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Wireless Charging of Electric Vehicle While Driving

Dr. S. S. Kadlag[1], Choure Mayuri Arunrao[2], Gaikwad Kaveri Kailas[3], Kolkar Ankita Aniruddha[4], Pawar Smita Baliram[5]
Department of Electrical Engineering
Amrutvahini College of Engineering, Sangamner, India

Abstract: *The main functions of wireless charging is to transmit power by an electromagnetic field across a given space. As electric vehicles are a better alternative to curb the ongoing pollution it is vital to make amendments in the battery charging process to attain greater reliability. Electric vehicle battery charging can be done by plug in charging at charging stations or by wireless power transfer.*
Wireless power transfer can be implemented as a static or dynamic charging system. Dynamic charging system can be implemented to charge the vehicle even when it is in motion. By using inductive power transfers the power from source can be transferred to the chargeable batteries through transformer windings. For preplanned routes such dynamic charging stations can be set up for charging batteries. This will not only increase the use of electric vehicles but also make them efficient and reliable for large distances as well. The paper specially presents an evaluation on how the future EV development and wireless charging methods can be implemented.

Keywords: Wireless Power Transfer[WPT],Wireless Charging of Electric vehicles[WCEV],Wireless Electric Vehicle Charging System [WEVCS]

I. INTRODUCTION

The ongoing climatic conditions have led to the research and development of electric vehicles over the past decade. The increasing global warming has caused an awareness among the people to switch to electric vehicles. The time required to wait at charging stations while the battery is being charged will be reduced by a considerable amount oftime when the charging will be done on road while driving the vehicle. Even though electric vehicles are analternative, there needs to be development in its charging system to make it the prime option for transport. For this purpose, the charging systems should be developed. Dynamic charging systems are more reliable, user friendly and time efficient. Also, the battery size can be reduced, and the range can be improved. This charging system can also be implemented in the travel routes, traffic signals, bus stations.

II. PRINCIPLE OF OPERATION

The technology of wireless charging is based on the Qi standard (driven by Wireless Power Consortium).This standard is used globally for wireless charging of smartphones. This can also be implied on wireless charging of electric vehicles. The working of wireless charging is based on Electromagnetic Induction. The coils of wire in the base unit act as primary winding and create a magnetic field when current passes through it. This field induces a current in the adjacent coil without actually touching it. If we consider this adjacent coil as a secondary winding and connect it to a charging unit, wirelesscharging is obtained. The electric vehicle charging systemsare still in the development phase due to many aspects such as safety, cost, infrastructure etc. However, in this paper we propose to demonstrate the Dynamic Wireless Charging System as a prototype which can be implemented in the future.

III. FUNDAMENTAL CIRCUIT

The Fig 1 shows the block diagram of the proposed circuit. The AC source voltage is stepped down using a transformer and converted to DC using a rectifier circuit. This voltage is then converted to AC voltage of the required frequency using an inverter. The voltage of desired frequency is fed to the transmitter coil of the system which is

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mounted on the base unit. In case of dynamic wireless charging this base unit will be mounted on the road. The receiver unit will be mounted on the base of the car. Power is transmitted from transmitter coil to receiver coil through inductive coupling. The power is then rectified and regulated to suit the battery specifications. Thus the charging of the battery will take place.

