HYBRID VEHICLES AND THEIR IMPACT ON POLLUTION REDUCTION IN URBAN AREAS

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Abstract
In this paper indicated general knowledge for construction of hybrid vehicles and efficiency of their use in transport, in order to reduce environmental pollution in urban areas, compared to vehicles with engine. Also there are showing tendencies towards creating greener vehicle, which does not cause environmental pollution, but also demand to leave the consumption of fossil fuels in transport vehicles. The following are analyzed types of hybrid vehicles and their main component systems compared with conventional vehicles, in order to make known the advantages of using hybrid and electric vehicles from citizens. Also it is shown the cost of producing hybrid vehicles by connecting with their use and the necessary infrastructure for the supply of electricity and performing technical services in order to promote their introduction in use in urban areas. For an urban intersection is calculated environmental pollution caused by vehicles, the structure of vehicles in circulation and the proposed structure with 5% hybrid cars will replace vehicles manufactured before 1995. The results indicate that for the current situation pollution is high in over 2000 kg (CO + NOx + HC + PM) in day. For proposed structure the level of pollution at the junction can be reduced over 22%.
To achieve the proposed structure and encourage the purchase of hybrid vehicles by citizens it is proposed abolition of customs duty on vehicles manufactured after 2009 and the hybrid vehicles and for the latter's the removal of road tax and environmental tax.

Key words: Hybrid vehicles, reduction of environmental pollution

1. Introduction
Increase of income is associated with individual mobility of people, which is a basic need, which is made with personal vehicles. The use of conventional vehicles has been increased in the world, reaching in 1998 to around 700 million cars [5]. Meanwhile it is known pollution problems caused by gas emissions, that vehicles releases in the atmosphere that affect human health and the creation of the greenhouse effect and global warming [2]. European experts have warned, that if vehicles and ways of gaining power does not change, in Albania and in many other countries flooding from rainfall will be much larger, sea levels will rise, collapse of land will continue rapidly and drought will hurt even more agriculture. So, the dramatic consequences of climate change is projected to increase even more in the coming decades.

Despite measures taken by the International Energy Agency (IEA) and the governments of the main countries to reduce the vehicle in use, their number continues to grow. Thus in 2012 the world the number of cars amounted to over one billion and expected to in 2050, this number to exceed about 2 billion [2,5]. China is now the largest producer of their energy consumption. Rich in land, which accounts 20% drive most cars. It is a condition of unequal.

Can we have fewer cars in rich countries? Will give people resignation from using of cars? This can not be trusted, because it has become an indispensable tool of transportation. In a test made in Switzerland one of the richest countries and the public better, where rail transport system works, community members do not vote for placement fees for big polluting cars. Instead they voted to reduce taxes, concluded that people do not give up the use of the car. The main user of energy in transport is road
Hybrid vehicles and their impact on…

Therefore, the challenge today is to reduce energy consumption and CO2 emissions in terms of the increase of the car number by 2050. The problem of reduction of pollutant gases in general is posed until 1996. 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 186 g/km in 1995 to 160 g/km in 2005, the 130 g/km in 2015 and it is expected to pass in the 95 g/km by 2020 under the EC Regulation. A health concern are NOx gases, which aggravate respiratory and heart disease and 40% of them come from road transport and 80% of these emissions come from diesel cars [5].

Facing the situation requires finding cars with small scale pollution. For this purpose the IEA since 1993 has set the task of fuel efficiency and pollution producing small cars with less CO2 production. Pursuant to this task there are experimented and produced hybrid cars (1993-2001). In fact the production of hybrid cars is still small. So in 2015 from 80 million cars, 1.2 million are hybrid vehicles, mainly in US and Japan [5].

A hybrid car is basically what uses two or more engines with different power, so an electric motor and a conventional engine (petrol or diesel). Driving electric motor provides power at lower speeds and conventional engine empowers it to high speed. A hybrid car not only saves fuel, but also produces less CO2 emissions and other pollution [9,10]. Due to lack of knowledge that how hybrid vehicles work and if they are as good as other vehicles with gasoline or diesel, yet few people are using it. This constitutes the purpose of this paper to provide knowledge on hybrid cars, types, their construction, benefits and impact in reducing pollution in order to make them more attractive for citizens.

