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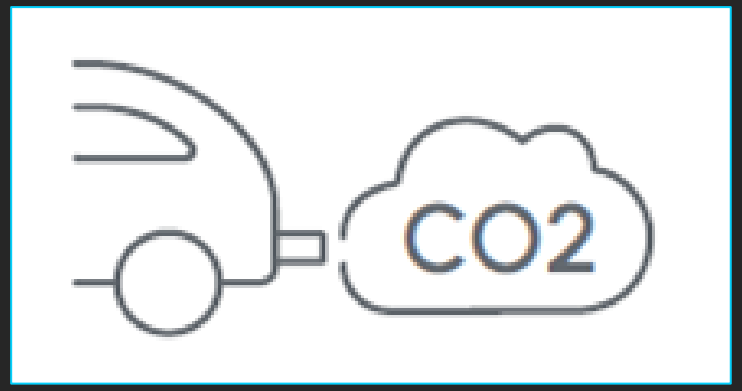
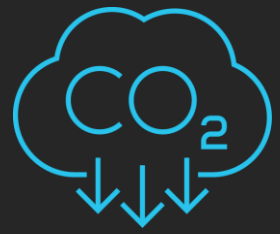
The Global Need for Wireless ERS

EVTeC 2025
THE 7TH INTERNATIONAL ELECTRIC VEHICLE TECHNOLOGY CONFERENCE
MAY 19-21 2025
PACIFICO YOKOHAMA, JAPAN

Dr. Andreas Wendt, Electreon

The Impact of Mobility on Climate Change





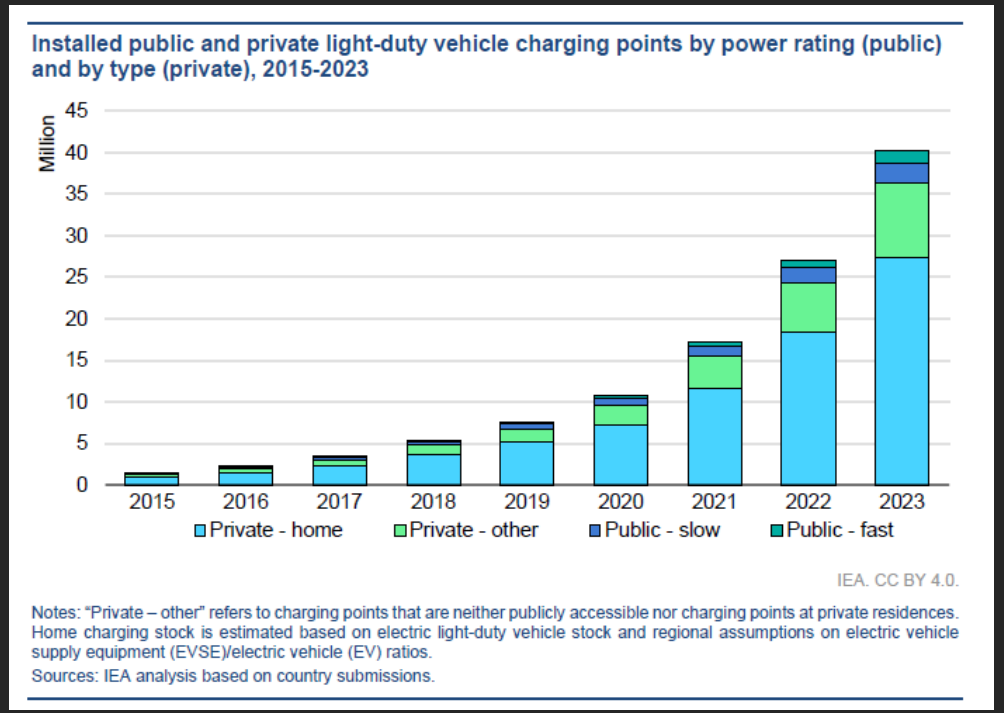
Over 20% of greenhouse gas emissions are caused by road vehicles

Traffic contributes to CO2 levels

EV Sales grow:
2022: 14%
2023: 18%

Charging solutions limitations become more obvious

Keeping up with the EV-Growth is challenging for the Charging Infrastructure as private charging dominates



Key challenges of transitioning to EVs

The battery dilemma

- Costly: 20~40% of EV cost is the battery
- Heavily impacts vehicle weight
- Large batteries diminish environmental benefits

Ineffective charging infrastr.

- Generic solutions fail to meet diverse needs
- High CAPEX and OPEX
- Disrupts urban aesthetics
- Limited scalability for mass adoption

Expensive energy demand

- High electricity rates, if focused on ‘over-night’
- Costly grid upgrades for e-fleets
- Challenging ‘green’ energy supply

Reduced e-fleet profitability

- Charging breaks disrupt fleet operations
- Charging supervision drives up costs
- Prolonged downtimes cut into revenue
- Not ready for autonomous operations

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Range Limitation

Free of the ‘fuel tank’ or battery icon

ICE

BEV

ERS

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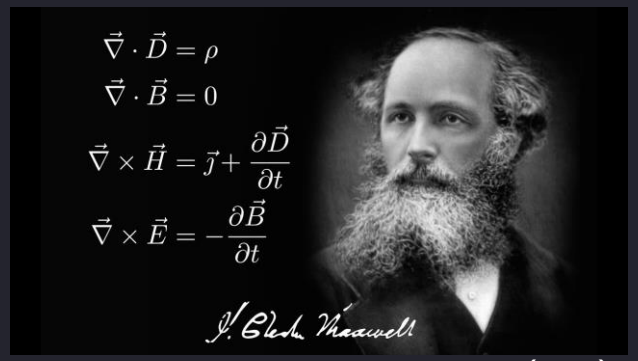
No more stopping at charging stations

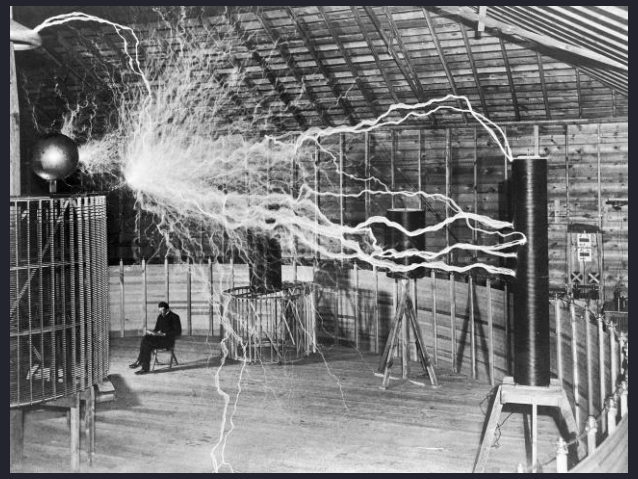
No more Worrying about When and where to charge

No more waiting In line for a plug

How can this work?

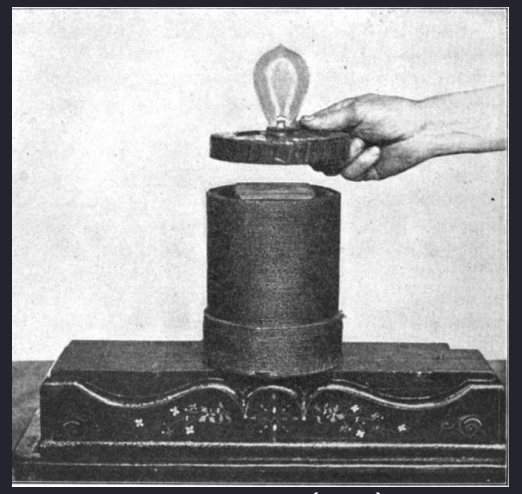


Maxwell, Ampère, Gauss, Faraday (1873)



Nikola Tesla, Colorado Springs (1899)

Wardenclyffe Plant, Long Island (1904)



Wireless light bulb (1910)

Toothbrush (2006) and Qi (2008)

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Dynamic Wireless Charging System

