METHODOLOGY OF FORECASTING AND FORECAST OF DEMAND FOR ENERGY CARRIERS BY LORRIES IN POLAND UP TO THE YEAR 2020 (PART II)

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Abstract

Discussed methodology of forecasting and forecast of demand for energy carriers have been presented in two parts. In first part has been given forecast of freight road transport volumes up to the year 2020. Estimated structure of the fleet in the initial period of the forecast. Variant forecast of the fleet size and its structure according to categories and age. In this part has been given forecast of demand for energy carriers by lorries. When forecasting the scale of demand for individual energy carriers by lorries in a given year, the following issues were taken into account: estimated numbers of vehicles registered according to categories and production periods, an estimated average consumption of fuels per 100 km of mileage according to specified categories of vehicles and their production periods, estimated average annual mileages of vehicles according to categories and production periods. A drop in the use of petrols by lorries in Poland is expected to have taken place by the year 2020. The estimated forecast level amounts to 315-325 Gg. The use of petrols in 2020 would decrease to the level of 55-57% of the consumption in the initial period of the forecast. An estimated increase in the demand for diesel fuels by lorries is expected to take place in Poland in 2020 and it is envisaged to reach the level of 5848-7680 Gg, which compared to the consumption in the initial period of the forecast, would be tantamount to an increase dynamics of 170-223%. The demand for LPG fuels by lorries in 2020 should amount to 264-287 Gg, (an increase of 147-160% compared to the initial period of the forecast). The demand for CNG fuel by lorries in 2020 would reach 61-68 Gg.

Keywords: *Lorries, energy consumption, forecast*

1. Introduction

Each and every modern transport policy has to take into account, besides the undeniable advantages, the problem of a destructive impact motor transport has on the environment. In search for a rational compromise, transport policy makes references to the principles of the so called sustainable development (French: development durable), understood, in the broadest possible terms, as meeting current needs in such a way so as not to inhibit future generations from satisfying their needs.

What poses a threat to sustainable development understood as referred to above, a threat generated by motor transport in the first place, is increasing use of oil-based fuels as well as contamination of the atmosphere due to pollutants emitted from combustion engines. (Motor transport is responsible among others for the vast portion of the estimated 30% of greenhouse gas emissions).

One of the basic challenges facing transport policy is limiting energy consumption by the road transport as well as curbing the level of emissions resulting from such consumption. Forecasting energy and ecological results of road transport development is significant in arriving at comprehensive evaluations pertaining to further development of this branch of transport, especially in view of current and future undertakings of the transport policy pursued by the state.

Hence, ITS (Motor Transport Institute) had developed a research and forecasting methodology

pertaining to measuring the demand for energy carriers in connection with the expected development of freight road transport. ITS has also developed means of verifying such methodology under specific domestic conditions.

The developed methodology of forecasting and a variant forecast up to the year 2020 refers to the following demand for energy carriers by lorries.

2. Forecast of demand for energy carriers by lorries

When forecasting the scale of demand for individual energy carriers by lorries in a given year, the following issues were taken into account:

- estimated numbers of vehicles registered according to categories and production periods,
- an estimated average consumption of fuels per 100 km of mileage according to specified categories of vehicles and their production periods,
- estimated average annual mileages of vehicles according to categories and production periods.

The sum of products of these amounts for each kind of energy carrier reflects an annual demand for fuels.

Average fuel consumption per 100 km of mileage of the respective lorry category for the forecast period was estimated on the basis of general premises resulting from the observed trends in technology as well as taking into account expected changes in the load structure of individual categories constituting the fleet of lorries. (Tab. 1).

Tab. 1. Forecast average consumption of fuels per 100 km of mileage according to specified categories and production periods (l/100km)

No.	Vehicle category	Average fuel consumption per 100 km of vehicle In produced in years						
1	Lorries of up 3.5 t GVW							
1.1	Including: positive ignition	13.5	12.0	8.1	8.1	8.1	8.0	7.9
1.2	compression ignition	9.3	8.3	8.0	8.0	7.8	7.7	7.6
1.3	LPG	-	14.5	13.9	13.1	13.1	13.0	12.7
1.4	CNG	-	0.0	0.0	0.0	10.0	9.8	9.7
1.5	two stroke	9.0	-	-	-	-	-	-
2	Rolling stock of more than 3.5 t GVW							
2.1	Including: compression ignition from over 3.5 t to 16.0 t GVW	23.0	22.0	21.5	21.5	21.5	21.2	20.9
2.2	compression ignition over 16.0 t GVW	34.0	33.0	31.0	31.0	31.0	30.5	30.0

Source: Research Task No 4 entitled „Forecast of the demand energy carriers by freight road transport" at ITS No. 9537/ZBE, Warsaw, 2006

When estimating average annual mileages of lorries according to the respective categories in the selected years of a given forecast, the following issues were taken into account:

- average annual efficiency of freight road transport volumes,
- an average weight of the transported load (calculated as the product of an average load capacity and an average indicator of the utilization of the load capacity),
- an average indicator of using the mileage.

