PROJECTIONS OF THE FUEL CONSUMPTION BY THE ROAD TRANSPORT IN POLAND

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Abstract

The article presents expert estimates for 2010 and a forecast up to year 2030 regarding the number of passenger cars as well as trucks and special vehicles and buses according to the maximum weight group. In case of trucks and special vehicles, included were vehicles with maximum weight of less than 3.5 Mg and maximum weight of more than 3.5 Mg. As regards buses – the condition and forecast number of buses with maximum weight of less than 5.0 Mg and more than 5.0 Mg was presented. The forecast concerning passenger cars and other types of vehicles with maximum weight of less than 3.5 Mg (5.0 Mg in case of buses) focused on the number of vehicles by type of energy. The following types of energy were included: petrol, diesel oil, LPG, NG and electrical energy in case of passenger cars and light duty trucks. Estimates also included the average annual statistical mileage of a vehicle registered in Poland according to the specified category and type of energy. Based on the assumed assumptions in the 2030 perspective – the average fuel consumption was determined per 100 km of statistical mileage in every specified category. The predicted consumption of respective types of energy by the overall Polish car fleet was calculated and according to the specified category in years 2015, 2020, 2025 and 2030.

Keywords: *transport, motor transport, vehicle, annual mileage, fuel consumption*

1. Introduction

Projected fuel consumption by road transport is considered in this paper for the following cumulative categories of motor vehicles [7, 18]:
- M1 – passenger cars,
- M2 – buses with the maximum mass less then 5 Mg (microbuses),
- M3 – buses with the maximum mass greater than 5 Mg,
- N1 – light duty vehicles with the maximum mass less then 3.5 Mg,
- N2 and N3 – trucks with the maximum mass greater than 3.5 Mg.

The following types of fuel were taken into consideration in the course of the study:
- gasoline – G,
- Diesel fuel – DF,
- liquid petroleum gas – LPG,
- natural gas as compressed natural gas – CNG and liquid natural gas – LNG, and gaseous biofuels: biogas fuel (bio-methane) as compressed and liquid.

As conventional, petroleum fuels, considered are in this paper: motor gasoline and diesel fuel. Motor gasoline is used to power spark-ignition engines of cars and light trucks.

Bio-fuels have environmentally friendly features [5, 7, 11], mainly due to the limited fossil carbon dioxide emission in the use of combustion engines [6, 13]).

The development of biofuels as self existing fuels is not very dynamic in Poland, which is due to the support for this initiative by the state only to a minimal extent required by EU legislation. Among the biofuels there should also be mentioned biogas fuel, but due to the nature of its use, it is considered in this paper together with the natural gas.

The forecast takes into account the increasing role of gas fuels used to power combustion engines of vehicles. This is not only for the environmental advantages of these fuels [1, 8, 17], but because of huge amount of natural gas resources, especially natural gas and – consequently – lower prices of gas fuels in relation to the prices for liquid petroleum fuels.

Liquid petroleum gas is used primarily to power the dual fuel spark ignition engines of passenger cars.

Natural gas, and also biogas fuels are so far still used for combustion engines to a small extent, as a result of, i.a. poorly developed distribution network of natural gas and biogas fuel. The most common solution is the combustion engine with spark ignition.

The forecast has not considered the electricity consumed by passenger cars. The scale of the electric cars development in Poland is now marginal, despite currently already available on the market cars with this type of drive. It is estimated that in 2011 there were a few dozens of electric cars registered in Poland. Despite the environmental benefits of electric vehicles [9], in particular the radical reduction of emissions by these vehicles, one can not expect in the next few years, the fast growth of this mode of transport in our country. Electric cars, mainly because of their limited range, are now seen by potential users as uncertain means of transport.

2. Forecast of the number of vehicles in Poland by the 2030

Number of passenger cars registered in Poland at the end of 2010 amounted to 17,239.8 thousand. [7, 14]. The share of passenger cars in the structure of the transport work is dominant now and will be in the next twenty years. [3, 7]. Forecast of the total number of passenger cars in Poland by 2030 [4] indicates that their number, in the years 2010 to 2030 is expected to increase from 17.2 million to 20.5–22.7 million. In 2010, for passenger cars, 62% of the vehicles were equipped with spark-ignition engines. In the recent years a dynamic growth in the number of passenger cars with spark-ignition engines has been seen. For example, this share in 2005 was about 9% [7, 14], and by the end of February 2011 increased to approximately 25% [7, 14]. However, it is expected that after 2020 due to the technical complexity and rising prices of cars powered by self-ignition engines, their share in the passenger car category can decrease in Poland.

