Application and Development Prospect of Wireless Charging For Electric Vehicles

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Abstract. Wireless charging technology for electric vehicles (WCT) is a new non-contact charging technology applied to new energy electric vehicles. Compared with traditional contact wire charging, WCT has the advantages of high safety factor, less weather factor, more intelligent charging and convenient configuration. Firstly, this paper discusses the background of wireless charging technology for electric vehicles, the development history of wireless charging and the research status at home and abroad. Then, it summarizes the basic composition, principle, category and performance characteristics of electric vehicle wireless charging, describes the main application status and development prospects of wireless charging technology in electric vehicle, and finally analyses the 3-60 kW high-power wireless charging case of ZTEV electric vehicle which has been applied in many places in China and Qualcomm case, put forward the future prospects of wireless charging technology for automobiles.

Keywords: Electric vehicle, Wireless charging, Prospect, Development trend

1 Words Before
Wireless charging technology is a new type of charging technology, which makes ev charging safer, more reliable and more convenient. In today's situation, the development of electric vehicles is inevitable, but the premise of the development of electric vehicles is to solve the problem of charging technology. Wireless charging of electric vehicles is the most potential charging technology. Based on this, this paper focuses on the principle, application status, development prospect and research trend of wireless charging technology for electric vehicles.[1]

2 Composition And Principle Of Wireless Charging For Electric Vehicle

2.1 Components Of Wireless Charging
The main body consists of power supply and electricity supply, both of which are indispensable.

2.1.1 Composition of power supply system
The power supply system shall be AC source-ac power supply; Rectifier & PFC & Amplifier -
Rectifier, power factor correction and power Amplifier circuit; Tuning Network- primary side Tuning circuit; The Tx Coil- emitting Coil.[1]

2.1.2 composition of the receiving system
One end of the receiving system is provided with an Rx coil- receiving coil. Tuning Network-secondary side adjustment circuit; Rectifier & Regulator Rectifier and on-board power management circuits; These make up the complete circuit.[1]

Power supply and receiving systems are indispensable, as shown in the following figure:

![Figure 1. schematic diagram of wireless charging for electric vehicles](image)

2.2 Principle Analysis Of Wireless Charging
Wireless charging starts from the ac power supply in the power supply part to the rectifier, power factor correction and power amplifier circuit, and then to the primary side tuning circuit, which serves as the primary coil and carries the ac of a certain frequency, transmitting the energy electromagnetic wave of a certain frequency from the transmitting coil to the outside.[2] The receiving coil in the power receiving part generates a current on the secondary circuit by electromagnetic induction, which is then transmitted to the secondary side regulating circuit. Finally, the rectifier and on-board energy management circuit are stored on the battery to complete the whole process of wireless charging. In the whole process, there is no need to connect the power with the traditional wire, avoiding the unexpected danger of electric shock.[2]

3 Research On The Application Status And Prospect Of Wireless Charging For Electric Vehicles

3.1 Application Status Of Wireless Charging Of Electric Vehicles
Fortunately, with the joint efforts of scientists, a new prototype electric vehicle with wireless charging technology has been developed. Honda and nissan are working with Witricity in the U.S. to develop the wit-3300 flat-panel wireless charging system with a total power of 3.3 kilowatts, transmission efficiency of more than 90%, and charging at a distance of 10 to 20 cm.[2] The 2015 infiniti LE luxury electric car and 2016 PRUIS components are in use; Meanwhile, BMW of Germany has teamed up with qualcomm to develop a Halo wireless charging solution for the i8 high-performance electric sports car. Car-parts maker Bosch and Evatran, an American firm, have come up with a wireless charging solution called Plug less L2, which allows them to boast not only wireless charging but also automatic parking. NASA's flagship bombardier research centre in Canada and HEVO Power in the us have also launched mobile wireless charging products.[3]

3.2 Development Prospects

3.2.1 advantages of wireless charging
Compared with traditional wired charging, wireless charging has two obvious advantages: convenience and safety.\[^{14}\] It is the convenience and security of wireless charging that makes its development prospect far-reaching. If there is no obvious advantage of wireless charging, there is no need to develop.

First, convenience. The development of science and technology is to bring more convenient and comfortable experience to human beings. When charging an ev wirelessly, it only needs to park the vehicle in the wireless charging area to charge automatically and intelligently. No driver needs to get off the car and connect the charging gun manually. The first service principle of wireless charging is to stop and charge immediately, so that drivers can fully enjoy the convenience of wireless charging. Since there is no external charging pile, it is more convenient to arrange on the ground surface. Under the same floor area, more wireless charging equipment can be arranged, which greatly improves the utilization rate of urban land with precious land. In addition, wireless charging has the advantages of no need for special personnel to watch while charging and low maintenance cost in the later period.

