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THE STATUS OF ELECTRIC ROADS IN CHINA Or THE STATUS OF SMART & INTELLIGENT ROAD SYSTEMS IN CHINA

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Summary

Please provide a concise summary of your abstract of no more than 100 words.

1 Research Questions

The World Road Association (PIARC) is an international non-profit organization established in 1909 to improve international cooperation and foster progress in the field of roads and road transportation. In 2018 it investigated the status of electric roads throughout the world. Electric road systems may help to attain transportation policy targets by reducing carbon dioxide emissions and increasing the energy efficiency of the transportation system in the long run.

PIARC's undertaking was extensive, and a variety of actors from 38 countries were investigated to discover the status of electric road system development (ERS). However, the PIARC investigation did not include data or analysis of China, and thus this report had extensive information of the rest of the world but nothing about the largest country in the world—despite the fact that China had become the world's largest market for electric vehicles some years earlier. China was thus a glaring blind spot in the PIARC report.

Based on the PIARC 2018 report, our main research purpose was to explore the status of electric roads in China in order to understand where China is standing and where China is heading in the developing the technologies for electric roads and it´s implementation status.

In our research following aspects were main grounds of inquiry following on the purpose:

1. Estimate the maturity levels of dynamic electric road technologies, expressed in TRV levels
2. Explore the driving forces and driving actors
3. Explore the driving forces and driving actors in dynamic electric roads.
4. Explore the process of implementing electric roads in China
5. Explore the full-scale implementation of electric roads
6. Explore the unification and standardization of electric roads
7. Explore the business models for electric roads
8. Explore the customer segmentation
9. Explore the ownership of electric roads

Based on the grounds for our inquiry we have made analysis and conclusions as presented in this paper.

2 Methodology

This research was designed of two major steps.

- A literature review and study of open public sources on the status of ERSs in China. The purpose was to identify what is happening in China regarding ERS, who are the main actors in the development of ERS, and what results have been achieved regarding the readiness of the technology and its commercial deployment.
- Based on this first step we conducted a one-week empirical study, visits and interviews and communication with main actors on the ministry level, national institutions and associations, national research university and business companies conducting commercialization of electric road technologies.

3 Results

The PIARC report showed China as a white spot in the ERS area. Our research shows that China is not working on ERS as it has been in the west, nor are they developing technologies for ERS. China is rather heading beyond ERS focusing on development of future society and smart and intelligent cities. Thus, ERS is inadequate approach. China is taking the lead in the development of static and dynamic wireless charging systems, and this will have an impact on the development of ERSs in the rest of the world.

Because of this, the PIARC 2018 report should be updated to actually reflect the status of ERSs in China.

China is heading towards smart and intelligent roads complementing future development of smart and intelligent cities. The technology needed on roads is based on wide and deep approach to system of integrated technologies such as digitalization, GPS navigation, vehicle interconnectivity, integrated local renewable energy production on solar PV systems and consumtion on the electric roads.

To achieve results China has taken radical approach to technology development. China has seen electro-mechanical technology as obsolete for roads in the cities and between cities. This is considered as old fashioned and without the intelligent being needed in the future smart and intelligent city perspective.

China has identified the next technology frontier as interesting. The future for electric roads in the Chinese seems to be electro-magnetic technology, i.e. static and dynamic inductive technologies.

China is not lagging behind west in the technology development. Rather, China is taking a lead by jumping to next level of technology. Also, the implementation is rapid of chosen technology.

In 2018 a number of electric roads sites were identified, integrated solar cell systems with inductive technologies. The identified conductive technologies are used only for limited areas such as intra-city trams. In 2019 new test sites will be launched with 19 km inductive technology and in 2020 1 40 km test site will be launched. The major barriers to large scale commercialization is the lack of universal standards, security regulations, and inter-compatibility between vehicle dependent systems. Technology itself is not seen as the big barrier to commercialization.

