http://dx.doi.org/10.18778/1429-3730.36.05

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THE RATIONALITY OF ENERGY MANAGEMENT IN THE TRANSPORT SECTOR IN EU

RACJONALNOŚĆ GOSPODAROWANIA ENERGIĄ W SEKTORZE TRANSPORTU W UE

Streszczenie

Mając dane ilościowe i jakościowe, podjęto próbę zbadania zależności i związków zachodzących między rozwojem transportu a efektywnością wykorzystania zasobów paliwowych, co stanowiło zasadniczy cel artykułu.

Przeprowadzona analiza pozwoliła stwierdzić, że transport drogowy zyskał obecnie szczególny status w życiu codziennym społeczeństwa. Wzrost mobilności mieszkańców Europy spowodował, że samochody osobowe są aktualnie w największym stopniu odpowiedzialne za potrzeby energetyczne transportu drogowego. Stało się tak mimo poprawy efektywności energetycznej tych samochodów oraz wzrostu przewozów towarowych. Prognozowany dalszy wzrost przewozów towarowych spowoduje dalsze zmiany w strukturze zużycia energii przez transport samochodowy. Mimo wysokiej dynamiki poprawy efektywności energetycznej napędów samochodów ciężarowych, udział zapotrzebowania na paliwo przez te samochody będzie wzrastał w całkowitym zapotrzebowaniu na paliwo sektora transportu drogowego. Jednocześnie zużycie energii przez samochody osobowe zmniejszy swój udział w całkowitych potrzebach paliwowych transportu samochodowego. Poprawa efektywności energetycznej transportu osobowego i ciężarowego nie zrównoważy wzrostu zapotrzebowania na energię w transporcie drogowym. Przedstawione powyżej prawidłowości wyznaczają kluczowe wyzwanie stojące przed systemem transportowym – sprostanie ciągle rosnącemu zapotrzebowaniu na energię. Istotną kwestią w realizacji założeń zrównoważonego rozwoju transportu nie jest tylko rozwój technologii, lecz ludzka świadomość kształtująca właściwe preferencje konsumentów. Od przewoźników i klientów zależny będzie kształt transportu w przyszłości.

Słowa kluczowe: transport, zrównoważony transport, konsumpcja energii, emisje CO_2

Numer klasyfikacji JEL: Q4

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Introduction

In the coming decades global energy and climate trends will constitute a key challenge which the transport will face – meeting the constantly growing demand for energy. Greener engines and fuels will have a decisive impact on improving the energy efficiency of transport and reducing the dependence on oil. However, technological solutions alone will not solve the problems with the increase in the mobility of European citizens and the increase in freight traffic. An important issue in implementing the resource-efficient and low-carbon transport development is not only technological development, but also increased human awareness which will be reflecting in the proper shaping of consumer preferences. From carriers to customers, all will contribute to the shape of future transportation. However, this requires the implementation of the long-term measures in the transport sector contained in the White Paper.

The main objective of this article is to make a quantitative and qualitative attempt to examine the relationship and the correlations between the development of transport and fuel efficiency and efficient resource use. The implementation of the approved work method was used to study the documents (desk research). Analysis of literature and secondary data constituted the basis for the scientific objective – to carry out a thought experiment using the method of analysis and logical construction.

Strategy to improve energy efficiency in the transport sector

Market integration, economic growth and transport activities are closely related. In the European Union (EU) effective transport connections have allowed for the creation and development of the internal market. Each enlargement was accompanied by a significant increase in transport activity. Not surprisingly transport policy was one of the common policy areas covered by the Treaty of Rome. Since the publication of the first White Paper on the Common Transport Policy many things have been achieved. The aviation market, road transport and rail have all been opened and liberalized. All modes of transport have become safer and securer. New regulations on working conditions and the rights of passengers have been adopted. Much has been done to improve the environmental performance of transport. However, these measures have proved to be inadequate to meet the growing needs in freight and passenger transport.

