

Investigation Of The Conversion Procedures For Fossil Fuel Vehicles To Electric Vehicles In Turkey

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Abstract

Globally, with the rapid growth of the population, the use of cars is also increasing. Although there is an increase in the use of electric vehicles, the vast majority of the vehicles used are internal combustion engine vehicles. Fossil fuel vehicles have disadvantages such as damaging the environment due to their high emission values, using non-renewable energy sources as fuel, high maintenance costs, and complex vehicle structures. Electric vehicles have many advantages such as being sensitive to the environment with a near-zero emission value, simple structures, low maintenance costs, and the use of renewable energy sources as fuel. Today, the reserve ratios of fossil fuels are rapidly depleting. Consumers tend to buy electric vehicles because of the environmental damage caused by fossil fuel vehicles due to the high emissions they emit, and because of the danger of depletion of non-renewable energy sources. The purchase of electric vehicles from the factory is difficult due to the few product varieties and the high prices in the market. It is possible for consumers to have electric vehicles with the features, colors, and models they want at much more affordable prices, by converting internal combustion engine vehicles to electric vehicles. Each country has its own regulations for the conversion process. Transformation operations in our country are carried out in accordance with the Regulations of the Ministry of Science, Industry, and Technology. There are ready-made conversion kits of different brands on the market that contain the components necessary for the conversion of internal combustion engine vehicles to electric vehicles. In this study, the advantages and disadvantages of internal combustion engine vehicles and electric vehicles, why conversion is necessary, and how conversion should be carried out will be discussed. Thanks to the conversion to an internal combustion engine, there will be a decrease in the emission of harmful gases to the environment, an economic contribution will be made to the country, and consumers will be able to have the vehicle they want at affordable prices.

Keywords: “Electric vehicles, fossil fuel vehicles, internal combustion engine, emission, conversion, renewable energy systems.”

1. Introduction

As a result of the increase in welfare in the globalizing world and the changes in transportation methods, tremendous growth has occurred in the transportation sector and the need for energy has increased to a great extent. While the efficiency of internal combustion engine vehicles is around 30-40%, the efficiency of electric vehicles is close to 100% [1]. Considering these ratios, it is seen that the efficiency of electric vehicles is approximately 3 times higher than the efficiency of internal combustion engine vehicles [2].

Today, fossil fuel vehicles are widely used in the transportation sector. According to TUIK's data, 26.2% of the vehicles registered in traffic in Turkey in the first 6 months of 2022 are gasoline vehicles, 0.9% electric or hybrid vehicles, 35.5% LPG vehicles and 37%, 3 of them are diesel vehicles [3]. 99% of the vehicles registered to traffic in our country are fossil fuel vehicles. Fossil fuel vehicles are disadvantageous due to the danger of depletion of non-renewable energy sources, emission of harmful gases to the environment, and low energy efficiency. High greenhouse gas emissions cause global warming [4]. Approximately 20% of the greenhouse gas emission values, which include the CO₂ emissions emitted from the transportation sector, cause air pollution, which brings along global climate change problems [5]. Reducing the use of fossil fuels in transportation is seen as the most effective method of reducing CO₂ emissions. Electric vehicles are shown as an alternative to fossil fuel vehicles. The use of renewable energy sources in electric vehicles has advantages such as no emission of harmful gases to the environment and higher energy efficiency. The emission rate of electric vehicles is lower than fossil fuel vehicles.

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Electric vehicles also have some disadvantages compared to fossil fuel vehicles. These are issues such as range, battery and high cost. Efforts are being made to solve the range problem and battery problems. In purchasing electric vehicles from the factory, both the cost is high and the consumer is offered few options. As a solution to the high cost problem, internal combustion engine vehicles are transformed into electric vehicles. There are many advantages to performing the conversion operation. These advantages are: contributing to the national economy by converting the internal combustion engine vehicle instead of sending it to scrap, contributing to the transformation of small automotive repair shops in city industries, the possibility of the consumer to convert the vehicle they want to an electric vehicle, the conversion process being less costly than purchasing a vehicle. It should be carried out in accordance with the Regulation of the Ministry of Industry and Technology, TSE, ISE standards.

