Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/GC03.20250373
Published: February 2, 2026

Green Hydrogen Supply Chain Network Design for Saudi Arabia's Energy Transition under Vision 2030

Muhammad Tayyab, Isma Javed and Irfanullah Khan
Department of Information Systems and Operations Management
King Fahd Business School, King Fahd University of Petroleum and Minerals
Dhahran 31261, Saudi Arabia
Interdisciplinary Research Center for Finance and Digital Economy
King Fahd University of Petroleum and Minerals
Dhahran 31261, Saudi Arabia
muhammad.tayyab@kfupm.edu.sa, g202315630@kfupm.edu.sa,
irfanullah.khan@kfupm.edu.sa

Abstract

Saudi Arabia's transition toward a carbon-neutral energy system requires a reliable and economically optimized hydrogen transport infrastructure. This study develops a mixed-integer linear programming (MILP) model to design a cost-effective, all-domestic green hydrogen network connecting eight major cities across the Kingdom. The model integrates multiple transportation modes including pipelines, compressed gas trailers, and liquid hydrogen tankers to evaluate logistics costs between renewable production sites, industrial demand centers, and storage facilities. By minimizing the total system cost, which encompasses production, storage, and transportation, the model identifies optimal facility locations and capacity configurations under uncertain demand scenarios. Results indicate that production costs dominate total expenditures (70–75%), while transportation and storage contribute approximately 15–20% and 5–10%, respectively. Dammam, Medina, and Tabuk emerge as the most cost-efficient production hubs, balancing renewable resource availability and industrial proximity. Gaseous hydrogen proves most viable for short-distance distribution, while liquid hydrogen and ammonia are optimal for longer or export-oriented routes. The optimized configuration yields minimum annual system cost demonstrating that integrated, data-driven planning can significantly reduce hydrogen supply chain expenses. This research offers a quantitative framework to support national policymakers and investors in advancing Saudi Arabia's hydrogen economy and achieving Vision 2030 goals of sustainability and energy diversification.

Keywords
Green hydrogen supply chain, transportation optimization, mixed-integer linear programming, infrastructure planning, Saudi Arabia energy transition.

Acknowledgements
This research work is sponsored by the Interdisciplinary Research Center for Finance Digital Economy (IRC-FDE) at King Fahd University of Petroleum Minerals (KFUPM) under the Project Number INFE2515 awarded on April 13, 2025.

Biographies
Muhammad Tayyab is an Assistant Professor in the Department of Information Systems and Operations Management at King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, Saudi Arabia. He holds a Ph.D. in Industrial and Management Engineering from Hanyang University, South Korea, specializing in operations and supply chain management. His teaching and research interests include operations research, logistics, production

management, and sustainable supply chains. Dr. Tayyab has published widely in leading international journals and focuses on applying optimization, simulation, and AI techniques to enhance operational efficiency and sustainability in industrial systems.

Isma Javed is a master's student in the Department of Management and Marketing at King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia, focusing on marketing analytics and sustainable business management.

Irfanullah Khan is an Assistant Professor in the Department of Information Systems and Operations Management at King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, Saudi Arabia. He holds a Ph.D. in Industrial and Management Engineering from Hanyang University, South Korea, specializing in sustainable supply chains and operations optimization. Before joining KFUPM, he was a Postdoctoral Fellow at the Interdisciplinary Research Center for Smart Mobility and Logistics, focusing on data-driven and green logistics solutions. His teaching and research interests include Supply Chain Management, Operations Research, and Data Science, emphasizing optimization, sustainability, and intelligent decision-making in industrial and logistics systems.