Second, security. Security is the foundation of science and technology. When charging an ev wirelessly, there is no need for the driver to insert a charging gun, avoiding the danger of electric shock. The current and voltage of wired charging piles are often fatal to the human body, especially in a thunderstorm or the risk of not using the charging piles in time during maintenance is greatly increased. Wireless charging does not involve the insertion of a charging gun, which means there is no mechanical wear, no weather, and it can be used in complex conditions with higher reliability.\[^{5}\]

Third, the sense of technology is stronger. Technology has been driving human development for a long time, and it has been proven that humans prefer to use products with a greater sense of technology. Examples from the advent of blue tooth and the existence of wireless charging for mobile phones have shown that more convenient, more tech-savvy products will be followed by more people. Car wireless charging brings people a sense of science and technology, this sense of science and technology can meet the new curiosity. As a result, more and more consumers will pay for it.

### 3.2.2 technical research trends

From static wireless charging to dynamic wireless charging, from low efficiency to high efficiency, and from low power to high power, will be the main research direction for the development of wireless charging. We improve the ability of control algorithm optimization and constantly add innovative basis points to further improve the performance of wireless charging system.\[^{6}\] Secondly, we set about the power conversion of amplifier circuit and the innovation of tuned structure network, and wireless charging will go further. Finally, it is important to change the control method and improve the algorithm, and propose a more accurate, more stable, lower input resistance and lower matching difficulty power supply topology to improve the working stability and transmission efficiency of wireless charging system.

Enable electromagnetic energy transmission to achieve higher biosafety. Security is the premise of all research, the technology can not achieve security is no practical significance. Due to the high-frequency operation of the wireless charging system of electric vehicles, the electric energy and magnetic field are continuously exchanged and transformed, so that the high-frequency alternating electromagnetic field in the surrounding area produces a certain amount of electromagnetic radiation. It is necessary for us to study whether this kind of radiation energy will cause harm to the biological human body, which is crucial for the promotion of wireless charging technology. If it turns out to be harmful to human body, then we should either give up or change the research on another harmless way of energy transmission. The radiation energy is inversely proportional to the charging working frequency, so we need to control the charging working frequency and conduct numerous experiments to grasp the best charging frequency. The charging speed is not only fast, but also very low harm to biological and human, and has no effect on the battery performance loss, which is the best result we want.\[^{7}\] The promotion and application of wireless charging systems require the development of more general and intelligent active protection methods for electromagnetic radiation safety.

Introduce new materials and improve wireless charging limits. Advanced materials with excellent
permeability and conductivity are introduced to solve the transmission efficiency problem. In recent years, the discovery and application of ultra-conventional electromagnetic materials [7] (left-handed materials), magneto electric layered composites and superconducting materials have opened up the possibility of further reducing the energy loss during wireless charging, and have also created space for the performance improvement of wireless charging systems. New materials will inevitably bring new opportunities. As long as we seize this new opportunity to promote the research and development of wireless charging technology, wireless charging will usher in a new development spring.

research on wireless charging technology and promote wireless charging at the same time. Wireless charging will be a revolution in science and technology, and it will be difficult to promote it, because it involves the market share of traditional technologies, which will have a fatal impact on a considerable portion of immediate interests. They will use biosafety and other reasons to oppose the development of wireless charging, but should not give up promotion. Mobile phone wireless charging is the first sound to promote wireless charging technology, making people feel that this technology is so convenient and the necessity of wireless charging. Therefore, the promotion of car wireless charging and the acceptance of wireless charging by more people also play an important role in the development of car wireless charging.

3.2.3 trends in applied research

dynamic wireless charging. One of the biggest bottlenecks in the development of electric vehicles is the low battery energy density, poor battery life and long charging time. All of these problems would be solved if the car could be recharged while moving. Electric cars also don't have to carry a heavy battery, which not only makes them lighter and faster, but also saves valuable energy and reduces motor work. Placing the transmission coils directly under the road surface to allow cars to be recharged while driving would be an important milestone in the development of electric vehicles.

assisted driving technology. By combining wireless charging with assistive technologies such as automatic parking and autonomous driving, human beings can experience the benefits of wireless charging belt more comprehensively.

two-way power transmission from vehicle to power grid and from automobile to residence. The intelligent combination of electric vehicles and power grid in two directions can automatically realize deduction, analyze power grid load, and charge when the power grid load is low, which has the function of regulating power grid pressure. Make electric vehicle intelligent, humanized, give full play to the performance of electric vehicle.

combine wireless charging with 5G technology. 5G's transformation of the network structure is also disruptive. 5G can improve the algorithm, and the optimized algorithm structure is conducive to the research and development of wireless charging technology. With wireless charging powered by 5G, the spark of innovation will be even more beautiful. Therefore, a new research on wireless charging based on 5G will be carried out, and the results will be presented in the near future.

If every ev needs to be equipped with a wireless charging system in the future, the value of the industry chain behind it will exceed 100 billion yuan every year. Therefore, the research market value of wireless charging technology is enormous. Who the enterprise layout in advance, take the first opportunity, and mature master this technology, who is the future automotive industry leading enterprises.

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