2. Types of hybrid vehicles, construction and benefits

Hybrid car technology has existed since the 1900s, but only in the past decade it is reached that price of their product to be accessible to citizens. Hybride vehicles produced by manufacturing factories are diverse. They are intended to improve fuel efficiency. This new generation of vehicles, can be divided into three categories [8,9]:

**Hybrid Electric Vehicles (HEV)**

These receive energy from an engine that works with conventional or alternative fuels and an electric motor that uses energy stored in a battery. Extra power provided by the electric motor creates the possibility of a smaller engine, resulting in better economy of fuel without sacrificing performance. The battery is charged by the engine or regenerative braking. So they catch energy normally lost during braking by using the electric motor as a generator.

**Plug hybrid Electric Vehicles (PHEV)**

These use the energy from conventional fuels and electricity from the network to charge the battery, which costs several times less and reduces consumption of diesel compared with conventional vehicles, and reduces emissions. These are set battery larger than the battery in hybrid cars, making possible driving the vehicle by using only electricity. Batteries can be charged by the engine, the electric power network and through regenerative braking. If it does not use the plug in to load, fuel economy will be almost the same with a HEV.

**Electric vehicles (EV)**

These use electricity to get the batteries, which are charged by placing the plug into a electric power source. Although electricity generation can contribute to air pollution, the Environmental Protection Agency (EPA) in the United States considers that these have zero emissions, because they use no fuel. A cable is used to supply cleaner 230V charging station in a public or a plug at home. Manufacturing factories usually aim for a minimum way from 100 miles, which is enough for more than 90% of journeys carried out by the owners. These are more environmentally friendly.

This group includes fuel cell electric vehicles (FCEV), who use the electricity generated by the fuel cells. A fuel cell is an electrochemical device, where chemical energy from union of hydrogen and oxygen converted into electrical energy [3, 7].
cells convert the hydrogen directly into electricity, generating more energy from the same amount of fuel. The fuel cell is effective because there are no moving mechanical elements. Most hydrogen fuel stations are installed today. Fuel cell electric vehicles are over 2 times of the efficiency of engine and can travel up to 240 kilometers. Due to the storage, recently Hydrogen is replaced with methanol.

Light models of HEV, PHEV, EV are currently available from a number of manufacturers and other models are expected to be released in the coming years with a variety of varieties. Together, they have great potential to reduce the use of fuel and emissions.

Key components elements of hybrid vehicles are:
1. Electric motors of car, which convert electrical energy into mechanical energy to start the hybrid car. Electric motors in a hybrid car are:
   - A single electric motor connected to the wheels through a transmission system, which works as a generator and the inverse or,
   - Some electric motors, located in each wheel.
2. Auxiliary power unit that serving for supply the necessary energy to start the vehicle and recharge the batteries and other devices. This may be an engine or a fuel cell.
3. Generatory that serve to convert mechanical energy into electrical energy,
4. Storage energy system that serves to keep the energy required for the movement of hybrid vehicles. This can be stored in batteries, capacitors or a flywheel.
5. Regenerative braking system serves to convert the mechanical energy of the rotating parts into electricity, which is stored in batteries.
6. Control system serve to manage processes in the power transmission from the engine.

In figure 2 it is shown 4 ways of giving the movement that carries a hybrid car [5,9]

![Diagram of Hybrid Car Movement Modes](image)

**Fig 2.** Four ways of giving the movement in a hybrid car

Benefits arising from the use of types of hybrid and electric cars about fuel economy, reduction of emissions, the cost of fuel during driving and flexibility of supply [8] is gived:

**For hybrid electric vehicle (HEV)**

a) Fuel economy is better than similar conventional vehicles

Driving fuel savings "Honda Civic Hybrid" versus a conventional Civic is about 38% in the city and 20% in the highway.

b) Emissions are lower than similar conventional vehicles and vary according to the type of engine and used fuel

c) The cost of driving is 2 times smaller than that of conventional vehicles. So the cost of fuel, result 0.05 to 0.07 $ per mile, while for conventional vehicles, from 0.10 to 0.15 $ per mile.

d) Refuelling is easy, because it can be supplied in any gas station

**For plug hybrid Electric Vehicles (PHEV )**

a) Fuel economy is better than similar conventional vehicles. These use 40% - 60% less fuel than
conventional vehicles, because they allow for driving at slow speeds and higher using only electricity.

b) Emissions are lower than hybrid vehicles and conventional vehicles and the reduction is around 38% in the city and 20% in the highway. This is because they provide movement with electric power. Emissions are lower for energy produced from plants than from vehicles operating with gasoline or diesel.

c) The cost of driving is 2 times smaller than an hybrid electric car and 5 times smaller than a conventional vehicle. Fuel cost may be 0.02 to 0.04 $ per mile. (Based on the average electricity price of US).

d) Refuelling is easy, it can be supplied in any gas station and with electricity at home or public stations.

