Concept Evaluation of an Inductive Charging System for Electric Vehicles

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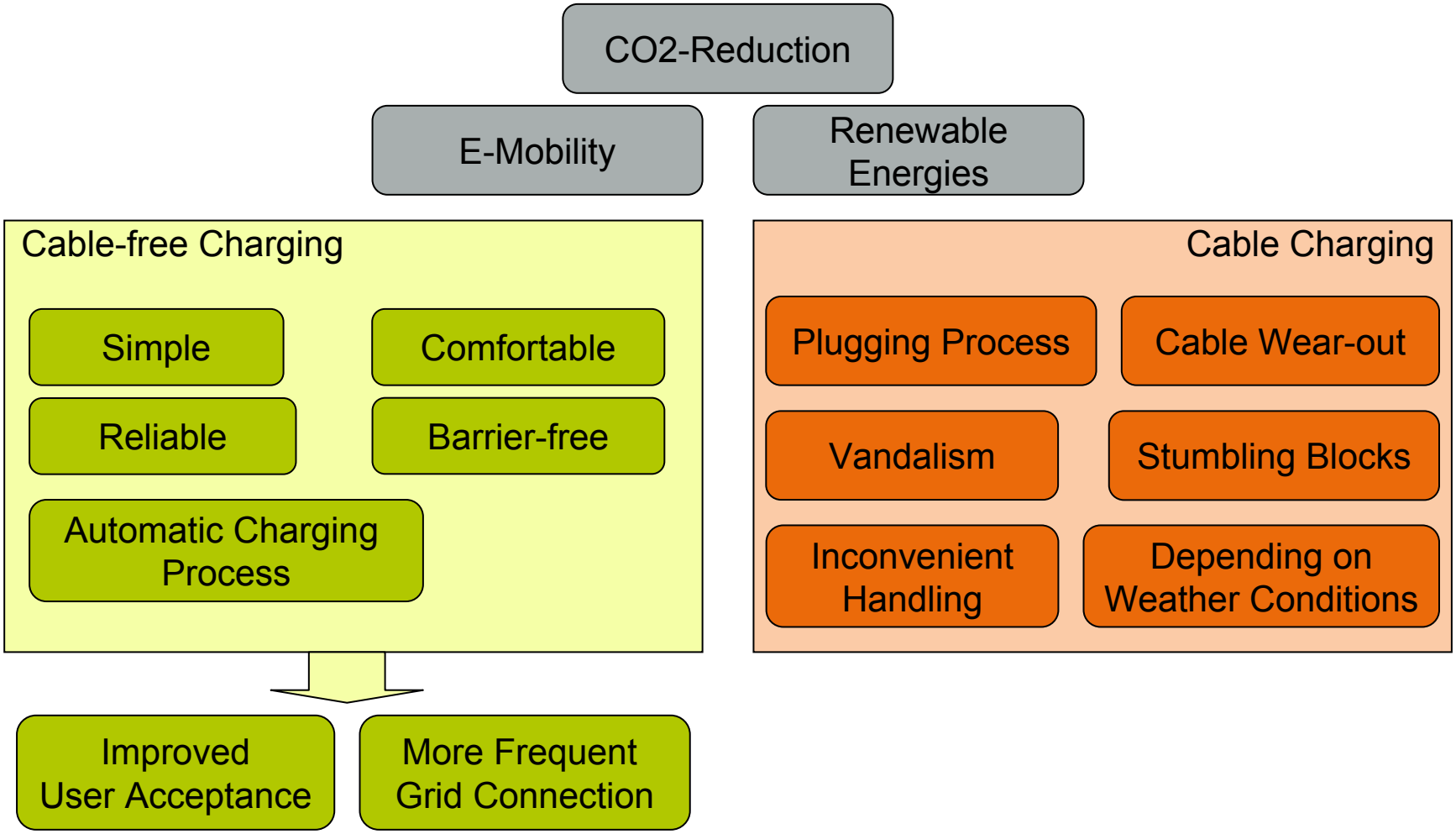
Outline

- Motivation for Inductive Charging
- W-Charge Project
- Technological Implementation
- Test System
- Parking Study

Inductive Charging - Why?