Since the first major oil crisis, which took place more than 40 years ago, the transport system has not changed in terms of energy needs. Transportation continues to be almost entirely dependent on fossil fuels as an energy source. While technological progress has contributed to a more efficient use of energy,

it has not done so to the extent to compensate for the effects of the increase in freight volume.[1] Assuming that no significant changes are made, the dependence on the transport of crude oil in 2050 may be about 90%. In view of the *Roadmap for moving to a competitive low carbon economy in 2050*[2] and *Energy Efficiency Plan 2011*[3]*,* the European Commission has developed a plan of action in order to create an efficient and competitive transport system. To meet the challenges, the transport sector must consume less energy, use green energy and modern infrastructure, and reduce its negative impact on the environment. It should also use natural resources such as water, land and ecosystems.[4] Further development of the transport sector must be based on assumptions such as[5]:

1. Improving the energy efficiency of vehicles in all modes of transport; development and implementation of the use of fuels and propulsion systems compatible with sustainable development;
2. Optimising the performance of multimodal logistic chains, including through the widespread use of resource-efficiency;
3. Efficient use of transport and infrastructure through the use of improved traffic management systems and advanced logistics and markets.

In order to take full advantage of the internal market and to contribute to the achievement of wider transport policy objectives in terms of efficient management of natural resources and reducing the dependence on oil, an action plan with concrete initiatives has been developed. In the medium term, these activities are focused on greener engines and alternative fuels that will have a decisive impact on the reduction of emissions resulting from mobility and also reduce dependence on oil. A sustainable alternative fuels strategy, which also includes infrastructure projects will still however not solve all the problems.[6] Their use will have to be reconciled with the constraints linked to the conserving of resources.[7] Thus vehi-

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[1] U. Motowidlak, *Trends in the Transport Sector as a Manifestation of Paradox Jevons'a*, SDS 2014 – Sustainable Development Symposium. 4th Annual European Postgraduate Symposium – Pan European University of Bratislava, Bratislava 2014.

[2] *A Roadmap for moving to a competitive low carbon economy in 2050*, COM (2011) 112, Brussels 2011, pp. 3–16.

[3] *Energy Efficiency Plan 2011*, COM (2011) 109, Brussels 2011, pp. 2–16.

[4] *White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system,* COM (2011) 144, Brussels, p. 6.

[5] *Expertise. Improving energy efficiency of transport in Poland – analysis of available resources and proposals for action*, made for the Ministry of Transport, Construction and Maritime Transport Policy and the Department of International Cooperation, ECORYS Poland, Warsaw 2012, pp. 28–29.

[6] *Clean Power for Transport: A European alternative fuels strategy*, COM (2013) 17 final, Brussels 2013, pp. 2–11.

[7] *Proposal for a Directive of the European Parliament and of the Council on the deployment of alternative fuels infrastructure*, COM (2013) 18, Brussels 2013, pp. 2–38.

cles must improve its energy efficiency. What's more, using less energy will be as important as making energy consumption greener.[8] Energy efficiency in transport is focused on technical, organizational and behavioral factors. The optimization of all journeys in terms of energy consumption is used to increase load factors, make systematic use of the most efficient modes of transport, and adopt a more integrated approach to land use and transport planning.

The consequence of the implementation of the initiatives described in the medium term is to be improvement of energy efficiency in transportation and reducing the dependence of the industry on imported oil. In the long term, increasing the energy efficiency of vehicles should occur at such a rate that the available supply of energy from alternative fuels will be sufficient to cover the expected increases in transport. The currently applicable and proposed CO_2 standards provide for reduction of energy consumption only in cases where its main source comes from fossil fuels. With decreasing emissions, the intensity of fuels in the transport sector's fuel consumption can again begin to increase. Therefore, in the future it may be necessary to replace the current energy efficiency standards. The combination of targets for CO_2 emissions from transport fuels and energy efficiency standards for vehicles should ensure a simultaneous decarbonisation of transport and the displacement of oil by alternative fuels in a cost-effective manner.

