HOW MUCH NEW MODES OF ENERGY ARE POSSIBLE IN THE OLD MODES OF TRANSPORT?

Wojciech Paprocki[1]

Abstract: This paper presents a short description of a few most modern technical solutions of energy production as well as of its consumption which have been already implemented in the transport sector or can be implemented soon.

Key words: modal split, transport system, cargo traffic.

1 Introduction

The traditional modal split in the global transport system has not changed for decades. However, it is necessary to look closer to realize that the way of production and consumption of the energy develops dramatically almost every day. There are several reason why exactly in the last 20 years so many new solutions were implemented. The most important reason is international acknowledgement of the global climate changes. The Kyoto Protocol was adopted in 1997. Since then all governments and top managers in the world have known that there is not an alternative for the new global policy towards reduction of the greenhouse gas (GHG) emissions. The development and implementation of absolutely new and original solutions in field of producing and consumption of energy are supported by public sector. Simultaneously, several administration barriers are settled to avoid the utilization of the old technological solutions in the future. It might be expected that the new goals will be defined during the conference in Paris at the end of 2015 and they will refer to the Sustainable Development Goals prepared last August [1].

Nowadays we need to have more fantasy but we have be realistic too. This is an important competence to understand what kind of changes are possible in the transport system and to predict which economic effects may occur in the next years in regards to both macro and micro economy. This paper presents a short description of a few most modern technical solutions of energy production as well

[1] prof. Wojciech Paprocki, SGH Warsaw School of Economics, Department of Economics of Transport Enterprise, Niepodległości 162, 02-554 Warszawa, Poland, E-mail: wojciech@paprocki.pl

as of its consumption which have been already implemented in the transport sector or can be implemented soon.

2 The transport system in Europe is established

The most important changes in the structure of industrial production happened in Western Europe in the 70's and 80's of the last century whereas in Central Europe (in the former socialistic countries) they took place just in the last decade of the XX century. Road transport plays the most important role in the transport system of all European countries (Table 1). The reduction of road transport of goods, which is one of the most important goals of the transport policy by the European Union, generally has not brought the expected results. This might be spectacularly observed in Germany. Some but only very modest results were achieved in Austria and Switzerland, where the administrative barriers regarding road traffic in transit through the Alps and also in inland traffic are the strongest on the whole continent. Recently, there have been the first comments, also from Brussels, that the expectations defined by politicians in the last decades, e.g. in the White Book 2000 and 2011, were partly unrealistic. [2] Experts report, what is at least obvious, that it is basically impossible to shift any part of cargo flows from road to rail transport, as the structure of commodities changed in favour of 'small shipments' containing high value goods while the volume of raw materials purchased by the shrinking heavy industry was drastically reduced in the last four decades.

Tab. 1: Share of the road transport in the modal split in cargo traffic (based on tkm)

	2013	2000	Changes in %-points
Iceland	100,0	100,0	0,0
Cyprus	100,0	100,0	0,0
Malta	100,0	100,0	0,0
Ireland	98,9	96,2	2,7
Spain	95,4	92,8	2,6
Luxembourg	94,2	87,8	6,4
Portugal	94,1	92,4	1,7

	2013	2000	Changes in %-points
Norway	86,3	83,5	2,8
Poland	82,9	57,3	25,6
Slovenia	80,7	71,9	8,8
France	80,6	76,0	4,6
Chech Republik	79,7	68,0	11,7
Croatia	76,2	-	
Slovakia	76,0	53,0	23,0
Bulgaria	75,9	52,3	23,6
Hungary	75,5	68,1	7,4
Lithuania	66,4	46,6	19,8
Romania	57,5	42,9	14,6
Estonia	55,9	37,2	18,7
Latvia	39,6	26,5	13,1

Source: author according http://ec.europa.eu/eurostat/web/transport/statistics-illustrated (read 19.08.2015).

