26th International Congress on Modelling and Simulation, Adelaide, SA, Australia, 30 Nov–4 Dec 2025
mssanz.org.au/modsim2025

Facilitating techno-economic evaluation of green hydrogen production pathways through accessible optimisation

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Abstract: The development of cost-effective hydrogen production pathways is essential to global decarbonisation strategies aimed at meeting climate targets. Hydrogen can serve as a zero-emissions feedstock for synthetic fuels used across transport, power generation, and industrial applications, including the replacement of natural gas and coal in high-temperature processes such as steelmaking. Assessing the techno-economics of hydrogen systems requires a rigorous evaluation of the interdependencies between energy supply, hydrogen production, and storage technologies, under a wide range of technical, economic, and climate scenarios. Modelling and optimisation tools play a critical role in this context—supporting project developers in risk assessment, and providing quantitative insight into the cost-effectiveness and feasibility of emerging hydrogen technologies. This work presents a flexible techno-economic assessment tool for hydrogen projects, developed using the PLEXOS® modelling and optimisation platform. The tool leverages an underlying mathematical optimisation framework to identify the least-cost system configuration for hydrogen production. A flexible simulation engine caters for diverse technology options and operational constraints across energy generation, hydrogen production, and storage domains. The ability to develop models with a range of generation, storage and electrolyser behaviours means that competing trade-offs between operational flexibility, efficiency, capacity, and cost can be thoroughly explored and optimum configurations identified for a given project. The integration of energy supply modelling with a flexible library for downstream electrolysers and industrial end-use processes allows analysts to co-optimise the economics of interacting energy-industrial systems, and identify optimum configurations to couple industrial processes to green energy supply options. The tool presented here is focussed on optimising green hydrogen production systems and provides a convenient wrapper around the end-to-end optimisation framework. The framework is based on a configurable template model, which allows commercial analysts to leverage the optimisation capability without need to fully develop models from scratch. The tool features a streamlined user interface that enables analysts to quickly specify candidate system components, key decisions, and constraints, execute the analysis, to rapidly explore alternative green hydrogen production pathways. The tool is designed to support feasibility analysis, sensitivity studies, and investment decision-making in hydrogen infrastructure development. This approach can be easily extended to examine more complex industrial processes, such as green steel, cement, or ammonia value-chains.

Keywords: *hydrogen, decarbonisation, heavy-industry, optimisation, PLEXOS*

