



The impact of hybrid cars on reducing urban pollution and global warming

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Keywords

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Environmental pollution

Abstract

In this report, the problem of environmental pollution in urban intersections, from vehicle gases and the impact of hybrid automobiles on its reduction and global warming is analyzed. For this purpose, it is proposed to change the fleet of vehicles, introducing electric hybrid vehicles into circulation. From the analysis of the types of hybrid cars, it is proposed to import plug-in hybrid electric vehicles, which can reduce the level of pollution up to 5 times. Then, the amount of polluting gases caused by vehicles was calculated, for the current structure of vehicles in circulation at a city intersection and for the proposed structure, removing vehicles manufactured before 2005 and adding 5% plug in hybrid electric vehicles. The results show that the level of pollution at the intersection for the current vehicle fleet is high over 2100 kg (CO+NO_x+HC+PM) per day and over 370 tons of CO₂ in day. While for the proposed structure the level of pollution at the intersection can be reduced by over 22% and the reduction of carbon dioxide to 12%. In order to implement the proposed structure, it is proposed that the customs tax, road tax and environmental tax be removed for hybrid electric cars.

Introduction

Economy is the main pillar of humanity, while transport is the skeleton of its development, without which economic production cannot be realized [1].

The growth of production in the world but also in our country has always relied more and more on road transport. The use of conventional vehicles has been increasing a lot in the world, reaching in 2012 in over 1 billion and it is expected that in 2050 this number will exceed around 2 billion [2]. Thus, in the USA over 30.7% of energy is consumed in the transport sector and 82% of this by vehicles [1].

From vehicle engines are released into the atmosphere gases CO₂, CO, NO_x, HC and PM particles, which affect the deterioration of human health and the creation of the greenhouse effect and global warming [3]. Air pollution is the biggest health and environmental problem of all big cities.

The European Environment Agency's report on air quality in Europe for 2016 has published that for Albania the number of premature deaths as a result of air pollution reached in 2120 people in 2016, when in 2013, there were 776 deaths. So this has almost tripled [4-5]. Statistics show that deaths from air pollution are 2 times higher than those caused by road accidents. The peoples at least have breathing problems, inhaling this polluted air, then there are high possibilities of heart attacks, autism, schizophrenia, up to insanity. So the lives of citizens are in danger, because life expectancy is being shortened, due to air pollution from two to three years

To change this situation, people should resign from using cars, but this cannot happen, because it has become an indispensable means of transportation.

Until 1996, the problem of reducing polluting gases was posed in general, where the production of CO₂ from vehicles was considered a gas of perfect combustion. Now the problem lies in the reduction of CO₂ through the

reduction of fuel consumption and the use of alternative energies. This evolution has gone from 200 g/km before 1995, to 186 g/km in 1995, to 130 g/km in 2015 and to 95 g/km in 2021 according to the CE regulation [5].

Therefore, the challenge in transport is to reduce energy consumption and CO₂ emissions in the conditions of the increase in the number of cars until 2050.

Solving this problem requires finding low-emission cars. For this purpose, the production of hybrid cars was experimented in years 1993-2001. So, in 2015, out of 80 million cars produced per year, 1.2 million are hybrid vehicles, mainly in the USA and Japan. Recently, production has increased and production costs have decreased. A hybrid car not only saves fuel, but also produces less CO₂ emissions and other pollution [6].

The lack of knowledge about hybrid/electric cars has created doubts among many users about the possibility to completely replace conventional vehicles in human activity. This constitutes the object of this report, to increase interest in the use of hybrid/electric cars, with the aim of reducing the level of pollution and improving human life.

Material and Method

Analysis of hybrid/electric cars

From the analysis of hybrid electric cars regarding the benefits with fuel economy, emission reduction, fuel cost while driving [6] of practical interest are plug-in hybrid electric vehicles (PHEVs) because:

- Fuel economy is better because these use 40% - 60% less fuel than conventional vehicles
- Emissions are lower than hybrid cars and conventional vehicles and the reduction is about 38% in the city and 20% on the highway

- The cost of driving is 2 times less than a hybrid car and 5 times less than a conventional vehicle. The cost of driving is very small, 0.02 - 0.04 \$ per mile, while for conventional vehicles, it costs 0.10 - 0.15 \$ per mile.