A similar situation is observed in passenger traffic. Rail transport, including the high speed trains technology, is preferred by authorities in several countries. Mostly the passengers choose the mode of transport not in favour of the recommendations made by politicians and technocrats. For example, they have used buses in long distance travels much more often in recent years than in the

past. The tendency presented in figure 1 is easy to follow in Germany, where when the road transport was liberalized in 2012 the number of passengers traveling by bus increased from 2 to 19 million in 5 years.

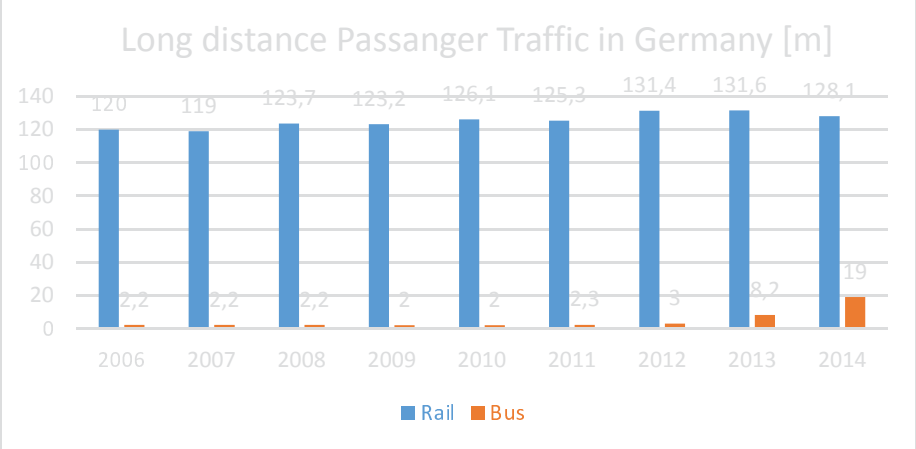

Fig. 1**:** Development of the passengers in the long distance traffic in Germany in 2006 – 2014 [16]

Concerning short distance transport in the big agglomerations it is observed that the share of public transport modes in total passenger traffic in the biggest towns in Germany has remained at the same level of about 14 per cent for last 10 years (Fig. 2). Besides, it is interesting that bicycle travel, unchanged, plays a very modest role, although this form of mobility is promoted very often in media.

The leading position of individual motorization remains unchanged in Western Europe. A similar level of individual motorization has been achieved in Central Europe during the past 25 years – e.g. in Poland there were 486 cars per 1,000 population in 2012 [3] and this already quite high level continues to increase.

The data mentioned herein lead to the clear conclusion that the transport system in Europe is established and currently there are no existing factors which would trigger significant changes of the modal split in both passenger and cargo transport.

