Energy Consumption in the Transport Sector

During the 20th century, transport sector demand in the OECD countries boomed. The main drivers for growth were road transport and, more recently, air transport. As emerging countries continue to develop and the world faces the threat of climate change, this sector represents a major long-term challenge.

Following the sharp rise in crude prices and the ratification of the Kyoto Protocol, the transport sector, heavily dependent on petroleum products, is back in the spotlight. Now is a good time to question and analyze the dominant characteristics of the transport activity, so vital to our economies.

Energy Balance

The world still consumes more oil than any other primary energy. In 2002, oil represented 36% of the market, or about 3.8 Gtoe (cf. Figure 1). The transport sector is clearly dominant in petroleum product consumption: 50%, versus 42% in 1973 (cf. Figure 2).

The OECD countries are the main drivers of petroleum product consumption in the transport sector. Collectively, they absorb 75% of the 1.75 Gtoe consumed by world transport, especially the United States, the Europe of Fifteen and Japan (55%). The share of other energies is marginal: a total of 1.9%. Electricity accounts for 1%, biomass 0.5%, coal 0.3% and natural gas 0.2%.

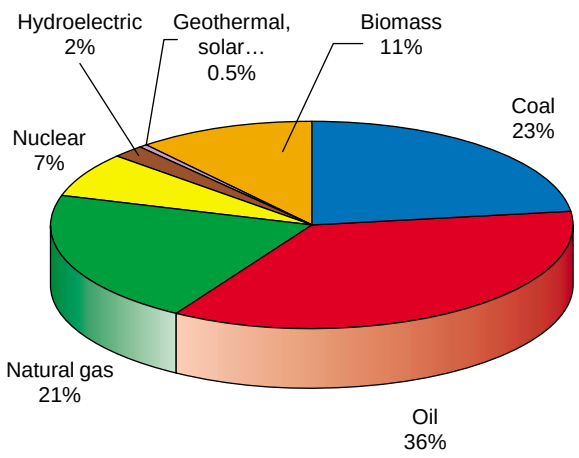
Categories and Past Trends

As far as mobility is concerned, road transport is the dominant mode. Representing 90% of all passenger journeys and 75% of all freight hauled, it has boomed in recent decades. In the last 25 years, the vehicle fleet has more than doubled in the OECD countries (80% of the world fleet). Today, there are nearly 600 million private automobiles and 209 million light trucks registered in the world.

Passenger transport demand is closely related to household revenue, commuting distance and the distance between home and school. Road transport totally dominates the energy balance: in the three key OECD regions — the U.S., Japan and the Europe of Fifteen — it represented 96% of the 13 760 billion passenger-kms traveled in 2000 (cf. Figure 3). Air, rail, tramway/metro and waterway transport account for the rest. Only Japan, which has the requisite infrastructure, reports a larger proportion of public transit.

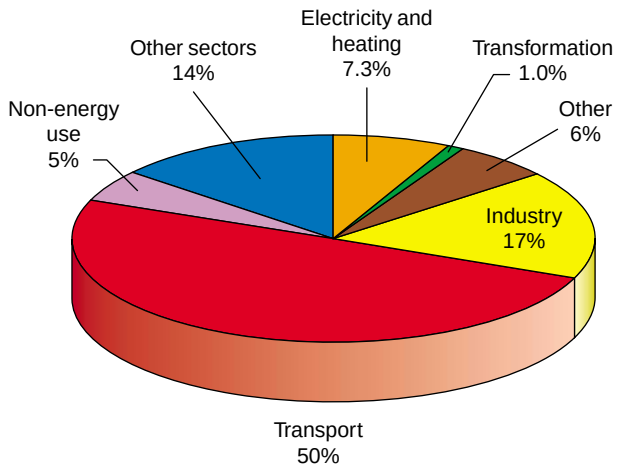
Over time, the household transport budget has remained fairly constant at about 13% of total household revenue.