An average annual mileage of a lorry of a given category was calculated as a quotient of an average annual transport capacity of a lorry, an average weight of the transported load and an average indicator of using the mileage. The average annual mileages calculated in this way were used in balancing average annual mileages of the specified lorry categories according to their

production periods. It was assumed that older vehicles were characterized by lower average annual mileages in comparison with the newer ones.

It was also assumed that average annual mileages of lorries in the forecast period should in principle increase together with the increase in the transport tasks, due to, among other factors, an estimated increase in the average distance of the transport. A decrease in the average annual mileages will probably be observed only in the vehicles category of the maximum total weight of up to 3.5 t, equipped with compression - ignition engines. The pace of increase will vary according to the forecast variant.

An average annual mileage of a statistical lorry of the GVW of up to 3.5 t in the period up to 2020 (compared with the initial period of the forecast) should go up by about 12% and amount to about 14.8 thousand km in 2020. Whereas an average annual mileage of a statistical lorry of the GVW in excess of 3.5 t should go up (depending on the forecast variant) by 40-47% and reach the level of 31.2-32.7 thousand km/year (Tab. 2-3).

Tab. 2. Forecast of average annual mileages of lorries according to specified categories (developmental variant ((km)

No.	Vehicle category	2004	2010	2015	2020
1	Lorries of up 3.5 t GVW	13223	14011	14538	14796
1.1	Including: positive ignition	9227	9382	9600	9921
1.2	compression ignition	17625	17081	16429	16130
1.3	LPG	16833	16899	16967	17036
1.4	CNG	0	0	17356	17544
1.5	two stroke	0	0	0	0
2	Rolling stock of more than 3.5 t GVW	22322	26537	29367	32720
2.1	Including: compression ignition from over 3.5 to 16.0 t GVW	11460	13447	15330	17954
2.2	compression ignition over 16.0 t GVW	45166	4906	5325	5771

Source: Research Task No 4 entitled „Forecast of the demand energy carriers by freight road transport" at ITS No. 9537/ZBE, Warsaw 2006.

Tab. 3. Forecast of average annual mileages of lorries according to specified categories (non-developmental variant ((km)

No	Vehicle category	2005	2010	2015	2020
1	Lorries of up 3.5 t GVW	13223	14032	14561	14799
1.1	Including: positive ignition	9227	9382	9600	9921
1.2	compression ignition	17625	17081	16429	16130
1.3	LPG	16833	16899	16967	17036
1.4	CNG	0	0	17356	17544
1.5	two stroke	0	0	0	0
2	Rolling stock of more than 3.5 t GVW	22322	25928	28259	31181
2.1	Including: compression ignition from over 3.5 to 16.0 t GVW	11460	13815	16380	18943
2.2	compression ignition over 16.0 t GVW	45166	46520	48214	51530

Source: Research Task No 4 entitled „Forecast of the demand energy carriers by freight road transport" at ITS No. 9537/ZBE, Warsaw 2006.

Calculations made on the basis of the adopted assumptions point to the fact that due to an increased freight road transport volumes according to the non-developmental variant, as well as

due to lower or similar (in some vehicle categories) average efficiency of the vehicle`s transport volumes and lower indicators of using load capacity and mileage as well as due to increased numbers of the estimated vehicle fleet, average annual vehicle mileages will be lower in this variant than the corresponding values in the developmental variant of the forecast. Total mileages of the lorry fleet will be bigger for the non-developmental forecast variant.

An estimated demand for fuels by lorries in the years 2010, 2015 and 2020 according to specified categories were calculated in each of the variants on the basis of the adopted assumptions. (Tab. 4-5).

Tab. 4. Forecast of fuel consumption by lorries according to specified categories (developmental variant) (Gg)

No	Vehicle category	2005	2010	2015	2020
1	Lorries of up 3.5 t GVW	1653	1750	1918	2133
1.1	Including: positive ignition	571	443	341	315
1.2	compression ignition	904	1072	1298	1493
1.3	LPG	179	235	255	264
1.4	CNG	0	0	24	61
1.5	two stroke	0	0	0	0
2	Rolling stock of more than 3.5 t GVW	2534	3571	3996	4355
2.1	Including: compression ignition from over 3.5 to 16.0 t GVW	675	879	1008	1162
2.2	compression ignition over 16.0 t GVW	1859	2692	2988	3194

Source: Research Task No. 4 entitled „Forecast of the demand energy carriers by freight road transport" at ITS No. 9537/ZBE. Warsaw 2006

Tab. 5. Forecast of fuel consumption by lorries according to specified categories (non-developmental variant) (Gg)

No	Vehicle category	2005	2010	2015	2020
1	Lorries of up 3.5 t GVW	1653	1775	1966	2202
1.1	Including: positive ignition	571	446	346	325
1.2	compression ignition	904	1083	1316	1522
1.3	LPG	179	246	278	287
1.4	CNG	0	0	27	68
1.5	two stroke	0	0	0	0
2	Rolling stock of more than 3.5 t GVW	2534	3888	4846	6158
2.1	Including: compression ignition from over 3.5 to 16.0 t GVW	675	1007	1369	1834
2.2	compression ignition over 16.0 t GVW	1859	2881	3478	4324

Source: Research Task No 4 entitled „Forecast of the demand energy carriers by freight road transport" at ITS No 9537/ZBE, Warsaw 2006.

