ANNALS OF FACULTY ENGINEERING HUNEDOARA
– International Journal of Engineering
Tome XI (Year 2013) – FASCICULE 3 (ISSN 1584 – 2673)

[1.] Arina NEGOIȚESCU, [2.] Adriana TOKAR

THE ESTIMATION OF ELECTRIC VEHICLE IMPACT ON CO_2 EMISSIONS REDUCTION

[1-2.] UNIVERSITY POLITEHNICA OF TIMIȘOARA, ROMANIA

ABSTRACT: *In this paper, we carried out an analysis to estimate CO_2 emissions discharged into the atmosphere by cars composing the car fleet that run on public roads in Romania. For this purpose, we have considered two types of cars, namely petrol engines, and diesel respectively. The calculation was performed for the total number of existing cars in Romania, in 2010, depending on the mileage and fuel consumption, having the total amount of CO_2 discharged into the atmosphere by them as result. To reduce the amount of emissions was proposed as a solution, the electric car. It was calculated in this way, the amount of CO_2 discharged into the environment in the process of electricity production required to power up this type of car. In the end, the CO_2 emissions discharged both by cars fueled with petrol, diesel respectively and electric cars were compared.*
KEYWORDS: *electric car, emission, carbon dioxide, petrol, diesel*

TRANSPORTS IMPACT ON THE ENVIRONMENT

In the EU transport recorded during 1990-2007 a continuous increase in energy consumption (Figure 1). Since 2008 the corresponding values of energy consumption in this sector decreased due to the economic crisis. Of all branches of transport, road transport is the largest consumer of energy representing 73% of total demand in 2009. During 1990-2009, total energy consumption increased by 32%. Road transport was very little affected by the economic crisis, so the drop recorded in 2007-2009 was of only 2.8%. [1].

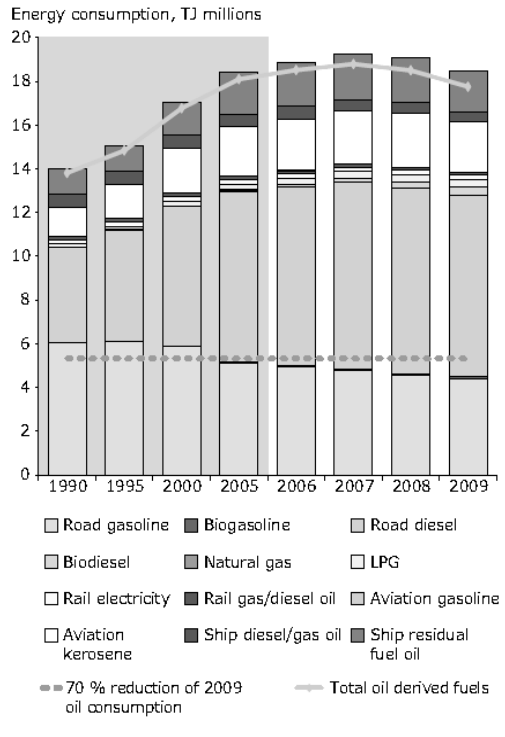

Figure 1. The total energy consumption in transport

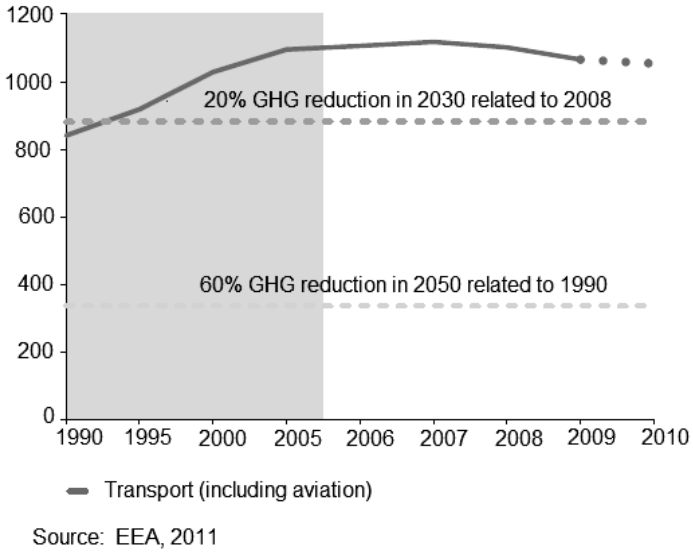

Figure 2. Greenhouse gas emissions in the transport sector in million tones

Regarding emissions of greenhouse gases (GHG) in the transport sector, the EU has decided that they should be reduced by 2030 with 20% compared to the level in 2008, and by 2050 with at least 60% compared to 1990 (Figure 2) [1].

All EU countries are obliged to achieve a 10% share of energy from renewable sources until 2020, for all forms of land transport.

In terms of CO_2 emissions, the objective is to achieve average limit values of 130g CO_2/km until 2015, exhausted by cars that compose the car fleet, and of 95gCO_2/km starting with 2020 by new cars [1].