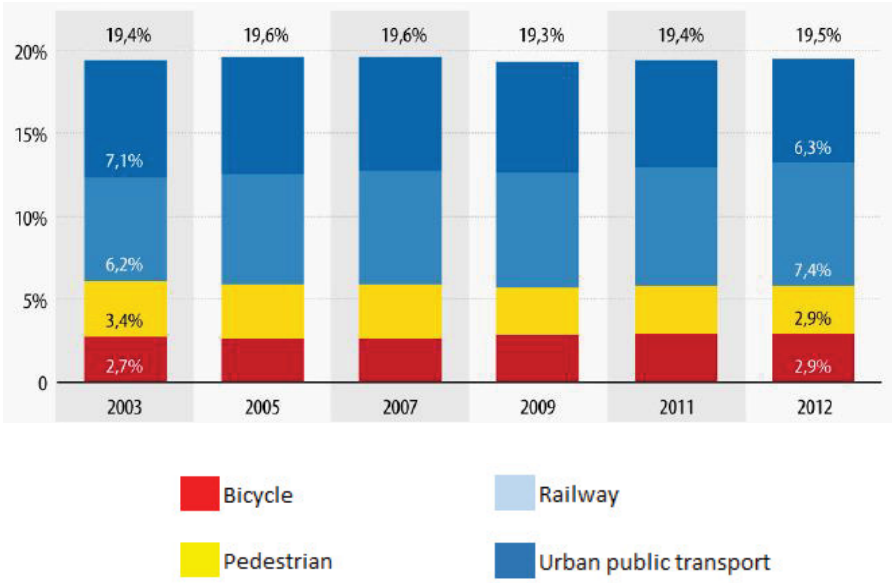

Fig. 2: Share of the environment-friendly modes of transport in the urban passenger traffic in Germany in 2003 – 2012 [17]

3 Conventional energy carriers used in the transport system

The steam railway and steam shipping are not existing because this technology is much less efficient than two others: motorization and electrification. The popularity of electrification in rail transport (as well as in underground and tram transport in the cities) is typical and obvious in Europe. This is not the fact on other continents, especially in North America where diesel traction is used almost everywhere in railway transport. The only small exception consists of local railway networks with electric traction around a few big cities and inside of them.

Motorization is the only solution used both in air and sea transport. The biggest question mark concerns road transport, though. Are there any other alternative energy drivers than fluid or gaseous fuels produced either from oil or gas or alcohol?

At the very beginning of the motorization in Europe there were more factories producing electro-cars than motor-cars. [4] At the same time also hybrid-cars [5] were produced. More than 100 years ago electro-cars did not find acceptance among drivers due to fact that the batteries allowed to travel no more than 50-80

kilometers. The same generation of batteries remain the most popular in cars until now. A new generation of batteries has capacity to power the car on a distance up to 440 kilometers. [6] But there are still several reasons why modern electro-cars are not popular. One of them and absolutely the most important is the high price of these cars as well as of the batteries which have to be exchanged every three to four years. [7] It is also important to note that car drivers still complain about the range anxiety today at the beginning of the XXI century in the same way as they did in the beginning of the XX century. Experts and politicians predicted in the 90's that the number of electric cars would increase rapidly. By 2010 they forecasted 1 million of them in Germany alone, both on the streets in towns as well as on roads in the regions. The real development has instead been very poor. In Europe in 2014 there were only about 30.000 electro-cars. In Germany only about 19,000 electro-cars were registered, while the total number of car-fleet in this country amounted to almost 50 million. [8]

4 What is new – hydrogen fuel cell, solar cells and once again bicycle

There are a few new solutions, which have already been implemented in the contemporary transport system or can be implemented soon. The first solution is the use of hydrogen fuel cells. After years of development works the first Toyota Mirai cars were sold in Japan in October 2014. In August 2015 the first of these cars arrived in Europe. [9] These are fuel cell cars with carbon-fibre fuel tanks in which hydrogen is stored. The front intake grills deliver the outside air to the fuel cell stack. Hydrogen travels from tanks to the fuel cell stack. There, it goes through a chemical reaction involving oxygen from the air, thus creating electricity. From this moment the car works like a standard electro-car. There are two differences between Mirai and standard electro-cars. Firstly, the delivery of the electricity power takes place from the stack and not only from (big) batteries. Secondly, the only by-product of creating electricity with hydrogen and oxygen in the fuel cell stack is water, which leaves the car through the tailpipe. [10] There is no emission of CO2 at all.

A second solution is the installation of solar cells on the aircraft. The "Solar Impulse-2" is the only airplane of perpetual endurance equipped with 17,000 solar cells which supply four electric motors and charge batteries with renewable energy. [11] It can also fly during the night using the stored energy. The first journey around the world started in March 2015 from Abu Dabi. This journey had to be suspended on Hawaii on July 3rd, 2015 after the airplane suffered battery damage. The next section flight is not planned before spring 2016. [12]