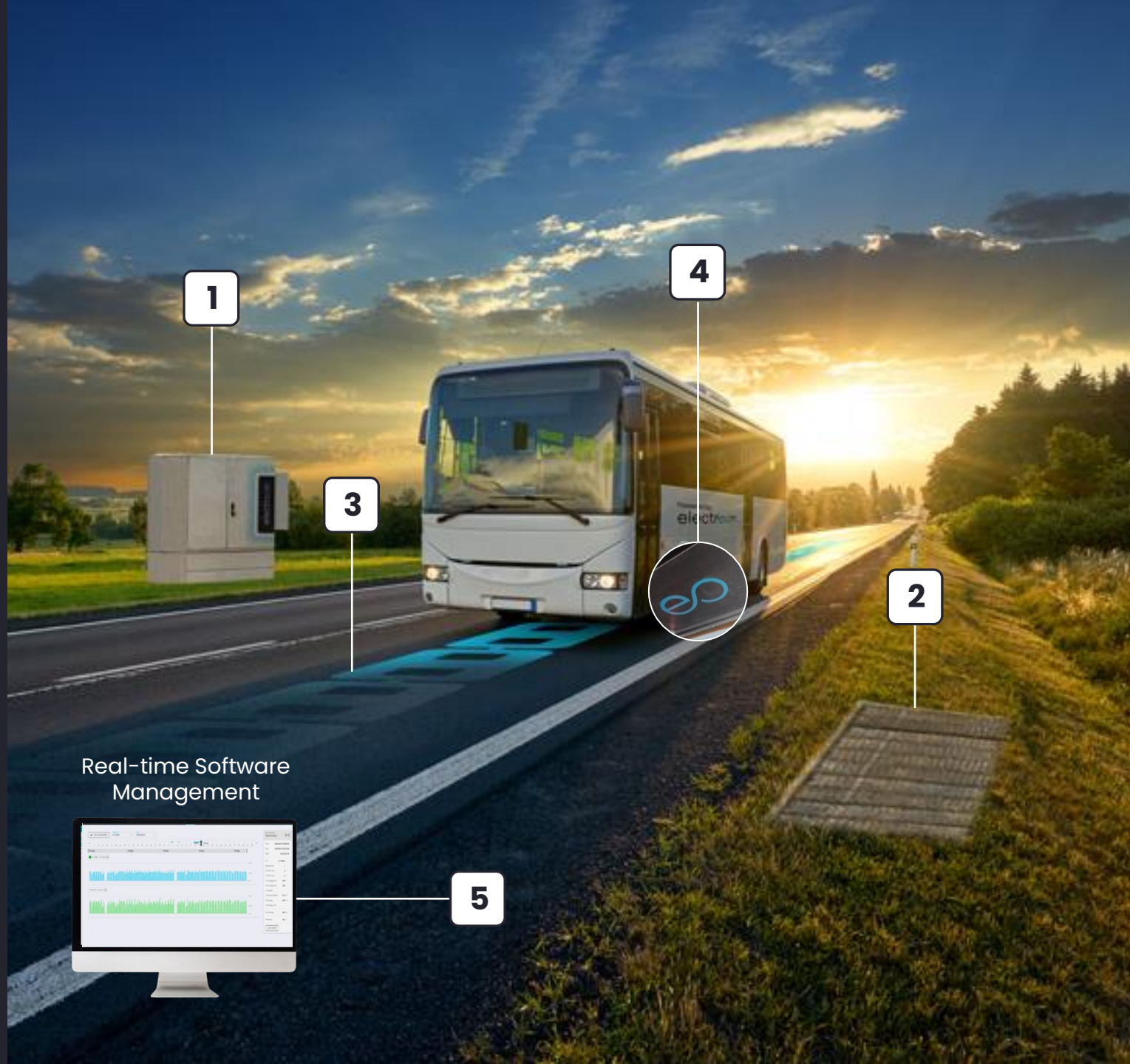
1. **Management Unit**
   Transfers energy from the grid to the charging infrastructure

2. **Underground Management Unit**
   Same functionality as without any visual impact

3. **In-road transmitter coils**
   Transfers power to the vehicles' receivers

4. **Vehicles receiver**
   Installed on the EV to transfer energy directly to the engine

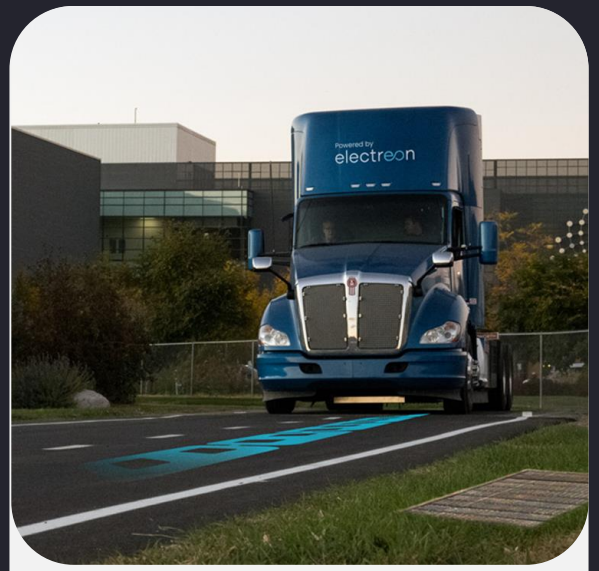
5. **Management Software**
   Monitors & manages optimal EV charging in real time



Electreon solution overcomes the challenges

The Battery dilemma

- Reduces battery costs
- Minimizes battery size & weight
- Enhances environmental and ethical practices



Charging infrastructure

- Universal charging for all vehicles and batteries
- Cuts infrastructure footprint
- Drives savings through economies of scale
- Requires minimal space
- Vandal-proof design

Power supply & grid integration

- Balances energy demand, cuts costs
- Utilizes existing grid infrastructure
- Integrated billing & energy tracking

Efficient e-fleet operations

- Eliminates charging wait times
- Zero labor costs for charging
- On-the-go charging minimizes downtime
- Autonomy-ready

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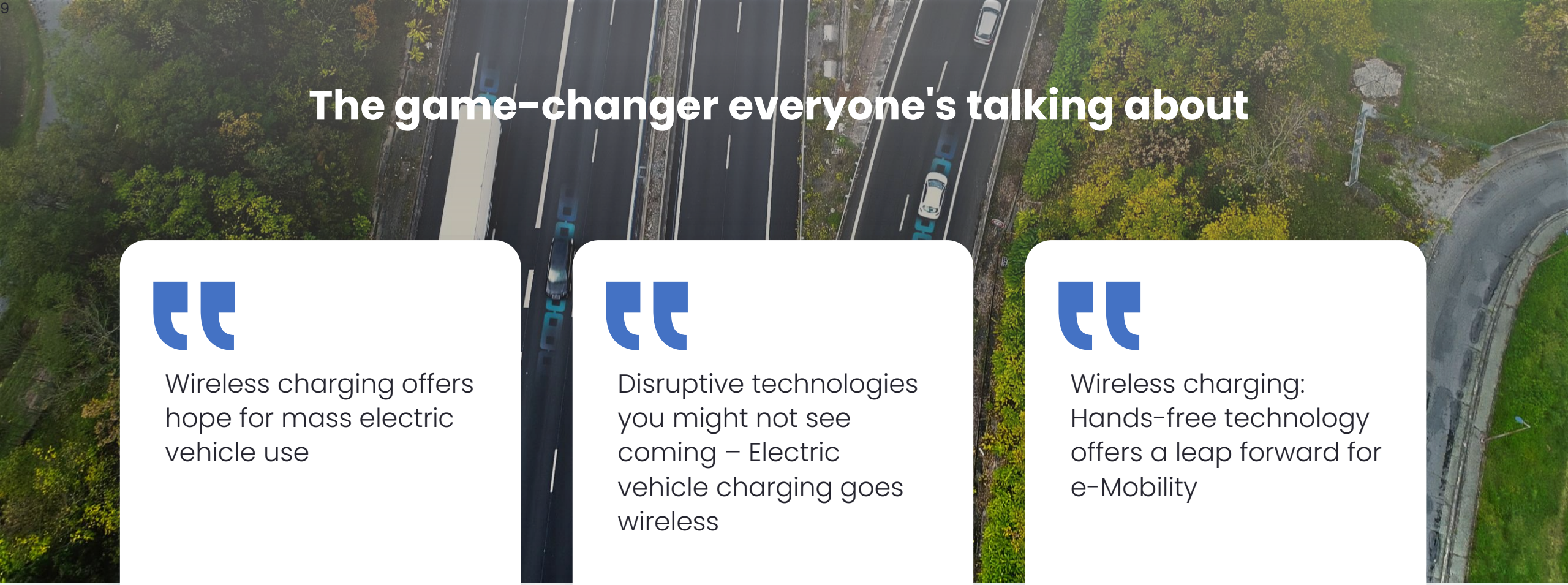


The game-changer everyone's talking about

Wireless charging offers hope for mass electric vehicle use

FINANCIAL TIMES

Disruptive technologies you might not see coming – Electric vehicle charging goes wireless

Gartner

Wireless charging: Hands-free technology offers a leap forward for e-Mobility

Forbes

ERS Carbon Footprint Reduction Possibilities

In the rush to transition to electric vehicles, charging solutions for EVs have been overlooked, and now, this threatens to limit future growth