Since 2000, CO_2 emissions from new cars of the car fleet in the EU-27 have been steadily reduced from 140.2g CO_2/km in 2010, being close to achieving the target of 130g CO_2/km (Figure 3).

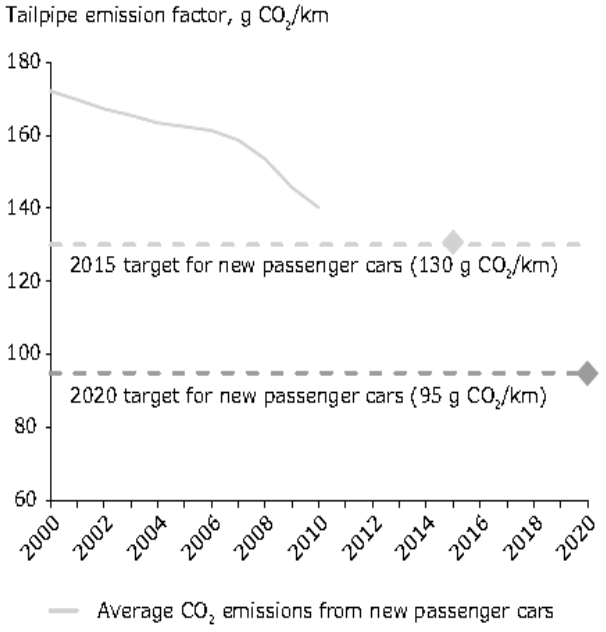

Figure 3. Average emissions from new passenger cars in EU, (gCO_2/km)

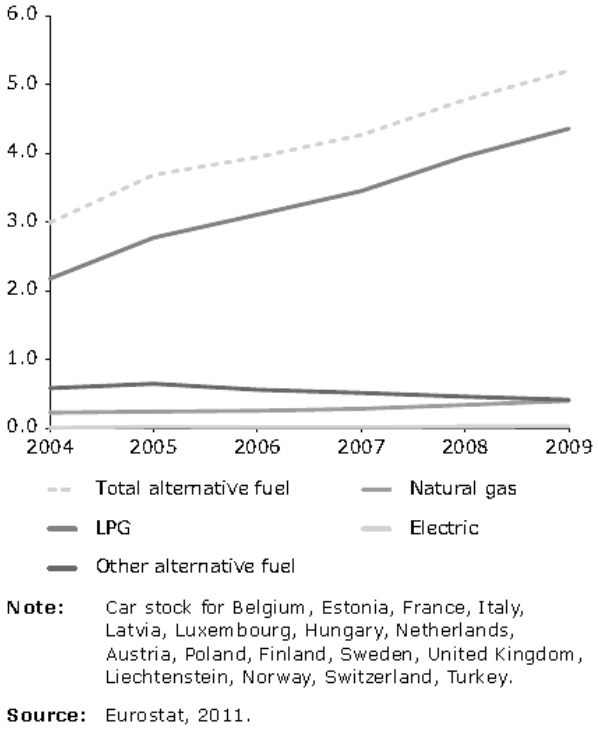

Figure 4. The stock of cars running with various alternative fuels

In Figure 4 is shown the stock of cars running with various alternative fuels for several countries which were chosen from the 32-EU [1].

A solution for reducing CO_2 emission in medium and long term is to promote alternative fuel vehicles. In Table 1 is presented the evolution of the characteristics of such vehicles [1].

Table 1. The evolution of alternative fuels vehicles characteristics

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Biodiesel	Registrations	0	0	0	0	0	0	0	0	0	0	52
	Medium capacity engine	0	0	0	0	0	0	0	0	0	0	1943
Dual fuel	Registrations	13416	12914	6679	0	0	0	0	0	0	0	0
	Medium capacity engine	1431	1583	1600	0	0	0	0	0	0	0	0
Ethanol	Registrations	0	0	0	0	0	0	0	0	8	1172	13220
	Medium capacity engine	0	0	0	0	0	0	0	0	1798	1811	1741
Electric	Registrations	0	0	1	145	75	0	9	0	38	158	663
	Medium capacity engine	0	0	0	0	0	0	0	0	0	0	1279
LPG	Registrations	0	1817	4928	2292	3307	11574	34786	89942	161544	497983	359271
	Medium capacity engine	0	1736	1658	1426	1584	1528	1469	1341	1330	1313	1312
Natural Gas	Registrations	117	108	4301	13101	19904	25458	14410	21654	22876	17943	78989
	Medium capacity engine	1581	1709	1801	1682	1587	1576	1789	1768	1790	1708	1389

ESTIMATION OF CO_2 EMISSIONS EXHAUSTED BY CARS IN ROMANIA

Although Romania ranks last in the EU regarding the number of cars per 1,000 inhabitants, however, given the road transport deficient infrastructure there is a frequent occurrence of jams. Long stationing of vehicles in traffic leads to a significant increase in CO_2 emissions, with disastrous long-term effects on the environment [2]. An alternative to reduce those emissions is to replace, even gradually, the classic cars with electric ones.

