

## **Fuel-Cycle Energy and Emissions Impacts of Fuels for Fuel-Cell Vehicles**

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Intensive R&D efforts are being made on fuel-cell vehicles to help increase vehicle fuel economy and reduce vehicular emissions of greenhouse gases and criteria pollutants. Among various fuels being investigated for fuel-cell vehicle applications, hydrogen (both gaseous and liquid), methanol, and gasoline have been researched extensively. Other potential fuel-cell fuels include crude naphtha, Fischer-Tropsch naphtha, liquefied petroleum gas (LPG), compressed natural gas (CNG), and ethanol (EtOH). Use of hydrocarbon fuels usually requires on-board fuel processors to produce hydrogen from these fuels. These fuels are produced from various feedstocks and are associated with different production processes, and consequently have different energy and emission impacts from wells to vehicle tanks. Energy and emission impacts of using these fuels in fuel-cell vehicles must be evaluated on the well-to-wheel basis. This is especially important since fuel-cell vehicles have near zero or zero emissions, making well-to-tank emissions a large emission source.

Argonne National Laboratory has developed a spreadsheet-based fuel-cycle model to provide a transparent computer tool that would allow researchers to evaluate fuel-cycle energy and emission impacts of various transportation fuels and vehicle technologies. The first version of the model, named the **Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET)** fuel-cycle model, was completed and released in 1996. Since then, the model has been significantly expanded and improved. The GREET model and its results have been used by over 130 organizations including government agencies, private industries, and research institutions.

The GREET model includes various potential transportation fuels for different vehicle propulsion systems including fuel cells. Argonne has applied the GREET model to evaluate energy and emission impacts of using hydrogen, methanol, naphtha, ethanol, natural gas, liquefied petroleum gas, among some other fuels in fuel-cell vehicles. In the past three years, Argonne has completed three studies on this area. This presentation will present results of Argonne's completed studies.

Key issues determining fuel-cycle energy and emission impacts of fuel-cell fuels include efficiencies of fuel production, fuel production and distribution pathway specifications, potential sequestration of carbon emissions in fuel production plants, and fuel-cell vehicle fuel economy. This presentation will explore these key issues in relation to energy and emission impacts of fuel-cell fuels.