While for electric cars (EV) we have:

- Fuel economy is better, because the vehicle has no fuel.
- Emissions in marmites are zero, because they only use electricity
- The cost of driving is very small, 0.02 -0.04 \$ per mile

Structure of vehicles in circulation

The number of vehicles in circulation in Albania has increased a lot, reaching at the end of 2022 in total to 588,766 for the whole country, which according to the years of production can be grouped as in Figure 1 [7]. The number of imported vehicles is around 50,000 per year, which can renew old vehicles that are out of circulation.

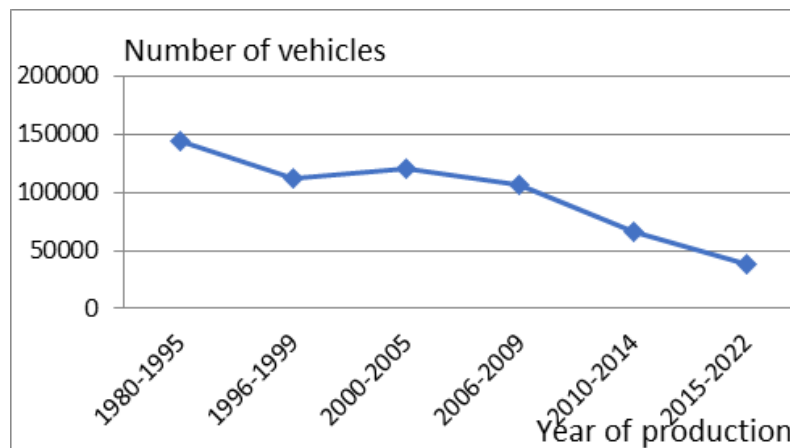


Figure 1. The number of vehicles in circulation in Albania, according to years of production

We propose to import about 25,000 hybrid electric vehicles (PHEV) every year

Determining the amount of pollution at the Intersection

Accepting that the vehicles in circulation are cars with diesel engines, (cars with petrol engines are very small) the calculation of the amount of pollution caused by the vehicles will be done accepting that the vehicles have pollution levels within the limits allowed by the EU regulations, given in table 1 in g/km [8].

From the measurements carried out at the intersection "21 Dhjetori" [9] it results $N_h = 4800$ car/hour, crossing time $T_{av} = 2$ min and speed $V = 0.1$ km/min. For this speed, the pollution values of CO, NO_x+HC, PM particles and CO₂ produced, calculated in g/min according to the years of production are given in Table 1.

Table 1. Pollution values for speed $v = 0.1\text{km/min}$

Standard	Year of production	CO g/min	NO _x +HC g/min	PM (g/min)	CO ₂ (g/min)
Euro 1	July 1992	0.316	0.113	0.018	21.1
Euro 2	July 1996	0.10	0.090	0.01	18.1
Euro 3	January 2000 January 2005	0.064	0.056	0.005	15.2
Euro 4	September 2009	0.0500.050	0.030	0.005	14.6
Euro 5	September 2014	0.050	0.023	0.005	13.1
Euro 6			0.017	0.005	12.6

For the structure of vehicles in circulation, the intersection pollution amounts in g/hour for the pollutant CO, HC+NO_x and PM particles can be calculated [9]:

$$G_h = (G_1 P_1 + G_2 P_2 + G_3 P_3 + G_4 P_4 + G_5 P_5 + G_6 P_6) T_{av} 60 N_h \text{ [g / h]} \quad (1)$$

Where:

- $G_1, G_2, G_3, G_4, G_5, G_6$ - are the pollution measures in g/min for every polluting according to 6 groups of production years, namely before 95, 1996-1999, 2000-2005, 2006-2009, 2009-2014 and after 2014 given in Table 2.

- $P_1, P_2, P_3, P_4, P_5, P_6$ - are the percentages of vehicles in circulation according to 6 groups of production years, namely before 96, 1996-1999, 2000-2005, 2006-2009, 2009-2014 and after 2014, calculated for the corresponding situation given in fig. 1, which are: $P_1=25\%$, $P_2=19\%$, $P_3=20\%$, $P_4=18\%$, $P_5=11\%$ and $P_6=6\%$

For the proposed structure, the number of vehicles manufactured before 1995 (25,000) will be replaced with PHEV vehicles. Then the new percentages will $P'_1=20\%$, $P'_2=19\%$, $P'_3=20\%$, $P'_4=18\%$, $P'_5=11\%$, $P'_6=11\%$. While the pollution of PHEV cars will be zero, because in the city they use electricity.