The performed estimated study aims to highlight the benefits of the implementation of strategies for upgrading the fleet and encouraging local producers to manufacture electric vehicles.

Calculation of CO_2 emissions for classic car fleet in Romania was performed using the DEKRA software for two cases: cars running on petrol or diesel.

A study carried out in 2010 by Romanian Department for Driving Licenses and Vehicle Registration indicates a number of 5.42 million vehicles registered in Romania, most of which are cars (4.3 million).

The analysis took into account a number of about 3.7 million cars equipped with petrol engines, 1.3 million with diesel engines, and the rest powered by other energy sources.

The car fleet structure depending on their length of service is shown in Table 2 [3].

Table 2. The total number of cars with diesel or petrol, depending on the length of service category

Length of service	Up to 2 years	3-5 years	6-10 years	Over 20 years
Petrol	384000	660000	780000	559200
Diesel	256000	350000	250000	372800

Between 2011 and 2012, there were no significant increases regarding the number of cars registered in Romania (1.17%).

a) Calculation of CO_2 emissions exhausted by passenger cars equipped with petrol engines

In order to estimate the CO_2 emissions, an average mileage and a medium consumption of 7l/100km were taken into account depending on each length of service stage (Table 3).

Table 3. CO_2 emissions depending on mileage and average consumption

Mileage	Car number	Specific CO_2 [g/km]	Total CO_2 [Mt]
20000	384000	165.9	1656.34
50000	660000		5474.7
100000	780000		12940.2
200000	559200		18554.25

Total emissions of CO_2 for the entire car fleet fueled with petrol were calculated [4].

For the petrol car fleet, it results a total estimated quantity of 38625.49Mt CO_2.

b) Calculation of CO_2 emissions exhausted by passenger cars equipped with diesel engines

For cars equipped with diesel engines, for estimating CO_2 emissions, we used a calculation method similar to that applied to petrol passenger cars.

In Table 4 are presented the values resulted from this analysis.

Table 4. CO_2 emissions depending on mileage and average consumption

Mileage	Car number	Specific CO_2 [g/km]	Total CO_2 [Mt]
20000	256000	185.5	1234.68
50000	35000		35246.25
100000	250000		4637.5
200000	372800		13830.88

For diesel passenger cars, it resulted from the calculations, a total of 96,686.81 tones CO_2.

c) Estimation of CO_2 emissions due to the electricity utilization for charging electric car batteries

We assume that an electric car consumes 0.177 kWh to travel a distance of 1 km. To produce one kWh of electricity in a gas turbine plant, 2200g CO_2 are released into the atmosphere [5].

In order to estimate CO_2 emissions when running the electric car, electricity consumption was determined depending on the number of kilometers driven.

Analysis was carried out considering the replacement of conventional cars with electric ones.

In Table 5 are given the values resulted from the performed calculation.

Table 5. CO_2 quantity depending on the electric energy consumed by electric cars

Mileage	Cars number	Electricity consumed by electric cars [MWh]	Total CO_2 [Mt]
20000	640000	22656	49.84
50000	1010000	35754	78.65
100000	805000	28497	62.69
200000	932000	32992.8	72.58

CONCLUSIONS

From the estimated study carried out it can be seen that for the production of electricity needed to power up electric cars, 263.76 MtCO_2 are released into the atmosphere. If we compare this value to the amount of CO_2 exhausted by petrol and diesel cars, it appears that if all classic cars would be replaced with electric cars, CO_2 emissions would be reduced by approximately 500 times.

In reality, however, this replacement is not possible, due to higher selling prices of this type of car, but mainly due to lack of infrastructure that must be provided in terms of electric power stations.

As a first step, the solution would be the adoption of legislative measures as severe for the cars which exhaust into the atmosphere large amounts of greenhouse gas emissions.

There also must be certain benefits for potential electric car buyers.

Last but not least, authorities need to consider the construction of electric vehicle batteries charging stations.

REFERENCES

[1] *Laying the foundations for greener transport, EEA Report, ISSN 1725-9177, No 7/2011.*
[2] *Negrea V.D., Sandu V. Combaterea poluării mediului în transporturile rutiere, Editura Tehnică București, 2000*
[3] *www.mediafax.ro/accesat 19.10.2012*
[4] ****, Information zum Thema CO_2, DEKRA Software, Version1.0, 2007*
[5] *Negoițescu A., Tokar A., Mihon L. The impact on greenhouse gasses emissions of the production of electric energy used by electric vehicles, XXIII Science and Motor vehicles, International Automotive Conference with Exhibition, pg. NMV11*5E08 1/7-7/7, 19-21 Aprilie, Beograd, Serbia, 2011*

ANNALS of Faculty Engineering Hunedoara

- International Journal of Engineering