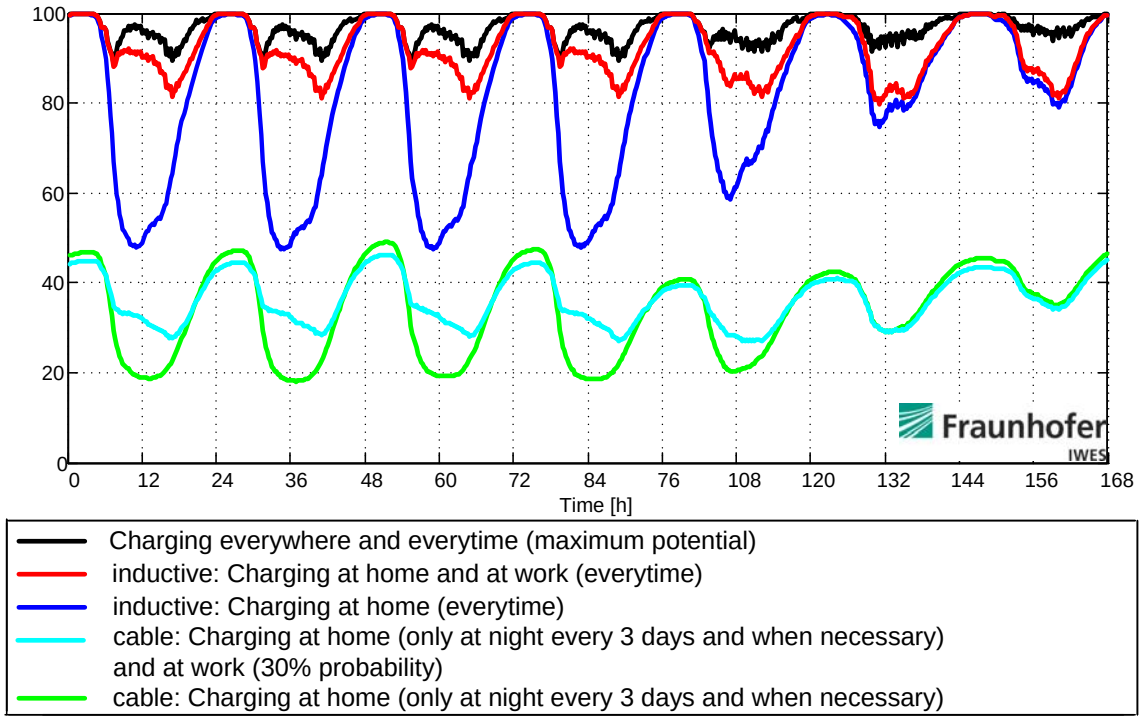


Potentials for Grid Integration

- Electric vehicles can store and balance out fluctuating energy production of renewable energy

  → but only when they are connected to the grid

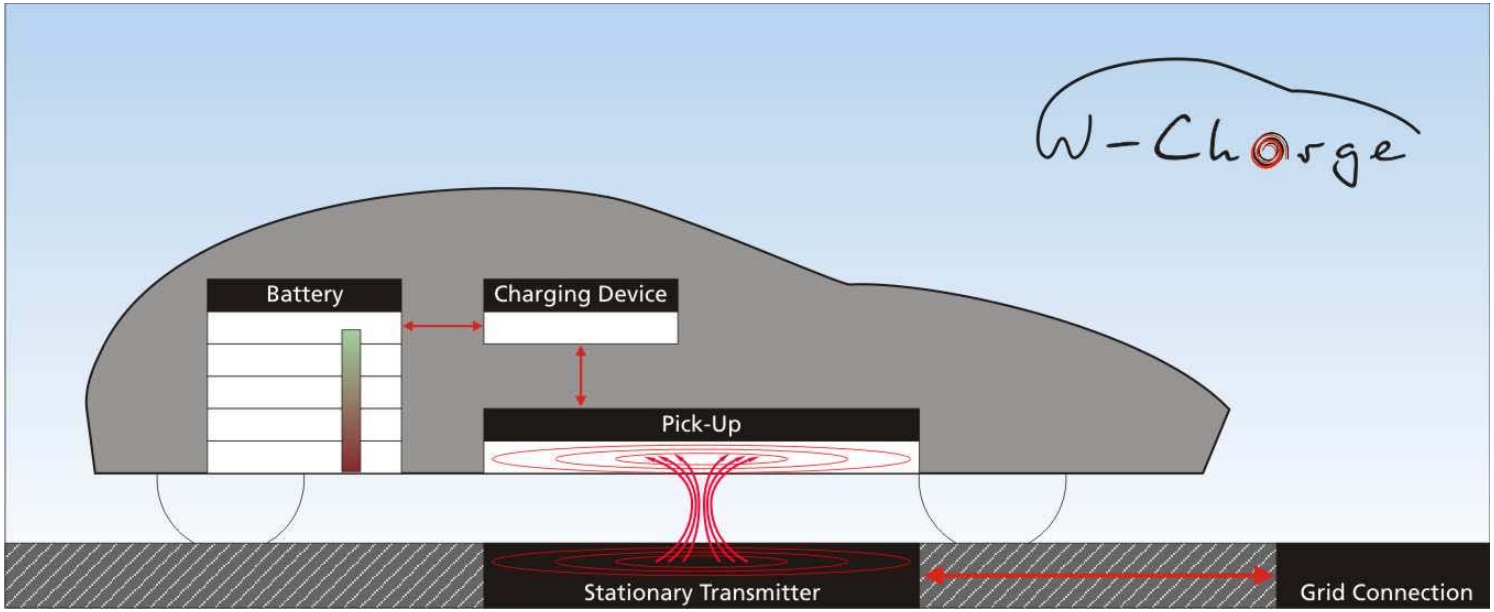
Share of connected vehicles to the grid under different scenarios [%]