We may renew the discussion, if humans shall be treated once again as source of power. The industrial revolution two hundred years ago brought new possibilities which allowed to stop using human-powered transport. Today there are some projects towards the re-implementation of humans as the source of power in transport. [13] As a bicycle rider everyone can move himself using his own power and as a cargo bicycle driver one may even start labor activity. [14] Walking and cycling are treated in such projects as important pillars of sustainable urban mobility. These two kinds of mobility create alternatives. But they cannot become the sole transport mean for the entire population of a large agglomeration, with today's urban sprawl compared to the past where small towns were walkable. [15] Cycling is possible in several regions only during a certain period of the year. Riding a bicycle is often impossible during the winter as snow or ice are on the streets. Due to these reasons cycling can become popular only in certain local communities. It should be considered that cycling has lost its leading position in the transport system in many Chinese towns ever since a significant part of the population has started to afford own cars.

It seems to be a strange coincidence that almost all new projects in the field of implementing new solutions regarding the consumption of energy concern only individuals, who have a choice to use new hydrogen techniques in their new cars or to restart using their old bicycles. The highest consumption of energy concerns cargo traffic, where the use of heavy commercial vehicles (HCV) remains the leading transport mode position, and high see vessels powered by motor engines. Modern HCV and vessels become friendlier for the environment but they consume not much less fluid or gaseous fuels than they used to do beforehand.

5 What can happen to make the transport system more sustainable?

The share of energy costs are different in particular modes of transport. A challenge for the future is the consumption of energy which production runs with marginal costs amounting to quasi zero. There is potential on the planet to produce electrical energy almost without limit using renewable energy technologies. The current situation on the electrical energy market in Europe shows that there are some hours during the day that the offered energy is very cheap because the spot price falls to a level of about 30 per cent of the average price. The real full cost of production of electrical energy and its consumption (reported as the purchasing price) can become extremely low if the consumption takes place in the same location as the production. This could be the case if the production of hydrogen is decentralized.

The production of hydrogen would be possible only in a limited period of the day when renewable energy can be produced at the lowest (full) cost. The storage and transport of hydrogen will become safe and effective soon. Then the supply of hydrogen will be possible and efficient every time. The construction of storage infrastructure as the network of fuel stations covering the network of roads would be a prerequisite to let the consumption of hydrogen become popular.

In road transport the exchange of motor-cars with new electro-cars equipped with hydrogen technique would be warmly welcomed in accordance with modern climate and environmental policies. Let us assume that electro-cars equipped with hydrogen technique will be offered for a price acceptable for the majority of drivers. A limitation for the popularization of these kind of cars is then the rate of reinvestment in the fleet of light vehicles (cars used by households). The average rate amounts currently to about 5 per cent. It means that the quasi total exchange of the fleet in the world takes a minimum of 20 years taking into consideration the purely hypothetic scenario that the automotive industry starts producing only electro-cars with hydrogen technique.

The scenario of the quasi total exchange of the existing light vehicle fleet is unrealistic for the next decades due to the fact that the automotive industry does not plan to terminate the production of traditional motor-cars. Falling oil prices since 2014 make each alternative for motor-cars unattractive. Climate policy can lead the governments in several countries to sharply increase the excise tax on fluid or gaseous fuels but such regulation will create several negative consequences for the economic growth and prosperity.

Cargo transport creates very huge GHG emissions. If the generation of electric energy used in the electric traction by railways will change the technology, this emission will be reduced. This question might be solved outside the transport system. There are no new ideas how to reduce the GHG emission in the cargo road transport.

The current transport system is well established in the global economy and it makes this system resistant for revolutionary changes, including any changes in the field of energy consumption. This means that a significant reduction of the consumption of fluid and gaseous fuels in the transport system should not be expected any time soon. The consequence is a very limited possibility to reduce GHG emissions in the transport industry, while a significant reduction will perhaps be achieved in mid-term first of all in the commercial production of electrical energy as well as in the traditional industries and municipal engineering.

Literature

[1] Transforming Our World. *The 2030 Agenda for Sustainable Development,*