Poland has one of the leading places in the world in terms of the number of cars with engines fuelled by liquid petroleum gas. By the end of 2010 the number of passenger cars with installations of LPG in Poland amounted to 2477.6 thousand, and at the end of 2011, even 2615.3 thousand. [14]. The reason for the development of solutions for LPG systems are primarily lower operating costs of cars equipped with dual-fuel supply system compared to the costs of operating vehicles with gasoline-powered engines. It is predicted, however, that in the coming years, the price difference of liquid petroleum gas and gasoline can get reduced – this is due to, among others the project of European Union legislation.

Number of cars with engines powered by natural gas in the passenger car fleet structure in Poland is low. According to the data from the CEP database in 2009 this figure was 1,915 cars, representing 0.01% of the passenger car fleet registered in Poland [2, 7]. The main barrier to the development of the use of natural gas in the road transport in Poland is a small number of public gas distribution stations and the relatively high costs of adapting vehicles to run on this fuel, but there is ever clearer trend towards more intensive use of natural gas in the road transport, including also passenger cars.

Figure 1 shows the forecast number of passenger cars in Poland by the 2030 by type of energy sources.

Projected numbers of trucks by weight groups are mainly subject to the maximum projected haulage work by the Polish road transport and predicted average haulage work productivity of the statistical vehicle. According to current projections [3] in the period to 2030 the dominance of transport work carried out heavy truck fleet will continue. In 2030, about 95% of the haulage work of the Polish lorry road transport will be carried out by cars of a maximum mass exceeding

3.5 Mg. The forecast for 2030 total number of trucks in Poland should be about 3390 thousand, including the number of heavy goods vehicles with a maximum mass of less than 3.5 Mg – about 2510 thousand, and with a maximum mass exceeding 3.5 Mg – about 880 thousand.

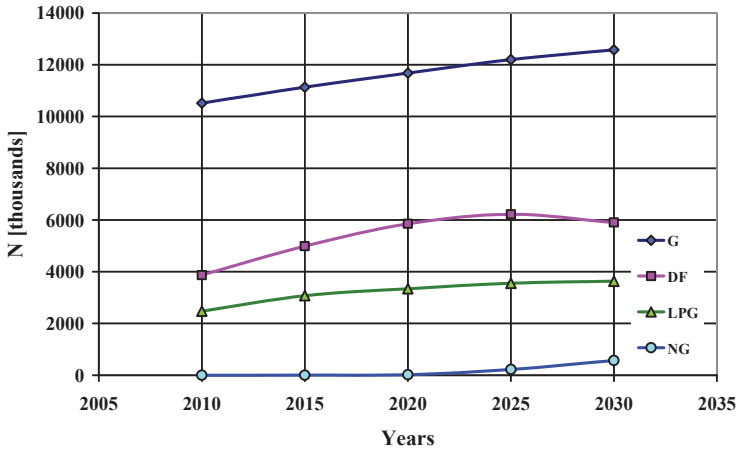

Fig. 1. Forecast of the numbers of passenger cars arranged by fuel type: G – gasoline, DF – diesel fuel, LPG – liquid petroleum gas, NG – natural gas

It is expected that in 2030 trucks with a maximum mass of less than 3.5 Mg and self-ignition engines will represent about 75% of this fleet (about 59% in 2010) [7]. It is assumed that the trend of declining share of cars with petrol engines in the structure of vehicles with a maximum mass of less than 3.5 Mg will be maintained. This share in 2030 will decrease to about 15% (about 33% in 2010) [7]. Dual fuel (petrol and LPG) supply systems for truck engines will still continue to develop, although the rate of change in this area will be smaller than in the first decade of the twenty-first century. It is expected that in 2030, their share in the structure of this fleet will be approximately 7% [7]. Expected development of natural gas distribution networks will allow increased use of the fuel in the automotive industry, including trucks with a maximum mass of less than 3.5 Mg. It is assumed that in 2030, approximately 3% of the truck fleet of this total weight will run on natural gas. [7].