Trends in the energy consumption of transport

The energy consumption of the EU transport sector increased very rapidly between 1990 and 2000 (2% per year). Between 2000 and 2007, there was a net slowdown (1.5%/year) linked to the sharp increase in oil prices, and thus in motor fuel prices, the slowdown in air traffic, and national measures in certain countries. Since 2007 consumption has been decreasing more rapidly (–2.2% per year over 2007–2013, on average), with a sharp drop in 2009 (–2.5%). The sector's energy consumption has increased by 84 Mtoe[9] since 1990, with trucks and light vehicles accounting for almost 40% of that growth, cars for about one-third and air transport (both domestic and international) for about 25%.

Of all sectors, transport has shown the most rapid energy consumption growth. As a result, its share in final energy consumption is increasing almost everywhere: it has now reached 33% of the EU energy consumption as a whole (368 Mtoe in 2009), up from 31% in 2000 (341 Mtoe). Growth in this sector has been especially

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[8] *Accompanying the White Paper – Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*, SEC(2011) 391 final, Brussels 2011, p. 32.

[9] Tonne of oil equivalent (toe) – this is the energy equivalent of one metric ton of crude oil with a calorific value equal to 10,000 kcal / kg. Mtoe = 1,000,000 toe.

rapid in new EU Member States from Central and Eastern Europe, with the share of the transport sector increasing by at least 10 percentage points in Bulgaria, Poland and Slovenia. That spectacular rise (in proportional terms) is due both to the reduction/slowdown of industrial energy consumption and the rapid increase in car ownership. With the exception of smaller countries like Luxembourg, Cyprus and Malta, where air transport is proportionally very developed, the share of transport is particularly high in certain countries (around 40%), i.e. in the UK, Greece, Spain and Ireland.

In 2012 road transport represented on average 82% of the total energy consumption of transport in the EU. Cars account for about half of the sector's total consumption (Fig. 1). The share of cars is declining (49% in 2012 compared to 53% in 1990), whereas that of road freight transport (trucks and light-duty vehicles) is slightly increasing (29% in 2012 compared to 27% in 1990).

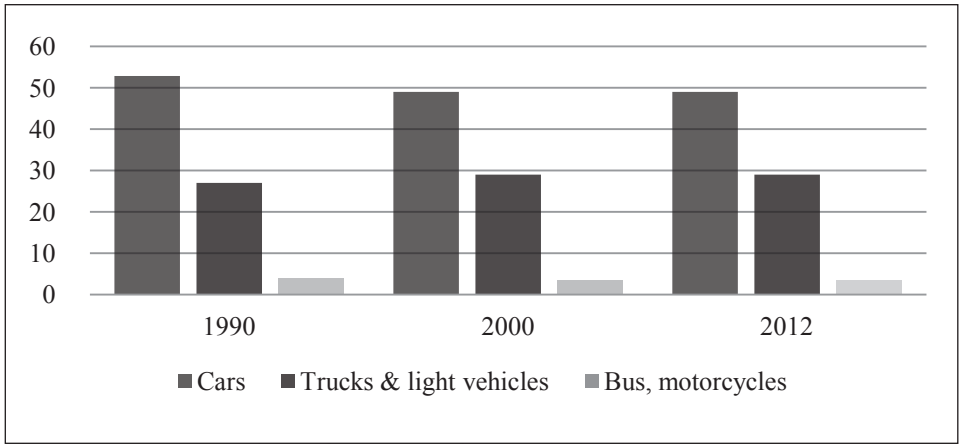

Fig. 1. Consumption of transport by mode in the EU (%)

Source: http://www.indicators.odyssee-mure.eu, 12.6.2014

The share of cars in the energy consumption of transport varies from around 35% in Norway, Greece or Romania to above 55% in Germany and Hungary. These differences stem from the level of car ownership (low in Romania) and the importance of other transport modes, namely air transport (high in UK and the Netherlands), water transport (high in Greece, Norway and the Netherlands) and road freight transport.

Oil products make up the bulk of the sector's consumption (94% on average in the EU in 2012, ranging from 91% to 100%). On average alternative fuels (compressed natural gas and biofuels) supplied 5.5% of the consumption in 2012, although their share is increasing rapidly (Table 1).

