Success Story

GREET Model Facilitates Fuel-Cycle Analysis

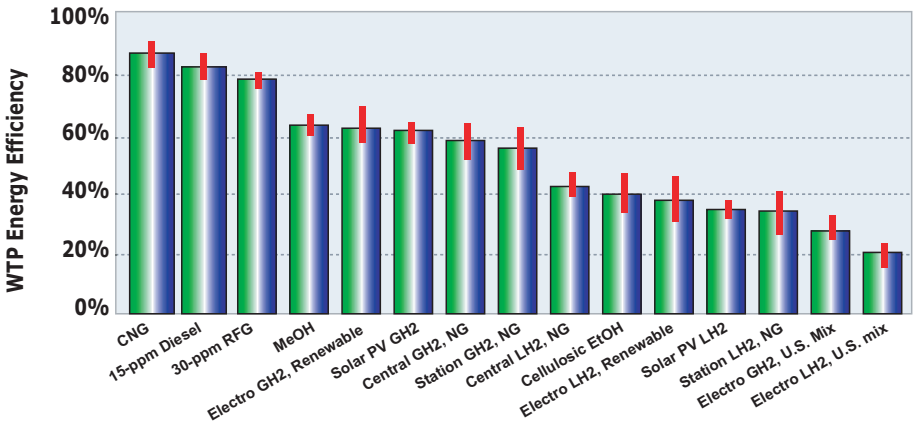
Background

In the quest to improve fuel economy and reduce emissions, policy-makers and researchers often look toward changing vehicle technologies and/or fuels. That's often a good strategy. But sometimes, it's not, because hidden environmental costs or unforeseen consequences of fuel and technology changes can be costly if they aren't anticipated. The only way to obtain a true picture of the energy and emission impacts of vehicle technology changes is to consider the fuel cycle from well to wheels.

Since most people don't have the tools on hand to perform such complex analyses, researchers at Argonne National Laboratory have developed a tool called GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation). GREET is a computer program that allows analysis of various engine and fuel combinations on a consistent fuel-cycle basis.

Technology

Based on Microsoft® Excel and Visual Basic, GREET can evaluate more than 35 fuel production pathways and more than 50 fuel technologies/fuel systems, including hydrogen fuel pathways and fuel cell vehicles. For a given engine and fuel system, GREET separately calculates:



In this example, GREET has calculated the energy efficiencies required to make various fuels available at the fuel pump. The results show compressed natural gas (CNG, far left) to be the most efficient; electrolysis liquid hydrogen (Electro LH2, far right) with average U.S. electricity, the least efficient.

- Consumption of total energy (energy in non-renewable and renewable sources), fossil fuels (petroleum, natural gas, and coal), and petroleum.
- Emissions of carbon dioxide–equivalent greenhouse gases — primarily carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O)
- Emissions of five criteria pollutants: volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxide (NOx), particulate matter with size smaller than 10 microns (PM10), and sulfur oxides (SOx).

GREET includes more than 30 fuel-cycle pathways, and it includes the following vehicle technologies:

- Conventional spark-ignition engines
- Direct-injection, spark-ignition engines
- Direct-injection, compression-ignition engines
- Grid-connected hybrid electric vehicles
- Grid-independent hybrid electric vehicles
- Battery-powered electric vehicles
- Fuel cell vehicles

Argonne has used GREET to evaluate a variety of engine and fuel systems for the U.S. Department of Energy, other government agencies, and industry. Examples include:

- A detailed analysis of energy and emission impacts of ethanol for the Illinois Department of Commerce and Community Affairs. The results of this study are cited by the fuels industry and government agencies.
- A milestone government study on ethanol — GREET's analysis of ethanol's greenhouse gas emissions completely changed the debate on ethanol's energy and greenhouse gas emissions benefits.
- A well-to-wheels energy use and greenhouse gas emissions analysis of advanced fuel/vehicle systems for General Motors' Fuel Cell Activities.

Commercialization

More than 1,100 registered users employ GREET, including government agencies, the auto industry, the energy industry, research institutions, universities, and public interest groups throughout North America, Europe, and Asia.

The public domain model is available free of charge at http://greet.anl.gov/download.html

GREET will continue to be updated and expanded so that public and private sectors can make use of it. In particular, earlier unpublished and undocumented fuel-cycle simulations of heavy-duty vehicles will be extensively updated and documented. Enhancements will include the "vehicle cycle" — the effects of construction and disposal of the vehicle. Additional user-interface features will be incorporated into the well-documented, light-duty version of GREET to streamline input data and output results.

Benefits

- Brings world-class scientific expertise to the desktop.
- Facilitates comprehensive evaluations of total energy consumption, greenhouse gas emissions, and criteria pollutant emissions for more than 35 fuel production pathways and 50 vehicle technologies/fuel systems.
- Provides a consistent basis for comparison across variables.
- Represents the industry "gold standard" for fuel-cycle analysis.
- Incorporates regular updates to ensure currency and accuracy.

Contacts

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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