Figure 2 shows the forecast number of heavy goods vehicles with a maximum mass of less than 3.5 Mg, classified according to the type of fuel criterion.

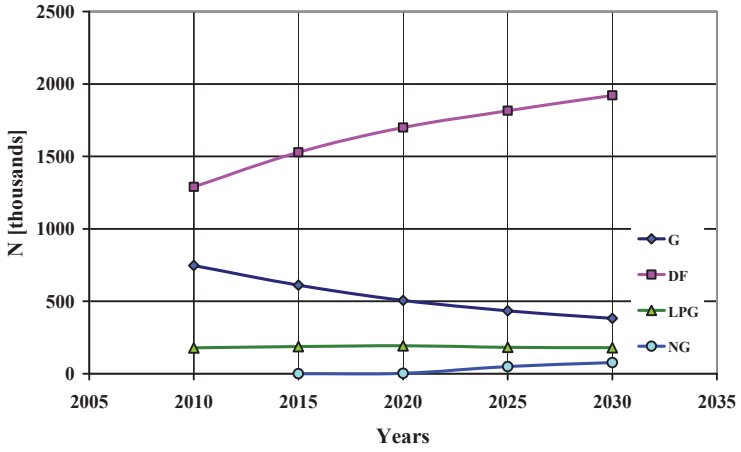

Fig. 2. Forecast of the number of light duty vehicles with a maximum mass less than 3.5 Mg and buses with a maximum mass less than 5 Mg, arranged by fuel type: G – gasoline, DF – diesel fuel, LPG – liquid petroleum gas, NG – natural gas

In 2010, the number of buses and special vehicles accounted for only 1% of the number of motor vehicles in Poland [14]. According to forecasts of demand for transport work [3], for the years 2010 to 2030 its decline is expected, although in the third decade of the century there should be some increase, mainly due to transport by extra urban buses. The forecast for the year 2030, number of buses with a maximum mass exceeding 5 Mg in Poland should be about 74.2 thousand [7], and with a maximum mass of less than 5 Mg about 8.2 thousand. [7]. Forecasting the number of buses with a maximum mass of less than 5 Mg according to the type of fuels, it was adopted (as in case of the forecast for trucks) that in 2030 about 75% of coaches of this group will be equipped with engines running on diesel fuel, 15 % – petrol, 7% – liquid petroleum gas and 3% natural gas. [7].

Figure 3 shows the forecast of the number of trucks and buses.

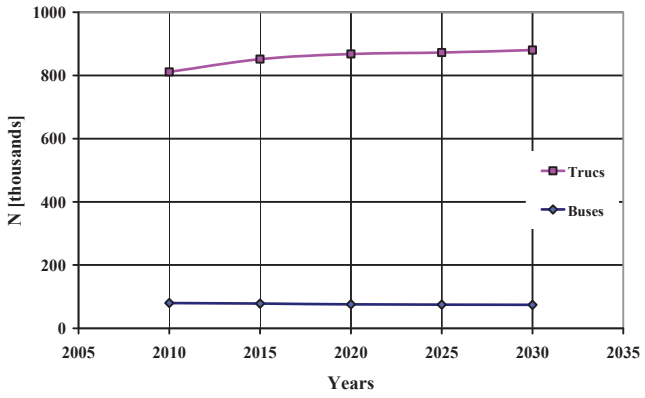

Fig. 3. Forecast of the number of trucks with a maximum mass greater than 3.5 Mg and buses with a maximum mass greater than 5 Mg

3. Forecast of the average annual mileages of vehicles in Poland by the 2030

Estimates of average annual vehicle mileages of the accumulated categories, taking into account an additional allocation in accordance with the fuel type used criterion is carried out at the Motor Transport Institute including the following values:

– transport work [3],
– the number of registered vehicles [3, 14],
– the average value of technical and operational indicators characterizing the road transport work (e.g. the average number of people in a car, the average rate of utilization of the rolling stock, etc) [3, 7].

To estimate the average annual mileages of vehicles the results of an ITS balancing are used of energy consumption by the road transport [19] and the studies results of the data from surveys at the vehicle inspection stations.

Estimated average annual car mileages for the individual categories are shown in Fig. 4–6.