Table 1. The structure of fuels in the transport sector (%)

Specification	1990	2008	2009	2010	2011	2012
Oil products consumption of transport, including:	97.44	94.89	94.34	93.90	93.58	93.18
– Gasoline	48.43	26.86	26.45	25.05	24.09	23.34
– Diesel	37.10	51.97	52.27	53.38	53.63	54.01
– LPG	0.95	1.33	1.44	1.45	1.52	1.55
– Jet fuels	10.05	14.23	13.60	13.54	13.92	13.90
– Fuel oil	0.54	0.45	0.54	0.45	0.38	0.34
Biofuel consumption of transport	0.01	2.59	3.20	3.60	3.78	4.14
Electricity consumption of transport	2.36	1.73	1.76	1.79	1.86	1.89

Source: *ODYSSEE*; http://www.indicators.odyssee-mure.eu, 12.6.2014.

Biofuels represent 92% of the alternative fuels at the EU level (around 75% for biodiesel). That good performance is mainly explained by the rapid penetration of biofuels, and especially of biodiesel, following the prompt implementation of the EU Directive on biofuels. If we limit the analysis to road transport, four countries have a large penetration of biofuels in total road transport consumption: Austria (9%), Portugal (6.5%), France (6.5%) and Germany (6%). The use of natural gas (CNG) is most strongly developed in Italy and Bulgaria, where gas represents around 1.5% of the road transport consumption in 2012.

Overall energy efficiency in transport

In 2012, energy savings in transport almost reached 70 Mtoe. Without energy efficiency improvement, the energy consumption would have been higher by 70 Mtoe. The slowdown in energy savings after 2007, mainly due to decreased goods transport, was a consequence of the economic recession. The consumption of transport since 2007 has decreased by more than 30 Mtoe at the EU level. Around 40% of that reduction is due to the economic recession, with the decrease in freight traffic and stability of passenger traffic, and almost 60% to energy savings, mostly for passenger cars (Fig. 2). Almost no efficiency improvements for road freight transport have occurred since 2007, mainly linked to the reduction in traffic.

The decreasing energy consumption for passengers since 2007 was mainly due to energy savings (17 Mtoe) that more than offset the growth in traffic. On average energy consumption of passengers has increased by around 1.7 Mtoe since 2000 due to an increase in traffic (30 Mtoe) and modal shift (0.2 Mtoe), but was offset by energy savings (28 Mtoe). The negative but marginal impact of modal split was due to a decreasing share of public transport in passenger traffic (or a shift from public transport to car).

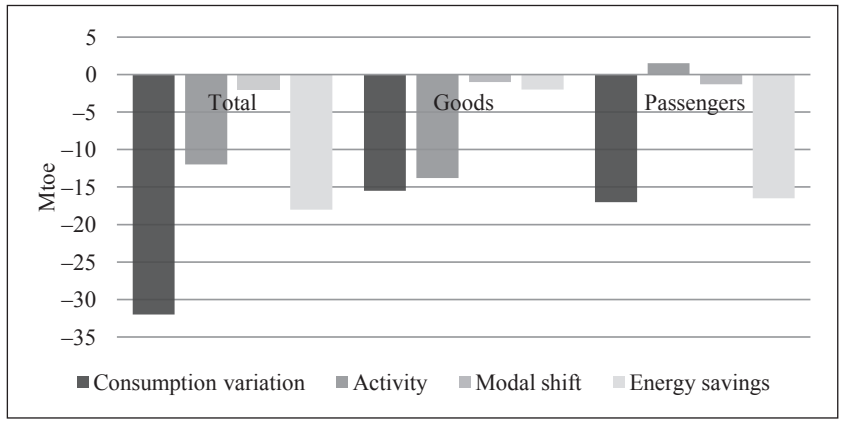

Fig. 2. Decomposition of energy consumption variation of transport in the EU (2000–2012)

Source: B. Lapillonne, K. Pollier, *Energy Efficiency Trends in Transport in the EU*, Enerdata 2014, p. 31

