5th ANNUAL CONFERENCE ON ELECTRIC ROADS & VEHICLES

Pilot Demonstration Projects of Electric Roads
- INTIS' DWPT Test- and Demonstration Facility -

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Our motivation for In-Motion-Charging-Solutions

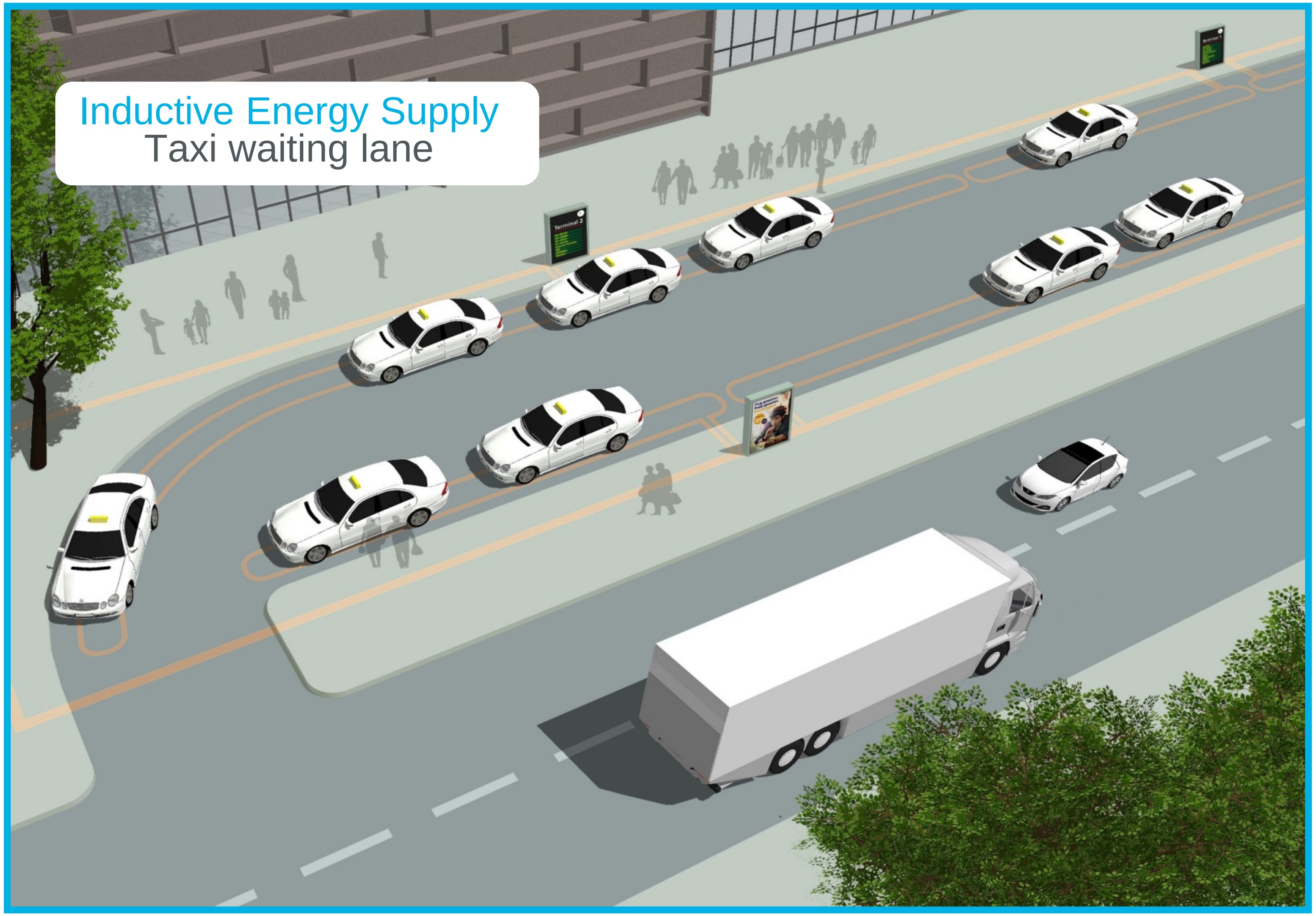
The low power density of battery technology today means electric vehicles need vast and expensive battery capacity today to replacement internal combustion engine vehicles.

