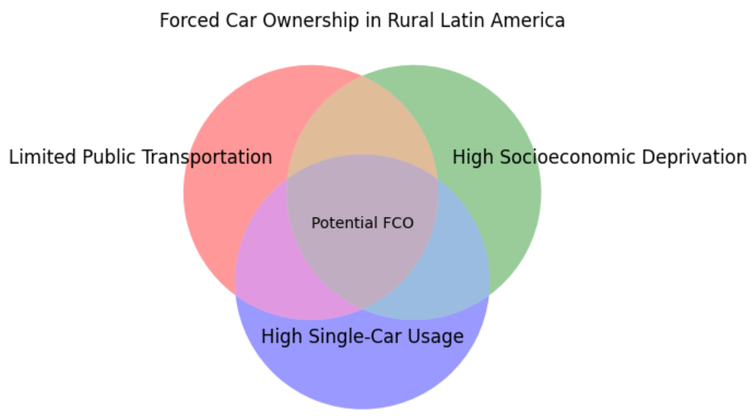

Fig.2. Venn Diagram of Factors Contributing to Forced Car Ownership in Rural Latin America. Adapted from P. Carroll, R. Benevenuto, B. Caulfield, Identifying Hotspots of Transport Disadvantage and Car Dependency in Rural Ireland, Transp Policy (Oxf) 101 (2021) 46–56. https://doi.org/10.1016/J.TRANPOL.2020.11.004.

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The main advantages of its incorporation in rural territories:

i. Energy Self-sufficiency: Utilizing local renewable resources for hydrogen production, minimizing dependency on energy imports.
ii. Sustainability: Hydrogen generated from renewable sources offers a completely fossil-free alternative, aligned with sustainability objectives and CO_2 emission reduction goals.
iii. Resilience: Establishing a hydrogen supply chain contributes to a more resilient energy system in rural areas, where infrastructure options may be limited.
iv. Available Space Potential: Rural areas provide abundant space for the installation of renewable energy generation infrastructures necessary for hydrogen production.
v. Sustainable Mobility: Hydrogen supports the transition towards sustainable rural mobility, reducing the carbon footprint of transportation.

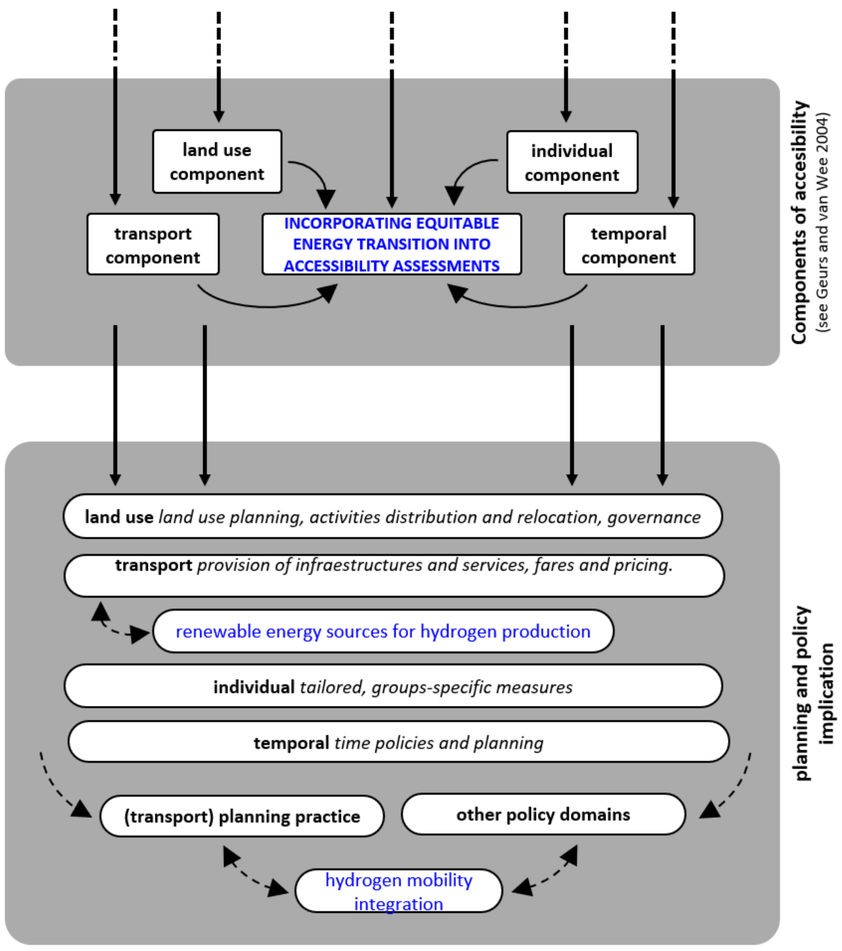

Fig.3. An adapted framework approach for assessing accessibility with a focus on equitable energy transition.

Conclusions

In conclusion, our study underscores the transformative role of hydrogen technology in revolutionizing rural mobility. By analyzing diverse pilot projects, we've showcased hydrogen's capability to provide sustainable transportation solutions that not only meet environmental standards but also advance social equity. These initiatives illuminate the path towards a more self-sufficient and resilient rural community by leveraging local renewable energy sources for hydrogen production.

In future research, we will endeavor to develop a verification model to assess the environmental impacts of hydrogen mobility solutions, focusing on pollution levels and ecosystem impacts across South America. This comprehensive model aims to compile and analyze environmental statistics to provide a clearer understanding of the regional implications of adopting hydrogen technologies. Additionally, we will delve into financial viability analyses for a pilot project, aiming to unravel the economic aspects and ensure the sustainability of hydrogen solutions in rural settings. These investigations will contribute to a holistic view of hydrogen's role in sustainable mobility, considering both ecological and economic dimensions.