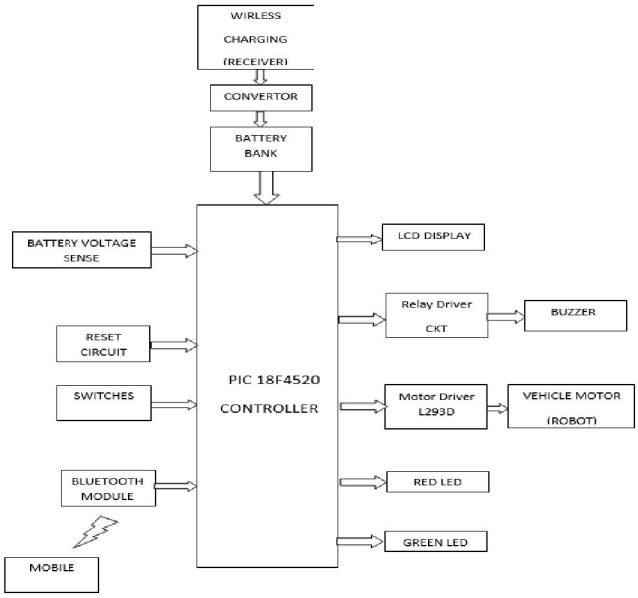

Fig 1: Block Diagram of working of wireless charger

IV. IMPLEMENTATION OF WIRELESS CHARGING

Wireless charging is useful in eliminating the need of conductive wires and thus conduction losses which can take place through wire can be completely cut out. Also the human handling of wires during the charging process for plug in and plug out can sometimes be hazardous if not done correctly. Thus the human intervention can be avoided for safety purposes. Even though wireless charging seems to be time saving and effective, it comes with certain limitations. The main aspect of implementation is the development in infrastructure which needs to be done to suit the purpose. This will require a huge investment of capital during all stages of the work and hence it is a costly affair. The first wireless charging technology to be developed was stationary, the system having been designed to charge EVs in garages or public parking spaces, when the vehicle is not operating for an extended period. Because a physical connection is not required, there has been major interest in the possibility of charging EVs while they are in transit. Charging an EV while in motion is called dynamic wireless charging.

V. STATIC WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

Static WEVCS (Wireless Electric Vehicle Charging System) can easily replace the plug-in charger with minimal driver participation, and it solves associated safety issues such as trip hazards and electric shock. fig 2. Shows the basic arrangement of static WEVCS.

The receiving energy is converted from AC to DC using the power converter and is transferred to the battery bank. In order to avoid any safety issues, power control and battery management systems are fitted with a wireless communication network to receive any feedback from the primary side. The charging time depends on the source power level, charging pad sizes, and air-gap distance between the two windings. The average distance between lightweight duty vehicles is approximately 150–300 mm. Static WEVCS can be installed in parking areas, car parks, homes, commercial buildings, shopping centres, and park ‘n’ ride facilities.

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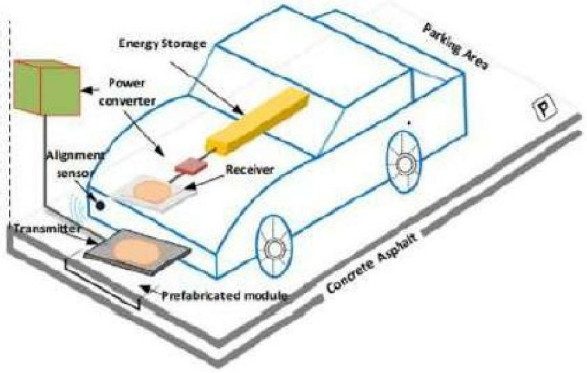

Fig :2 Static wireless ev charging

DYNAMIC WIRELESS CHARGING SYSTEM [DWCS]

As the name suggests Dynamic wireless charging system isthe system in which EV is charged while it's in motion. The main concern for electric vehicle deployment is the power and range. For improving the range of the vehicle dynamic wireless charging will be beneficial. The DWCS is also termed as "on road charging". If the charging is done at proper intervals a large capacity battery is not required and this makes the vehicle lighter and more economical.

DWCS provides a better option for the charging of electrical vehicles to improve its range. The base unit will be placed below the roads on predefined routes and the car will have the battery bank. The car will pass over the road and charging will be done when the car is in motion. This will require a lot of investment and infrastructure modification at the initial stages but slowly the system will help in gaining market for electric vehicles making a better option over conventional means of transport. Wireless power transfer is the latest technique to charge/discharge the EVs without any physical contact between source and load. WPT transfers electrical energy through electromagnetics. There are several advantages of WPT, such as:

The physical connection requirement is avoided, which leads to less fault in charging equipment. Also, it helps to start the charging using the software interface (mobile phone, tablet, in-vehicle application).

The charging equipment is installed under the ground, which helps to facilitate higher numbers of EV charging simultaneously in the same size station. In addition, charging equipment is protected from environmental hazards.

