ENERGY EFFICIENCY IN PASSENGER CARS AND LIGHT TRUCKS

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Contents

Summary

Personal passenger vehicles are the largest consumer of energy in the transportation sector. Indeed, they account for over half of all the oil used by transportation modes worldwide. Moreover, half of the oil consumption by personal passenger vehicles is attributable to the United States. The efficiency of personal passenger vehicles has improved substantially over the last few decades. Much of the progress was in response to increasing costs and decreased availability of oil. When oil prices fell in the 1980s, market forces reduced the demand for higher efficiency vehicles. The result was a leveling off of fuel efficiency in the mid-1990s in the United States. Today, the average fuel efficiency of vehicles on the road is far less than is technically, and cost-effectively, feasible. Implementation of even modest technologically mature improvements could increase fuel efficiency by up to 50% in the near term. In addition, further development and implementation of alternative vehicles, such as hybrid electric, battery electric, and fuel cell vehicles, could potentially improve efficiency by up to 300%. This article describes trends in travel and energy use by personal passenger vehicles. It then discusses potential energy efficiency opportunities as they relate to reducing travel demand, shifting to more efficient modes, improving vehicle efficiency and operation, and invoking change through intervention and technological advances.

1. Introduction

Passenger cars and light trucks fall under the general category of personal passenger vehicles. Passenger cars are small automobiles, including compact cars, mid-size sedans, station wagons, and so on. Light trucks include two-axle four-wheel trucks, vans, and sport utility vehicles (SUVs). Motorcycles are also personal passenger vehicles, but account for a negligible proportion of travel and energy. For example, in the United States passenger cars accounted for 59% of the energy consumed by personal passenger vehicles, while light trucks accounted for 41%, and motorcycles represented less than 1%.

Worldwide, personal passenger vehicles represent roughly half of the transportation sector's total demand for oil. They are the largest end users of energy in the transportation sector. Though the efficiency of vehicles has improved greatly over the last several decades, there is still a potential for enormous gains in fuel efficiency. Even wider implementation of technically mature advances could yield energy savings of 25 to 50% in the near term, with low incremental costs. Historically, efficiency gains have been strongly driven by oil prices. When prices are high, there is increased incentive to develop advanced automotive technologies; when prices are low, progress slows. Now that the period of inexpensive oil is coming to a close, it is likely that the efficiency of vehicles will increase: indeed, this is absolutely necessary. Technologies currently exist that can improve fuel efficiency by the order of 100 to 300%. However, their costs are still prohibitive for widespread implementation. Nevertheless immediate energy savings are possible through measures that encourage energy-efficient operation and maintenance of vehicles, and through measures that reduce travel demand or shift the demand to more efficient transportation modes.

To put the demand for personal passenger vehicles into perspective, Section 2 describes trends and current levels of travel by personal passenger vehicles in selected countries. Next, to illustrate the large-scale nature of energy consumption by personal passenger vehicles, Section 3 details energy consumption, fuel efficiency, and energy intensity trends for the largest end-user of transport energy, the United States. Lastly, Section 4 discusses a number of potential measures for improving the energy efficiency of travel by personal passenger vehicles.

2. Personal Passenger Vehicle Travel

Figure 1 compares passenger travel, as measured in passenger-kilometers, for the United States, Canada, European Union Countries (the EU 15: Austria, Belgium, Germany, Denmark, Spain, Greece, France, Finland, Italy, Ireland, Luxembourg, the Netherlands, Portugal, Sweden, and the United Kingdom), and Japan during the mid-to-late 1990s. The United States leads the areas in passenger travel, with about 6216×10^9 passenger-kilometers (3860×10^9 passenger-miles) during 1998. EU 15, Japan, and Canada follow with 3676, 723, and 384×10^9 passenger-kilometers (2283, 449, 238×10^9 passenger-miles), respectively.

Personal passenger vehicles account for significant portions of total passenger travel (i.e., by the modes of personal passenger vehicle, bus, railway, transit rail, and air) for each of the geographical areas examined in Figure 1. Specifically, personal passenger vehicles represented 86% of passenger travel for the United States in 1998. The shares of passenger travel represented by personal passenger vehicles for Canada (81%), the EU 15 (79%), and Japan (55%) were also large in the mid-to-late 1990s.

