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Journal

ECS Meeting Abstracts, MA2024-02(28)

ISSN

2151-2043

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Publication Date

2024-11-22

DOI

10.1149/ma2024-02282211mtgabs

Modeling framework for the assessment of a sustainable hydrogen production and supply chain network in California

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Abstract
The cost effective and sustainable deployment of hydrogen supply and demand networks, especially in large economic regions like California, can be challenging considering the spatial-temporal availability and variability of the different actors across the network such as production processes, distribution modes, and end-users. In this presentation, we will provide an overview and demonstration of a modeling framework used to assess the environmental, economic, and human health impacts of plausible hydrogen production and supply chain networks in California. Scenarios focus on green hydrogen production pathways using water electrolysis and biomass gasification. End use applications included in the model are transit and medium and heavy duty trucking, port authorities, and power and aviation companies that currently consume natural gas, diesel, and aviation fuel for their day-to-day operation. Representative locations for hydrogen production and end use are based on recent projections of the hydrogen economy in California.

All mass and energy flows, as well as estimated emissions, are based on H2A process model designs and projections of technology performance, literature review, and LBNL process, economic and life cycle modeling, and not on company data for the sake of this presentation. Human health impacts are included following methodologies developed for the University of California Irvine HyDeal project. Life cycle phases associated with hydrogen production include feedstock preparation (water and biomass), energy production and consumption (renewable, grid, and combination of renewable and grid electricity), maintenance (chemical utilization in electrolysis and natural gas combustion in gasification), carbon sequestration, hydrogen storage (compression and liquefaction), and distribution (truck and pipeline). We apply the framework utilizing California specific emission factors, financial data, and human health damages and explore the impact of network characteristics on results. Example variations include: the inclusion of policy incentives or not, different representations of the electricity grid and source, electrolysis versus gasification versus combinations of both for production, liquefaction versus compression based on producer capacity cutoffs, transportation truck versus pipeline based on existing infrastructure, and ultimate end use. Comparison of these different scenarios can help inform future projects by demonstrating the trade-offs among environmental, economic, and human health impacts. This model, automated in R, is a starting platform upon which new analysis, modeling capabilities, locations, and emission factors can be rapidly tested and integrated.