Electric cars. Advantages and disadvantages

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Abstract: The article considers the positive and negative aspects of the use of electric vehicles. A rough calculation of the energy efficiency and average cost per month was made. Also priorities to avoid the existing problems in the market of electric vehicles were set.

1. Introduction

The vehicles, equipped with an electric motor, were created before inventing cars with an internal combustion engine. The first models were assembled in 1830-1840 and were clumsy and unreliable units that are moved at very low speed.

The end of the XIX century - beginning of the XX century could be called a boom of electromobility. In this period, the production of electric vehicles has been established in Europe and the United States. Production of electric vehicles by the beginning of the XX century has reached 10 thousand copies in the United States, and their number is several times higher than the number of gasoline vehicles.

In 1899, an electric car was able to overcome the barrier of 100 km/h. This momentous event happened in the French town Asher, near Paris. Electric vehicle record was created by the Belgian Camille Jenatzy. The car had a streamlined body of aluminum alloy and tungsten. Its appearance resembled the torpedo, installed in the chassis. The body of the electric vehicle was open. It was equipped with two motors and had a mass of about 1 ton. The designer himself drove his brainchild. The electric car reached a speed of 105,88 km/h. This “miracle” of the late nineteenth century is shown in figure 1.
Figure 1. Electric car of Belgian Camille Jenatzy, 1899

In the first decades of the XX century, there were the cars with internal combustion engines and electric vehicles in the streets of major cities. Electric vehicles had indisputable advantages in an urban environment. In New York, for example, in the 1910s, there were up to 70 thousand taxis on electricity. However, the percentage of electric vehicles among the vehicles slowly but surely decreased. In 1920, their number was reduced to 1%.

At the moment the electric car market is small and for good reason. Electric cars are still a luxury, and not turned into a means of transportation. In general, the total number of electric vehicles in the world is 750 thousand units - or less than 0.1% of the total number of cars. However, the positive prospects are telling us that by 2020 electric vehicles will reach the number of over 10 million worldwide.

The advantages of the electric vehicle is attributed the environmental friendliness and the absence of emissions, compact car, the cheaper cost, cheap “fuel” - electricity. The car for 7-10 thousand dollars is three times less than the cost of filling, which is undoubtedly the best solution [1].

A progressive reduction of the main component of an electric car - battery - expanding market prospects. In six years, the average cost of a battery for an electric vehicle was brought down to the level of $500. Although, it should be said that in reality the batteries will cost 3000-6000 dollars, and even more. Although in 2008-2010, the cost of the battery was averaged at about $ 1,000; in reality, for consumers the price reached $ 10,000.

In any case, the advent of cheap battery is not so far. It can be compared with the solar market, where the cost of 1 watt fell from $ 4 in 2010 to $ 1 in 2015.

2. Results and Discussion
Let us compare the efficiency of different types of cars.

For comparison, let us take the Honda vehicles of various types of propulsion systems, one of the most economical diesels - VW JettaDiesel, and a sports car TeslaRoadster. To compare, selected Renault cars are not very different in weight with a sports electric car.

Since the electric vehicle is currently a main means of local communication, it is compared to the energy consumption by the movement in the combined cycle. For all vehicles, the minimum numbers of fuel consumption were chosen.

Electricity supplied for charging electric vehicles can be obtained at nuclear power plants or from renewable energy sources (via solar, hydro or wind power). However, it is difficult to calculate the effectiveness of these methods of producing electricity, therefore for calculations, the electricity, produced in heat plants by burning natural gas, was taken.

The data of calculations were combined in table 1:
Table 1. Comparative table of energy efficiency for different types of cars [2]

| Technology                | Car             | The original source of energy | The efficiency of processing, delivery and refueling (total) | Distance traveled per unit of fuel | Energy efficiency of the vehicle | Full energy efficiency |
|---------------------------|-----------------|------------------------------|-------------------------------------------------------------|-----------------------------------|----------------------------------|------------------------|
| The engine on natural gas | Honda CNG       | Natural gas                  | 86.0%                                                       | 17.5 km/kg                        | 0.39 km/MJ                      | 0.32 km/MJ             |
| Hydrogen fuel cells       | Honda FCX       | Natural gas                  | 61.0%                                                       | 84 km/kg                          | 0.7 km/MJ                       | 0.43 km/MJ             |
| Diesel engine             | VW JettaDiesel  | Oil                          | 90.1%                                                       | 17.2 km/l                         | 0.47 km/MJ                      | 0.42 km/MJ             |
| Petrol engine             | Honda Civic VX  | Oil                          | 81.7%                                                       | 14.2 km/l                         | 0.46 km/MJ                      | 0.38 km/MJ             |
| A hybrid vehicle (Petrol/Electro) | Honda Civic Hybrid | Oil                        | 81.7%                                                       | 17.3 km/l                         | 0.56 km/MJ                      | 0.46 km/MJ             |
| Electric                  | Tesla Roadster  | Natural gas                  | 52.5%                                                       | 151 W*h/km                        | 1.84 km/MJ                      | 0.97 km/MJ             |

*calculations made at the rate of 1 Ruble = 5 Tenge

As can be seen from this table, the most energy-efficient car is an electric car with a performance of 1.84 km/MJ. In general, the main reference is high performance cars, the original source of energy of natural gas. There were very large financial injections in this area. This is evident in the available investment projects. Below, there is a comparative table, reflecting the benefits of the acquisition of electric vehicles.