There are 3 types of electric roads in China:

- Photovoltaic (PV) roads built using photovoltaic solar energy systems
- Modern city-based trams
- Inductive charging technology for static and dynamic wireless charging roads

Based on secondary data collection and analysis, we have identified at least five electric roads in China, with different TRL levels. Thus, this report can provide a deeper understanding of the status of electric roads in China, including their introduction, their main functions, the main actors involved, difficulties and challenges faced, and the direction of development of each electric road, as well as Chinese policies on electric roads.

The most advanced contemporary electric roads in China are PV roads, which can generate power through solar panels placed on the road surface. In the near future, such PV roads will be capable of both static and dynamic wireless charging. There are three PV roads in China, located in Jinan, Shandong province; Shaoxing, Zhejiang province; and Tongli, Jiangsu province. Among them, only the Jinan PV road has been completed; it has been open to traffic since the end of 2017. Shaoxing's PV road is still in the testing stages. Tongli's PV road is under construction.

The Jinan PV road is the most developed and mature of such roads in terms of TRL levels because it has already been completed and has been open to public traffic since 2017. It has achieved the functions of power generation and weather monitoring. The future development for this road is to integrate static and dynamic wireless charging and intelligence through interconnectivity to other systems. This PV road is estimated to be at TRL level 6-7 currently.

The second PV road is being built in Shaoxing. It is still in the testing stages. However, it has achieved the functions of power generation, high load-bearing capacity, and dynamic wireless charging in the lab. The future direction of R&D on this road is to test it in extended practical usage. The Shaoxing project is now at TRL level 3-4.

The third PV road is located in Tongli, Jiangsu province. This is a ring road around Tongli's historical center that is still under construction. It has achieved the functions of power generation and intelligent ammeter. In the future, this road will be capable of dynamic wireless charging and autonomous vehicle traffic. It is now at TRL level 3-4.

The second type of electric road in China is the modern tram in Zhuhai. Modern tram technology uses a catenary-free power supply system provided by Ansaldo STS, Italy. This modern tram was opened to public use on October 13, 2017. The actors involved in the modern tram are Ansaldo STS, CRRC Qingdao Sifang Rolling Stock Research Institute Co., Ltd., Zhuhai Urban Transportation Co., Ltd., and the Zhuhai government. This technology is intended for use only in intracity transportation and not for long distances and intercity travel. The tram system receives its electricity from the grid. The future direction for modern trams is to expand the tramline in Zhuhai by using catenary-free power supply technology. This system is estimated to be at TRL level 8-9 currently. This tram technology will probably only be used in traditional tram system zones in certain cities and not as an alternative to ERS solutions.

The final electric road in China is a dynamic wireless charging road in Zhangbei, Hebei province. This road is undergoing large-scale laboratory testing. The key breakthrough for this road is that it has achieved full-scale functionality of dynamic wireless charging. It is that a 40 km dynamic charging road will be built near Beijing in 2019. It now at TRL level 3-4, including the dynamic charging function.

We have noticed in our research that many different ERS-related technologies and projects were undertaken by various different R&D centers, institutes, and universities. Gradually they have been integrated into coherent systems. We have looked closely at wireless charging test facilities at Tongji University, Shanghai Dianji University, and Jiao University, all in Shanghai. All are conducting research on advanced wireless charging systems, and two of these institutions have systems nearing full commercial readiness.

Basically, China is not developing ERS as it is understood in the West. The final target for all these projects is to create smart and intelligent cities interconnected by smart and intelligent roads and transportation systems. The next generation of vehicles will be electric, and thus the entire system has to be integrated as a system that can handle autonomous driving, interconnectivity between all elements, and so on. This is the goal driving all these projects. Even though they are separate and competing with each other, they will gradually be integrated into the final direction of smart and intelligent cities. In China, political leaders and local actors are talking about superhighways with integrated energy and intelligence linked to urban and social development.

PV roads will be developed to cover side lanes on roads and collect solar energy as a supplement. These will be integrated with wireless static and dynamic charging, intelligence and interconnectivity. Wireless charging will be expanded in all systems, and tram systems will be limited to certain urban areas. Thus, conductive technologies are not seen as interesting, as these technologies are perceived as outdated technology with limited development functionality and potential.

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References

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