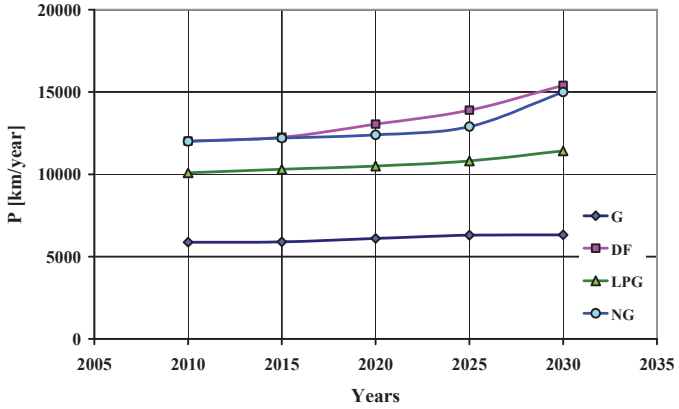

Fig. 4. Forecast of the average annual mileages of passenger cars by fuel type: G – gasoline, DF – diesel fuel, LPG – liquid petroleum gas, NG – natural gas

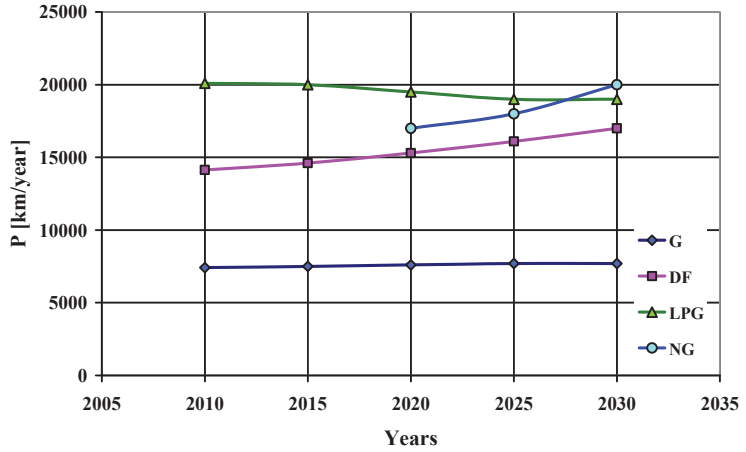

Fig. 5. Forecast of the average annual mileages of light duty vehicles with a maximum mass of less than 3.5 Mg and buses with a maximum mass less than 5 Mg, arranged by fuel type: G – gasoline, DF – diesel fuel, LPG – liquid petroleum gas, NG – natural gas

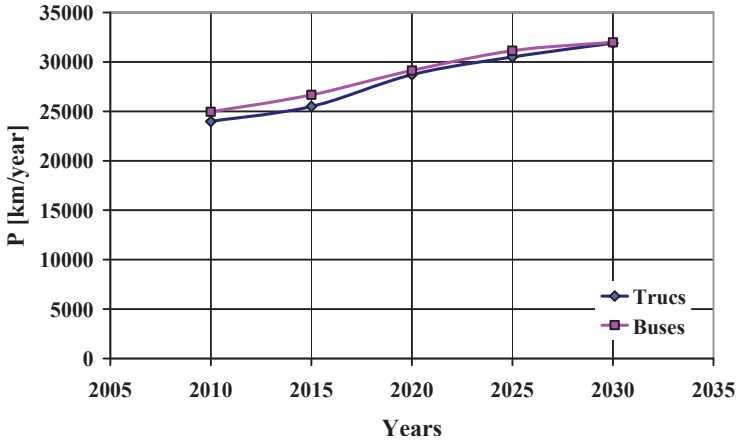

Fig. 6. Forecast of the average annual mileages of trucks with a maximum mass greater than 3.5 Mg and buses with a maximum mass greater than 5 Mg

4. Forecast of the average operation fuel consumption by vehicles in Poland by the 2030

Average operational fuel consumption (per 100 km of vehicles mileage) in Poland by the 2020 was estimated using the databases included in the INFRAS AG software [15] and the model of delaying motorism in Poland in relation to the state in Western Europe [10] – Fig. 7. For the years 2025 and 2030 the average operational fuel consumption was determined using extrapolation.