A drop in the use of petrols by lorries in Poland is expected to have taken place by the year 2020. The estimated forecast level amounts to 315-325 Gg. The use of petrols in 2020 would decrease to the level of 55-57% of the consumption in the initial period of the forecast.

An estimated increase in the demand for diesel fuels by lorries is expected to take place in Poland in 2020 and it is envisaged to reach the level of 5848-7680 Gg, which compared to the consumption in the initial period of the forecast, would be tantamount to an increase dynamics of 170 - 223%.

The demand for LPG fuels by lorries in 2020 should amount to 264-287 Gg, (an increase of 147-160% compared to the initial period of the forecast). The demand for CNG fuel by lorries in 2020 would reach 61-68 Gg.

3. Variant forecast of energy consumption by freight road transport up to 2020

An average amount of energy consumed by freight road transport in the initial period of the forecast is estimated at about 1668 TJ/10^{12} tonne-kilometres. An average forecast energy consumption in 2020 should amount to 1411-1756 TJ/10^{12} tonne-kilometres (Tab. 13.). According to the developmental variant, energy consumed by freight road transport in 2020 would account for about 90% of the energy consumption in the initial period of the forecast. According to the non-developmental variant of the forecast, energy consumed by freight transport would total about 113% of the energy consumed in the initial period of the forecast.

Tab. 6. Variant forecast of energy consumption by freight road transport by 2020

Specification		2004	2010		2015		2020	
			dev. variant	n-d variant	dev. variant	n-d variant	dev. variant	n-d variant
Use of energy carriers (Gg)		4187,5	5321,2	5663,0	5913,5	6812,4	6488,4	8360,1
including:								
Petrol		570,7	443,3	445,5	340,8	345,6	314,7	325,4
Diesel oil		3438,2	4643,0	4971,1	5293,3	6162,0	5848,2	7679,9
LPG		178,6	234,9	246,4	254,9	277,9	264,1	287,2
CNG		0,0	0,0	0,0	24,5	26,9	61,5	67,6
Use of energy carriers (TJ)	Calorific value (GJ/t)	184380	234624	249716	260936	300619	286399	368985
including:								
Petrol	43	24540	19063	19158	14655	14862	13531	13994
Diesel oil	44,1	151625	204755	219224	233434	271742	257905	338682
LPG	46	8216	10806	11334	11726	12783	12147	13212
CNG	45,8				1122	1232	2816	3098
Freight road transport values 10^{12}tkm		110,5	142,5	143,2	164,2	166,7	190,2	196,4
Energy consumption	Gg/10^{12}tkm	37,9	37,3	39,5	36,0	40,9	34,1	42,6
of transport	TJ/10^{12}tkm	1668,6	1646,5	1743,8	1589,1	1803,4	1505,8	1878,7

Source: Research Task No 4 entitled "Forecast of the demand energy carriers by freight road transport" at ITS No 9537/ZBE, Warsaw, 2006

Diversification according to variants of energy consumption by freight transport envisaged for the forecast period depends upon the adopted set of organizational, economic and technical conditions in transport and its environment, which are expected to come up in the near future and the impact of which was taken into account during implementation of the task in question.

4. Conclusions

In 2020, depending on the forecast variant, one envisages the following demand for energy carriers by lorries registered in Poland:

- petrol 315 - 325 Gg
- diesel oil 5848 - 7680 Gg
- LPG 264 - 287 Gg
- CNG 62 - 68 Gg.

Total energy demand necessary to perform freight transport in 2020 is estimated at 286400 - 369000 TJ.

Compared to 2004 an increase in energy demand in the discussed area will not exceed 155-200% (depending on the assumptions of the forecast variant).

Energy consumed during performance of freight transport by lorries in 2020 should reach the level of 1506-1879 TJ/10^{12} tonne-kilometres. Compared to energy consumption in 2004, this would constitute a decrease by 10% in the developmental variant and an increase by 13% in the non-developmental variant.

The forecast decrease in energy consumption by lorries will result predominantly from organizational factors, reflected by improved technical and usage indicators of freight road transport and an expected modernization of the fleet.

Presented results of the forecast consumption of fuels and emissions from combustion engines of the lorries registered in Poland are obviously of purely indicative character.

Improvement of forecast results pertaining to energy carriers demand and to the amounts of energy consumed during transport carried out by lorries requires further studies and research.

References

[1] Menes, E., Waśkiewicz, J., Gis, W., *Research project supervised by Dr. Edward Menes entitled*, Sustainable development of motor transport in Poland, Research project No. 4 T12C 037 28, Motor Transport Institute, September, Warsaw 2006.

[2] Waśkiewicz, J., Zakrzewski, B., *Vehicles in road transport in Poland in 2005 and and their average annual mileages in the context of pollutants emissions from combustion engines*, Part 2, Estimated average annual mileages of the vehicle fleet according to specified categories, ITS Paper No 6607/ZBE, Warsaw 2006.

[3] Lorries` approval research carried out at the Motor Transport Institute.