For electric vehicles (EV)

a) Fuel economy is better than the above two categories, because there is no fuel.

b) emissions in the exhaust are zero, because only use electricity. However, emissions produced by electricity plant are usually lower for electricity generated by power plants than from vehicles.

c) The cost of driving is a lot less, because it works only with electricity. Driving in an electric car costs 0.02-0.04 $ per mile.

d) The refueling with power can be done at home or public stations.

But hybrid cars also have disadvantages:

1. They are more expensive than a petrol car and can cost 5,000-10,000 $ more than a standard version.

2. They have maintenance costs higher, because they are more complicated and more difficult for mechanics to repair the car. It is also difficult to find a mechanic with experience.

3. They work with high tension, which in case of an accident, can be deadly to the user and can also be difficult task of issuing passenger and the driver of the car, for the provision of assistance teams.

Besides these, there is the popular myth that they are powerful and are driving in the city and not for speed and acceleration. In fact they are less powerful engine, but engine combined with electric, hybrid cars have just as much power as regular cars and have no problem with driving on the road or mountain attraction.

From hybrid cars data above plug hybrid Electric Vehicles is with great interest to our country, which in the first phase put into circulation, because they save up to 5 times the fuel which reduces to 5 times the production of CO2 and other gases. In the second phase when it is completed the requirements for gas station and electricity will be introduced and electric vehicles and with fuel cell.

3. Determination of the pollution amount in Junction from vehicles

For determination of the pollution amount we have determined the structure of vehicles in circulation for the existing situation and proposed structure with the introduction of 25,000 hybrid vehicles, and the removal of such vehicles manufactured before 1995 (these account half of imported cars in a year).
The number of vehicles in circulation in our country, has increased too, reaching the end of 2015 to 550 764 in total for the whole country [1]. The number of vehicles in circulation by group of the production years is shown in Figure 3. The number of vehicles in circulation in our country, has increased too, reaching the end of 2015 to 550 764 in total for the whole country [1]. The number of vehicles in circulation by group of the production years is shown in Figure 3. The number

<table>
<thead>
<tr>
<th>Standards</th>
<th>Year of production</th>
<th>CO g/km</th>
<th>NOx+ HC g/km</th>
<th>PM g/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro 1</td>
<td>July 1992- January 1993</td>
<td>3,16</td>
<td>1,13</td>
<td>0,18</td>
</tr>
<tr>
<td>Euro 2</td>
<td>July 1996- January 1997</td>
<td>1,0</td>
<td>0,90</td>
<td>0,1</td>
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<td>Euro 3</td>
<td>January 2000</td>
<td>0,64</td>
<td>0,56</td>
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<td>Euro 4</td>
<td>January 2005</td>
<td>0,50</td>
<td>0,30</td>
<td>0,025</td>
</tr>
<tr>
<td>Euro 5</td>
<td>September 2009</td>
<td>0,50</td>
<td>0,23</td>
<td>0,005</td>
</tr>
<tr>
<td>Euro 6</td>
<td>September 2014</td>
<td>0,50</td>
<td>0,17</td>
<td>0,005</td>
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</tbody>
</table>

Recognizing that vehicles in circulation are cars with engine diesel, the calculation of the amount of pollution caused by vehicles will be done admitting that the vehicles have scale pollution within the limits of the norms of the EU, given in Table 1 [6,7]. From measurements carried out at the intersection "21 dhjetori" [4] result that number of vehicles is $N_h = 4800 \text{ v / hour}$, the time of passage of the intersection $T_{av} = 2 \text{ min}$ and $v = 0.1 \text{ km / min}$. For this speed values of pollution CO, HC + NOx and particulates PM calculated in g / min by years of production are given in Table 2.

