ENERGY EFFICIENCY IN FREIGHT TRANSPORTATION

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Summary

Freight vehicles are used worldwide to transport goods from one location to another, either domestically or internationally. Freight transport is extremely important for the economy, and the magnitude of transport at any given time is intrinsically related to economic activity.

There are five main modes of freight transport: road, pipeline, rail, water, and air. Each mode has its merits and limitations, with some modes better suited for certain types of freight than others.

This article describes the types and quantities of goods typically transported by each mode. It further presents modal energy usage and energy intensity values. Finally, energy-efficiency opportunities as they relate to freight transport are highlighted.

1. Introduction

Freight transport involves the transport of goods from one location to another. The types of goods transported vary widely, and include fuels, water, chemicals, building materials, mail, textiles, foods, value-added consumer products, and so on. The demand for freight transport varies in different countries, and depends on their relative production and consumption of goods.

Moreover, freight transport, and its associated energy use, is intrinsically related to the economy of the individual country, as well as to that of the world.

Freight transportation accounts for a significant share of worldwide energy use. For example, the US transportation sector currently consumes about 27% of the nation's total energy consumption.

Of this amount, about a quarter is for freight transport, roughly two-thirds is for passenger transport, and the remainder is for other modes, such as off-highway transport for construction and agriculture, military transport, and recreational boats.

This equates to an overall energy consumption of around 6×10^{15} Btu (where 1 Btu equals 1.055 kJ) in US freight transport alone.

Freight can be transported by several main modes of travel, including road (mostly via heavy freight truck), pipeline, rail, water, and air. Of all freight transport modes, road vehicles generally consume the largest share of energy. Indeed, road vehicles use about three-quarters of freight transport energy in the United States.

The freight trucks' high share of energy use is in part because they transport a significant share of goods; however, their relatively high energy intensity when compared with other modes, such as pipeline, rail, and water transport, is also an important contributing factor.

Figure 1 shows the modal breakdown by weight (metric tons) of domestic freight transported in the United States. On strictly a tonnage basis, road transport accounted for 44% of freight transported in 1996, followed by pipeline (22%), rail (20%), and water (14%).

Air transport was responsible for less than 1% of the freight by weight. Therefore, although US road freight vehicles use about three-quarters of freight transport energy, they lift less than half of all freight on a tonnage basis.

This is in part because of the higher energy intensity of road transport, and in part because of the nature of goods typically transported by road. In recent years, there has been a shift toward transporting higher value goods by trucks and aircraft.

These higher value goods are often less dense, and therefore take up more space per unit weight than, for example, building materials. In contrast, pipeline, rail, and water are commonly used to transport heavier bulk items.

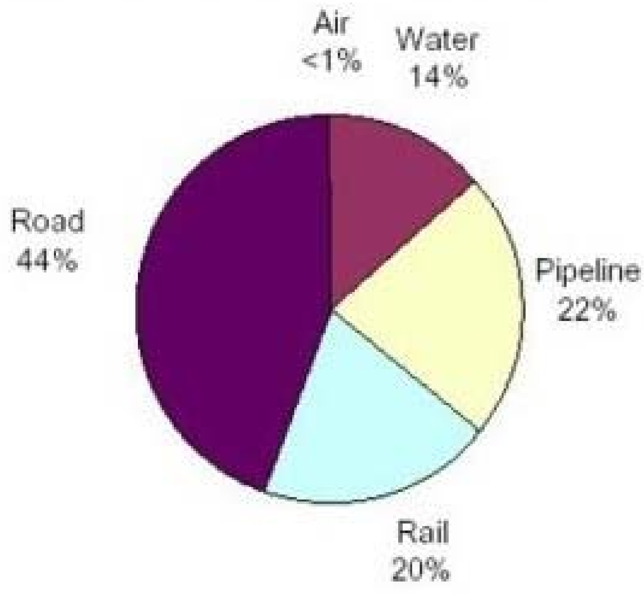

Figure 1. Modal share by weight of domestic freight transported, 1996 (United States). Total weight transported = 7321 × 10^6 metric tons. Source: data compiled from US Department of Transportation Statistics, Bureau of Transportation Statistics; US Department of Commerce, Census Bureau; Statistics Canada; Transport Canada; Instituto Mexicano del Transporte; Instituto Nacional de Estadistica, Geografia e Informatica; and Secretaria de Comunicaciones y Transportes. (2000). *North American Transportation in Figures,* BTS00-05, Table 5-1. Washington D.C.: Bureau of Transportation Statistics.

Figure 2 shows the breakdown by freight mode of weight carried multiplied by distance traveled (metric ton-kilometers). When weight by distance is considered, road transport only contributes 24%, while rail contributes 34%, and water contributes 19%. This figure indicates that rail and water vehicles generally transport freight longer distances than road vehicles.

