Pulse report series

January 2023

# Wireless vehicle charging: cutting the power cord

csa.catapult.org.uk

Compound Semiconductor Applications

# Introduction

**As the UK sets its sights on net zero emissions by 2050 and begins transitioning away from the internal combustion engine, electric vehicles (EVs) are set to become a mainstay on Britain's roads.**

Developing a UK-wide network of charging points and stations to support the uptake of EVs is a logistical and technical challenge, with significant amounts of money already being invested in infrastructure across the country.

There are roughly 35,000[1] charging points in the UK, each with the potential to fully charge EVs from as little as 30 minutes to more than 12 hours. By 2030, it is estimated that at least 300,000[2] charging points will be required to service the number of EVs on the road.

For EVs to reach their full potential, it is imperative that this charging infrastructure is reliable, fast, and affordable.

Even though wired plug-in points are becoming increasingly available at service stations, car parks and on our streets, industry is already setting its sights on future innovation, most notably wireless charging.

Despite being in its infancy, industry analysts forecast the global EV wireless charging market to be currently worth around $17-22M in 2023 and expect it to grow rapidly in the next five years to $200-300M, with a compound annual growth rate (CAGR) ranging from a modest 25% to a somewhat optimistic 86%.

Europe is a hotbed for wireless charging with 65% of the global market worth around $10.4M in 2022, according to Markets and Markets most recent report, with the UK accounting for 10% of that total addressable market (TAM).

And with £400M[3] of funding set aside by the UK's Department of Transport to build out an EV infrastructure, it's likely that wireless charging will become a critical part of the country's expansion plan.

**Pulse Report Series**

The Pulse Report Series is produced by the Market Inteligence team at the Compound Semiconductor Applications (CSA) Catapult.

The reports are designed to offer a light introduction to emerging trends across markets in which compound semiconductors can make a real difference, from space to electric vehicles.

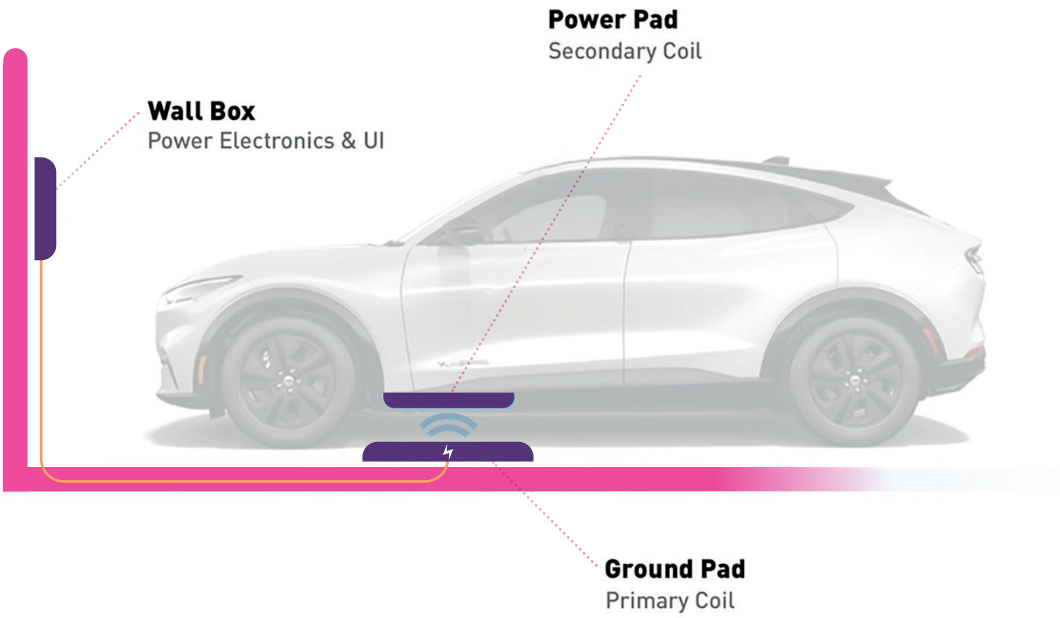
The information contained in the reports is obtained from a variety of sources and was correct at the time of publication.

[1] *Department for Transport, Electric vehicle charging device statistics: October 2022*
[2] *Department for Transport, Office for Zero Emission Vehicles*
[3] *Infrastructure and Projects Authority*

# Static versus dynamic charging

There are two types of wireless charging for EVs currently being explored by both industry and academia for commercial application: static and dynamic.

Static wireless charging, as the name suggests, is where a vehicle is parked above a charging pad at a fixed location and can involve both inductive and magnetic resonant power transfer.

