

## Experts forecasts on the demand for energy carriers in motor vehicle transport in Poland up to year 2035

*Presentation of the number of passenger cars, vehicles other than passenger cars with GVM up to 3.5 tons and above 3.5 tons (trucks, buses and special vehicles), registered in Poland as at the end of 2015, with types of energy carriers. Forecasts of transport performance of the vehicle fleet and the forecast of the fleet volume in Poland by year 2035. Expert forecasts of energy carriers consumption (petrol, diesel oil, LPG, CNG, electric power, hydrogen) up to year 2035.*

Key words: energy, forecast, vehicle, transport, passenger cars

### 1. Introduction

Forecasts of the demand for energy carriers (activities) by motor transport basically arise from the draft Ordinance of the Council of Ministers of 23 December 2011 regarding the scope of information to be included in forecasts of changes in activity in respective sectors of industry. As a result, the Ministry of Infrastructure – among others – is required to submit a forecast to fulfil the authorisation laid down in Art. 9 (3) of the Act on the management of greenhouse and other substances emissions of 17 July 2009 (Journal of Laws of 2017, item 2.8.6).

Exhibit no. 17 to the draft ordinance relating to the scope of the 20-year forecast of the activity of road transport as volumes characterising the said activity lists the following:

- consumption of fuels by passenger cars, including:
  - petrol [Mg], diesel oil [Mg], liquified gas (LPG) [Mg], biodiesel [Mg],
  - bioethanol [Mg], natural gas (LNG) [Mg], electrical energy [MWh], hydrogen [Mg],
- consumption of fuels by vehicles other than passenger cars with mass up to 3.5 tons, including:
  - petrol [Mg], diesel oil [Mg], liquified gas (LPG) [Mg], biodiesel [Mg],
  - bioethanol [Mg], natural gas (LNG) [Mg], electric energy [MWh], hydrogen [Mg],
- consumption of fuels by vehicles with mass above 3.5 tons, including: diesel oil, biodiesel.

The scope of forecasts relates to every group of vehicles separately (as listed in Exhibit no. 17 to the draft Ordinance), i.e.:

- passenger cars,
- vehicles other than passenger cars with mass up to 3.5 tons,
- vehicles with mass above 3.5 tons.

This publication focuses on experts' forecasts of the demand for energy carriers by the Polish vehicle fleet [1] up to year 2035.

The specified group of “vehicles other than passenger cars with mass up to 3.5 tons” includes the following sub-groups:

- trucks with GVM up to 3.5 tons,

- special vehicles with GVM up to 3.5 tons,
- buses with GVM up to 3.5 tons,
- “Vehicles with mass above 3.5 tons” includes the following sub-groups:
  - trucks with GVM above 3.5 tons, including trucks with trailers,
  - buses with GVM above 3.5 tons (country, city, tourist),
  - special vehicles with GVM above 3.5 tons (with a different usage range).

The forecasts of the consumption of energy carriers was prepared based on the methodology proposed by MTI and adopted by the Department of the Transport Policy & International Affairs of the Ministry of Transport, Construction and Marine Economy in 2011 [2, 8].

The applied method of predicting the demand for energy carriers by the Polish vehicle fleet in relevant years of the forecast must consider three primary factors determining the volume of the demand and relating to specified sub-groups of vehicles, i.e. forecasts of the number of vehicles, forecasts of average annual mileage of vehicles, forecasts of average consumption of energy carriers per 100 km of mileage.

This publication uses the results of the forecasts of demand for transport services in Poland by year 2030 made at the Gdańsk University in 2017. Anticipating the development of the sector's activity in 2035, the trends for years 2015-2030 were used expertly, those trends quantified in the cited forecast paper. The aforementioned forecast comprises numbers of registered vehicles in Poland as at the end of 2015 quoted by official statistical sources – the Main Statistical Office [GUS]. Those data have been determined based on the data of the Central Vehicles Register (CEP). When balancing the fuels (petrol, diesel oil and LPG) consumed by motor transport in 2015, the balance values provided by KOBiZE [The National Centre for Emissions Management] have been used [3].