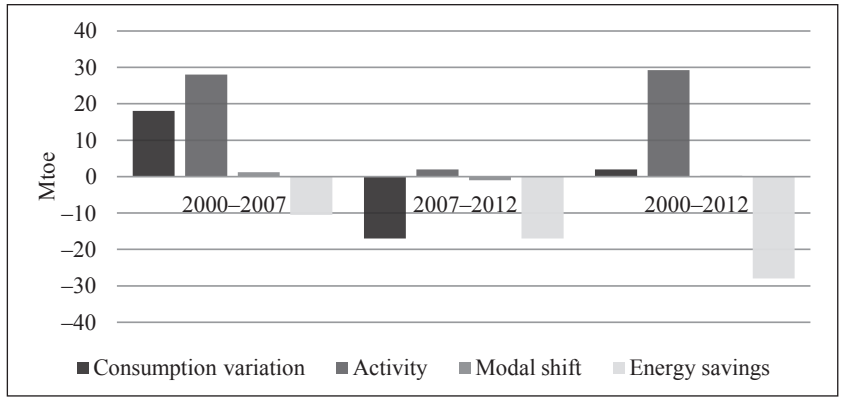

Fig. 3. Breakdown of the energy consumption variation for passenger transport in the EU

Source: B. Lapillonne, K. Pollier, *Energy*..., p. 32

Energy savings for cars can be measured according to the reduction in the energy used by car per passenger-km.[10] These savings may stem from improvements in their technical performance, from changes in driving behaviour ("eco-driving"), from changes in the average car size or horsepower, or from an increase in car occupancy ("car pooling"), as shown in Fig. 4.

Technological savings resulting from the decrease in the average specific consumption per car in l/100km are estimated at 28 Mtoe for the EU in 2012 (compared to 1990), i.e. about 16% of the total consumption of cars. In other

[10] This is the definition used to monitor the Energy Services Directive (ESD).

words, without these savings the consumption of cars in 2012 would have been 28 Mtoe above its actual level, or 17% higher. This corresponds to an average annual savings of 1.4 Mtoe/year. Fuel switching from gasoline to diesel contributed to an increase of energy consumption by about 0.5 Mtoe/year between 2000 and 2012. Changes in car occupancy, which is a behavioural factor, had only a small effect.

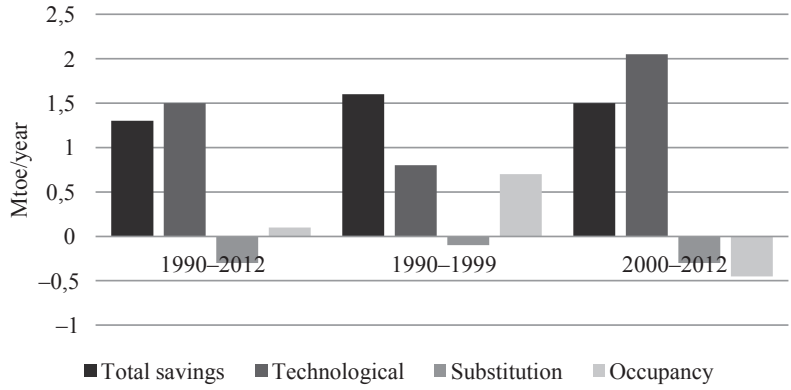

Fig. 4. Energy savings from cars in the EU

Source*: Energy Efficiency Trends in the Transport sector in the EU*, Lessons from the ODYSSEE MURE project, 2012 and 2014, p. 38

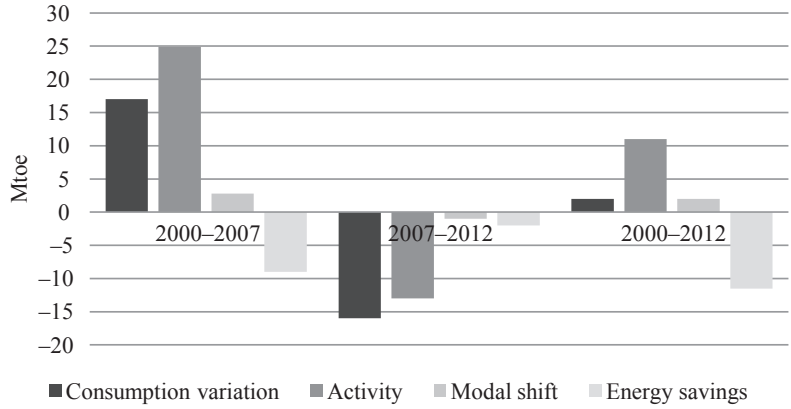

Fig. 5. Decomposition of energy consumption for freight in the EU

Source: B. Lapillonne, K. Pollier, *Energy*…, p. 33

Decreasing energy consumption of freight transport since 2007 was mainly due a decrease in the traffic in ton-km, and to a lesser extent due to modal shift. In con-

