Well-to-wheels Analysis of Energy Use and Greenhouse Gas Emissions of Hydrogen Produced with Nuclear Energy

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Abstract

A fuel-cycle model—called the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model—has been developed to evaluate well-to-wheels (WTW) energy and emission impacts of motor vehicle technologies fueled with various transportation fuels. The GREET model contains various hydrogen (H_2) production pathways for fuel-cell vehicles (FCVs) applications. In this study, the GREET model was expanded to include four nuclear H_2 production pathways: (1) H_2 production at refueling stations via electrolysis using light water reactor (LWR)-generated electricity; (2) H_2 production in central plants via thermo-chemical water cracking using heat from high temperature gas-cooled reactor (HTGR); (3) H_2 production in central plants via high-temperature electrolysis using HTGR-generated electricity and steam; and (4) H_2 production at refueling stations via electrolysis using HTGR-generated electricity. The WTW analysis of these four options include these stages: uranium ore mining and milling; uranium yellowcake transportation; uranium conversion; uranium enrichment; uranium fuel fabrication; uranium fuel transportation; electricity or H_2 production in nuclear power plants; H_2 transportation; H_2 compression; and H_2 FCVs operation. Our well-to-pump (WTP) results show that significant reductions in fossil energy use and greenhouse gas (GHG) emissions are achieved by nuclear-based H_2 compared to natural gas-based H_2 production via steam methane reforming for a unit of H_2 delivered at refueling stations. When H_2 is applied to FCVs, the WTW results also show large benefit in reducing fossil energy use and GHG emissions.

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