### 2. Forecast of the number of vehicles by types of energy carriers

#### 2.1. Passenger cars

Considering – among others – the general predicted data regarding passenger cars (“pessimistic variant of the prog-

nosis of the Gdańsk University of 2017) and considering the conditions and assumptions adopted by the experts as regards the development of the fleet of passenger cars in Poland in terms of number in a breakdown into types of energy carriers up to year 2035, the forecast numbers of passenger cars was presented (Fig. 1).

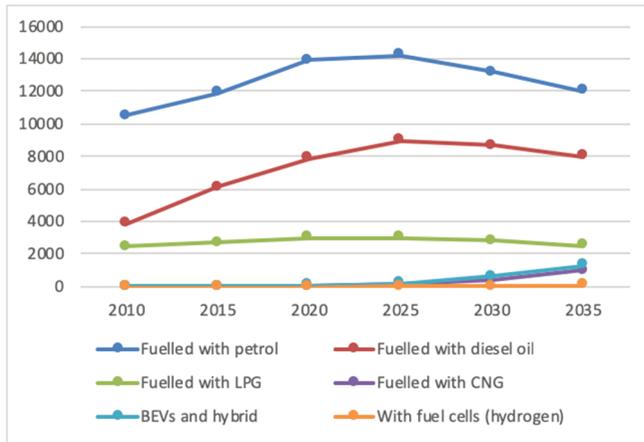


Fig. 1. Forecasted number of passenger cars in Poland up to year 2035 by types of energy carriers [in thousands]

According to the forecasts within the period of the forecast passenger cars equipped with petrol engines and cars fuelled with diesel oil would continue to dominate in Poland, however their share in the structure of the total passenger cars fleet is expected to drop. It is also expected that passenger cars equipped with engines fuelled with natural gas will develop. Similarly, the share of electrical vehicles and hybrids is expected to grow, with PHEV (plug-in) among hybrid vehicles in the 2035 perspective.

## 2.2. Vehicles other than passenger cars according to GVM groups

The number of vehicles other than passenger cars with GVM up to 3.5 tons in forecasts up to year 2035 according to types of energy carriers is shown in graph 2 below.

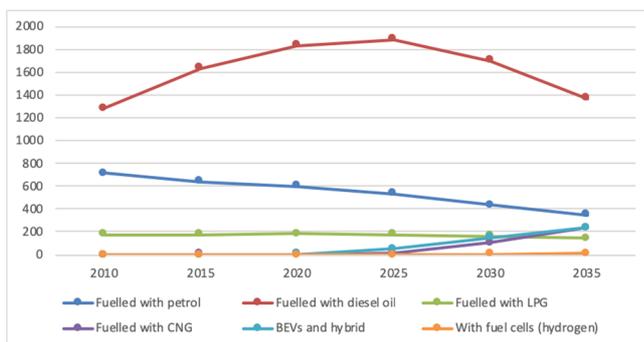


Fig. 2. Forecasts of number of vehicles other than passenger cars with GVM up to 3.5 tons by types of energy carriers in Poland up to year 2035

The number of trucks and buses in the forecasts up to year 2035 was determined based on the volume of the predicted transport performance [4] of those vehicles and the predicted average transport efficiency of statistical vehicles.

In 2015 the motor truck fleet with GVM up to 3.5 tons accounted for approx. 71% of the overall number of trucks

registered in Poland. The forecast assumes that the share of vehicles with petrol-fuelled engines in the structure of trucks with 3.5-ton GVM is expected to continue falling as well as that of vehicles with bi-fuel engines.

The expected development of the natural gas distribution network will allow for increasing the use of that fuel in motor transport, including also trucks with up to 3.5 tons GVM.

It is expected that within the period of the forecast the use of electrical and hybrid (combustion-electrical) vehicles [5, 9] should to some extent increase in the fleet of trucks with GVM up to 3.5 tons. Those vehicles will be used mainly as delivery vehicles in areas inaccessible (due to administrative decisions) to diesel-fuelled vehicles.

The 2035 forecast also assumes a minor share of trucks with GVM up to 3.5 ton with fuel cells powered with hydrogen.

The share of trucks with GVM up to 3.5 tons fuelled with diesel oil is expected to dominate but will tend to drop.

From 2025 onwards, considering the forecasted increase in the demand for bus transport services in country transport and the statutory obligation of local authorities to provide public transport in towns presently devoid of public transport, the number of buses with GVM up to 3.5 tons is expected to increase to a certain extent.