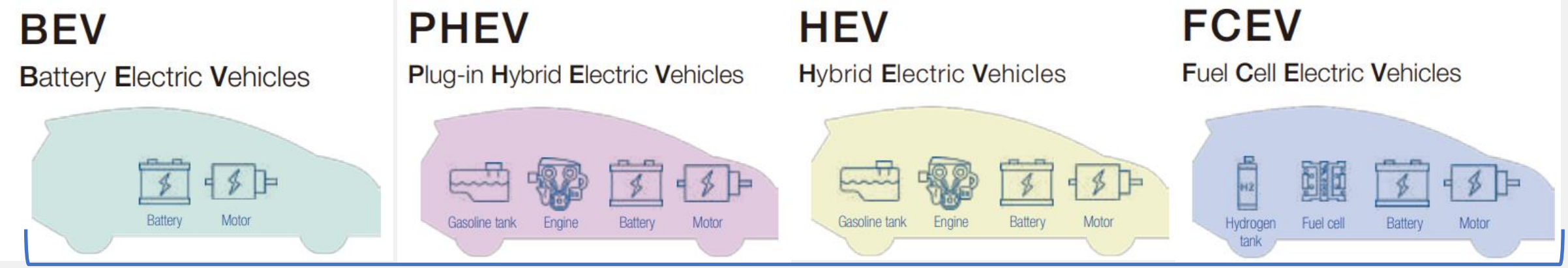
Benefit 1: Reducing battery-related emissions

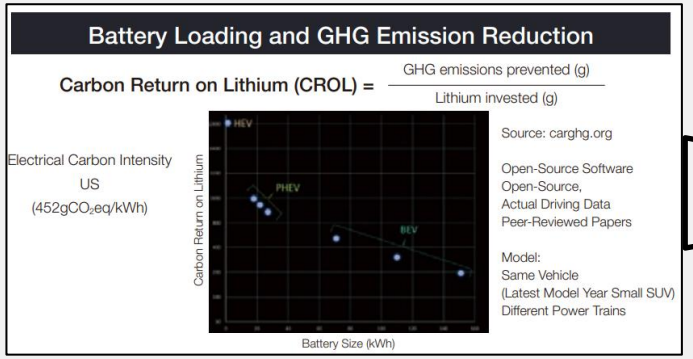
Benefit 2: Sourcing from renewable energy

Benefit 3: Generating energy on-site

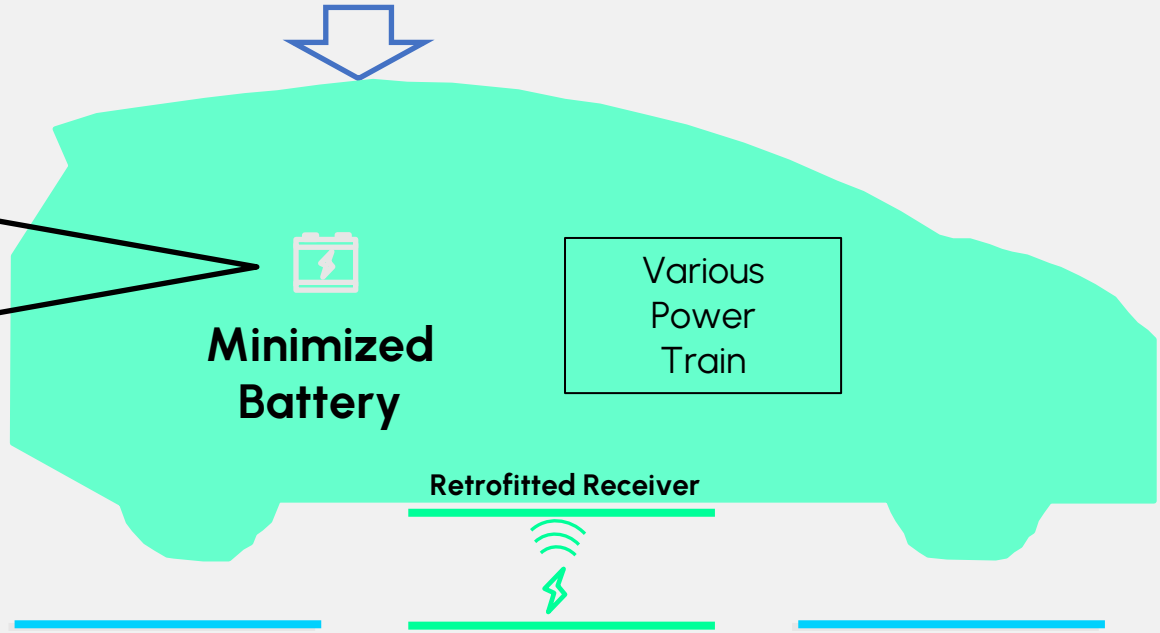
Benefit 4: Dynamic roads as shared charging platforms

Benefit 1: Reducing battery related emissions





Ref: <https://global.toyota/pages/global_toyota/ir/library/annual/2023_001_integrated_en.pdf>



Cf. THB4.1 Wireless Electric Road Systems
– Technology Readiness and Recent Developments

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Benefit 1: Battery reduction allows cost reduction

Transport Research Arena (TRA) Conference

The electric road system: technical, economic and environmental study carried out in France. Part 2. Economic and environmental aspects

Fabien Perdu[a], Pierre Chaniot[b], Marc Raynal[b]*, François Combes[c]

[a]Université de Grenoble Alpes; CEA/LITEN F-38402 Saint Martin d'Hères, France
[b]CEREMA, 110 rue de Paris, 77171 Sourdun, France
[c]Université Gustave Eiffel, Cité Descartes, F-77420 Champs-sur-Marne,, France

Table 2. Optimal ERS size found by the model

	ERS length (L)	Required vehicle range (R)
ERS for HGVs only	8 666 km	254 km
ERS for all vehicles	16 882 km	130 km

Originally: 800 km (HD), 500 km (LD)