<table>
<thead>
<tr>
<th>Standards</th>
<th>Year of production</th>
<th>CO g/min</th>
<th>NOx+ HC g/min</th>
<th>PM g/min</th>
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<tr>
<td>Euro 1</td>
<td>July 1992- January 1993</td>
<td>0,316</td>
<td>0,113</td>
<td>0,018</td>
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<tr>
<td>Euro 2</td>
<td>July 1996- January 1997</td>
<td>0,10</td>
<td>0,090</td>
<td>0,01</td>
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<tr>
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<td>January 2000</td>
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<td>0,056</td>
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<td>January 2005</td>
<td>0,050</td>
<td>0,030</td>
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<td>Euro 5</td>
<td>September 2009</td>
<td>0,050</td>
<td>0,023</td>
<td>0,0005</td>
</tr>
<tr>
<td>Euro 6</td>
<td>September 2014</td>
<td>0,050</td>
<td>0,017</td>
<td>0,0005</td>
</tr>
</tbody>
</table>

On the structure of vehicles in circulation, the quantities of pollution for each pollutant CO, HC + NOx and PM can account [4]:

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

where:

- $G_1, G_2, G_3, G_4, G_5, G_6$ - are pollution mass in g/ min for each pollutant by 6 groups of production years, respectively before 95, 1996-1999, 2000- 2005, 2006-2009, 2009- 2013, and after 2013 given in Table 2
- $P_1, P_2, P_3, P_4, P_5, P_6$ - are the percentages of vehicles in circulation by 6 groups of production years respectively before 95, 1996-1999, 2000- 2005, 2006-2009, 2009-2013 and after 2013 calculated for the relevant condition given in Table 4, which are: $P_1=34\%$, $P_2=21\%$, $P_3=20\%$, $P_4=17\%$, $P_5=8\%$ and $P_6=3\%$

For the proposed structure for the number of vehicles produced before 1995 (25000) will be replaced with hybrid vehicles. Then the new percentages will be $P_1'=25\%$, $P_2'=21\%$, $P_3'=20\%$, $P_4'=17\%$, $P_5'=8\%$, $P_6'=3\%$. While pollution of hybrid car would be zero, because in the city they use electricity.

### 4. Results and Discussion

The amounts of pollution per hour for the main pollutants CO, HC + NOx and PM are calculated according to the formula 1 for the current state of vehicles in circulation and the proposed structure, with hybrid vehicles, which are shown in Figure 4.
The results show that the amount of pollution daily caused by diesel vehicles in the intersection “21 Dhjetori” is too high and goes to 1350 kg CO, 675 kg (NOx + CH) and 75 kg particles PM on the day. Total pollution is 2100 kg per day. This great pollution in the intersection is caused by vehicles produced before 1996, which prevail in our country over 2 times and have a degree of pollution over 3 times higher than those produced after 2000.

![The amount of pollution in intersection](image)

**Fig. 4** The amount of pollution in kg / hour during the day to the current and proposed structure

While from the introduction of hybrid automobile daily quantities of pollution will be 1050kg CO, 540kg (NOx + HC) and 60 kg particulate PM per day. The results show that from introduction of 5% hybrid automobile have a decrease of pollution by about 22%. This shows that if this scheme will apply for 2 years we reduce the degree of pollution in the city 44%.

Based on obligations of Agreement of IEA [5], Albania should be introduced into circulation up to 2020 more than 25,000 hybrid vehicles. To make this possible should be encouraged buyers of these vehicles by reducing customs duties that their price be similar with conventional cars. While it should that for these vehicles toll of road and environmental pollution are removed. For this purpose it should be prepared in advance laws for these kinds of vehicles and must be created the necessary infrastructure for electricity supply, preparation of specialists with the necessary knowledge to hybrids and then the opening of services to these vehicles. So it should be taken provisions to introduce this knowledge in professional schools.

Also to motivate people to purchase hybrid car it can be used government stimulus programs to support the purchase and use of hybrid vehicles as insurance premium reduction and free or reduced parking.

5. Conclusions

1. Hybrid vehicles are more effective than conventional, because consume less fuel and have less environment pollution. plug hybrid Electric Vehicles (PHEV) and electric vehicles (EV), have the largest Effectiveness who have the cost of driving 5 times
2. High environmental pollution by vehicles at intersections in the city caused by vehicles produced before 1996, who have a degree of pollution over 3 times higher than those produced after 2000 and prevail in circulation over 2 times in our country.
3. The proposed structure with the introduction of 5% of hybrid vehicles in circulation, which replace vehicles manufactured before 1996, provide a reduction of environmental pollution in urban intersections up to 22%.
4. The introduction of hybrid vehicles in Albania, it can be achieved if will remove traffic and duties taxes for these vehicles, and using incentive programs by the government to reduce the insurance premium and parking tax.

6. References
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