As regards buses with GVM up to 3.5 tons, the number of petrol-fuelled buses and buses equipped with bi-fuel engines (LPG) will definitely decrease in the structure of the registered buses fleet. The said fuelling system will be replaced gradually by natural gas fuelling (CNG and LNG). The relatively dynamic development of buses with GVM up to 3.5 tons fuelled with natural gas and electrical and hybrid (combustion – electric) buses stems mainly from the administrative requirements shaped by environmental factors, i.e. limited access to chosen zones for vehicles with conventional combustion engines.

In 2015 among special vehicles with GVM up to 3.5 tons, vehicles with petrol-fuelled engines accounted for 2/2 in the fuel structure of the vehicle fleet. In the period of the forecast the share of vehicles with engines fuelled with natural gas (CNG and LNG) and BEVs or hybrid vehicles (with combustion – electric engines) is assumed to increase.

As regards trucks with GVM above 3.5 tons it is expected that this category of vehicles will be equipped – within the period of the forecast – mostly with diesel-fuelled engines with a minor share of natural gas and electric energy (2–3%).

As regards buses with GVM above 3.5 tons, considering the EU policy aimed at achieving high environmental standards, over the period of the forecast among energy carriers the importance of natural gas (CNG and LNG) and electric energy is expected to grow. Except that natural gas (also biomethane) – besides diesel oil – will be used in city and country bus transport, whereas electric energy will be used mainly in city transport (BEV and hybrid buses) owing to efforts to limit combustion emissions in the area of – e.g. city centres. However, it should be noted that in the general balance of exhaust gases emission the use of vehicles with electric engines when electrical energy is and will be produced in Poland chiefly from coal, is not favourable for the environment.

Buses fuelled with natural gas characterise with very good combustion emission parameters and moreover – are much more cost-effective compared to the presently promoted electrical buses [6]. Art. 64 (4) of the draft Act on Electromobility stipulates that in 2028 every third bus in city transport should be an electric bus. Electric vehicles – according to the provisions of the draft act – also include hybrid vehicles (with combustion & electric engines).

Because of the safety issue, i.e. the reliability of the city bus transport – in the opinion of city transport specialists’ electrical buses in the bus fleet should not be expected to account for more than 1/3. This matter relates to BEV buses.

Apart from the aforementioned energy carriers the use of which most likely will grow in the forthcoming decades, attention should be given to hydrogen. Hydrogen is a fuel used – among others – in city bus transport to power fuel cells producing electric energy used by electric engines, in this case – buses. According to Polish expert opinions as many as 100 buses with fuel cells may be used in 2030 in Poland [7].

In 2015 among a total number of 134.3 thousand special vehicles registered in Poland with GVM above 3.5 tons, just 0.1% was fuelled with methane (CNG). By 2035 the use of that fuel is expected to increase considerably in special vehicles with GVM above 3.5 tons, i.e. up to 15% of the said fleet.

The number of vehicles other than passenger cars with GVM above 3.5 tons according to forecasts up to year 2035 by types of energy carriers is shown in Fig. 3.

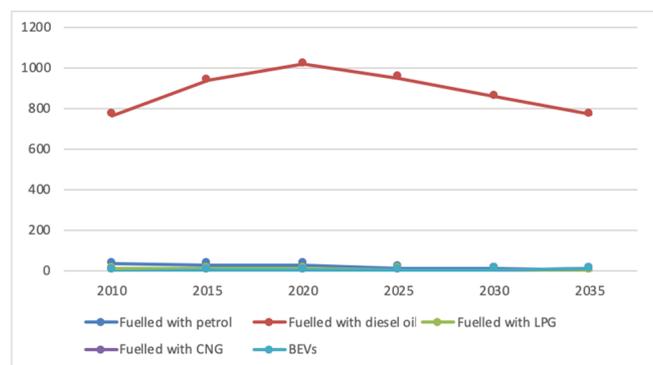


Fig. 3. Number of vehicles other than passenger cars with GVM above 3.5 tons by types of energy carriers in Poland in 2010 and 2015 and in the forecast up to year 2035

### 3. Forecasts regarding the need for energy carriers

A summary of the results of the estimated energy carrier’s consumption by the Polish vehicle fleet in 2015 and experts’ forecasts in this respect up to year 2035 are presented in Table 1.