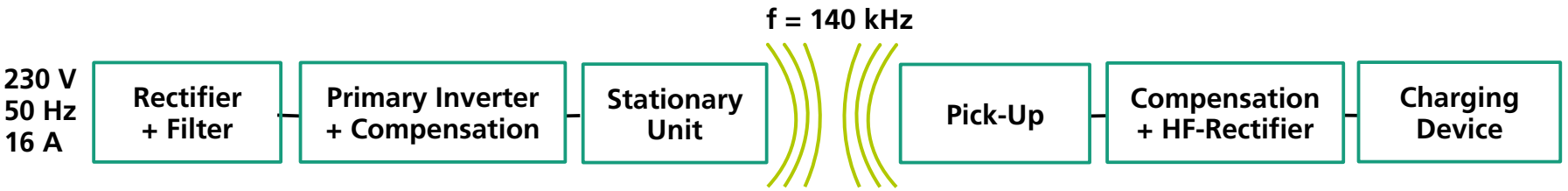
Based on data from:
Mobility in Germany 2008

W-Charge Project

- Development of a cable-free energy transmission system for stationary battery charging of electric vehicles
- Integration into test vehicles (BEV and PlugIn-HEV)
- Development of a multifunctional on-board battery charger



Basic Topology (Vahle)

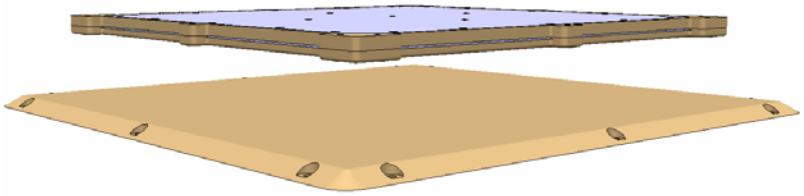


- Technical specifications
  - Single-phase grid connection (230 V, 50 Hz, 16 A,max)
  - Rated power: 3 kW
  - Rated frequency: 140 kHz
  - Transmission distance: 60mm-170mm
- Conform to German application guideline for inductive charging (VDE-AR-E 2122-4-2)