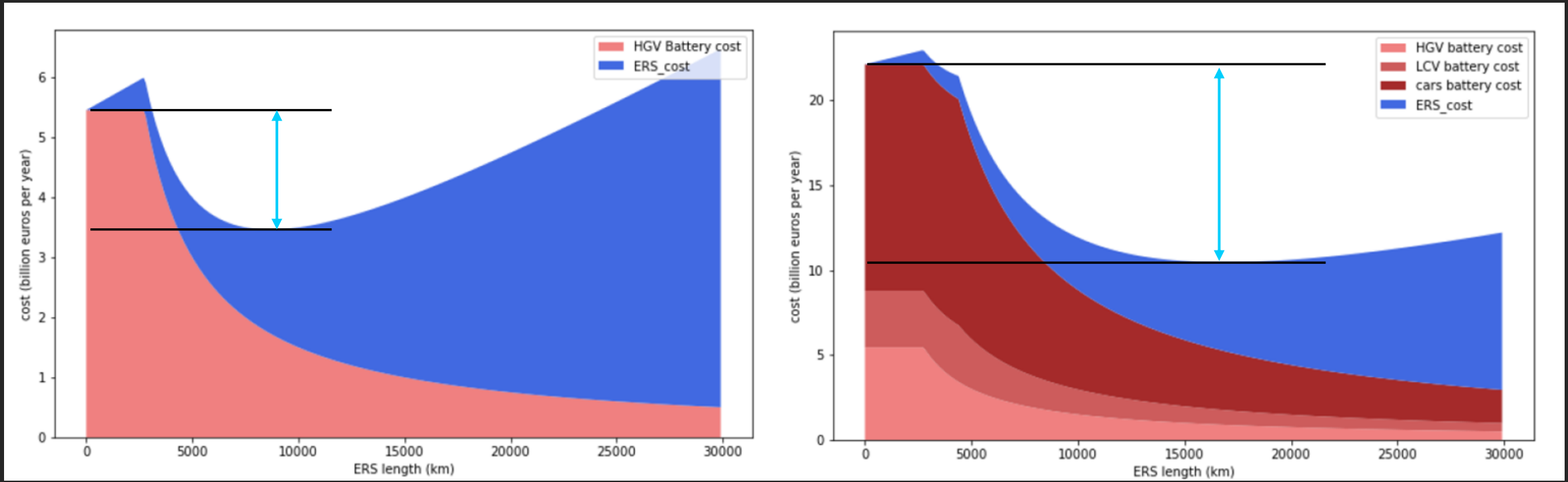


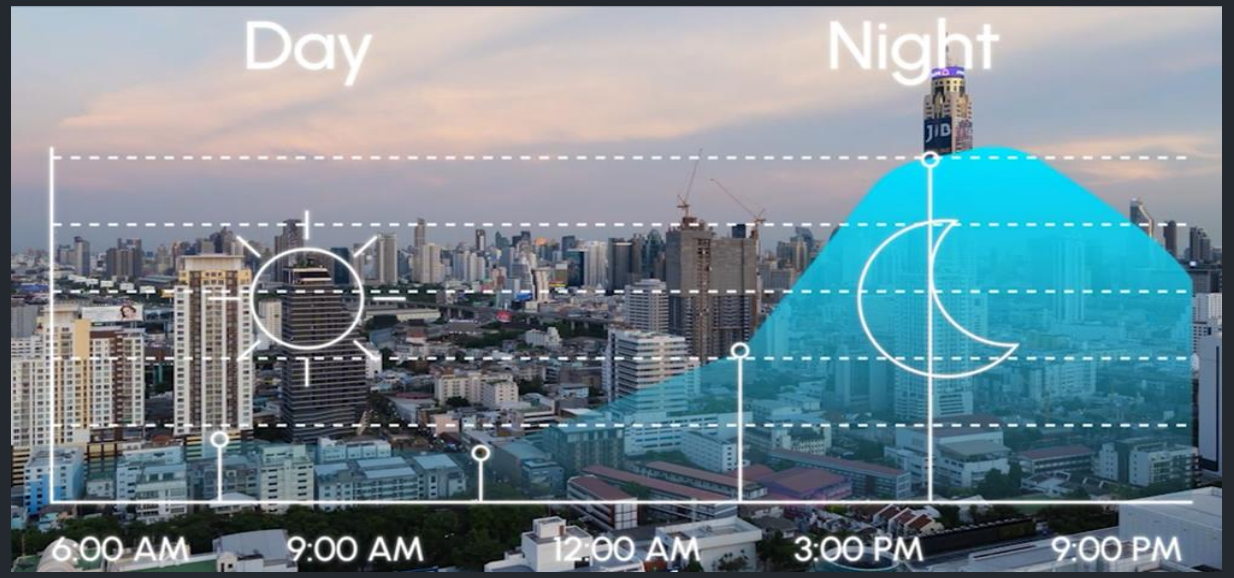
Fig. 1. Total yearly investment cost including batteries and ERS as a function of the ERS length.

https://cea.hal.science/cea-04425855

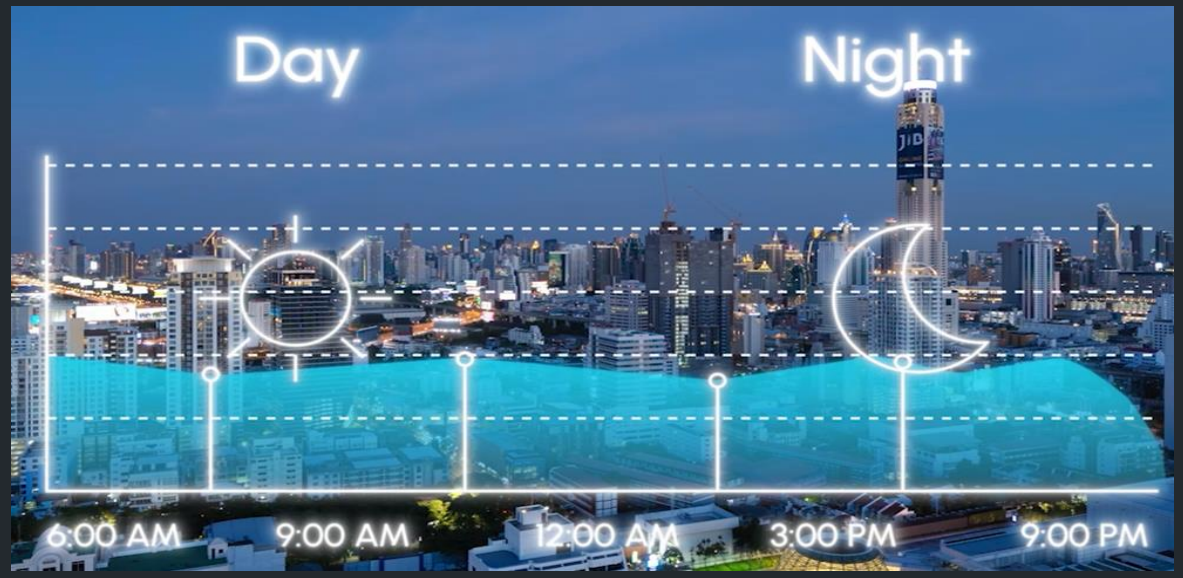
Benefit 2: Sourcing from renewable energy

Grid Reduction Benefits

Nighttime charging
Increases energy demand &
places pressure on the national grid



Day & night charging
Spread over time & space eases the
pressure on the national grid



Benefit 3: Generating Energy on-site

- Wireless **reduces pressure on the grid, minimizes grid connections, and reduces the need for electricity transmission** – significantly lowers costs

- **Easily integrate with on-site renewables** – to accelerate transport decarbonization and **minimize energy storage requirements** – e.g., wireless solar combo lowers costs

- Studies show **ERS offers the highest CO2 emissions reduction** of all known technologies - 67% more than FCEVs

The Sustainable Duo
Wireless Electric Road & Solar Power

1 km of solar fence could provide
up to **1 MW** of power daily

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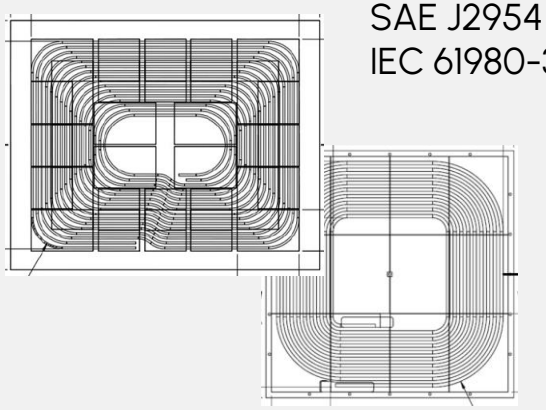
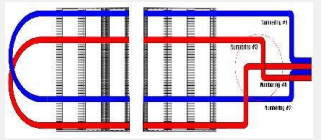
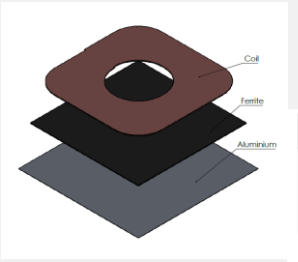
Benefit 4: ERS are shared charging platforms

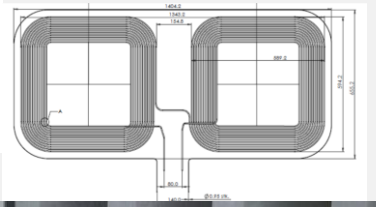
Light Duty WPT
SAE J2954
IEC 61980-3



Heavy Duty WPT
SAE J2954/2
IEC 61980-4

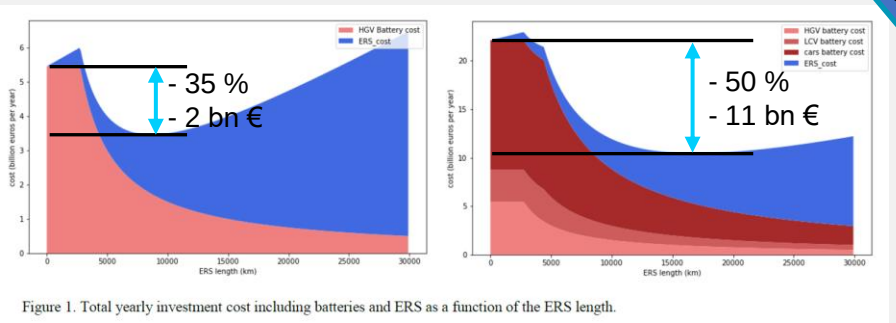






Common Sense / BC

Fundamental Use Case



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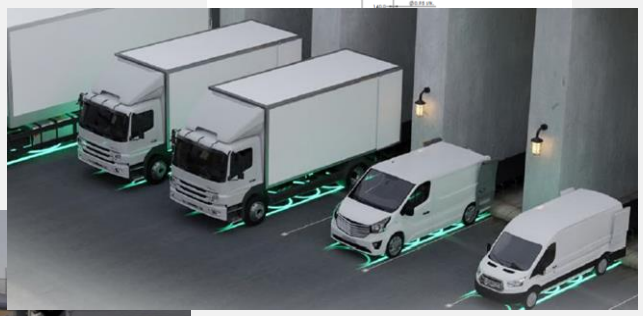
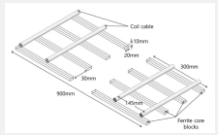
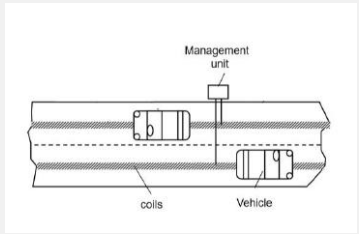


