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AN INNOVATIVE AND ENVIRONMENTALLY FRIENDLY SOLUTION FOR EXTENDING THE RESERVE RANGE OF ELECTRIC VEHICLES

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A R T I C L E I N F O.

Key words:
electric car, fast charging equipment, emergency course, climate control system, hydrocarbon fuel, carbon dioxide.

Annotation:

This article provides analyzes and recommendations for increasing the reserve and preventing environmental pollution. This is done by improving the system for charging electric vehicles with alternative energy sources, namely the installation of solar panels on the outer part of electric vehicles.

Introduction

Cars have already become an integral part of human life in our modern world. They have a place in all spheres of industry and our daily lives, in cities and megacities, and even in entertainment. Experts estimate that there are about 1.2 billion vehicles worldwide[1]. If we take into account the current development trend of the industry, it is estimated that another 1 billion will be added in the next 20 years. An increase in numbers means an increase in environmental problems as well. If 1 billion cars emit 1 million tons of toxic gases into the atmosphere in a day, the daily increase in these figures will increase environmental problems. This is a catastrophic situation, so preventing it remains the most pressing issue in all areas. It is crucial to make cars 100% environmentally friendly, given the need to phase out the use of fossil fuels and replace them with low-carbon sources of energy to achieve the 2°C goal of the Paris Agreement [2]to combat global warming.

At first glance, EVs look like vehicles running on eco-friendly fuel. However, given that EVs receive electricity directly from the grid and that approximately 80% to 85% of the global energy needs are fulfilled using fossil fuels[3], it can also be said that they run on fossil fuels.

Electric cars now account for 1.6% of all cars in the world. To make it convenient to charge electric cars, each electric car should have one charging station. Today, there are about 7 million charging stations worldwide. In the U.S, there is about one public charge point per ten battery electric vehicles[4]. If all one billion cars in the world were replaced by electric cars, the same number of charging stations would be needed. In addition, extra energy is needed to meet the increasing demand for electricity needs of electric cars. Finding new sources of electricity and delivering it to consumers will be another big challenge. If the charging equipment of electric vehicles is also connected to the current grid, it will not be able to cope with this as there is going to be five times more demand for electricity supply during evening peak hours. Europe alone will need about 80 billion euros to deploy all those chargers and to get to scale. If we make the transition to solar mobility, we can reduce the cost up to 3 times so we can reduce about 50 billion euros of that. Extrapolating to the rest of the world, we can save humanity more than 100 billion euros on investing in this infrastructure.

The question arises, should we really need to invest all of that in something that we might not need after all?

The most common models of electric cars are equipped with lithium-ion batteries with a capacity of 65-80 kWh. These batteries serve not only for the car's running gear, but also for several systems, such as climate control, the use of onboard computers, security systems, and lighting. The energy used for all systems except the running gear reduces the EV's range, which is their main function.

We will look at the disadvantages of only the climate control system, in particular, the effect of heating on the range of an electric car, and its solutions.

The initial calculations will be made in the example of the TESLA Model 3 Long Range electric car. In this model, the HVAC (heating, ventilation, and air conditioning) system controls the climate of the electric car interior. The system operates in fully automated and partially automated modes. The effect of the system on the electric car range in 3 different cases has been studied and we will analyze these experiments. The battery capacity was 80 kWh, the electric car speed was about 112 km/h, the temperature was about 3.33°C, and Michelin X-Ice Xi3 winter tires were set to the factory setting of 42 psi[5].

Case 1. Baseline consumption with the HVAC turned off completely was 215 Wh/km, which implies a possible range of 372 km.

Case 2. The HVAC system was partially automated, where the Model 3 consumed energy at a rate of 251.25 Wh/km. At that rate of consumption, the predicted range fell to 318km.

Case 3. The HVAC system was fully automated. The electric car range dropped to a meager 274 km by consuming 291,25 Wh per km.

The analysis of the results shows that compared to the initial case, the EV travels 15% less when the HVAC system is in the partially automated mode, and 26% less than its baseline run in the fully automated mode.

If the surface of the TESLA Model 3 Long Range is covered with 8 m2 of solar panels, about 1700 W of electricity per hour can be obtained. The energy can be diverted to the HVAC (heating, ventilation, and air conditioning) system to increase the range of electric vehicles up to 10 km per hour. If the temperature is relatively high and the speed of the electric car is low, it is even possible to increase the range using solar panels to 15 km per every single hour. By covering the electric car with solar panels, it is possible to save an average of 11 kW per day and with this amount of energy, it is possible to travel a distance between 55 and 60 km. This means that electric car users with a daily running distance of less than 50 km can entirely rely on solar energy. According to statistics from the Japanese Ministry of Land, Infrastructure, Transport, and Tourism, about 70% of family cars in Japan travel less than 30 km per day[6]. There are over 16 million electric vehicles on the roads around the world[7]. Conventional power plants use hydrocarbon fuel of 125 grams of fuel equivalent to producing 1 kWh of electricity. Covering the electric car with solar panels and saving 11 kW economizes 1,375 kg of fuel equivalent per day. This means 16 million EVs save 22,000 tons of hydrocarbon fuel or 40,700 tons of carbon dioxide (CO_2) emissions per day.

Conclusion

Taking into account that each electric car prevents the release of about 1 ton of carbon dioxide into the atmosphere per year, it is undeniable how promising it is to cover electric cars with solar panels in the future and how it will unravel environmental problems.

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