Fig. 1 World primary energy consumption in 2002: 10.4 Gtoe



Source: "Energy Balances of Non-OECD Countries, 2001-2002" IEA 2004 Edition

Fig. 2 World petroleum product consumption in 2002: 3.5 Gtoe



Source: "Energy Balances of Non-OECD Countries, 2001-2002" IEA 2004 Edition

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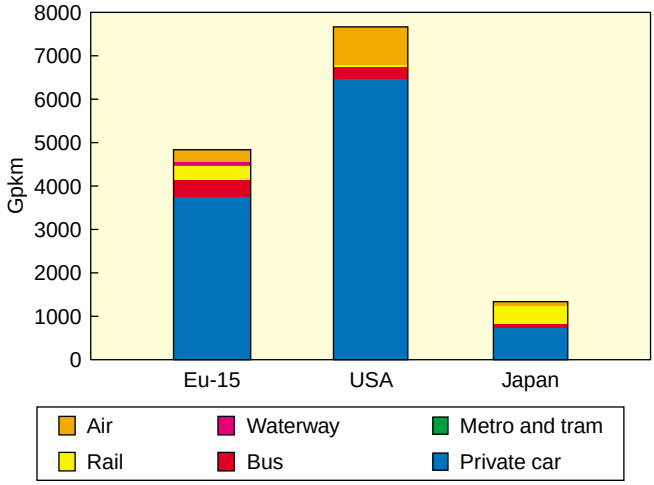
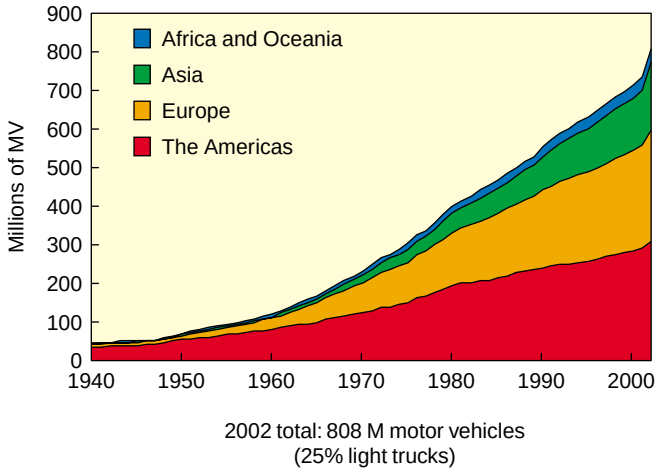
Fig. 3 Passenger transport breakdown, 2000



Source: "European Union Energy and Transport in Figures", European Commission, 2003

Fig. 4 World motor vehicle fleet, 1940 to 2002



Source: CCFA

Induced by growth in GDP and by substantial improvements in infrastructure and technology, there has been an increase in motor vehicle ownership per capita.

The United States reports the highest ownership rate: 775 private cars per 1000 inhabitants, 25% higher than in Japan or the Europe of Fifteen. This is due to its low motor fuel taxation, large size and a road system that is well-developed, unlike other transport systems. This rate seems to be stabilizing in the U.S. and converging towards 500 vehicles per 1000 inhabitants in Japan and Europe.

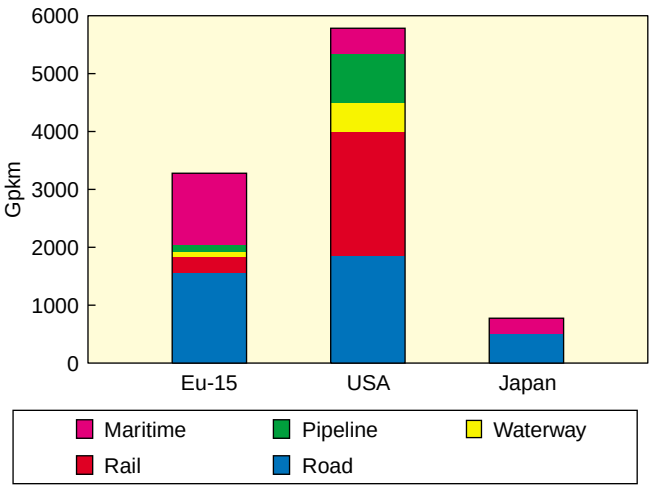
The world private car fleet has more than tripled in 30 years (cf. Figure 4). In 2003, it numbered nearly 600 million vehicles, with 64% in the three key regions just mentioned.