Electric Road System
SAE J2954/3
IEC 61980-5/6





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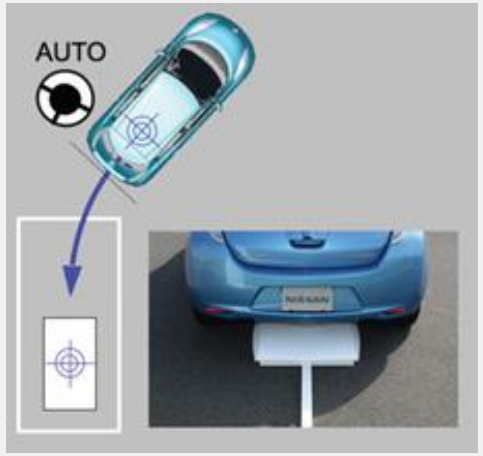
Numerous J2954 compliant 11kW static chargers in the pipeline

OEMs who have announced development or planned to offer their own intergated wireless static solution



Nissan

BMW

Hyundai

TOYOTA

Mercedez Benz

Tesla

Static Heavy Duty Charging -> J2952/2

S6 & S12

Commercial sales and installations worldwide

Park & Charge
Without any human contact

S12 charges up to 4 buses or 12 PVs simultaneously - **Up to 360 kW**

S6 charges up to 2 buses or 6 PVs simultaneously - **Up to 180 kW**

Dynamic Charging -> J2954/3

Charge as you drive

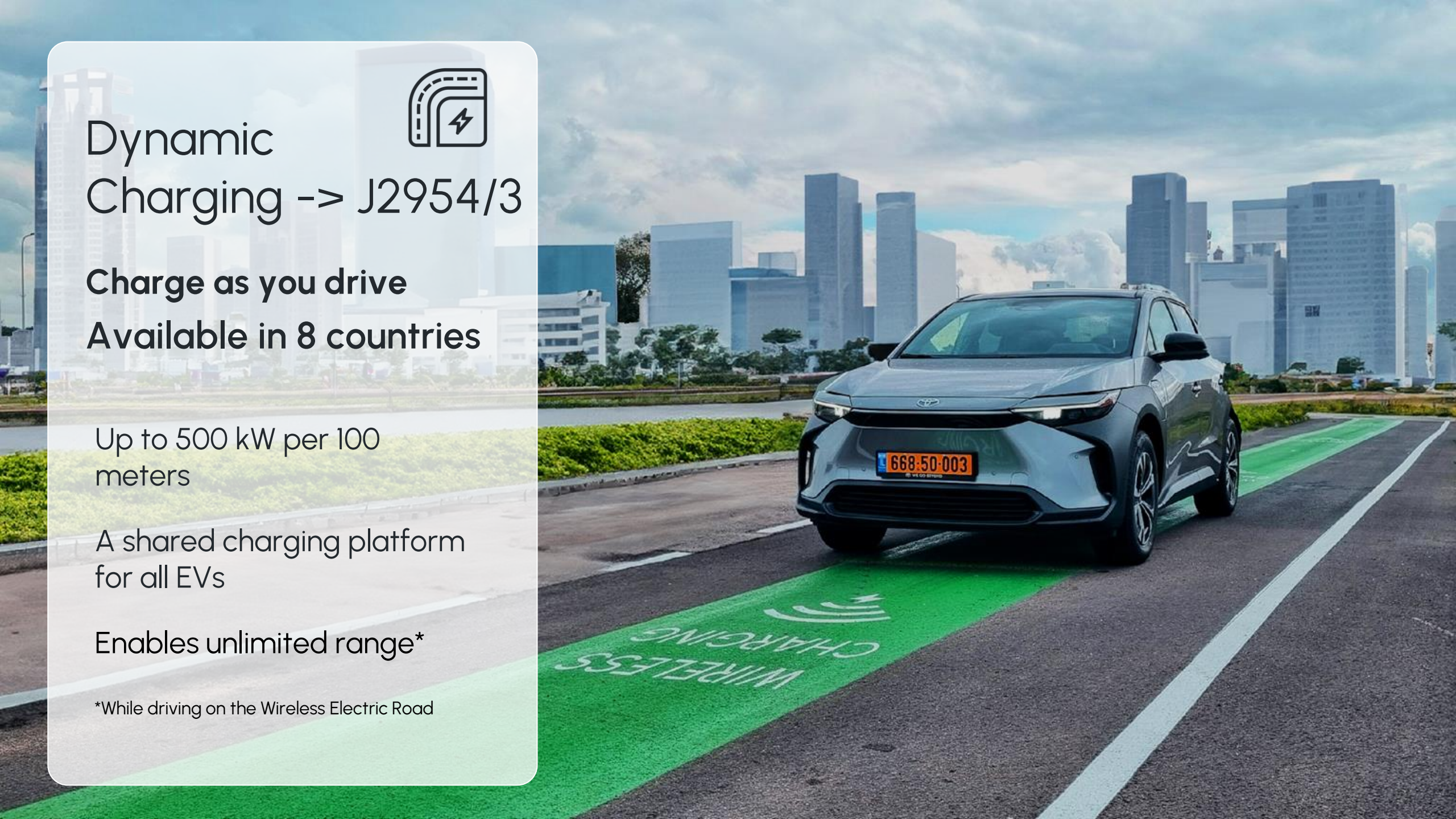
Available in 8 countries

Up to 500 kW per 100 meters

A shared charging platform for all EVs

Enables unlimited range*

*While driving on the Wireless Electric Road



Combine static and dynamic: Flexibility for Private customers

Seamless
Effortless at home, dynamic on the road

Convenient
Energy anytime, anywhere

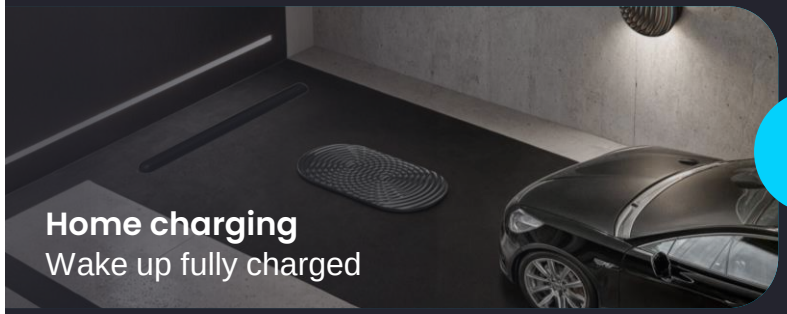
Limitless
always powered-on the move or at rest

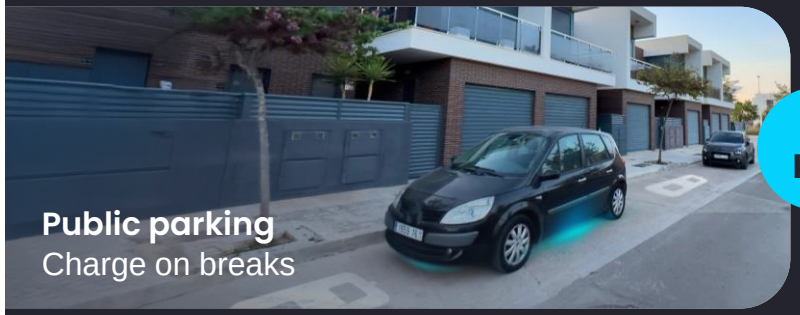
Electreon: Future-ready charging with one vehicle receiver—home, public, and dynamic wireless charging f a stress-free EV experience

Ready for wireless future!

3 in 1

One receiver, three charging modes





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Endless Driving Range

25% of the route was electrified -
enabling unlimited range for a HEV (only 18 kWh)

