Model simplifies hydrogen production analysis

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Demand for hydrogen in the United States is projected to increase severalfold by 2050 as its production becomes more cost competitive. Although hydrogen is one of the most abundant elements on Earth, molecular hydrogen is not naturally found in nature and needs to be produced from a feedstock such as water, biomass, or fossil fuels, and all these processes require energy input.

The ability to analyze economic performance of the various hydrogen production pathways is critical as industries seek to transition to renewable energy. This ability—techno-economic analysis—estimates capital costs, operating costs, and revenue based on technical and financial variables. Results help identify barriers to the success of the technologies, primary cost drivers, and remaining research and development challenges.

The new Hydrogen Analysis Lite Production (H2A-Lite) model provides a high-level techno-economic view of select hydrogen production technologies. Created by the National Renewable Energy Laboratory (NREL), the model is part of a suite of hydrogen analysis tools that are actively being developed.

"The H2A model is rigorous, with process information about each of the production technologies that helps you actually calculate nuanced production scenarios," said Michael (Misho) Penev, senior analyst for infrastructure and energy storage analysis at NREL, currently on detail to the U.S. Department of Energy (DOE). "In the Lite model, we are focusing on making that framework more accessible to a wider set of audiences."

Current hydrogen production pathways include thermochemical, electrolytic, direct solar water splitting, and biological processes. These technologies are in various stages of maturity, and research efforts are underway to reduce costs and minimize environmental impacts from many of these production pathways.

Simplifying hydrogen production analysis

H2A-Lite was developed as an extension of the Hydrogen Analysis (H2A) production models and case studies. The H2A production model is the official DOE tool for performing in-depth techno-economic analysis of hydrogen production pathways and is used for publishing official DOE case studies in which NREL is a key collaborator.

Unlike H2A, however, H2A-Lite offers a high-level techno-economic analysis with only a minimal number of inputs. This might look like entering only a hydrogen production technology of choice and adapting technology default values to specific scales or regional energy prices. H2A-Lite takes these minimal inputs to produce estimates about scale, capital, and operations, as well as greenhouse gas and criteria pollutant emissions characteristics. Price projections for energy and feedstock are based on current data published in the latest Annual Energy Outlook from the Energy Information Administration.

H2A-Lite's built-in assumptions about comprehensive aspects of hydrogen production technologies can be fully customized. The first section of the model enables selection of production and supply chain technologies and manipulation of key cost and performance parameters to examine projected costs and emissions impact. Another section allows users to provide annual data points for hydrogen feedstock cost, use, and equipment utilization. The last section provides a summary of the annual projected income statements, cash flow statements, and balance sheets of the selected hydrogen production technology.

Both H2A-Lite and H2FAST are based on prior NREL models that have been used by thousands of stakeholders around the world. Taken together, NREL's tools can support a broad range of techno-economic analysis capabilities related to hydrogen production systems and the integration of renewable energy sources. From evaluating the environmental impacts of land and water usage for hydrogen production to the impacts of building a hydrogen plant, NREL's tools can provide high-level material performance guidance and identify research gaps that will help solve some of the key challenges of the transition to renewable energy.

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