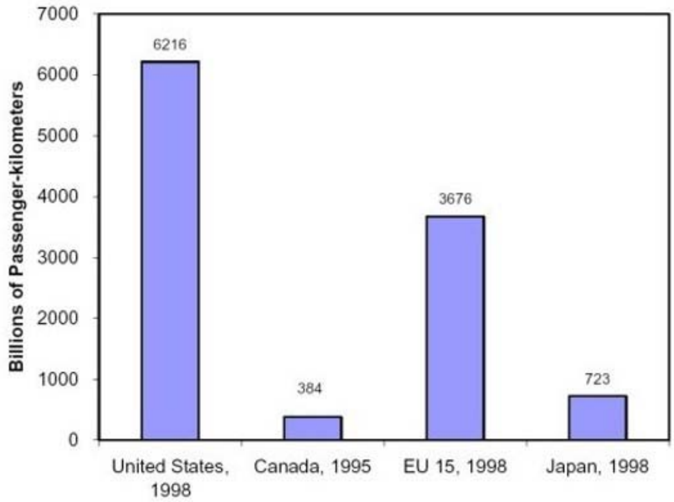

Figure 1. Passenger travel by personal passenger vehicles (selected countries) (passenger-kilometers $\times 10^9$). Source: data compiled from Europa, European Union. (2001). *Energy and Transport in Figures*, 3.1.13 - Comparison EU 15–World: Passenger and Freight Transport, <www.europa.eu.int/comm/energy_transport/etif/transport_general/world_passenger_freight.html>, and Consumer Policy Institute, *Passenger Travel by Motorized Modes*, Canada, 1970–1995, <www.nextcity.com/cpi/trans/transpo.html>.

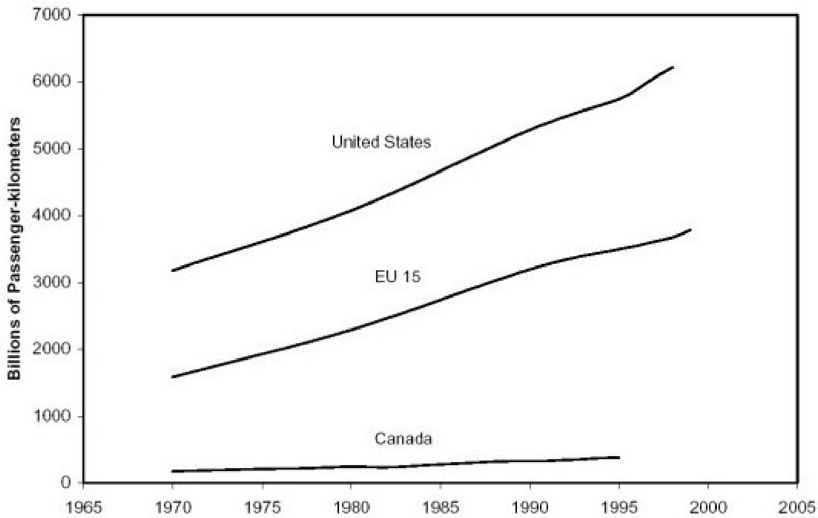

Figure 2. Passenger travel by personal passenger vehicles 1970–1999 (selected countries) (passenger-kilometers $\times 10^9$). Source: data compiled from Europa, European Union. (2001). *Energy and Transport in Figures*, 3.5.2 – Performance by Mode of Transport EU-15, and 3.5.21 – Performance by Mode of Transport USA, <www.europa.eu.int/comm/energy_transport/etif/>, and Consumer Policy Institute, *Passenger Travel by Motorized Modes*, Canada, 1970–1995, <www.nextcity.com/cpi/trans/transpo.html>.

Figure 2 shows trends in passenger travel for the United States, the EU 15, and Canada between 1970 and 1999. Passenger travel increased steadily in each of the three geographical areas. In the United States, passenger travel rose from 3181 to 6216 × 10^9 passenger-kilometers (1975 to 3860 × 10^9 passenger-miles) between 1970 and 1998. In EU 15, it increased from 1588 to 3784 × 10^9 passenger-kilometers (986 to 2350 × 10^9 passenger-miles) during the slightly longer period of 1970 to 1999. In Canada, passenger travel climbed from 177 to 384 × 10^9 passenger-kilometers (110 to 238 × 10^9 passenger-miles) between 1970 and 1995.

