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WELL-TO-PORT ASSESSMENT OF HYDROGEN PRODUCTION PATHWAYS FOR SEAPORT DECARBONIZATION

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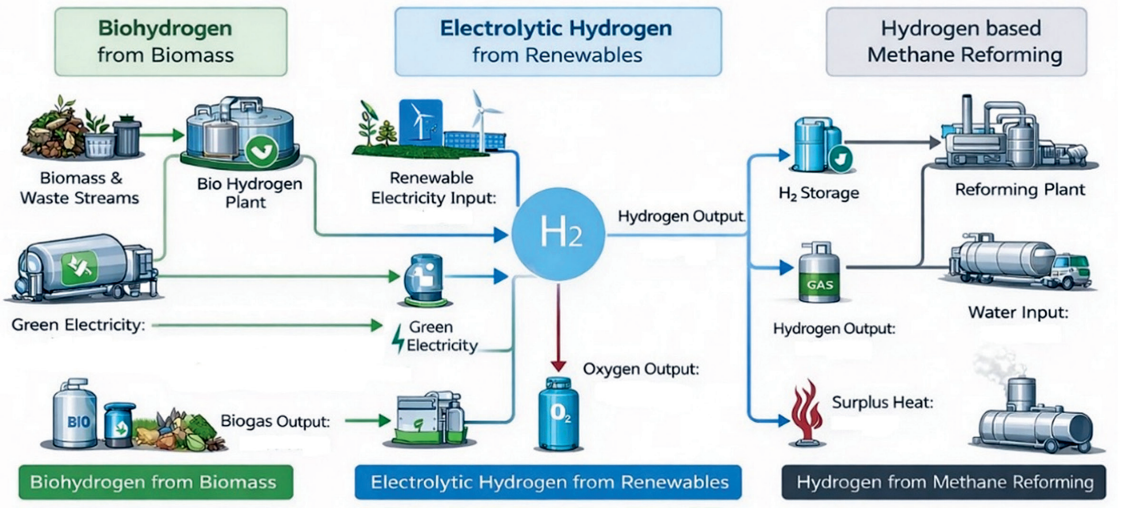
Abstract – This research investigates hydrogen production and supply chains integrated within seaport environments using a well-to-port perspective to support the decarbonization of maritime and port-related activities. Three hydrogen production pathways are analysed: biohydrogen derived from biomass and waste streams, electrolytic hydrogen produced using renewable electricity, and methane-based hydrogen generated through reforming processes. Hydrogen transportation from production sites to the port area is included within the well-to-port system boundary and assessed through pipeline transport, road-based delivery, and on-site production options. The results are based on scenario modelling performed with the energyPRO software, which was used to quantify key input and output parameters for each production pathway. Model outputs include hydrogen production volumes, energy and feedstock inputs, electricity demand, process efficiencies, and associated by-products, providing a detailed comparison of system performance across scenarios. Environmental impacts are calculated using methods consistent with the Product Environmental Footprint (PEF) framework and emission factors aligned with Intergovernmental Panel on Climate Change (IPCC) guidelines. In accordance with EU PEF Category Rules principles, the functional unit is defined as 1 MJ of hydrogen energy (lower heating value) delivered to the seaport gate at the specified purity and pressure. The results highlight differences in resource use, energy intensity, and environmental performance among the assessed hydrogen production pathways.

Keywords – Hydrogen production; product environmental footprint; seaport decarbonisation; well-to-port



OpenAI, "Hydrogen production pathways diagram", AI-generated image, ChatGPT (DALL·E), 2026