### 4. Conclusions

Conclusions following the experts forecast of the demand for energy carriers of the Polish vehicle fleet in 2035 in view of the accepted assumptions are as follows:

- the demand for petrol is expected to come to approx. 3835 Gg and show a falling tendency,
- the demand for diesel oil is expected to amount to c.a. 10780 Gg and will also show a falling tendency,
- the demand for liquified petroleum gas (LPG) is expected to come to approx. 1360 Gg and show a falling tendency,
- the demand for natural gas in 2035 is estimated at roughly 1780 Gg and will be greater than the demand for LPG,
- the demand for hydrogen to power fuel cells in EVs equipped with such cells may account for as much as 37 Gg,
- the demand for electric energy to charge batteries in BEVs is expected to be equal to approx. 4806 GWh in 2035.

The mass of bio-components of fuels, i.e. esters of plant oils (biodiesel and bioethanol) – estimated and presented in Table 1 – is included respectively in the demanded mass of diesel oil and petrol to fuel motor engines estimated for 2015 and forecasted up to year 2035.

Table 1. Summary of the results of estimates regarding the consumption of energy carriers by the Polish vehicle fleet in the year 2035

Characteristics feature		Unit	2015	Forecast			
				2025	2030	2035	
Transport services	Trucks	mln tkm	273107	328000	329000	329000	
	Buses	mln pas km	51500	42600	51700	57800	
	Passenger cars	mln pas km	221000	307000	313000	340000	
Passenger cars	Petrol	Gg	3196	3887	3789	3741	
	Diesel oil	Gg	3413	4942	4797	4430	
	LPG	Gg	1261	1391	1317	1182	
	Biodiesel	Gg	341	692	768	797	
	Bioethanol	Gg	160	544	644	748	
	Natural gas	Gg	4	101	271	681	
	Electric energy	GWh	11	341	1189	3175	
	Hydrogen	Gg	0	0.3	4.5	30	
	Vehicles other than passenger cars with mass up to 3.5 tons	Petrol	Gg	179	135	112	93
		Diesel oil	Gg	1546	2280	2281	2025
LPG		Gg	210	227	210	183	
Biodiesel		Gg	155	308	342	334	
Bioethanol		Gg	9	19	19	19	
Natural gas		Gg	3	26	211	535	
Electric energy		GWh	1.3	193	701	1306	
Hydrogen		Gg	0.00	0.02	0.27	2.70	
Vehicles with mass above 3.5 tons	Diesel oil	Gg	4325	4653	4585	4323	
	Biodiesel	Gg	432	628	688	713	
	Natural gas	Gg	9	60	241	561	
	Hydrogen	Gg	0	0	1.3	4.1	
	Electric energy	GWh	15	73.1	185.3	325.8	
Consumption of energy carriers by the vehicle fleet in total	Petrol	Gg	3375	4023	3901	3835	
	Diesel oil	Gg	9284	11875	11663	10778	
	LPG	Gg	1471	1617	1527	1364	
	Biodiesel	Gg	928	1603	1749	1778	
	Bioethanol	Gg	169	563	663	767	
	Natural gas	Gg	16	187	722	1777	
	Electric energy	GWh	27	607	2075	4806	
	Hydrogen	Gg	0	0.32	6.0	36.8	

### Nomenclature

BEV Battery Electric Vehicle  
 CEP Central Vehicles Register  
 CNG Compressed Natural Gas  
 EV Electric Vehicle

GUS the Main Statistical Office  
 GVM Gross Vehicle Weight  
 LPG Liquefied Petroleum Gas

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Wojciech Gis, DSc., DEng. – Prof. ITS, Motor Transport Institute.  
e-mail: [wojciech.gis@its.waw.pl](mailto:wojciech.gis@its.waw.pl)



Jerzy Waśkiewicz, DSc., DEng. – Motor Transport Institute.  
e-mail: [jerzy.waskiewicz@its.waw.pl](mailto:jerzy.waskiewicz@its.waw.pl)



Maciej Menes, MSc. – Motor Transport Institute.  
e-mail: [maciej.menes@its.waw.pl](mailto:maciej.menes@its.waw.pl)