Results

Hourly pollution amounts for the main pollutants CO, NO_x+HC and PM, calculated according to formula 1 for the current state of vehicles in circulation and for the proposed structure, with PHEV, are shown in figure 2.

The results show that the amount of daily pollution caused by vehicles at the "21 Dhjetori" intersection is extremely high and amounts go to 1350 kg CO, 675 kg (NO_x+CH) and 75 kg PM particles per day with a total pollution of 2100 kg per day. While the amount of CO₂ produced by vehicles is about 23 tons/hour, or about 370 tons/ day. The results show that with the introduction of 5 % PHEV into circulation the production of CO₂ will decrease to 20 tons/hour, or 320 tons/ day.

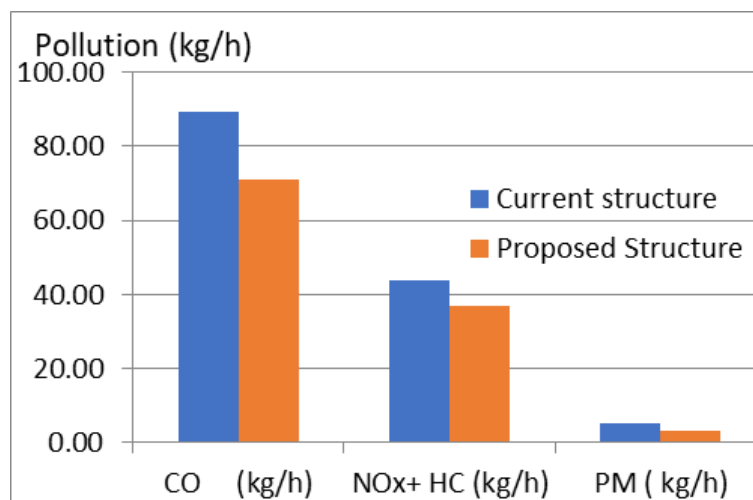


Figure 2. Amounts of pollution in kg/hour during the day for the current and the proposed structure

Discussion

This high level of pollution at the intersection is mainly caused by vehicles manufactured before 1996, which in our country predominate in circulation and have a pollution rate more than 3 times higher than those manufactured after 2005. While with the introduction of PHEV, the daily pollution amounts will be 1040 kg CO, 520 kg (NO_x+HC) and 50 kg PM particles per day.

The results show that with the introduction of 5 % PHEV into circulation, we have a reduction in pollution of around 22%. This shows that if this scheme is implemented for 2 years, we halve the pollution rate in the city. In this direction, a great help is the initiative of the Municipality of Tirana to review the current legislation and creating facilities for hybrid electric vehicles.

Based on the obligations of the agreement according to the [2], Albania should have introduced more than 25,000 hybrid/electric cars into circulation by 2020. This becomes possible if buyers of these cars are stimulated by reducing customs duties. In the meantime, we propose to remove the road tax and environmental pollution tax for electric hybrid vehicles. For this purpose, legal acts must be prepared in advance for these types of cars and must to set the tasks to create the necessary infrastructure for electricity supply, the preparation of specialists with the necessary knowledge for the maintenance of hybrid vehicles. This requires to set the tasks to introduce knowledge about hybrid/electric vehicles in vocational schools.

Also, to motivate citizens to buy hybrid cars, government incentive programs can be used, giving special credits and discounts to support the purchase and use of hybrid cars,, such as reduced insurance premiums and free or reduced parking.

Conclusion

High environmental pollution from vehicles at intersections in the city is caused by vehicles manufactured before 1996, which have a pollution rate over 3 times higher than those manufactured after 2005 and prevail in circulation in Albania. Also, the amount of CO₂ produced by these vehicles is very high.

The proposed structure with the introduction of 5% of PHEV in circulation, which replace vehicles produced before 1996, ensure a reduction of environmental pollution in urban intersections up to 22% and a reduction of CO₂ up to 12%

The introduction of hybrid/electric vehicles in Albania can be achieved by helping vehicle owners with the removal of customs tax, road tax and the reduction of environmental tax, insurance premium, parking tax to zero, as well as by used incentive programs from the government for their purchase.

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