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Demonstration of a wireless electric road concept

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Summary

Electric road systems by ElectReon has the potential of creating a paradigm shift through its smart infrastructure solutions. As the required infrastructure around the world move away from fossil fuels, the main form of propulsion will be some combination of e-mobility. ElectReon uses inductive technology for wireless charging of electric vehicles. A vehicle can contain more than one receiver where each receiver can generate up to 20 kw and each management unit can power up to 6 buses or 18 cars in parallel. This solution creates a modular concept which is very cost- and weight effective for different vehicle types. A typical passenger car would need one receiver and a 40-ton truck would use five or six. The development has taken large steps during the last year and will start demonstration of the technology on public road in Tel Aviv and on Gotland (pending decision).

1 Introduction

To mitigate global warming and avoid severe climate change, governments, NGOs and the commercial sectors have embarked on a journey to decrease the use of fossil fuels. Road transportation is a major contributor of greenhouse gases (GHG) and therefore the transition to electric vehicles is the focus of many government policies. In the past three years, 11 countries, representing over 50% of total vehicle market unit sales, have declared a ban on new internal combustion engine (ICE) vehicle sales by dates ranging from 2020 to 2040. The decision of China, the largest car market in the world with about 30% market share, to ban all ICE vehicles by 2040 was an end-game call for all manufacturers and lagging countries and puts an end to the ICE era. A growing number of cities around the world are not waiting for central government regulations and are rather implementing registration and zoning policies that promote clean transportation, including designating car-free city centres and major metropolitan areas.

2 Technology overview

ElectReon uses smart road technology for wireless charging of electric vehicles. The company installs coils beneath the surface of roads for charging electric vehicles while they are traveling. This can extend the vehicles' traveling range, while saving time spent on charging them and significantly reducing their weight. The vehicles can be equipped with only a small battery to enable them to travel on road sections that lack the ERS infrastructure.

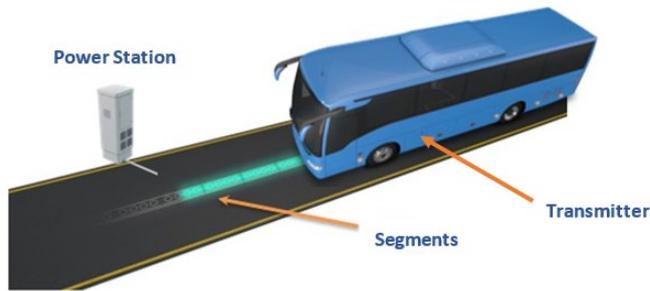


Figure 1 System components

Management Unit

The Management Unit located at ground level and resides in a concrete, weather-proof housing. Each Management Unit will handle a 100 meter section of road and convert energy from the electric grid (50 Hz) to the 85khz required by the stripe. The Management Unit communicates in real time with all vehicles in the system. The Management Unit is responsible for powering Strips on and off as required, depending on the location of each vehicle.

Stripe

The Stripe resides below the asphalt to support wireless inductive charging. It is optimally shaped to improve efficiency and reduce radiation. The copper-only stripe reduces cost, the need for maintenance and increases reliability. The stripe is passive and comprises 1.5-meter segments. When a vehicle rides over a given segment, only the segment located directly under it is activated (via the Management Unit) and transmits energy to the receiver, thus saving energy and enhancing safety. Each stripe is located 80mm beneath the road's surface in the centre of the lane.

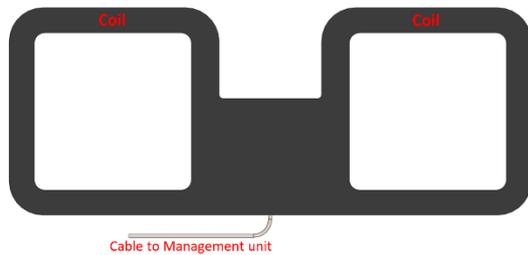


Figure 2: Stripe

Receiver

A Receiver that enables the reception of energy during the drive. The receiver is installed at the bottom of a bus or vehicle and transmits the energy directly to the engine or a battery.



Figure 3: Reciever

Safety concept

The stripe transfers energy only to electric vehicles with the appropriate receiver. The stripe is inactive when non-electric vehicles travel on the lane. The safety is ensured by two protection levels are in operation in a

situation where there are no vehicles on the road. This is done by two independent solutions implemented in hardware.