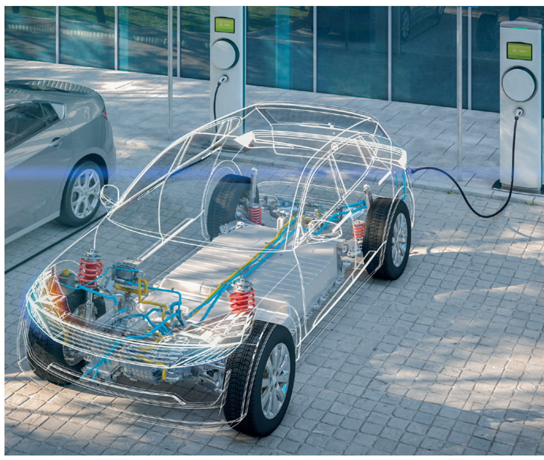



*Source: WiTricity*

Inductive power transfer technology is based on the principle of electromagnetic induction and consists of a transmitter coil located on a charging device and a receiver coil on an EVs battery charging unit.

When a current is passed through the transmitter coil, a varying magnetic field is formed which induces a current in the receiver coil, which is used to charge the vehicle's battery.

The air gap between the two coils must be near each other for the power to transfer and to maintain high efficiency. The bigger the gap, the slower the speed.



Similar to inductive power transfer, magnetic resonance coupling involves the transfer of power through electromagnetic coupling between the transmitter and receiver coils or resonators.

The difference lies in the requirement that the natural frequencies of the two resonators must be approximately the same for the magnetic resonance to work.

The advantage of this method over inductive power transfer is that the distance between the two coils can be larger without any drop in efficiency.

Public transport is likely to benefit from static charging when vehicles are parked – InductEV, for example, is currently working with Volvo on a three-year trial with XC40 taxi cabs that charge at a wireless stand in Gothenburg, capable of delivering up to 40kW.


*Source: InductEV*

Dynamic wireless charging, where the vehicle is charged as it moves over a piece of road, offers many advantages over static charging in terms of the size, weight, and efficiency of the car battery, but comes with more technological challenges.

The technology is still in its infancy; however, some interesting progress has been made around the world, such as a proof-of-concept project in South Korea whereby the Korea Advanced Institute of Science and Technology launched an electric highway embedded with wireless charging strips under the roads. The highway ran for 15 miles and was tested for electric buses.

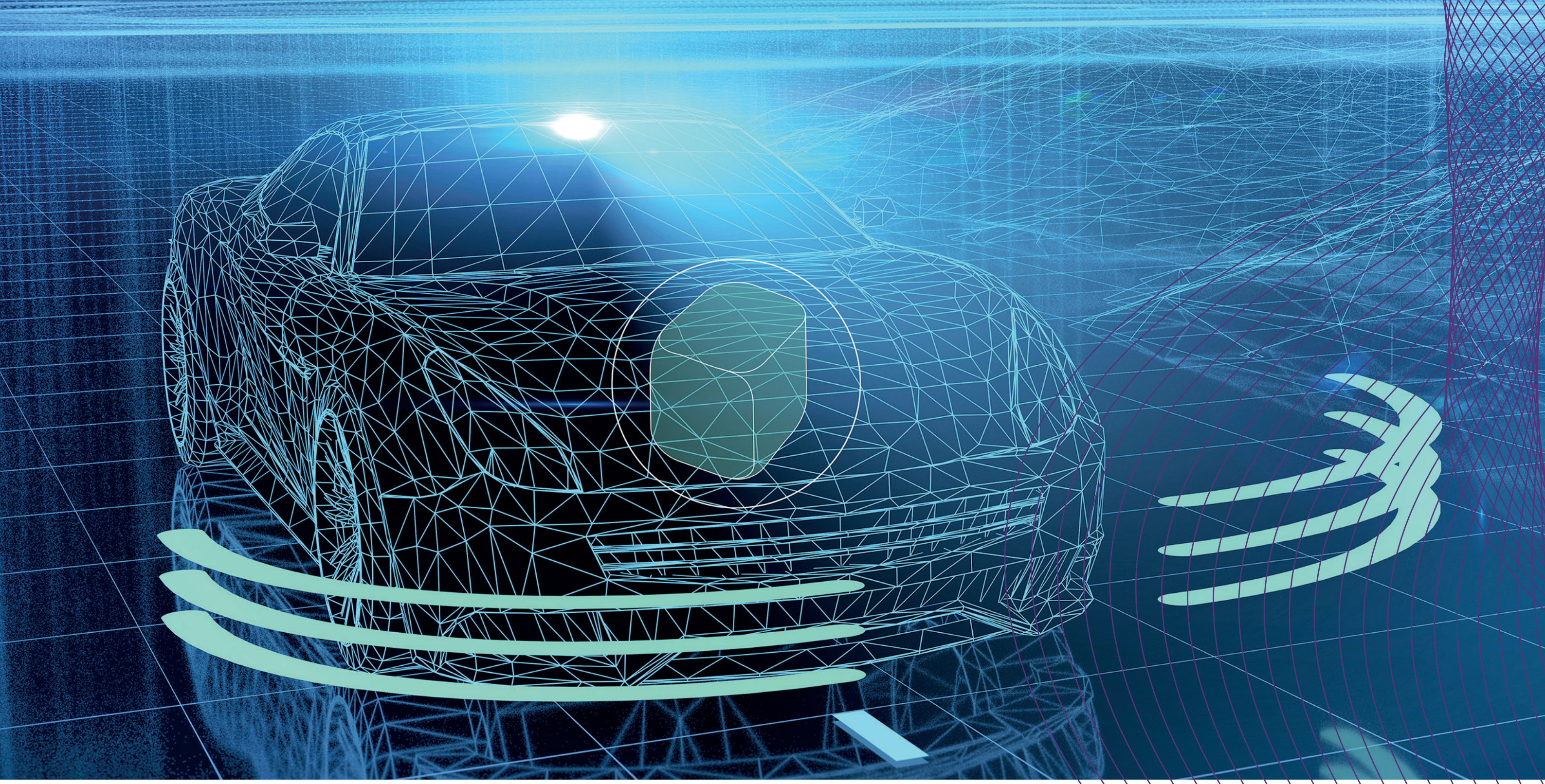
Israeli start-up, **Electreon** has built test tracks in Israel, Germany and Sweden for testing its technology with trucks, which don't need to travel at high speed. More recently it worked with **Stellantis**, the owners of Fiat, Maserati and Peugeot, who opened Arena del Futuro, a 1000 metre test track for cars and buses.