trast, reverse trends in energy savings occurred because of an increase in the energy consumed per tonne-km. On average energy consumption of road freight only increased by 1.8 Mtoe since 2000 due to an increase in traffic (11.3 Mtoe) and modal shift (1.6 Mtoe), but offset by energy savings (11.0 Mtoe), as shown in Fig. 5.

Energy savings for goods (11 Mtoe in 2012 compared to 2000) are mainly due to savings from trucks and light vehicles, due to a decrease in specific consumption per tonne-km before 2007. Since 2007 no more savings for road goods can be seen, and even reverse trends are visible (Fig. 6).

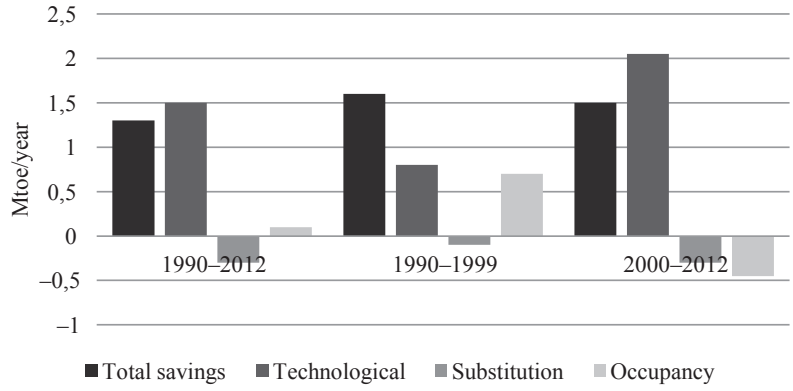

Fig. 6. Energy savings for goods in the EU

Source: B. Lapillonne, K. Pollier, *Energy*…, p. 38

CO_2 emission trends in transport

The transport sector is driving up total CO_2 emissions from energy use: CO_2 emissions from transport have increased from 19% in 1990 to 25% in 2012, whereas in all other sectors these emissions are far below their 1990 levels. As a result, transport represents a growing share of the total emissions of end users (i.e. excluding the power sector), at 45.5% in 2012 compared to 32% in 1990. Since 2000, the increase of emissions from transport has slowed down (0.3% per year compared to 1.7% per year over 1990–2000). All modes participated to that reduction except trucks & light vehicles (+2%).

Road transport represents 90% of the total emissions from transport. The emissions from road freight transport increased by nearly 36% between 1990 and 2012 and made up 35% of the sector's emissions (compared to 31% in 1990), which is the main source of the sector's rapid growth in emissions. Emissions from cars

have increased by 15%. Although emissions from domestic air transport have increased by 17% since 1990, they represent less than 3% of the total. Almost half of the increase in CO_2 emissions between 1990 and 2012 have been offset by CO_2 savings. These savings limited the increase in CO_2 emissions to 167 Mt and have offset almost half of the baseline CO_2 emissions' increase since 1990 (Fig. 8). Around 40% of the savings come from trucks and light vehicles and 30% from cars. Around 86 Mt of CO_2 emissions were avoided in 2012, which more than offset the effect of an increase in traffic (activity effect).