Total Time Driven

100h 24m 15s

Total Distance Driven

1942.56km

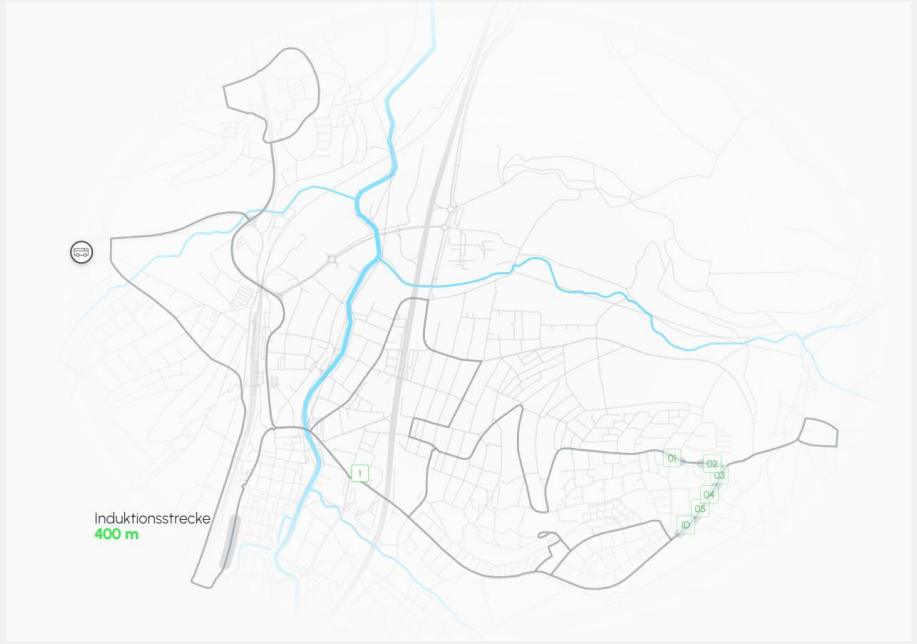
Total Energy Transferred

241.69kWh

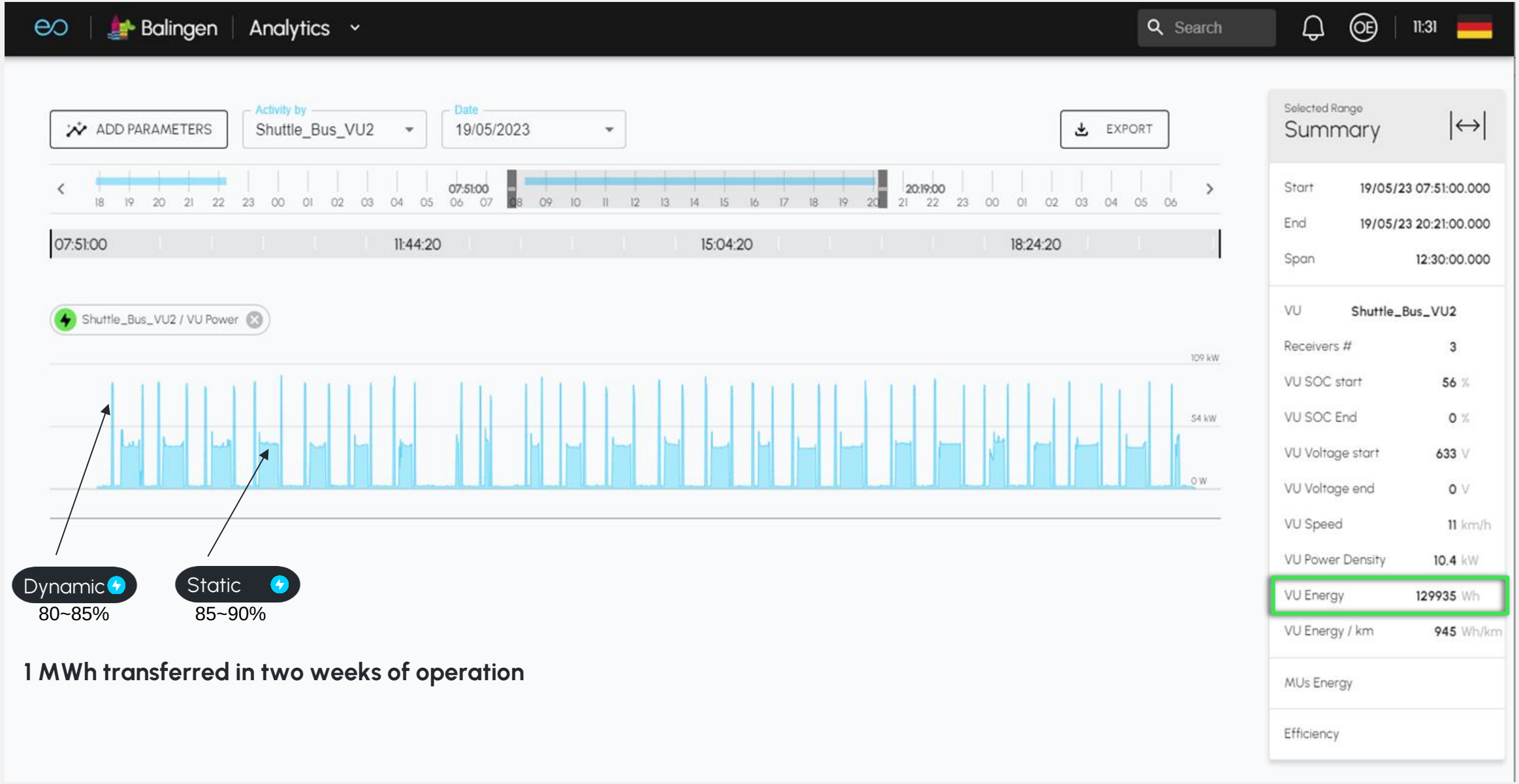
Employment of dynamic WPT in public transportation

Public-operated bus in the City of Balingen

- Phase 1: Shuttle Bus for ‚Gartenschau‘
- Phase 2: Regular bus operated for public transportation
- 1 km of ERS
- 4 static charging stations (bus stops and a depot charger)



Example day of operation from Phase 1



1 MWh transferred in two weeks of operation

Electreon Fleet Operation Software

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World's First Commercial Wireless Charging Terminal for Buses

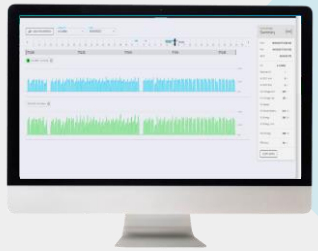
24/6 - Operation

Extended driving range

Daytime opportunity charging &

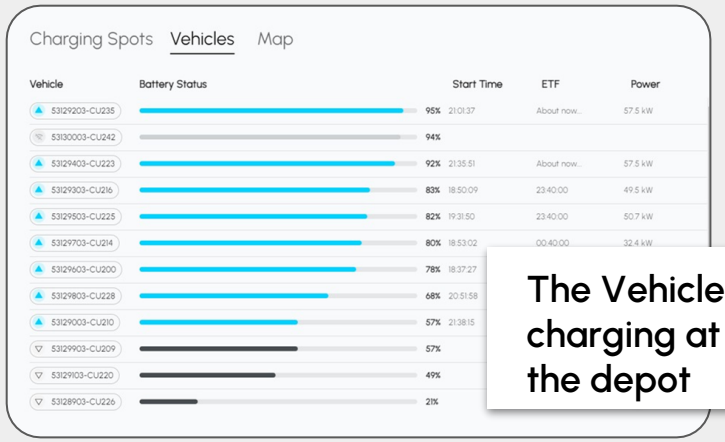
Overnight charging

Real-time Software Management

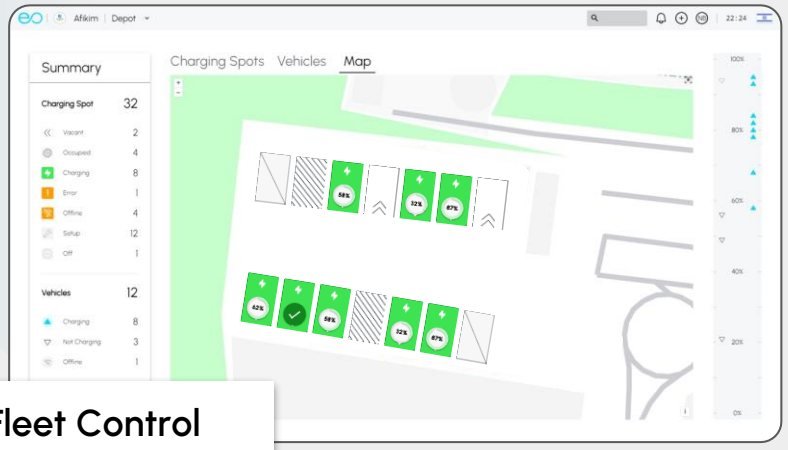


Power Management

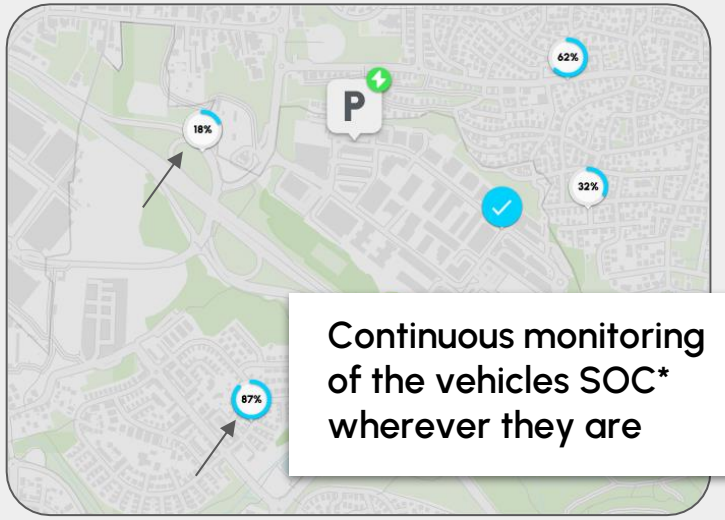
Time-of-use (TOU) prioritization



The Vehicles charging at the depot



Fleet Control



Continuous monitoring of the vehicles SOC* wherever they are

SOC - State of charge

A comparison of efficiencies

eTruck:
- 600 kWh Batterie
- 4.5h Fahrt mit 80 km/h -> 360 km
- 1.2 kWh/km -> 432 kWh