2. Electric Vehicles

Electric vehicles are vehicles that get their power from an electric motor. Electric motors are used in electric vehicles. Electric motors work through new generation batteries. Electric vehicles are divided into three as Full Electric Vehicle (BEV), Hybrid Electric Vehicle (HEV) and Plug-in Hybrid Electric Vehicle (PHEV).

2.1. Hybrid Electric Vehicle (HEV)

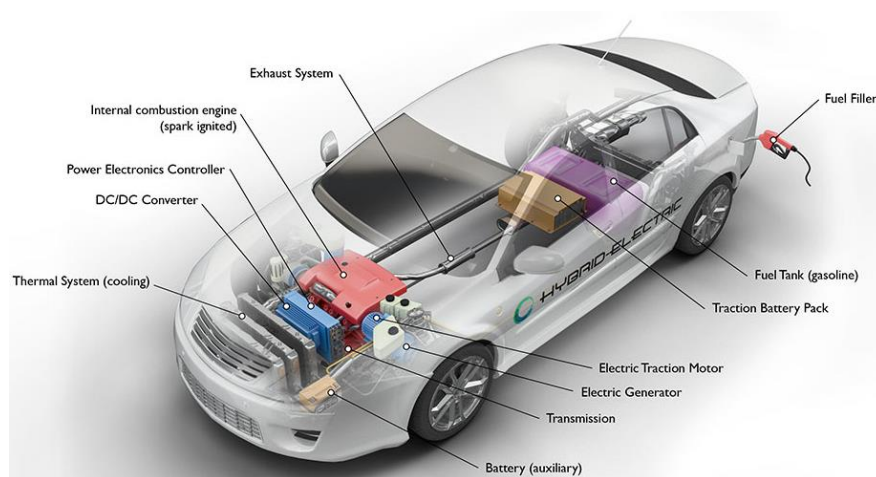


Figure 1. Hybrid Electric Vehicle (HEV) [6]

In hybrid electric vehicles, the vehicle's power is provided by using two or more energy sources [7]. Hybrid electric vehicles can switch between the internal combustion engine and the electric motor, or they can be used simultaneously. Hybrid electric vehicles differ from other electric vehicles in that they do not need to be recharged. Regenerative braking system is used to charge the battery in hybrid electric vehicles.

Hybrid electric vehicles are divided into three as serial hybrid electric vehicle, parallel hybrid electric vehicle and serial-parallel hybrid electric vehicle. Parallel hybrid electric vehicles are the most common hybrid type vehicles. In parallel hybrid electric vehicles, the internal combustion engine and electric motor are connected in parallel to the vehicle and work together to provide power. In such vehicles, the internal combustion engines are supported by the electric motor. In a parallel hybrid electric vehicle, the two engines used combine their power. In this case, in parallel hybrid electric vehicles, the internal combustion engine and the electric motor are mechanically interconnected. The powers of the electric motor and the internal combustion engine are combined with torque converters. The characteristic of the parallel hybrid electric vehicle is that the power is transferred in parallel [8]. In series hybrid electric vehicles, the wheels and the internal combustion engine are not mechanically interconnected. In series hybrid electric vehicles, the electric motor provides the movement of the vehicle. In these vehicles, the electric motor gets its energy from the internal combustion engine. In series hybrid electric vehicles, the engines are connected in series to transfer power. In series hybrid electric vehicles, power is transmitted from the internal combustion engine to the battery via the generator, and from there to the electric motor to turn the wheels. In series hybrid electric vehicles, there is no physical connection between the internal combustion engine and the electric motor. In this case, since there is no connection between the internal combustion engine and the electric motor, it can be placed anywhere on the vehicle [8]. Since the electric motor directly drives the vehicle in serial hybrid vehicles, it is usually sufficient to use a single-stage gearbox in such vehicles [9]. Series-parallel hybrid vehicles consist of a combination of parallel hybrid electric and serial hybrid electric vehicles. Vehicles of this type can run on electricity only, fuel only, or both. These vehicles offer the features offered by both parallel and serial hybrid electric vehicles. This type of vehicle has an internal combustion engine, generator and electric motor. In series-parallel hybrid electric vehicles, these three components are mechanically interconnected [10].