Freight transport is mainly influenced by GDP and world trade. Its globalization is accelerating because world trade (expressed in value) has expanded so very quickly (+170%) compared to GDP (+50%) in the last two decades. The increase in total distances traveled was superior to that of total tonnage hauled.

As regards annual hauled tonne-kms, the road and air segments have posted the strongest growth worldwide in the last 20 years: +120%. Other transport modes (pipe, rail, international and domestic maritime) saw more moderate growth, ranging from +50% to +80%. This being said, for international freight, maritime transport continues to dominate today.

In the three key OECD areas (U.S., Japan and Europe of Fifteen), domestic commerce relies most heavily on road transport: 36%, expressed in tonne-kms (cf. Figure 5). Europe

Fig. 5 Freight transport breakdown, 2000



Source: "European Union Energy and Transport in Figures", European Commission, 2003

and Japan show a preference for maritime and road transport solutions. The freight breakdown is more evenly distributed in the U.S., where road transport is not economically viable for long hauls and where other transport modes, especially rail, are — and will continue to be — essential for domestic freight haulage. On the other hand, the road segment is still winning market share from the rail sector in Europe and Japan, where the geographic scale is smaller.

Road transport accounts for an even higher percentage of energy consumption. It represents 81% of transport-related energy demand (cf. Figure 6) and, despite recent advances in energy efficiency, is still the most energy-intensive mode of

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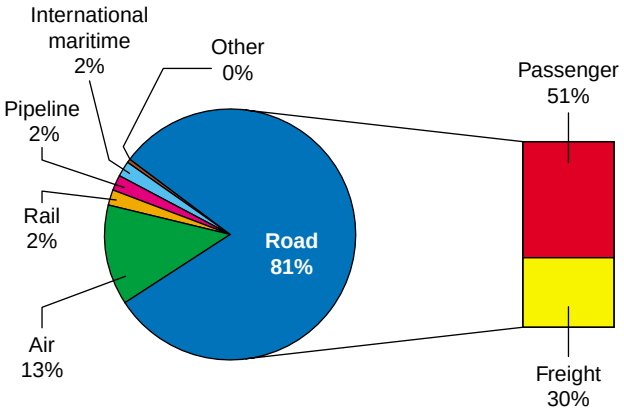
Fig. 6 Energy consumption breakdown for the transport sector, 2001



Source: IEA and IFP estimates

transport (per tonne of product hauled and/or per passenger carried per kilometer).

High road transport growth limits the impact of energy conservation policies in the area of environmental protection as well as oil dependence. One key factor in this paradoxical trend is that transport modes consuming little or less energy are not sufficiently competitive and/or lack the necessary infrastructure. These alternatives are becoming less and less adapted to current economic requirements, for three main reasons:

– Current land occupancy practices: Residential areas and rail activities are increasingly remote, destinations less centralized.

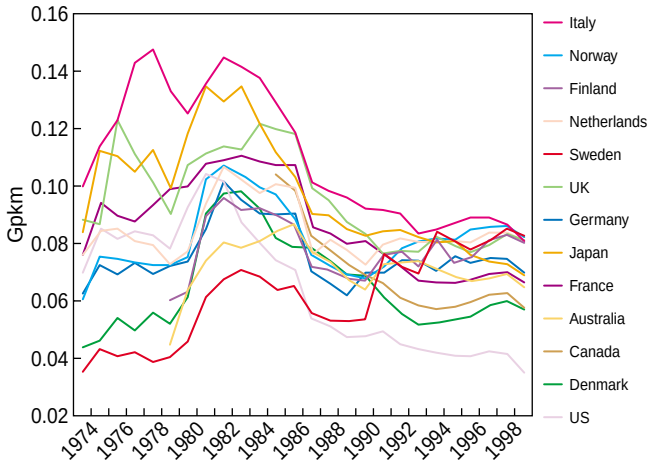
– The cost of motor fuel per vehicle-km has significantly decreased since the last oil countershock (cf. Figure 7), which has boosted private car ownership. In 2004, the soaring price of oil renewed concern over the economic challenges at hand as well as debate about alternatives to gasoline and diesel fuel, especially biofuels.