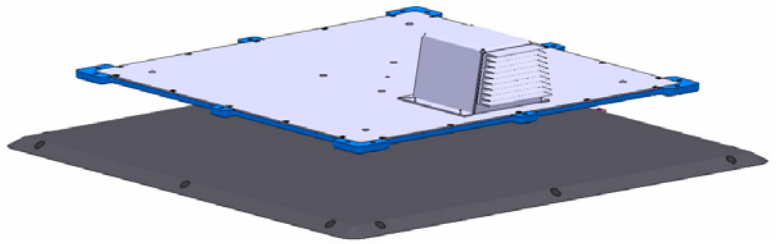
Inductive System

- Stationary transmitter unit
  - area = (1000 x 1000) mm
  - height = 25 mm

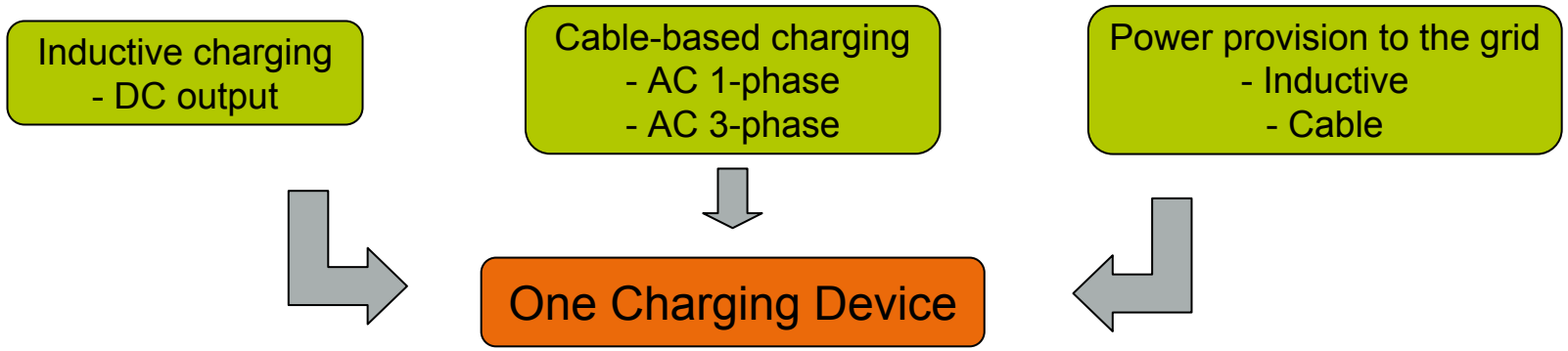
- Two versions of the on-board unit ("pick-up")
- "Integrated" version
  (incl. secondary electronics)
  - area = (800 x 800) mm
  - heigth = 35 mm