2.2. All-Electric Vehicle (BEV)

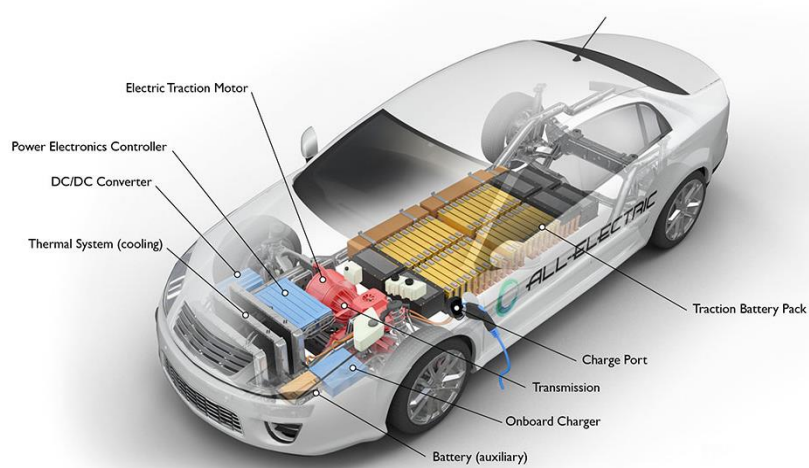


Figure 2. All-Electric Vehicle (BEV) [6]

All-electric vehicles use the energy stored in the battery to power the electric motor and turn the wheels. All-electric vehicles have drivetrains that come from all-electric, high-capacity batteries charged via power lines [10]. When the energy in the battery of fully electric vehicles is completely depleted, the battery is recharged using the charging unit or wall socket. This type of vehicle works with 100% electricity. In fully electric vehicles, there is no internal combustion engine, fuel tank and exhaust system. Fully electric vehicles have one or more electric motors powered by a larger onboard battery [11].

All-electric vehicles are driven by an electric motor, the power of which is expressed in kilowatts (kW). In fully electric vehicles, batteries (usually lithium-ion) are needed for the electric motor to power the vehicle. VW ID3, Tesla Model Y, Nissan Note and Renault Zoe fully electric vehicle models are among the best-selling electric vehicles worldwide [11].

2.3. Plug-in Hybrid Electric Vehicle (PHEV)

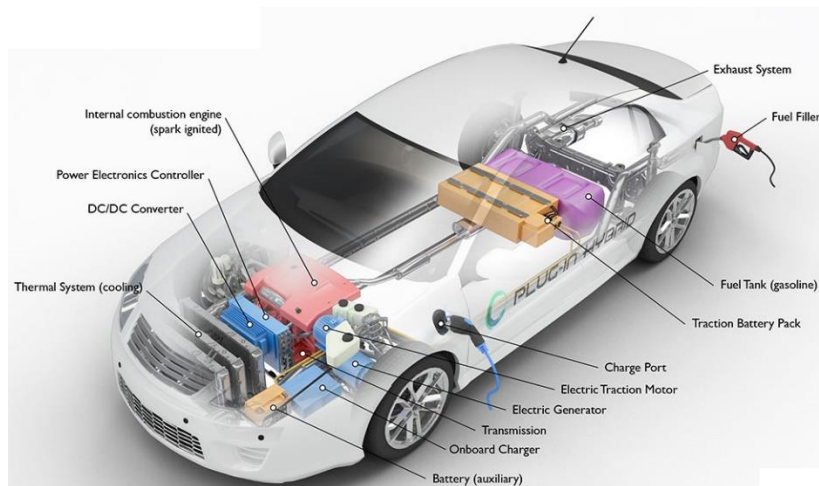


Figure 3. Plug-in Hybrid Electric Vehicle (PEV) [6]