– The generalization of industrial "just in time" management and rising consumer demand for specialized, customized products imply faster reaction times and less massive transport flows. In the motor industry, for instance, customers can choose from several dozen versions of a given model (70 for Renault's *Mégane*, 92 for Peugeot's 307) with a one-month wait time, compared to a dozen versions twenty years ago. Transport by waterway is slow. Rail transport, more suitable for large-scale flows, imposes scheduling constraints. Road transport is the most competitive in light of industrial and distribution constraints.

Rapid growth in road transport demand is to be expected throughout the 21st century, with the emergence of countries like China and India.

In the OECD countries, there has been exponential growth in the last thirty years. In the medium term, developing countries, especially China and to a lesser extent in India and Indonesia, can be expected to follow this pattern.

Fig. 7 Fuel price per vehicle.km (including tax) $US/vehicle.km



Source: "Oil Crises & Climate Challenges - 30 Years of Energy Use in IEA Countries"; IEA 2004

It is already happening in China. In the last six years, vehicle production has increased nearly ninefold to 4.4 million vehicles in 2003, equivalent to more than 20% of European production. The vehicle ownership rate only stands at 10 vehicles per 1000 inhabitants in China, so this is just the beginning.

According to the baseline "World Energy Outlook 2004" scenario *(i.e.* no major changes in technology or in the behavior of major players), the non-OECD motor vehicle fleet will triple by 2030 to about 550 million, but remain 25% lower than the OECD fleet. By 2030, the world fleet will double, reaching nearly 1.3 billion vehicles.

Showing a similar uptrend, transport energy demand should reach 3.2 Gtoe by 2030, with oil accounting for 95% (cf. Figure 8). The transport sector is expected to represent 54% of total oil demand by 2030 — compared to 47% today and 33% in 1971 — absorbing nearly two-thirds of the increase in oil demand by that date.

In addition to increasing oil dependence, the transport sector plays a disquieting role as regards climate change.

Two factors weigh heavily in the world CO_2 emissions balance: electricity production and transport account for 41% and 21% of the market, respectively (cf. Figure 9).

According to the baseline WEO scenario, the transport sector will see its CO_2 balance rise 78% by 2030.

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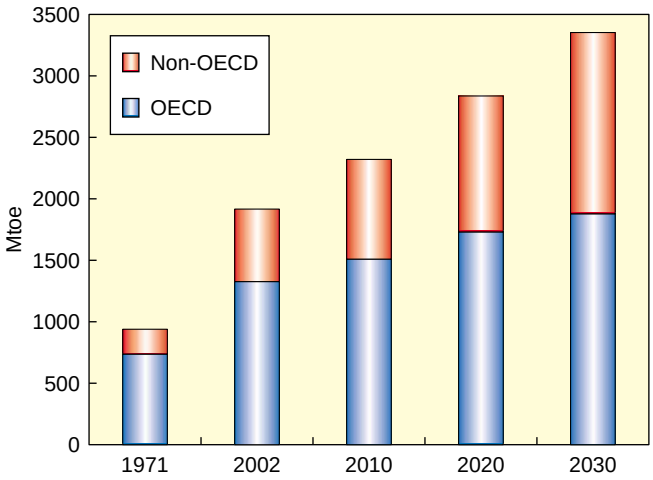
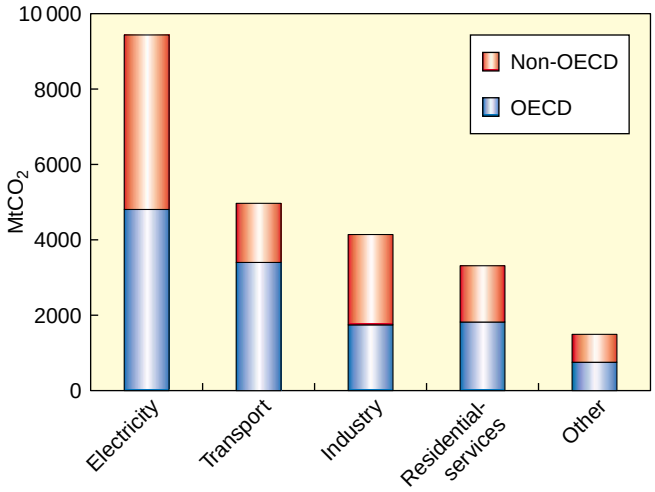
Fig. 8 Energy consumption in the transport sector 1971-2030