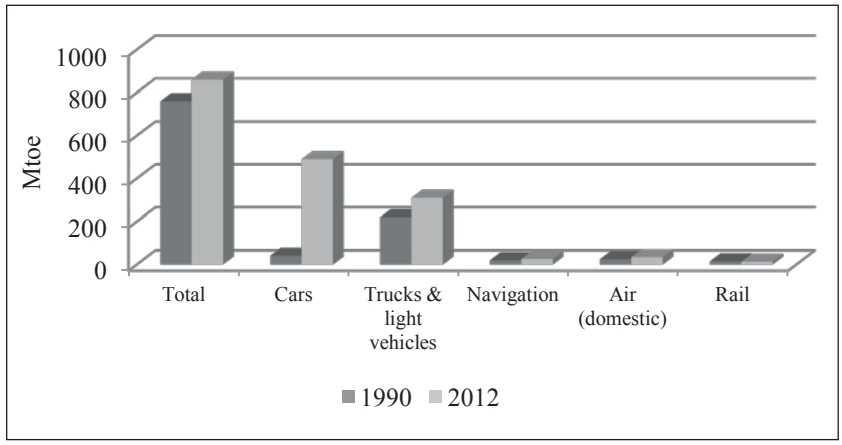

Fig. 7. CO_2 emissions from transport in the EU

Source: EEA for total emissions and ODYSSEE for the emissions by mode, http://www.eea.europa.eu/data-and-maps/indicators; http://www.indicators.odyssee-mure.eu, 6.5.2014

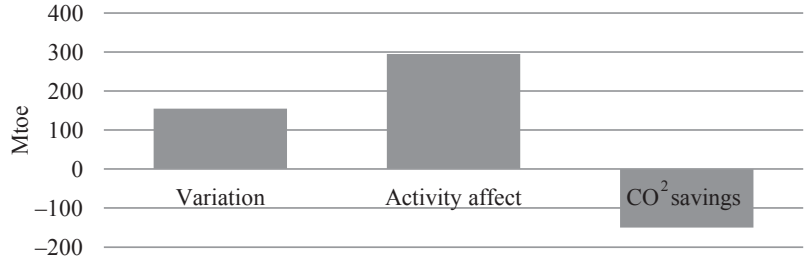

Fig. 8. Variation of CO_2 emissions from transport in 1990–2012

Source: *ODYSSEE*; http://www.indicators.odyssee-mure.eu, 6.5.2014

Conclusions

The enlargement of the EU and the increasing integration of world markets has led to a significant increase in the amount of transported goods. This has been accompanied by an increase in the mobility of Europeans, despite the high congestion in many cities. Thanks to its advantages (mainly speed), the widespread availability of means of transport, the possibility of direct transport of goods and people, as well as the favourable distribution of the space infrastructure, road transport is today the dominant and most important mode of transport. Our analysis shows that road transport has now gained a special status in people's daily lives.

The directions of development of transport systems have a direct impact on the energy needs of the transport sector. Transport is still almost entirely dependent on fossil fuels as an energy source. Technical progress has contributed to a more efficient use of energy, but not enough to offset the effects of the increase in transport overall. The prospects for further growth in demand for petroleum resources while increasing the market share of diesel cars point to the need to take active measures in terms of creating a competitive and resource efficient transport system.

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http://www.odyssee-indicators.org/online-indicators/.

Abstract

The main objective of this article was to make a quantitative and qualitative attempt to examine the relationship and the correlations between the development of transport and fuel efficiency of resource use.

The analysis has shown that road transport has now gained a special status in people's daily lives. The increased mobility of European citizens has caused cars to currently have the greatest share of the energy needs of road transport. This happened in despite improvements in the energy efficiency of these cars and freight transport growth. The projected continued growth of freight transport will contribute to the further changes in the structure of energy consumption by road transport. Despite the high growth rate of energy efficiency and improvement in trucks, the share of demand for fuel by these vehicles will increase the total fuel demand for the road transport sector. At the same time the energy consumption of cars will reduce their share in the total fuel needs of transport. The improvements of energy efficiency of passenger cars and trucks will not offset the increase in demand for energy in road transport. The above regularities create a key challenge facing the transport system – how to meet the constantly growing demand for energy? An important issue in achieving the objectives of sustainable transport is not only the development of technology, but also human awareness shaping proper consumer preferences. The future of transport will depend on both the carriers and the customers.

Keywords: transport, sustainable transport, energy consumption, CO_2 emissions

JEL classification: Q4