Plug-in hybrid electric vehicles are types of electric hybrid vehicles with a charging port and a fuel inlet. Plug-in hybrid electric In vehicles, the internal combustion engine and the electric motor work independently of each other. However, these motors are activated alternately with each other while driving. The operating mode of plug-in hybrid electric vehicles differs from hybrid electric vehicles. hybrid electric vehicles it is dependent on gasoline, which means that the energy from the battery and the generator partially assist the engine. Plug-in hybrid In electric vehicles, electricity from the rechargeable battery will play a leading role, while the fuel engine will be retained as the auxiliary drive unit [12].

3. Why is Conversion Necessary and How Is Conversion Made?

With the conversion process, the cost of owning an electric vehicle is minimized and the old vehicle can still be used. In addition, electric vehicles create a greener lifestyle and therefore a healthier environment. In order to have the vehicles with the desired features, model and color at more affordable prices, it is the most appropriate option to carry out the electric vehicle conversion process today.

Consumers who want to convert their electric vehicles can consult a professional with a conversion background or they can do this conversion themselves. They can use more affordable conversion kits instead of individually procuring the components needed for the conversion. Among the companies that do the conversion and have kits, the best are Flash Drive Motors , Zero Labs , Zelectric_Motors are Electric GT, EV West . Among these companies, the recommended company is Flash Drive Motors [13].

In order to convert an internal combustion engine car into an electric vehicle, components such as the internal combustion engine, radiator, fuel tank, distributor, carburetor, alternator, exhaust pipe must be removed from the vehicle. In order to turn our vehicle into an electric vehicle instead of the removed parts, the electric motor, inverter, controller, battery, cooling system and pump, fuse and contactor components must be attached to the vehicle. In fact, there are multiple product options for each component on the market. Therefore, the components must be carefully selected according to the type of electric vehicle desired in line with the user's needs [14]. After removing the components that we do not need from the internal combustion engine vehicle, we need to add the components required for the electric vehicle to the vehicle.

The choice of the electric motor directly affects the important performance parameters of electric vehicles such as power, torque and speed. The selection of the electric motor is therefore very important. To achieve good vehicle control, the mass of the conversion components must be evenly distributed throughout the vehicle, especially the battery with the largest mass. The battery can be distributed to various centers of gravity depending on the vehicle used. The important thing at this stage is to achieve balance. Battery selection: It should be done in a way that will meet the expectations of the person who will use the vehicle, depending on the vehicle converted and the place where the vehicle will be used. After the electric motor, inverter, controller, battery, DC/DC converter, cooling system and pump, fuse, contactor components have been installed in the converted vehicle, the required process is wiring. First, the installation of the power cable is carried out. Power cables are used in serial circuit such as battery poles, battery poles going to motor controller and auxiliary components using high current. The state of charge of the batteries is checked and the battery is placed in a suitable place in the vehicle.

4. Number of Electric-Hybrid Vehicle Sales in Turkey

According to the Electric and Hybrid Vehicles Platform (TEHAD) report in Turkey, as of the end of June 2021, a total of 894 electric vehicles were sold. 27% of these vehicles are Porsche Taycan, 19% are Renault, 17% are Mercedes Benz, 16% are BMW, 15% are MG and 2% are Jaguar. In the first 6 months of 2022, 2143 electric vehicles were sold, with a total of 3 times more sales compared to 2021. According to TEHAD's 2022 data, BMW Group (i3,iX3,iX) is in the brand ranking for 2022, and Renault Zoe is in the list of the most sold models [15].