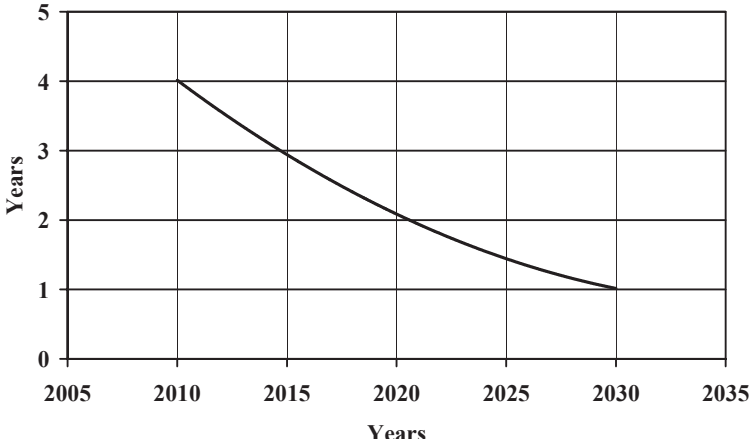

Fig. 7. Model of the delay of the Polish motorism compared to Western Europe

Average operational consumption of LPG engines of passenger cars was adopted on the assumption that it is about (20-25)% greater than of gasoline. This is due to the fact that usually it is the vehicles with an engine displacement of a large volume (and thus a relatively high fuel consumption) are and will be in future years adapted to run on gas fuels.

In the case of the average operational natural gas consumption the conversion was assumed in relation to the petrol consumption: 1.1 Nm^3 CNG is an equivalent to 1.0 dm^3 petrol [7].

5. Forecast of the total fuel consumption by vehicles in Poland by the 2030

The course of the projected total fuel consumption by cars in Poland by the 2030 is shown in Fig. 8.

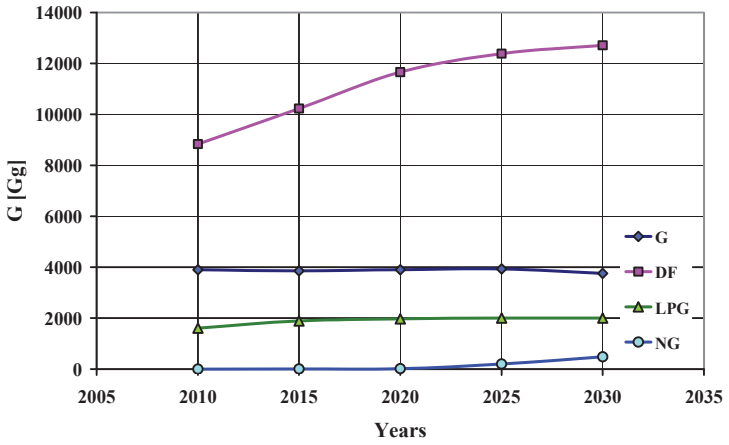

Fig. 8. Forecast of the total fuel consumption: G – gasoline, DF – diesel fuel, LPG – liquid petroleum gas, NG – natural gas

Total petrol consumption will remain almost constant at about 4000 Gg. The significant increase in the total consumption of diesel fuel is forecast – a relative increase of the total diesel consumption is more than 40%. It is expected that from 2015 the total consumption of LPG will remain practically constant. A significant increase in the total consumption of natural gas is expected after 2020.

6. Conclusions

The forecasts of the fuel consumption by motor vehicles in Poland by the 2030 show significant stabilization of the total consumption of petrol and LPG and the strong upward trend of the total consumption of diesel oil and natural gas (and biogas fuel). Political pressures to reduce greenhouse gases emissions give rise to increasing total consumption of bio-fuels One ought to expect the use of other substances resulting from the biomass processing for the composition of liquid fuels.

Prognostic predictions are based first of all on the likely course of events influencing the development of this phenomenon. For this reason, with changing over time various factors that determine the subject of predictions, the periodic updating is appropriate. This is clearly evident in the case of forecasting fuel consumption by motor vehicles. Therefore, the projection of the demand for energy sources by the Polish car fleet should be updated in the coming years. The document for the revision of the forecasts of demand for energy sources is a draft regulation being prepared by the Council of Ministers on the scope of information that should be included in the projections of the activity for the individual sectors of the economy. Upcoming Regulation represents an implementation of the authorization contained in Art. 9 paragraph 3 of the Act of 17 July 2009 on the management of emissions of greenhouse gases and other substances. These documents testify the need to develop future versions of the demand for energy sources every five years.

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