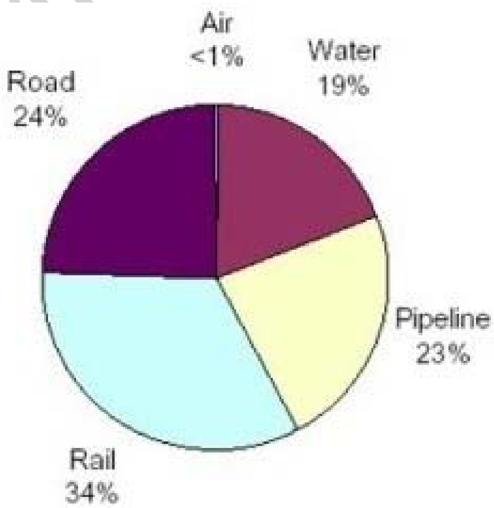

Figure 2. Modal share by weight-distance of domestic freight transported, 1996 (United

States). Total weight × distance transported = 5916×10^9 metric ton-kilometers. Source: data compiled from US Department of Transportation Statistics, Bureau of Transportation Statistics; US Department of Commerce, Census Bureau; Statistics Canada; Transport Canada; Instituto Mexicano del Transporte; Instituto Nacional de Estadistica, Geografia e Informatica; and Secretaria de Comunicaciones y Transportes. (2000). *North American Transportation in Figures*, BTS00-05, Table 5-2. Washington D.C.: Bureau of Transportation Statistics.

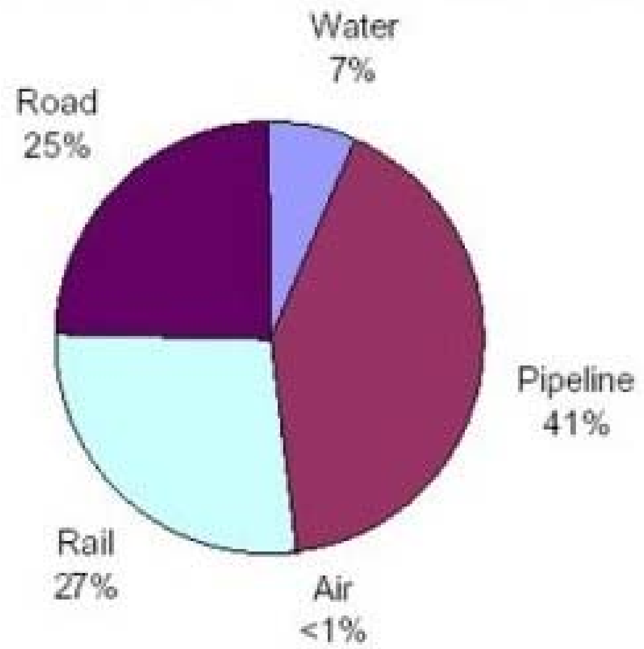

Figure 3. Modal share by weight of domestic freight transported, 1996 (Canada). Total Weight Transported = 734.6×10^6 metric tons.

Source: data compiled from US Department of Transportation Statistics, Bureau of Transportation Statistics; US Department of Commerce, Census Bureau; Statistics Canada; Transport Canada; Instituto Mexicano del Transporte; Instituto Nacional de Estadistica, Geografia e Informatica; and Secretaria de Comunicaciones y Transportes. (2000). *North American Transportation in Figures*, BTS00-05, Table 5-1. Washington D.C.: Bureau of Transportation Statistics.

Figures 3 and 4 show similar pie charts of freight activity for Canada. Figure 3 illustrates that pipeline transport is responsible for the largest share of weight transported (41%), followed by rail (27%), road (25%), water (7%), and then air (less than 1%).

As in the United States, a comparison of Figure 3 with Figure 4 shows that loads are not transported as far by road as they are by rail; hence road's share of weight-distance transport is smaller.

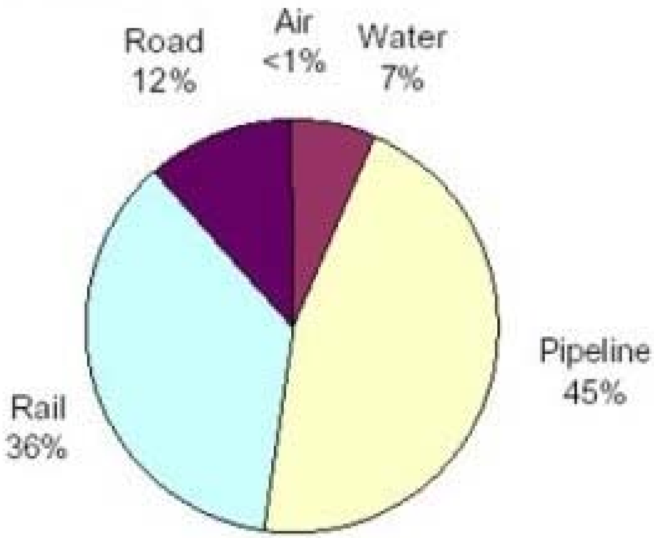

Figure 4. Modal share by weight–distance of domestic freight transported, 1996 (Canada). Total weight × distance transported = 614 × 10^9 metric ton-kilometers. Source: data compiled from US Department of Transportation Statistics, Bureau of Transportation Statistics; US Department of Commerce, Census Bureau; Statistics Canada; Transport Canada; Instituto Mexicano del Transporte; Instituto Nacional de Estadistica, Geografia e Informatica; and Secretaria de Comunicaciones y Transportes. (2000). North American Transportation in Figures, BTS00-05, Table 5-2. Washington D.C.: Bureau of Transportation Statistics.

Sections 2 through 6, respectively, describe freight transport characteristics and energy use values for each transport mode, namely freight trucks, pipelines, railways, waterborne vehicles, and aircraft. Section 7 then summarizes the main energy efficiency opportunities for freight transport.

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Victoria Transport Policy Institute. (Ongoing). Freight transport management: Increasing commercial vehicle transport efficiency. *Online TDM Encyclopedia*, 37 pp. <www.vtpi.org/tdm/tdm16.htm>. [This chapter describes measures to improve the efficiency of freight transport. It is part of an on-going encyclopedia of transport demand management (TDM).]

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.