Source: World Energy Outlook 2004

Fig. 9 World CO_2 emissions breakdown, 2002 (Total: 23.7 $GtCO_2$)



Source: World Energy Outlook 2004

In the electricity sector, there are a number of ways to reduce emissions in the short and medium term, but the solutions available to the transport sector are more limited in scope and take longer to implement.

A transport vehicle is a mobile source of dispersed greenhouse emissions and pollutants. Although the method consisting of capturing and sequestering CO_2 is often considered for power plants, it cannot be applied to transport unless a carbon-free motor fuel (electricity or hydrogen) — which implies a new motor vehicle technology (an electric vehicle with or without a fuel cell) — has already come into general use.

Furthermore, when a new technology is introduced to reduce energy consumption and CO_2 emissions, fleet penetration takes time. Naturally, it takes 13 years to reach 50% penetration, 24 years to reach 95%. There are ways to accelerate this process:

– impose stricter technical inspections: vehicles no longer in conformity are taken out of circulation faster;

– implement standards: vehicles equipped with the new technology come into circulation faster.

The impact of such measures is limited; they only gain three years over the natural penetration rate.

In the absence of incentives, the length of time required for new technologies to penetrate the private car fleet is long. It would also take years to radically change infrastructure to promote use of public transit systems. Yet several actions can be taken to obtain faster effects:

– Up to a certain percentage, alternative motor fuels of vegetable origin (*e.g.* ethanol in ether form, vegetable oil methyl esters, or biodiesel obtained by the gasification of biomass) can be blended with conventional motor fuels without requiring modifications in terms of vehicle technology. This is already being done in Brazil, Europe and in the United States.

– Taxes to limit new vehicle purchase (Denmark) or curb motor vehicle use (motor fuel tax) can be levied.

But the impact of such measures is limited. By themselves, they cannot significantly inhibit the expected increase in petroleum product consumption and greenhouse emissions in the years to come.

It is imperative to boost penetration of low-consumption, low-emissions vehicles now. It is imperative to promote R&D that is focused on reducing per-unit consumption in conventional vehicles and on alterative solutions. Certain alternative vehicles and technologies, recognized for good environmental performance, are already available. These include hybrid vehicles and natural gas vehicles. However, efforts to introduce them on the market are still feeble, for reasons of insufficient competitiveness and/or distribution capacity.

As for freight transport, which generates nearly 40% of CO_2 road transport emissions, there is even less leeway to maneuver, because it is so closely linked to economic growth. Of course, this sector will be able to benefit from any technology advances made relative to the private car. In the meantime, it is vital to stimulate growth for other, less energy-intensive transport modes by making them more

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competitive and bringing them more in line with industrial needs. One way to reconcile user needs and environmental concern is the utilization of combined transport (rail/road, waterway/road). However, the development of appropriate infrastructure would be capital-intensive. These solutions have already been proven viable in countries like Switzerland and Germany. In the years to come, they should be a key European priority.

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