In the United States, many wind and solar power plants are built along the highways, in which the dynamic WPT technology can be integrated with renewable energy technology. For such situations, the electric energy used for charging EVs mainly comes from wind turbines (during the night) and solar photovoltaic arrays (during the day) on both sides of roads, and the power from the main grid can be used as a reserve. This system provides an electric energy source for EVs right close to where the electricity is generated, which helps to reduce the transmission network congestion, reduce power transmission losses, improve the utilization rate of renewable energies, improve power system control and management, and greatly reduce carbon emission from the transportation system. The diagrammatic representation of the DWCS system is shown in fig-3

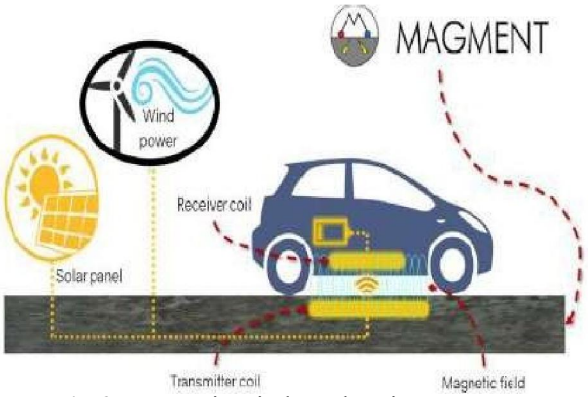

Fig-3 : Dynamic wireless charging system

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VI. MERITS AND DEMERITS OF WIRELESSCHARGING SYSTEM

Merits:

- Environment-Friendly – The biggest and the best reason to use an electric vehicle is that it is environment-friendly. They do not release vicious gases that lead to air pollution as against the fossil fuel powered cars.
- No Fuel or Gas Cost – Since electric vehicles need no fuel or gas to power them, a user can escape the steep rise in prices of these commodities. All it needs is to be pluggedin and ready to go another 100 miles.
- More convenient – The electric vehicle is easy to recharge. You will no longer need to run the fuel station to get your car recharged before hitting the road! Even a regular household socket could be used for charging an electric car.
- Quieter – Electric cars cut noise pollution as they have fewer moving parts than a conventional vehicle. They are much quieter when in operation. An electric car is very quiet and very smooth compared to a petroleum-powered internal combustion engine vehicle.

Demerits

- Lack of Charging Stations – One of the major advantages of using an EV is the fact that it does not need any petrol or diesel to run. Instead, it just needs a charging station where the vehicle can be plugged and ready to go. However, one of the major challenges that are hindering its adoption is the lack of a sufficient number of charging stations. For example, India has very few EV charging stations. Even if you buy an EV, it will make no sense unless there is a charging station in your vicinity. For promoting an increased adoption of these vehicles, it is first necessary to build an adequate number of charging stations.
- Expensive – Buying an electric vehicle is still expensive. There are many fossil fuel cars available in the market at different price points. However, electric vehicles offer lesser options to choose from, and the better ones are highly priced. It is absolutely necessary for governments to promote the usage of EVs through subsidies and incentives – both to buyers and manufacturers. Even the batteries that are used are still costly, though their prices are estimated to drop in near future.
- Lack of Power and Reduced Range – Fossil fuel based cars offer better acceleration when compared to electric vehicles. Though Tesla and Volkswagen are making EVs with better range, an average electric car can easily run at 100 miles to 200 miles per charge. Hence people are still skeptical about using electric vehicles for long journeys/ highway drives.
- Minimal Amount of Pollution – Electric vehicles are not 100% emission free. Even they cause a little amount of pollution indirectly. The batteries and electricity used for charging are not necessarily generated from renewable energy sources.

VII. FUTURE SCOPE

Based on the policy guidance and technologies that spring up. This section is supposed to envision the future WEVC Nowadays, global EV inventories are expanding vigorously. Under the trend of industrial prosperity, two potential orientations in WEVC consist of how to guarantee a sustainable growth of EV ownership and how to allow full play of scalable development of EVs. Moreover, arising new technologies, materials and theories could make WEVC even more competitive. Power electronic devices can benefit from advanced materials as well. For one thing, besides flux leakage, switching loss is another major source of energy waste in a WEVC system. Dispensed with manual operation, static WEVC can liberate the operators' hands but fails to make charging sites more flexible. In this context, dynamic WEVC shows its unique advantage. This technology could be roughly divided into tram-based and on-road type

VII. CONCLUSION

With the advancement of EV technology, charging infrastructure and grid integration facilities, EV popularity is expected to increase significantly in the next decade. In this context, wireless charging has aroused wide attention since it is spark-free, independent of environment and applicable to unmanned operation. This paper has outlined a comprehensive overview of wireless charging technology for EVs. This paper has outlined a comprehensive overview

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of wireless charging technology for EVs.WPT technology offers the possibilities for better energy performance, lower environmental impacts, lower life cycle cost, and more convenience and operational safety benefits.

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