- "Flat" version
  - area = (800 x 800) mm
  - height (plate) = 16 mm

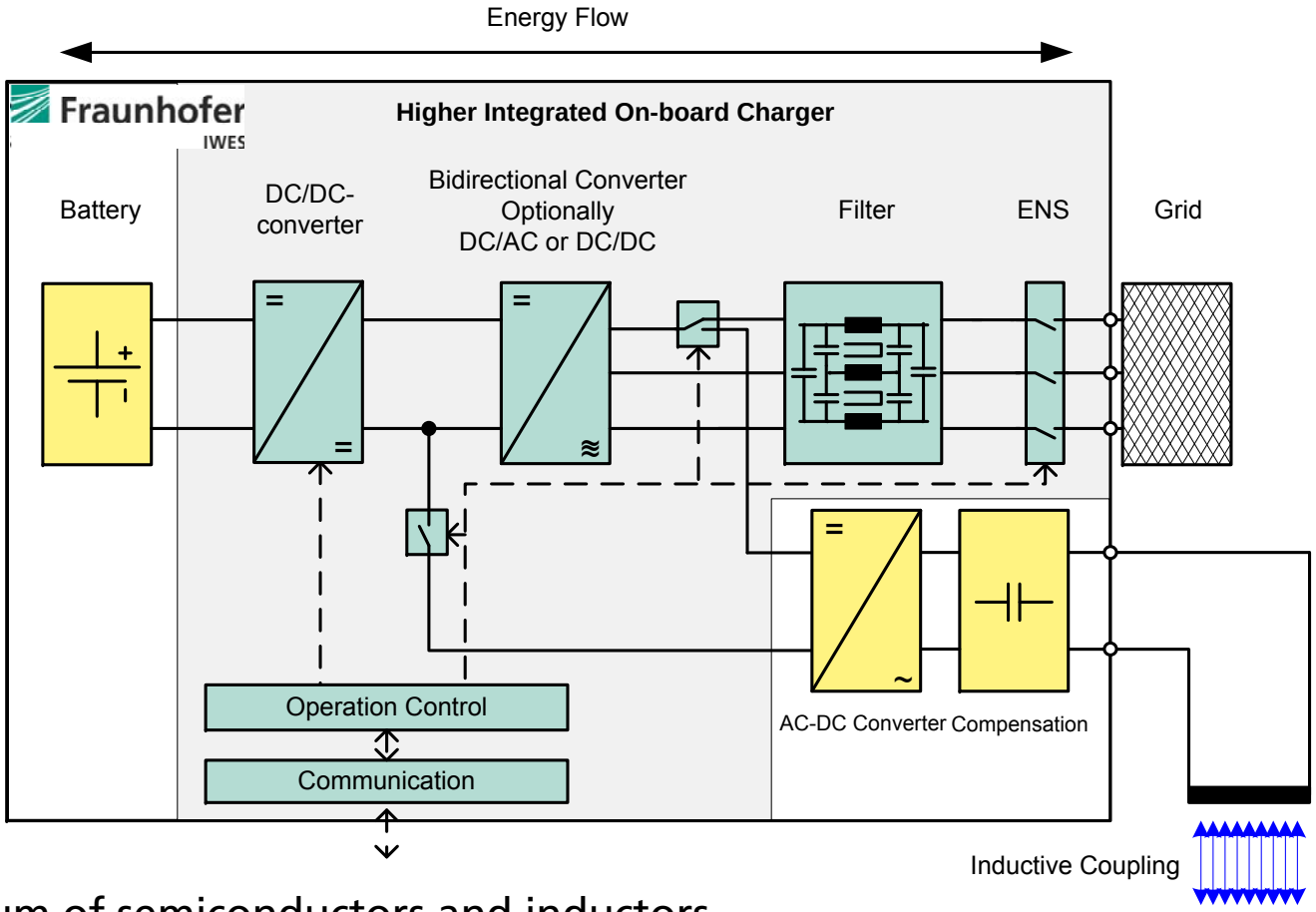


Higher Integrated On-board Charging Converter



- Actual functionality of the laboratory prototype (Fraunhofer IWES):
  - Cable-based connection
    - 3-phase charging
    - 3-phase power provision to the grid
    - 1-phase charging
  - Cable-free charging connection
    - 3 kW charging with wide DC-voltage range

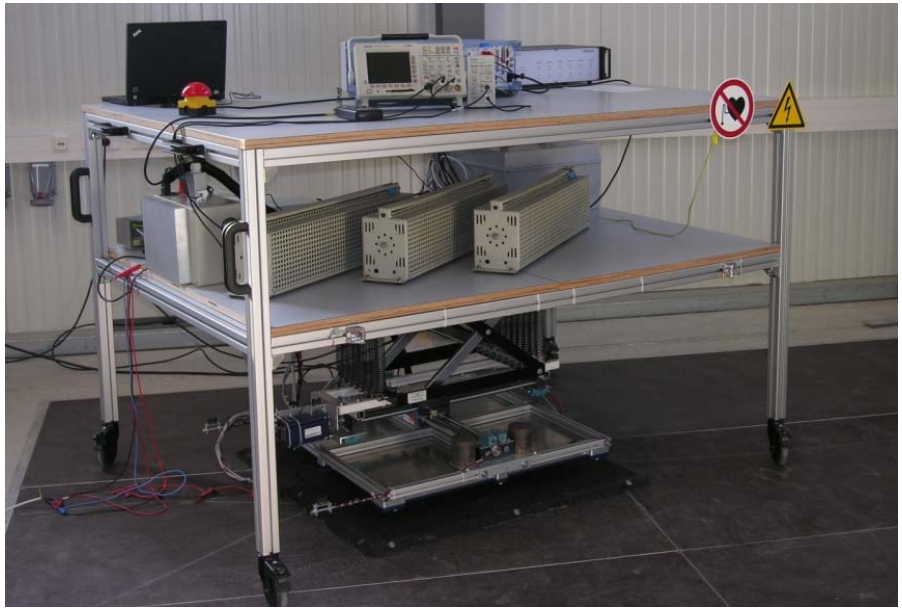
Higher Integrated On-board Charging Converter



- Minimum of semiconductors and inductors
- Communication with battery management system and pick-up

Test System

- Integration and analysis of inductive charging systems
- Mobile test system with mounting for pick-up, space for measuring devices and charging converter
- Pick-up can be moved in three dimensions
- Automated approach to predefined measuring points in x-, y- and z-direction
- For reproducible efficiency and field measurements