Vehicle configuration

A vehicle can contain more than one receiver where each receiver can generate up to 20 kw and each management unit can power up to 6 buses or 18 cars in parallel. This solution creates a modular concept which is very cost- and weight effective for different vehicle types. A typical passenger car would need one receiver and a 40-ton truck would use five or six.

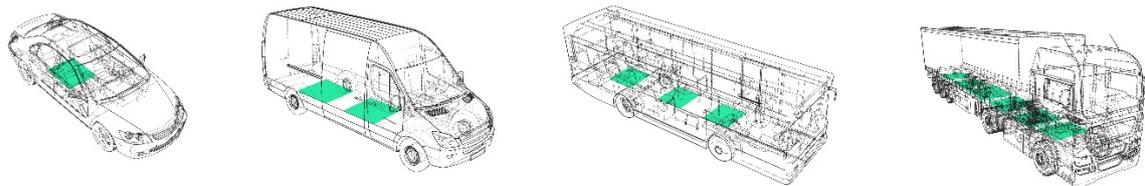


Figure 4: Modular approach. A vehicle can contain only one or multiple receivers

3 Test and demonstration

Test in Tel Aviv

A two-year durability test has been carried out in cooperation with the Tel Aviv municipality and Technion, Israel Institute of Technology. The trial was aimed at testing the durability of the coil infrastructure under real conditions in which buses and private cars travel on the road on which the infrastructure has been installed at all hours of the day, including testing whether the coils beneath the road surface really do transmit energy to an external receiver above the road. The result showed that the system had worked as planned and had transmitted energy to the receiving unit at more than 80% efficiency.

Test track

ElectReon is currently performing test on a new test site north of Netanya. The company is planning demonstrations of its technology in the coming months with an electrical vehicle with no battery and charging a small battery in a traveling electric car.



Figure 5: Test site north of Netanya

Demo site Tel Aviv

The Tel Aviv municipality have recently decided to conduct a pilot [1] of an electrified road section for passenger buses. The pilot includes deployment of at least one kilometre of electrified road infrastructure and testing the economic viability of operating a bus on the company infrastructure. The pilot is in cooperation with Dan Bus Company.

Demo site Gotland

The detailed planning of an electric road on the 4 km route between the airport and city centre of Visby is currently being finalized. Visby is a well-preserved medieval city with many historical sites and the major city on the Swedish island of Gotland. A challenge in this setting is to integrate new technology in balance with historical sites. This demonstration will be funded (if approved in April) by the Swedish Transport Administration as part of a pre-commercial procurement [2].

The demo site will consist of almost 2-kilometre-long dynamic segment. In order to demonstrate the interoperability between different vehicle types the ambition is two test a bus with three receivers and a 40-ton truck with five receivers.



Figure 6: Demo site Gotland

4 Next step

There are currently ongoing discussions with several actors, both vehicle OEMs, cities and regions. Beyond the demonstrations in Tel Aviv and Gotland the next challenge is a larger semi-commercial pilot on highways and bus operation in cities. To reach the full potential of the technology standardisation is important to ensure interoperability with static charging.

References

- [1] <https://en.globes.co.il/en/article-electreon-tel-aviv-municipality-to-lay-pilot-electric-road-1001275432>
- [2] Trafikverket, [National roadmap for electric road systems](#), 2017

Authors



Oren Ezer graduated Magna Cum Laude a bachelor's and master's degree in electronic engineering, specializing in signal and video processing. He co-founded Electreon in 2013. Along with vast experience in leading several startups, Oren has acquired knowledge in managing large-scale multidisciplinary projects for well-known international companies. He held a senior position as a chief electronic engineer and head of the R&D department at Elop (a division of Elbit while managing dozens of projects such as missile tracking systems, thermal imaging systems, laser systems



Dr. Håkan Sundelin is a senior researcher in electromobility projects at RISE. He is currently the project leader of the Research and Innovation Platform for Electric Roads in Sweden and the Swedish project leader of the Swedish -German collaboration on Electric Roads. He has a long industrial background from Scania where he has been evaluating and testing the concept of electric roads using both inductive and conductive power transfer in many different research projects. During his work at Scania he led the inductive part of the Swedish research project Slide-in. He was also the project leader of a joint project together with Siemens where overhead line technology was tested. He has taken part in the investigation of the electric roads made in UK by TRL and was responsible for the Scania part in the EU project FABRIC.