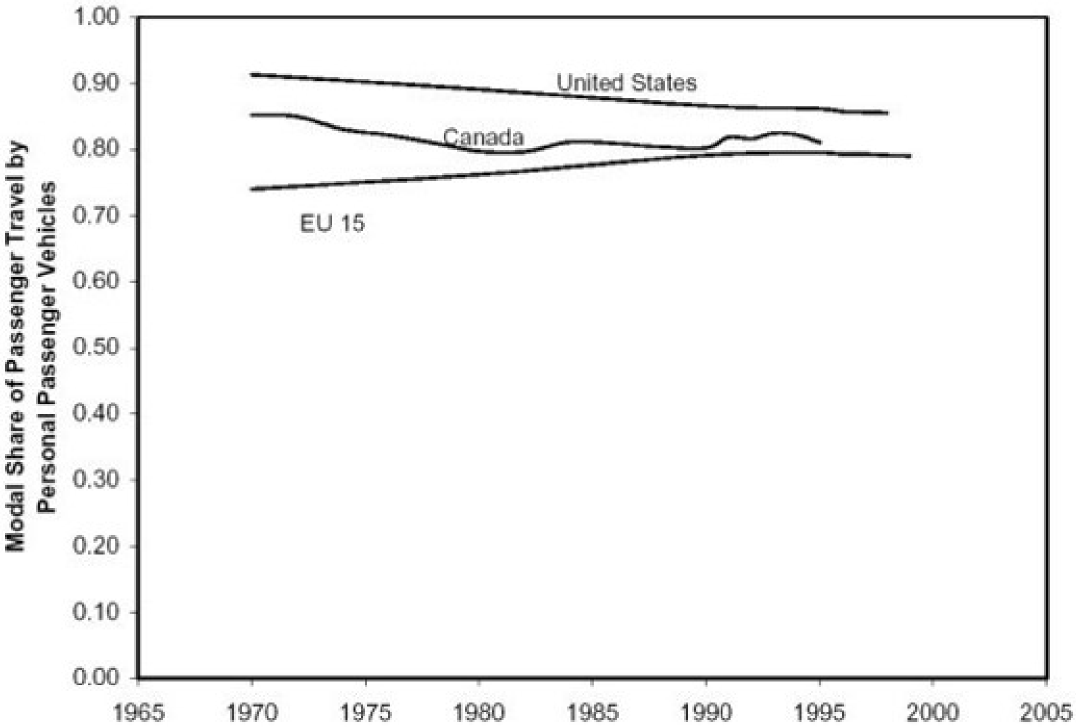

Figure 3. Modal share of passenger travel by personal passenger vehicles 1970–1999 (selected countries). Source: Data compiled from Europa, European Union. (2001). *Energy and Transport in Figures*, 3.5.2 – Performance by Mode of Transport EU-15, and 3.5.21 – Performance by Mode of Transport USA, <www.europa.eu.int/comm/energy_transport/etif/>, and Consumer Policy Institute, *Passenger Travel by Motorized Modes*, Canada, 1970–1995, <www.nextcity.com/cpi/trans/transpo.html>.

Figure 3 plots the modal share over time of passenger travel by personal passenger vehicle for the United States, Canada, and the EU 15. The modal share for the United States gradually decreased from 91 to 86% between 1970 and 1998. This decrease was the result of an increase in the modal share represented by air transport. In contrast, the modal share of passenger travel by personal passenger vehicles in the EU 15 increased from 74 to 79% between 1970 and 1999. The increase in the EU 15 was the result of decreases in the modal shares represented by railway, transit rail, and bus travel. The modal share of passenger travel represented by personal passenger vehicles in Canada experienced an overall drop from 85 to 81%; however, the curve is characterized by two dips to 80% around 1980 and 1990.

The United States clearly dominates when it comes to passenger travel and energy consumption (see Section 3) by personal passenger vehicles. In addition, the United States accounted for about 30% of the world's personal passenger vehicles in 1998. The number of vehicles per capita for the United States is also larger than any other country, with roughly 0.78 vehicles per capita in 1998. This is significant compared with the world average of about 0.1 vehicles per capita.

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Biographical Sketches

Clark W. 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). He coined the term DSM and developed the accompanying DSM framework, guidebooks, and models now in use throughout the world. He provides leadership in The Electric Power Research Institute (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 his 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 of 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 pipeflow. Dr. Parmenter's areas of expertise include: energy efficiency, project management, research and analysis, heat transfer, and mechanical and thermal properties of materials.