*Source: Stellantis*

A specially adapted Fiat 500 has been demonstrated that can maintain highway speeds on this special road, without consuming the energy stored in its battery.

Specifically within the UK, a project called 'DynaCov', led by Coventry City Council who have partnered with Cenex, Coventry University, Transport for West Midlands, Western Power Distribution, Electreon, Hubject, and National Express, will study the technical and economic viability of the dynamic wireless charging by constructing a stretch of road embedded with charging coils under the asphalt. Uniquely, the vehicles to be tested will have receiver coils in the wheels instead of the undercarriage.

Consumers are also testing static wireless chargers in Marlow, Buckinghamshire where the infrastructure provider char.gy is leading a peer-to-peer car sharing service in partnership with **hiyacar** using a fleet of Renault Zoe EVs fitted with induction chargers.



# The challenge ahead

The development of a reliable wireless charging system is not, however, without challenges, the main one being the speed at which EVs can be charged compared to traditional 'plug-in' chargers.

The maximum speeds of wireless charging achieved at present are on average 3 to 7kW and at best 40kW. In comparison, a 'plug-in' unit can deliver three to four times the amount of power in tens of minutes.

Whilst this may provide sufficient power to charge an EV in a pay and display car park for an hour or two, it is less convenient at places such as service stations where more rapid charging is required.

Dynamic charging is much more attractive but would naturally require a huge investment from the Highways Agency to upend existing road infrastructure, at a massive cost to taxpayers and inconvenience to motorists.

What is more likely to happen is that wireless charging is built into newer roads, with the costs being covered by a toll, or that stretches of dynamic coils could be built into short sections of roads so that motorists could 'top up' as they drive.

# The role of compound semiconductors

Regardless of how wireless charging is implemented on our roads, the battery inside every single EV will require power electronics – an area in which compound semiconductors excel.

Wide-bandgap compound semiconductors such as silicon carbide (SiC) and gallium nitride (GaN) are already revolutionising the EV industry.

As the home of the Driving the Electric Revolution Industrialisation Centre for South West and South Wales, the Compound Semiconductor Applications (CSA) Catapult is playing a vital role in projects to transform the transport sector.

Our power electronics team at the CSA Catapult believe that GaN could be the compound semiconductor of choice within wireless charging systems due to its ability to operate at higher frequencies.

GaN-based wireless power solutions have already been demonstrated to enable higher device placement, spatial freedom, and more extensive air gaps between the transmitter and receiver.

And as GaN has already been used in high-capacity consumer chargers, there is potential to see this replicated in the components used in wireless charging systems on the roads of the near future.

You can find out more about the CSA Catapult's power electronics work **here** and the Driving the Electric Revolution Industrialisation Centre for South West and South Wales **here**. To get in touch, please contact us at **collaboration@csa.catapult.org.uk**.

01633 373121

collaboration@csa.catapult.org.uk

@CSACatapult

Compound Semiconductor Applications (CSA) Catapult

www.csa.catapult.org.uk

CATAPULT Compound Semiconductor Applications