EFFICIENT USE AND CONSERVATION OF ENERGY IN THE TRANSPORTATION SECTOR

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Keywords: Transportation, energy efficiency, alternative fuels, electric drive vehicles, passenger cars, trucks, rail, aircraft, buses, waterway, pipeline, mass transit vehicles, freight transportation

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Summary

Transportation represents about one-quarter of worldwide energy consumption. The predominant energy-consuming transport mode consists of passenger vehicles; in the United States, passenger cars and trucks account for over half of the total transport energy use. Moreover, the transport sector is fueled almost entirely by petroleum products. This huge demand for, and use of, petroleum puts a large strain on reserves, aggravates foreign tensions, and results in environmental degradation. This topic presents current and historical energy usage patterns in transport for selected countries. It further describes several alternative transportation fuels, and highlights energy efficiency opportunities for passenger cars and trucks, mass transit systems, and freight transportation.

1. Introduction

Transportation is responsible for a large share of energy use. In fact, worldwide, the transportation sector accounts for one-fourth of total consumption. In many individual countries, transportation's share is even larger, equaling one-third or more of total energy consumption. Almost all of transportation energy use is in the form of petroleum. This results in a large drain of resources, and in political and economic tensions with oil-supplying countries. The environmental costs of burning petroleum products are enormous. Ultimately, the cost of utilizing petroleum products for transportation will be prohibitively high, as the supplies diminish to the point at which they are more expensive to employ than alternative forms, and as the environment continues to suffer. Implementing energy efficiency measures and shifting to alternative fuels and electric drive vehicles will alleviate some of these pressures.

Section 2 of this topic highlights current transportation energy usage patterns for selected countries. The various modes of transportation investigated include passenger transport, aircraft, urban mass transit, rail, bus, and freight transport. Section 3 discusses historical trends in fuel efficiency and energy intensity, with a particular focus on the United States and the United Kingdom. Section 4 presents the attributes of the main alternative fuels applicable to transportation. Section 5 describes three types of electric drive vehicles. Increased use of alternative fuels and electric drive vehicles will shift the burden from petroleum products to other resources, as well as reduce emissions, and decrease dependence on foreign oil supplies. Section 6 summarizes the primary energy efficiency opportunities associated with freight transport, mass transit systems, and passenger cars and light trucks. In general, efficiency can be increased by:

- improving engine and vehicle designs;
- increasing the load factor for a given transport mode;
- ensuring traffic and usage patterns are optimal (for example, efficient routing, and no empty back hauls);
- shifting from less to more efficient transportation modes;
- reducing the need for transport; and
- implementing electric drive systems, as well as using alternative fuels.

Details for the three primary categories of transportation are presented in more detail in the following three EOLSS articles: *Energy Efficiency in Freight Transportation, Energy Efficiency in Mass Transit Systems,* and *Energy Efficiency in Passenger Cars and Light Trucks.*

Intrinsically related to transportation energy use is the air pollution that transport vehicles generate. Indeed, transportation is responsible for a large share of worldwide emission. For example, carbon dioxide, carbon monoxide, nitrogen oxide, volatile organic compound, and particulate matter (PM-10 and PM-2.5) emissions from US transportation accounted for the following percentages of total US emissions in 1998:

- Carbon dioxide: 32%
- Carbon monoxide: 60%
- Nitrogen oxides: 41%
- Volatile organic compounds: 36%
- Particulate matter (PM-10): 45%
- Particulate matter (PM-2.5): 35%

As a result of increasingly stringent environmental regulation significant advancements have been made in recent years to reduce pollution from gasoline and diesel engines. In general, current vehicles are much cleaner than their predecessors. (Air pollution from transportation is treated separately in other areas of EOLSS On-Line, 2002.) Nevertheless, the number of vehicles in operation is on the rise, as is the quantity of fuel consumed by the transportation sector. Reductions in transportation energy use, as well as conversion to less polluting alternative energy sources, will therefore not only increase the sustainability of energy resources, but also improve air quality.

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Biographical Sketches

Clark Gellings' 30-year career in energy spans from hands-on wiring in factories and homes to the design of lighting and energy systems to his invention of "demand-side management" (DSM). Mr. Gellings coined the term DSM and developed the accompanying DSM framework, guidebooks, and models now in use throughout the world. He provides leadership in EPRI, an organization that is second in the world only to the US Department of Energy (in dollars) in the development of energy efficiency technologies. Mr. Gellings has demonstrated a unique ability to understand what energy customers want and need and then implement systems to develop and deliver a set of R&D programs to meet the challenge. Among Mr. Gellings' most significant accomplishments is his success in leading a team with an outstanding track record in forging tailored collaborations—alliances among utilities, industry associations, government agencies, and academia—to leverage R&D dollars for the maximum benefit. Mr. Gellings has published 10 books, more than 400 articles, and has presented papers at numerous conferences. Some of his many honors include seven awards in lighting design and the Bernard Price Memorial Lecture Award of the South African Institute of Electrical Engineers. He has been elected a fellow in the Institute of Electrical and Electronics Engineers and the Illuminating Engineering Society of North America. He won the 1992 DSM Achiever of the Year Award of the Association of Energy Engineers for having invented DSM. He has served as an advisor to the US Congress Office of Technical Assessment panel on energy efficiency, and currently serves as a member of the Board of Directors for the California Institute for Energy Efficiency.

Kelly E. Parmenter, Ph.D. is a mechanical engineer with expertise in thermodynamics, heat transfer, fluid mechanics, and advanced materials. She has 14 years of experience in the energy sector as an engineering consultant. During that time she has conducted energy audits and developed energy management programs for industrial, commercial, and educational facilities in the United States and in England. Recently, Dr. Parmenter has evaluated several new technologies for industrial applications, including methods to control microbial contamination in metalworking fluids, and air pollution control technologies. She also has 12 years of experience in the academic sector conducting experimental research projects in a variety of areas, such as mechanical and thermal properties of novel insulation and ablative materials, thermal contact resistance of pressed metal contacts, and drag reducing effects of dilute polymer solutions in pipe flow. Dr. Parmenter's areas of expertise include: energy efficiency, project management, research and analysis, heat transfer, and mechanical and thermal properties of materials.