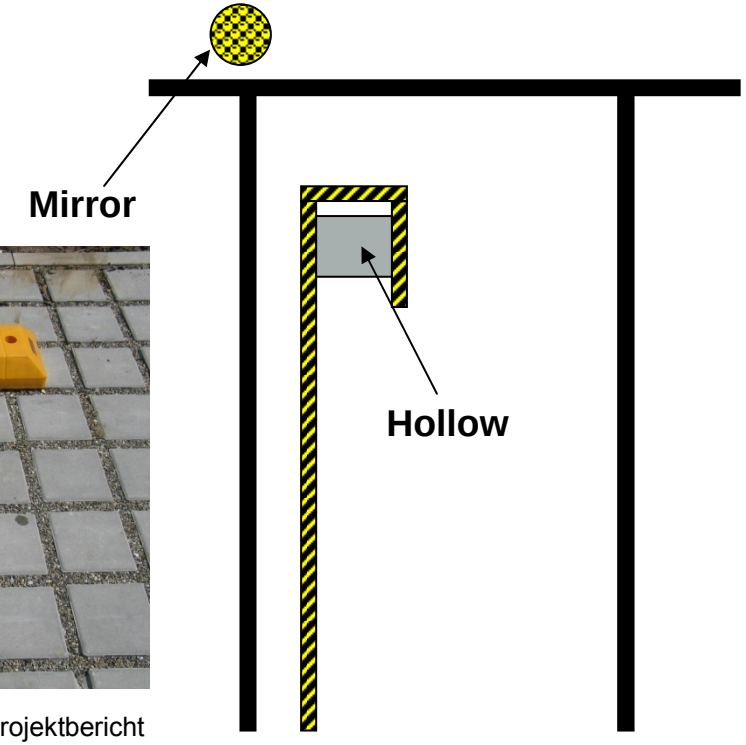


Parking Accuracy

- How accurate do I have to park for inductive charging?

  → ±10cm according to German application guidline for inductive charging

- Is this possible without any means?
- How accurate is vehicle positioning possible with simple non-electronic means?
- What about the expenditure of time?



Source: B. Elias (Audi): Zwischenergebnisse Einparkstudie Teil 2, Interner W-Charge-Projektbericht

Results of the Study on Parking Accuracy

- **Preferred parking assistance**
  - Approx. 85% of the test persons prefer the combination of parking assistance means ground marking + hollow + mirror
- **"cable-free" vs. "cable-based charging"**
  - In average 55 s are needed to get out the cable, plug in, plug out and stow it
  - In average 43 s are needed additionally for cable-based charging compared to cable-free charging
- **Results for cable-free charging**

Parking Assistance (90% are 26 of 28 test persons)	Deviation (90% are better than)		Expenditure of time compared to parking without charging (90% do not need more than … additionally)
	(radial)	(angle)	
Ground Marking (GM)	83 cm	4,9 °	14 s
GM + Mirror	15 cm	3,1 °	14 s
GM + Hollow	21 cm	4,5 °	10 s
GM + Hollow + Mirror	8 cm	2,5 °	11 s

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Inductive Charging – Current Status and Outlook

- The technology is here and working!

- Issues to be treated and solved to become a success:
  - Interoperability between systems of different manufacturers
  - Vehicle design towards effective integration of the inductive charging system
  - Parking guidance
  - Fundamental evaluation of the environmental impacts of the electromagnetic fields

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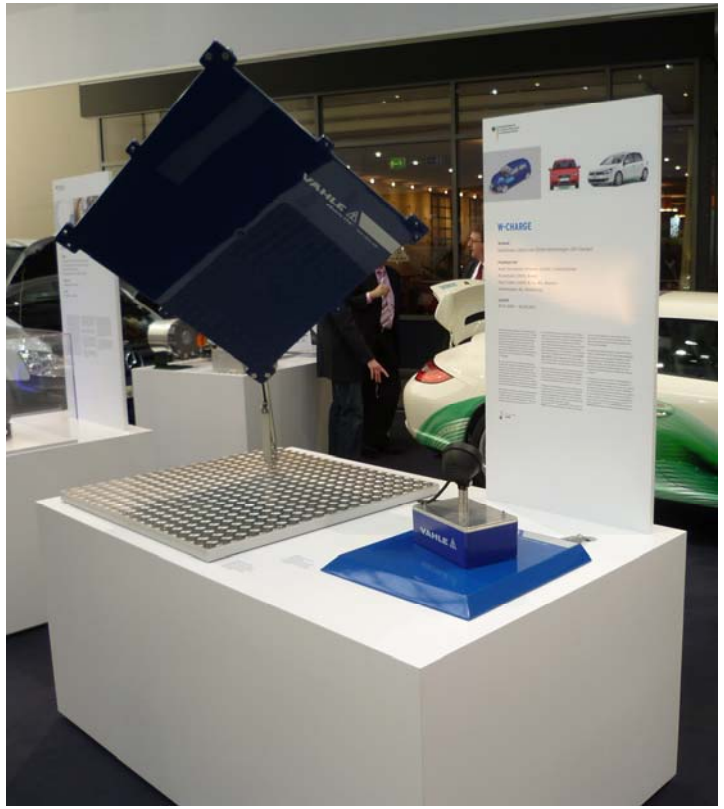

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VAHLE STROMZUFÜHRUNGEN

VOLKSWAGEN AKTIENGESELLSCHAFT

www.w-charge.de