Type of Power Supply	System / Information	Energy Transfer Efficiency	Typical Charge Rate	Storage / Conversion Efficiency	Total Efficiency (Input of Infrastructure to Input of Motor)	Comments
In-Route Energy Supply	Wireless ERS – Electreon's Data from commercial Operation	80 - 85 %	100 kW - 0 C	100 %	80 - 85 %	Data from daily operation of a 12m city bus since May 2023 are available.
	MCS Charging	90 ~ 95 % [1], [2], [5]	1.2 MW - 2 C	85 % [3], [4]	77 ~ 81 %	High battery charging losses reduce the otherwise high efficiency to a comparatively low level. Higher level is only an "ideal" value.
	Overhead Catenary	80 - 85 % [5]	400 kW - 0.5 C	95 % [3], [4]	76 - 81 %	The overhead line is also seen as a 'fast charging infrastructure' (for cost reasons), the resulting disadvantages are, in line with DC fast charging, high battery charging losses.
	Hydrogen Fuel Cell	< 70 % [7], [8]	> 10 C	~ 60 % [9]	~ 40 %	Indicative data, only.

1) https://doi.org/10.3390/en11081937, 2018
2) https://doi.org/10.1016/j.asej.2023.102391, 2023
3) https://pdfs.semanticscholar.org/9f31/00a2bff3b680553bf8d8a9ba2819783ac4ca.pdf, 2015
4) http://dx.doi.org/10.1016/j.energy.2017.03.015, 2017
5) https://www.siemens.com/global/en/products/energy/emobility/sicharge-d.html, 2024
6) https://www.mobility.siemens.com/global/de/portfolio/strasse/ehighway.html, 2024
7) https://h2connect.eco/der-mythos-vom-schlechten-wirkungsgrad-des-wasserstoff-antriebes, 2024
8) https://www.bmbf.de/bmbf/shareddocs/kurzmeldungen/de/wissenswertes-zu-gruenem-wasserstoff.html
9) https://www.energy.gov/eere/fuelcells/articles/fuel-cells-fact-sheet, 2015

ERS Future:
Long Haul Decarbonization

ERS roads that charge light, heavy-duty and 40-ton trucks could slash CO2 emissions by 86%

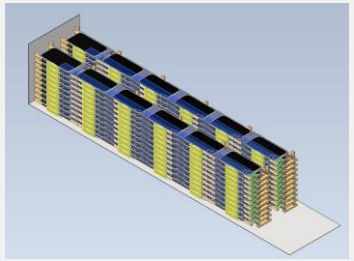
ERS is particularly cost-effective for heavy duty trucks that follow well-defined routes

One ERS platform can simultaneously support any vehicle type

Thousands of kms of ERS are part of the government roadmap of several countries in Europe

Financially viable: +20% vs standard road refurbish

Mid-scale Pilot ERS Germany – deployed NOW!



- Automated Production and Deployment of ERS -

The research project E|MPOWER addresses the automatization of manufacturing processes for Electric Road Systems (ERS) with a focus on the electrification of Heavy-duty traffic.

E|MPOWER

FAU Friedrich-Alexander-Universität Technische Fakultät

Die Autobahn

FAPS

TECHNISCHE HOCHSCHULE NÜRNBERG GEORG SIMON OHM

VIA IMC

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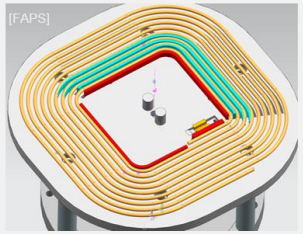
risomat

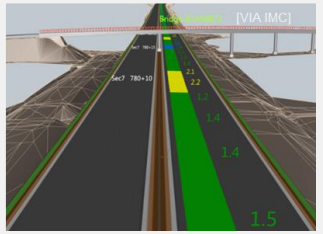
Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

DLR Projektträger





Cf. A22-WPT / 20299062 Recent Developments for Wireless Electric Road Systems

E|Road-Center

Project for Electrification of the highways

> The E|RoadCenter is researching innovative technologies for the **design** and **industrialization** of WPT to electric vehicles.

Designated Advisory Board

Prof. Dr.-Ing. Jörg Franke
FAU Erlangen-Nürnberg

Prof. Dr. Alexander Kolb
DENSO / TUM

Prof. Dr.-Ing. Nejila Parspour
Univ. Stuttgart

Dr. Andreas Wendt
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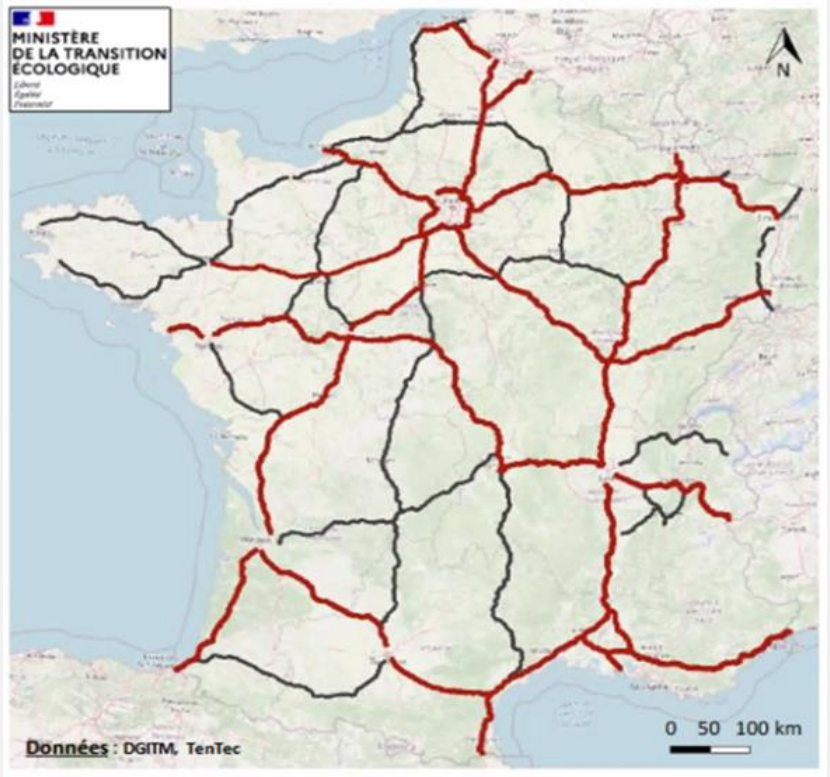
ERS Tender in France

EU: 30% reduction (vs. 2020) of CO_2 emissions for new trucks until 2030

In 2021: French Work Group on Electric Road Systems concluded ERS is the best solution:

- Large **reduction of battery capacity** VS big battery truck (-75%)
- TCO **equivalent to diesel trucks**
- Bigger range and no charging stops **Less standby time**

- CO2 impact:
- **86% reduction** for HD and LCV in comparison to Diesel trucks
- **64% reduction** in comparison to big battery trucks



The French government's road map

- ERS on **4950 km until 2030** (red), followed by **3950 km until 2035** (black).
- Investment between € 30bn and € 40bn

ERS Future: Smart Cities

Shared wireless ERS:

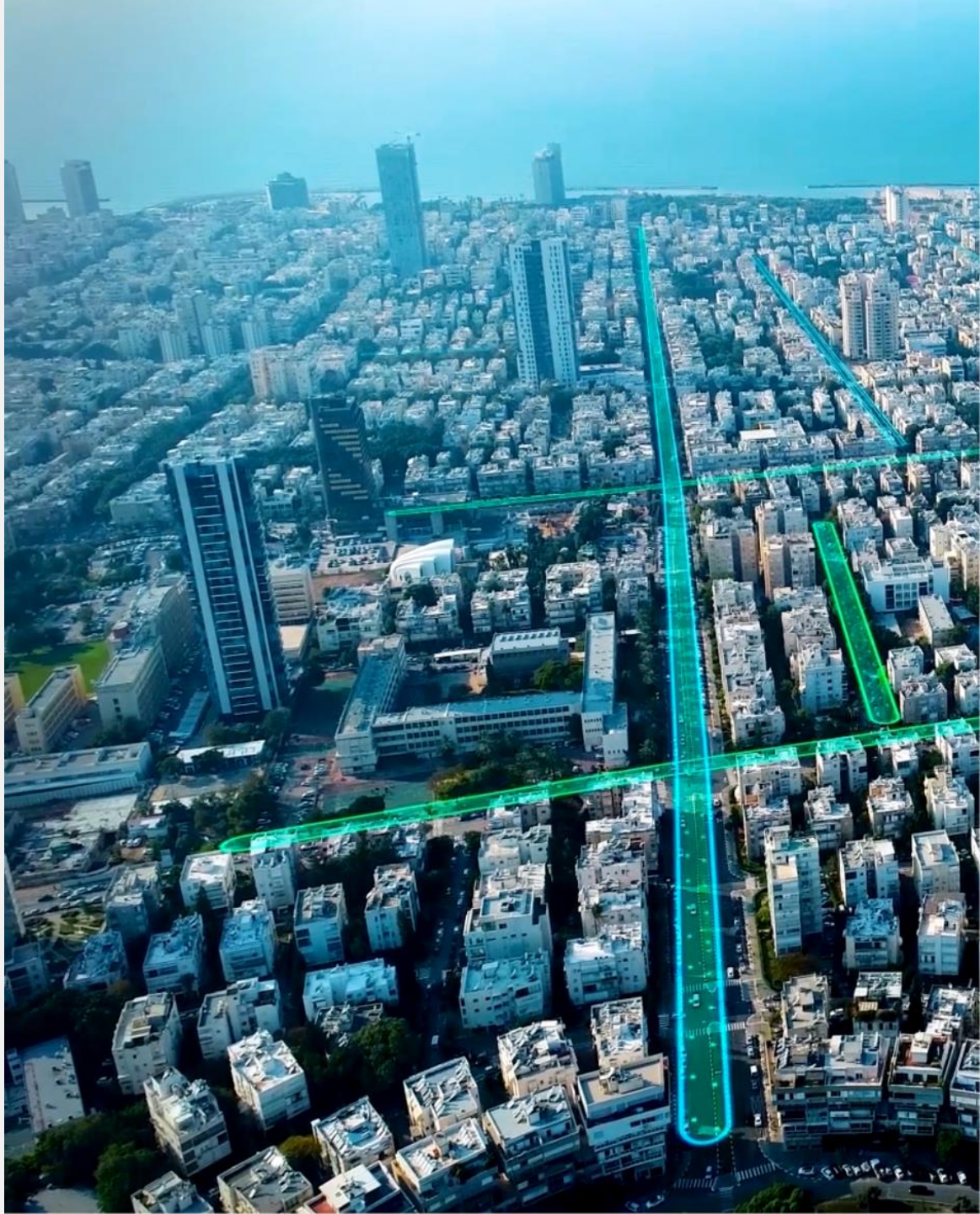
- Smart charging available 24/7
- Charging for all driving scenarios
- Spreading out charging throughout space/time at a city level reduces regional grid pressure

One charging platform for all EVs:

- Public transportation
- Taxis
- Last mile delivery LCVs
- Car sharing
- Private vehicles
- Municipality vehicles

The long-term outlook for smart cities requires a charging solution that is electric, connected, shared, urban, and accessible - *all features that only ERS can support.*

Only small fraction of the roads need to be covered: 1~3%



*Honma, Yudai et.al. (2024). Locational Analysis of In-motion Wireless Power Transfer System for Long-distance Trips by Electric Vehicles: Optimal Locations and Economic Rationality in Japanese Expressway Network. Networks and Spatial Economics. 24. 1-30. 10.1007/s11067-023-09608-w.

Electreon's International OEM collaborations

Passenger Vehicles

- **Stellantis** Italy
- **Toyota** Japan
- **Hyundai** South Korea
- **Ford** U.S.A

Commercial Vehicles

- **UES** U.S.A.
- **XOS** U.S.A.
- **Stellantis** Netherlands
- **IVECO** Italy
- **Maxus** China

Buses

- **IVECO** Italy
- **Yutong** China
- **Higer** China
- **Zhongtong** China
- **Sunwin** China
- **Ankai** China

Trucks

- **Kenworth** U.S.A.
- **GINAF** Netherlands
- **Dongfeng** China

Automotive Partner

- **DENSO** Japan
- **MAHLE International** Germany

Healthy WPT Industry

- **ENRX** Norway
- **InductEV** USA
- **Siemens** Germany
- **Electric Green** UK

Electreon go-to-market segments

Airports

University campuses

Last mile deliveries

Shared cars

Point-to-point fleets

Taxi & MaaS

BRTs

Fleet Management

Highway ERS

Passenger EVs

electreon

Electreon: World leader in wireless EV charging

Projects Subsidiary

2013
Founded

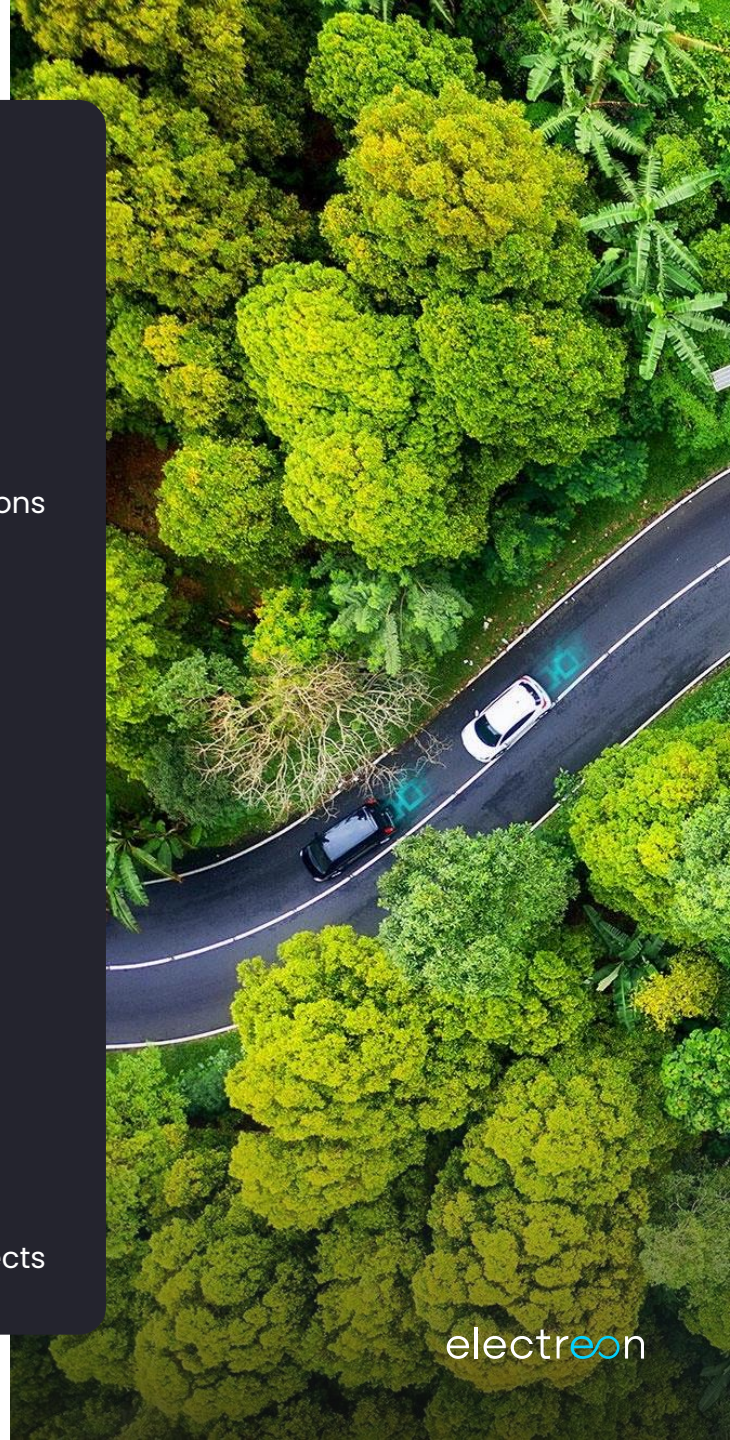
TIME
2021
One of the best inventions of the year

32+
Patents*

16
Automotive partners

140+
Employees globally

20+
Global projects



*Registered and Pending

Summary

- Several studies (e.g. France, Finland, Denmark and Sweden) have concluded that ERS is collectively more cost-effective than battery-only solutions because it allows for large-scale battery downsizing. (Perdu et al., 2023, Connolly, 2016 and Trafikverket, 2017)
- ERS is most efficient if as many vehicles as possible are involved. This is a clear advantage of wireless ERS.
- Interoperability and Standardization is key. This is underway.
- The cost of the ERS system can be covered with a very limited financial impact on road users.
- The environmental impact is positive, with a substantial reduction in raw resources consumption, thanks to the highly reduced need for large batteries.

- **ERS is an emerging technology, massive global spread!**
- **Let's extend this to Japan, too!**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Thank You