LIFECYCLE-ANALYSIS FOR HEAVY VEHICLES

By

Linda Gaines, Frank Stodolsky and Roy Cuenca

Center for Transportation Research
Energy Systems Division
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, IL 60439

and

James Eberhardt
Office of Heavy Vehicle Technologies
U.S. Department of Energy
Washington, D.C. 20585

Air & Waste Management Association
Annual Meeting
June 1998
San Diego, CA

Work sponsored by the U.S. Department of Energy, Office of Heavy Vehicle Technologies, Assistant Secretary for Energy Efficiency and Renewable Energy under contract W-31-109-ENG-38.

Lifecycle Analysis for Heavy Vehicles

Paper # 98-WP61B.03

Linda Gaines, Frank Stodolsky, and Roy Cuenca

Center for Transportation Research, Argonne National Laboratory, Argonne, Illinois 60439

James Eberhardt

Office of Heavy Vehicle Technologies, U.S. Department of Energy, Washington, D.C. 20585

ABSTRACT

Various alternative fuels and improved engine and vehicle systems have been proposed in order to reduce emissions and energy use associated with heavy vehicles (predominantly trucks). For example, oil companies have proposed improved methods for converting natural gas to zero-aromatics, zero-sulfur diesel fuel via the Fischer-Tropsch process. Major heavy-duty diesel engine companies are working on ways to simultaneously reduce particulate-matter and NO_x emissions. The trend in heavy vehicles is toward use of lightweight materials, tires with lower rolling resistance, and treatments to reduce aerodynamic drag. In this paper, we compare the lifecycle energy use and emissions from trucks using selected alternatives, such as Fisher-Tropsch diesel fuel and advanced fuel-efficient engines. We consider heavy-duty, Class 8 tractor-semitrailer combinations for this analysis. The total lifecycle includes production and recycling of the vehicle itself; extraction, processing, and transportation of the fuel itself; and vehicle operation and maintenance. Energy use is considered *in toto*, as well as those portions that are imported, domestic, and renewable. Emissions of interest include greenhouse gases and criteria pollutants. Argonne's *G*reenhouse Gases, *R*egulated *E*missions, and *E*nergy Use in *T*ransportation (GREET) model is used to generate per-vehicle fuel cycle impacts. Energy use and emissions for materials manufacturing and vehicle disposal are estimated by means of materials information from Argonne studies. We conclude that there are trade-offs among impacts. For example, the lowest fossil energy use does not necessarily result in lowest total energy use, and lower tailpipe emissions may not necessarily result in lower lifecycle emissions of all criteria pollutants.

INTRODUCTION

The overall objective of lifecycle analysis is to evaluate the energy and environmental implications of different technological and strategic alternatives so that society (or some subset of it, such as the United States) can satisfy its demands for various services with minimal impacts. In earlier work, we have discussed what these impacts are and how tradeoffs among impacts should be weighed (1). We have studied consumer goods packaging (2) and several options for reduced-impact automobiles, including lightweight vehicles, electric vehicles, and hybrids (3-5). These studies included all stages of products' lifecycles, from material extraction, through the production and use phases, to final disposition of the product by recycling or disposal.

In this paper, we examine the lifecycle energy use and emissions for heavy-duty trucks. This work is sponsored by the U.S. Department of Energy (DOE), Office of Transportation Technologies, Office of Heavy Vehicle Technologies, and is performed by Argonne National Laboratory's (ANL's) Center for Transportation Research. Trucks are of interest for several reasons. They are highly visible on our highways and in our cities and make significant contributions to petroleum usage and deterioration of air quality in urban areas. Indeed, since the