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Contribution of Feedstock and Fuel Transportation to Total Fuel-Cycle Energy Use and Emissions

Dongquan He and Michael Wang
Center for Transportation Research, Argonne National Laboratory

ABSTRACT

In recent years, various alternative fuels have been proposed and studied for application in motor vehicles. Consequently, fuel-cycle analyses have been conducted to evaluate their energy and emissions effects. In a typical fuel-cycle analysis, feedstock recovery; feedstock transportation and storage; fuel production; and fuel transportation, distribution, and storage are examined. The general belief is that transportation and storage of feedstocks and fuels have small impacts on fuel-cycle results. However, no thorough studies have been conducted to confirm or disprove this belief.

Transportation of feedstocks and fuels via different transportation modes requires use of various fuels and generates air pollutant emissions. Storage of liquid and gaseous fuels is subject to fuel losses, which also lead to air pollutant emissions. In fuel-cycle analyses, while feedstock recovery and fuel production have been studied carefully, transportation and storage of feedstocks and fuels are often not studied in detail. As part of a comprehensive fuel-cycle analysis at Argonne National Laboratory, we recently began to characterize transportation modes for different feedstock types, fuel types, production locations, and consumption locations. We collected data on the energy intensities of various transportation modes and the distances traveled for given feedstocks and fuels. We included five transportation modes — ocean tanker, barge, truck, rail, and pipeline — for various feedstocks and fuels. On the basis of the collected data, we estimated energy use and emissions associated with transportation and storage of gasoline, diesel, compressed natural gas, liquefied natural gas, liquefied petroleum gas, methanol, ethanol, gaseous and liquid hydrogen, and Fischer-Tropsch diesel. Our assessment indicates that, in some cases, transportation, storage, and distribution (T&S&D) can make a significant contribution to total fuel-cycle energy use and emissions for transportation fuels. For example, nitrogen oxide (NO_x) emissions from T&S&D of gasoline, diesel, liquefied petroleum gas, dimethyl ether, Fischer-Tropsch diesel, and ethanol can comprise over 50% of total upstream emissions. Moreover, when fuel losses are taken into account, T&S&D can contribute over 60% of upstream VOC emissions for gasoline, diesel, liquefied petroleum gas, dimethyl ether, Fischer-Tropsch diesel, and methanol.