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Extended Abstract

Electric Vehicles and Driving Range Extension – A Literature Review

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Abstract

Electric vehicles are gaining popularity due to their low carbon footprint and ease of integration with renewable energy. They are an important element in the smart grid ecosystem. Increasing the driving range of storage driven electric vehicles is the biggest challenge facing the light weight electric vehicle industry. A literature review has been performed to identify various techniques to improve the driving range. Various methods of driving range improvement such as new storage topologies, switching techniques, motor configurations are studied. A new quantitative measure called as impact factor has been derived to see the effect of each technique on the driving range. Impact factor for different methods has been calculated. It is shown that increasing the storage capacity has the highest impact factor on the driving range.

Keywords:

Electric vehicles; Hybrid Electric Vehicles (HEVs); Plug in Electric Vehicle (PEV); Battery range; Ultracap; Vehicle chargers; Regenerative braking; Vehicle to grid (V2G)

Introduction

Electric vehicles have been around since early 19th century.However, the electricity was primarily generated using coal and other fossil fuels. Driving electric vehicles meant double energy conversion, first one was from fossil fuel to electric energy and the second one was from electric energy to kinetic energy. This made it economically expensive solution. In addition to that, ample oil reserves were discovered and gasoline powered vehicles became the most cost and energy efficient means of transport. Now that the world is facing severe shortages in the gasoline and rising effects of environmental pollution such as climate changes, efforts are being carried out to reduce the pollution and improve the carbon footprint. Every country has set out policies and Framework for achieving this target. This has given a significant boost to the research and development in the areas of renewable energy sources and electric vehicles. There is a strong connection between the two. As the renewable energy sources have become cheaper and commercially attractive, more energy is being generated by them. These sources are intermittent and hence they need storage for their complete utilization. With ever-evolving storage technologies, the electric vehicles became economically a more viable option. Besides giving power to the electric vehicles, storage made them an important element in the smart grid.

There are many different terminologies for the electric vehicles based on their utilization of electricity. Grid connected electric vehicles are the ones which use the electricity from overhead or underground cables. Typically, electric trains and trolley buses are developed using this concept. Battery based electric vehicles have rechargeable batteries on the vehicles. The vehicle uses the energy from the battery. Battery needs to be charged after the drive.

Structure of Electric Vehicle

All the electric vehicles have four main building blocks. They are as follows: A. Battery to generate a DC voltage, B. A DC to AC converter to convert the DC voltage to a high-frequency AC voltage, C. an AC motor coupled to the drive train .The battery charger circuit to charge the batteries. Sometimes, an additional DC to DC converter is also required to step up the low voltage from the batteries.

Battery

The battery specifications for the electric vehicles differ for different types of electric vehicles. Most of the cars use lithium-ion batteries with 370V as nominal DC voltage. The battery capacity ranges from 20 kWh to 100 kWh. Higher is the battery capacity, more is the driving range of the vehicle. The driving range for the current electric vehicles ranges from 60 miles per

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charge to 380 miles per charge.

DC to AC converter

DC to AC converts the DC voltage to an AC voltage with varying frequency and voltage. This enables smooth speed control of the vehicle. The input DC voltage to this converter has a nominal operating range of 280V to 360V. This voltage is generated either by directly using high voltage batteries or a separate step-up converter along with the low voltage batteries.

Motor

Three types of motors are used for electric vehicles. They are brushless permanent magnet synchronous motors, AC induction motors and switched reluctance motors. AC induction motors are more popular for cars for various reasons . They have ease of manufacturing and lower cost. They also have good overall efficiency over the entire load and speed operating range.

Battery chargers

Most of the electric vehicles are supplied with onboard chargers. They are categorized into level 1 or level 2 chargers. They can take input from the AC voltage of the residential electricity outlet and convert the AC voltage into a DC voltage to charge the battery. They are slow chargers but are most popular due to direct AC outlet connections. Level 1 chargers take input from 110V AC and level 2 chargers take input from 220V AC. To have fast charging abilities, level 3 and level 4 chargers were developed.

Conclusion

Use of electric vehicles has been growing. Increasing the driving range of the electric vehicles is a topic of much interest in the commercial world. A detailed review of available methods to improve the driving range is presented in this paper. Driving range can be increased by using advanced storage materials, improving the converter technology, improving the motor, using renewables in the vehicles, on-road contactless power transfer, and effective vehicle thermal management and following efficient driving practices.

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