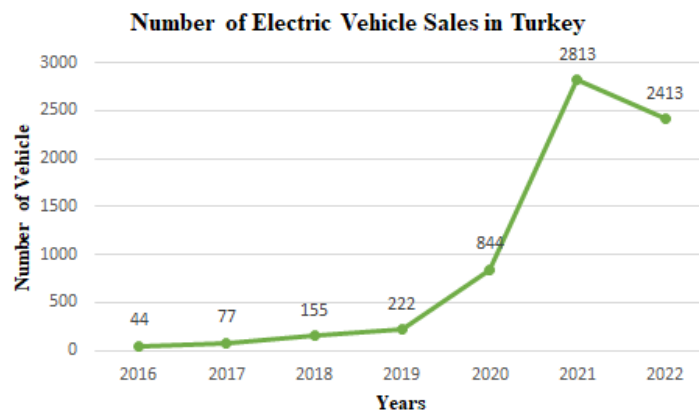


Figure 4. Graphical Representation of the Total Number of Electric Vehicle Sales in Turkey

According to the Electric and Hybrid Vehicles Platform (TEHAD) 2022 data in Turkey, 11,851 hybrid vehicles were sold as of the end of June 2021. 97% of these vehicles are Toyota Corolla (9667 units), 3% are Volvo, Honda, Hyundai, Jeep, Kia, Lexus. According to the TEHAD 2021 report, 20915 hybrid vehicles were sold throughout 2021 [16]. In the first 6 months of

2022, with a total loss of 40% compared to the same period of 2021. 9731 hybrid vehicles were sold. In 2022, there was a decline in hybrid vehicle sales. According to TEHAD 2022 data, 69% of these vehicles are Toyota Corolla (5709 units), 12% Honda, 12% Fiat, 3% Hyundai, 1% Volvo, 1% Jeep, 1% Kia constitutes 1% and MG constitutes 1% [15].

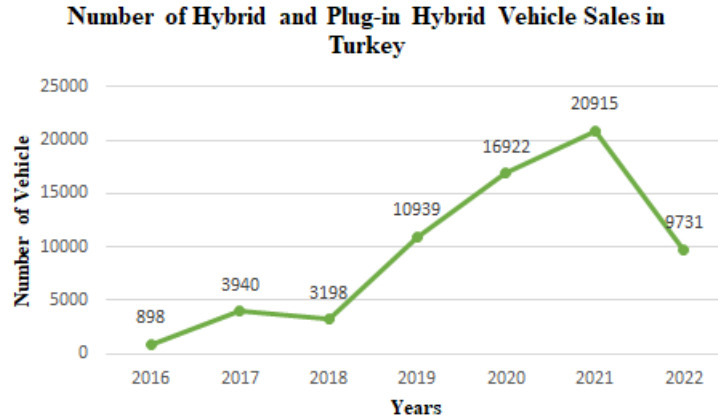


Figure 5. Graphic Display of Total Sales of Hybrid and Plug-in Hybrid Vehicles in Turkey

5. What is Being Done for The Transformation of Electric Vehicles in Turkey

There are companies in Turkey that carry out the conversion of electric vehicles. These companies do not carry out individual vehicle conversions in accordance with the conditions of the Regulation on the Manufacturing, Modification and Assembly of Vehicles (AITM). These companies are venture companies, carries out the vehicle transformation of automotive companies, universities, research centers. A feasibility study is carried out to realize the vehicle conversion. As a result, the fee required for the conversion and the conversion time are determined.

The Ministry of Science, Industry and Technology continues to work on the “Transformation of Fossil Fuel Vehicles to Electricity Project”, which is widespread abroad, so that internal combustion electric vehicles can be put on the road in Turkey.

6. Conclusions

Electric vehicles are seen as alternative vehicles to be used in the future. Electric vehicles are environmentally friendly thanks to their use of renewable energy sources and zero carbon dioxide emissions. Consumers demand for electric vehicles is increasing day by day. The lack of variety and economic conditions make it difficult for consumers to buy new electric vehicles from the factory. Electric vehicle transformation is shown as a solution to this situation. With the realization of the conversion process, the internal combustion engine vehicles that are no longer used will not harm the environment by waiting in the junkyard, and it will reduce the cost of buying the majority of the materials required for the electric vehicle from old vehicles instead of ordering them from abroad. This will benefit both the consumer and the country's economy. In addition, trained electrical-electronic technicians will be needed for conversion operations. There will be a need for electrical-electronic technicians and thus the employment rate in Turkey will increase.

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