

ABSTRACT

This study offers a comprehensive techno-economic and thermal feasibility analysis of a liquid hydrogen production and storage system to support clean energy transportation infrastructure in the framework of the global energy transition. A dual modeling approach was used to assess hydrogen production through seawater desalination and electrolysis, combining process simulation with SuperPro Designer and thermal analysis with ANSYS to examine the insulation performance and heat transfer properties of a three-layer cryogenic storage tank. Due to economies of scale, the project becomes financially feasible when seawater input surpasses 250–300 metric tons, according to the economic evaluation. At 500 MT input, the Net Present Value (NPV) is approximately USD 47.1 million. The thermal simulations verify that the designed tank, which is made of stainless steel, carbon steel, and multilayer insulation (MLI), successfully keeps liquid hydrogen at subcritical temperatures in a distribution scenario that lasts twenty-four hours. The low thermal ingress shown by the directional and total heat flux analyses ensures the preservation of hydrogen in its cryogenic state. Together, these simulations offer a thorough framework for evaluating the feasibility of hydrogen supply chains. The results also support strategic planning for the implementation of hydrogen infrastructure in line with Indonesia's national hydrogen roadmap and more general decarbonization objectives. This work advances the role of hydrogen in future sustainable energy systems by providing crucial insights.

Keywords: Energy transition, cryogenic storage tank, seawater desalination, Techno-Economic Analysis