The total energy efficiency of the electric vehicle is 2 times higher than the nearest competitor - hybrid cars and hydrogen fuel cells.

Cars with hydrogen fuel cells were not as good as they were advertised and actively promoted. The efficiency of the car with hydrogen is quite high (0.7 km/MJ is the second result after the electric car). However, the handicap of this technology shows the total energy efficiency comparable to the efficiency of a diesel with incomparably greater cost and complexity.

The energy efficiency of the electric vehicle is too high (1.84 km/MJ) to blame the high efficiency of the installation. The calculations cast doubt on the claimed efficiency of vehicles with internal combustion engines – one can encounter statements that the efficiency of the diesel engine is 40%, which allows speaking about the futility of electric cars. Hopelessness due to the fact that the total capacity exceeds the total capacity of the power plants and the replacement of a car using electric power is simply not enough. Perhaps at the optimum speed, diesel has 40% of efficiency; however, if one takes the real conditions, the efficiency of the diesel is not more than 20% (otherwise, the electric car would have an efficiency of 160% - a so called perpetual motion machine). So to power electric vehicles, one will need 4 times less energy with the complete replacement of the modern car fleet. However, since the mass of a modern electric vehicle increases in local communities, then there will be an increase in the number of power plants. On the contrary, electric vehicles can become an important element of the energy system of the world, smoothing out the night drop in the consumption of electricity.
Table 2. Calculations of average costs of the electric car in modern conditions [2]

| Consumption with the daily mileage (52 km) | Electric car | Automobile |
|--------------------------------------------|--------------|------------|
| The cost of daily run                      | 11 kWh       | 3,75 l     |
| The time for charging/ refueling is 115 km (the maximum range for an electric car) | 8 hours (cord 220V, 2 minutes 30A) | 401,5 tenge |
| The cost of charging/refueling at 115 km   | 267,6 tenge (daily rate) | 800 tenge |
| The average consumption per month          | 320 kWh      | 86 l       |
| The average cost per month                 | 3600 tenge (daily rate) | 9235 tenge |

* calculations made at the rate of 1 Ruble = 5 Tenge

Table 2 shows that the average daily rate of the cost of the vehicle exceeds more than 2.5 times the consumption of the electric vehicle. However, such exorbitant comparison does not always bring only benefits, otherwise one should skip the stage of development of electric vehicles, when the main problem, in particular for Kazakhstan, arises due to the unprepared infrastructure.

Therefore, besides the advantages, there are also disadvantages - problems. Unfortunately, the problems of using electric cars still remain without a solution [3].

- The main problem is battery capacity: one charge allows passing only 60-100 km at best. The prospects of expanding the capacity of the batteries are not planned.
- As it was mentioned earlier, there are no electric stations in Kazakhstan. Theoretically, travelling around even a city will not work. The truth is that those 2 hundred users of electric vehicles will find the output power in the household fixed outlets, but in fact it is a questionable option for an electric car working as a vehicle [3].
- There is a rapid wear of the battery. In the best case, it will work for 3-5 years, and then it will need a replacement and quite a lot of money - an amount equal to the value of the entire car.
- The problems should include the question of storing the auto: being in cold conditions, the battery will wear faster, that is why the car will need a warm garage.
- Development of electric vehicles in Kazakhstan, in principle, is impossible without state support, which in the current economic situation is quite expensive. There should be the right kind of subsidies for electric vehicles market: this concerns the question of import duties on cars, and creation of favorable conditions for plants construction, at least - for the production of batteries.

3. Conclusion

The efficiency of an electric vehicle when driving 60-100 miles per a single charge raises the question: who will use this car? From a practical purpose, it is still difficult to go by electric vehicle at such long distance. It is unlikely that there are many of those who would buy an electric car for fun and status.

In the end, unfortunately, most people almost on the entire territory of the former Soviet Union perceive the electric cars as a beautiful tale and are willing to “vote” for it.

In light of the current achievements and challenges, it is necessary to find a real niche for such new ‘product’ as the electric car.

The car is primarily used for comfort. When there are alternative, faster ways of moving around the city, people are stubbornly stuck in traffic. Expansion of roads leads to the fact that in the streets there are more and more cars and all repeats. In all countries, economic and restrictive measures are the most effective. For example, in Manhattan to put the car in the cheapest place will cost $ 250 USA per day, and entry to the island is also paid. In Austria, annual insurance for old Lada will cost about 6000 Euro. In Beijing, it is necessary to pay a license to transport themselves and only then one is free to drive on toll roads.
Thus, on the basis of the identified advantages and challenges, the path of development of electric vehicles will be shaped, in which existing problems can be solved. First, an electric vehicle should occupy as little space as possible on the road, that is, it must be small. Second, electric cars need to occupy a small part of the road area for parking, and this is possible if most of them will be individual and public transportation serving throughout the day for many citizens. It implies short term renting for one trip. In such circumstances, the movement will become faster, safer, while preserving most features of the car.

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