Recharging vehicles with a plug and cable is only possible while stationary and requires active intervention by people. If vehicles could be charged more often and automatically, the problem of limited range would be solved.

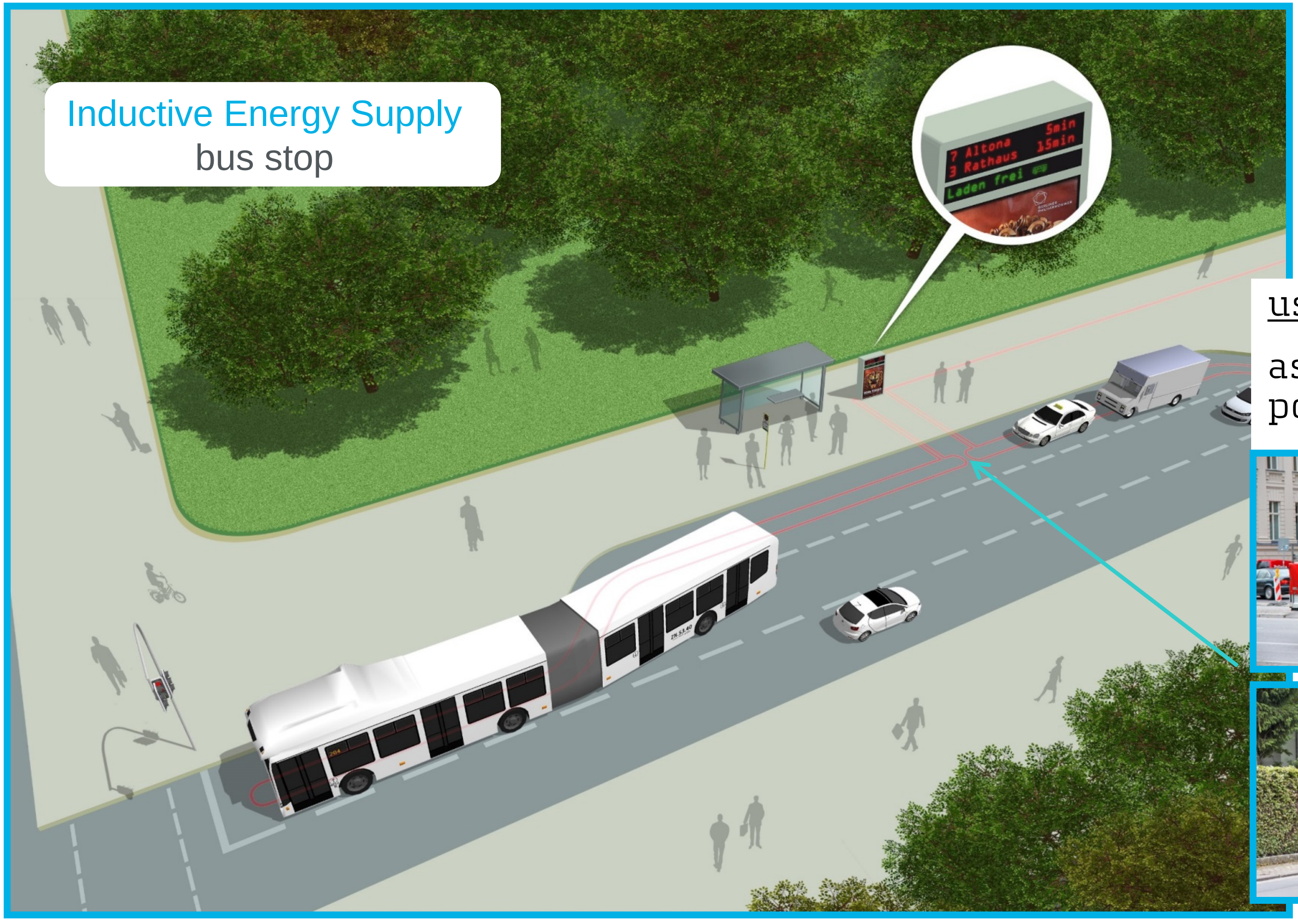
This is where Wireless Power Transfer systems can help; they don’t require cables or a direct contact to transfer energy and can also be used while the vehicle is on the move.

Wireless Power Transfer allows electric vehicles to become as flexible as their internal combustion engine counterparts. Inductive power transfer is a key technology in the journey to making electric mobility a success.

Our application focus: semi-dynamic charging – taxi lane



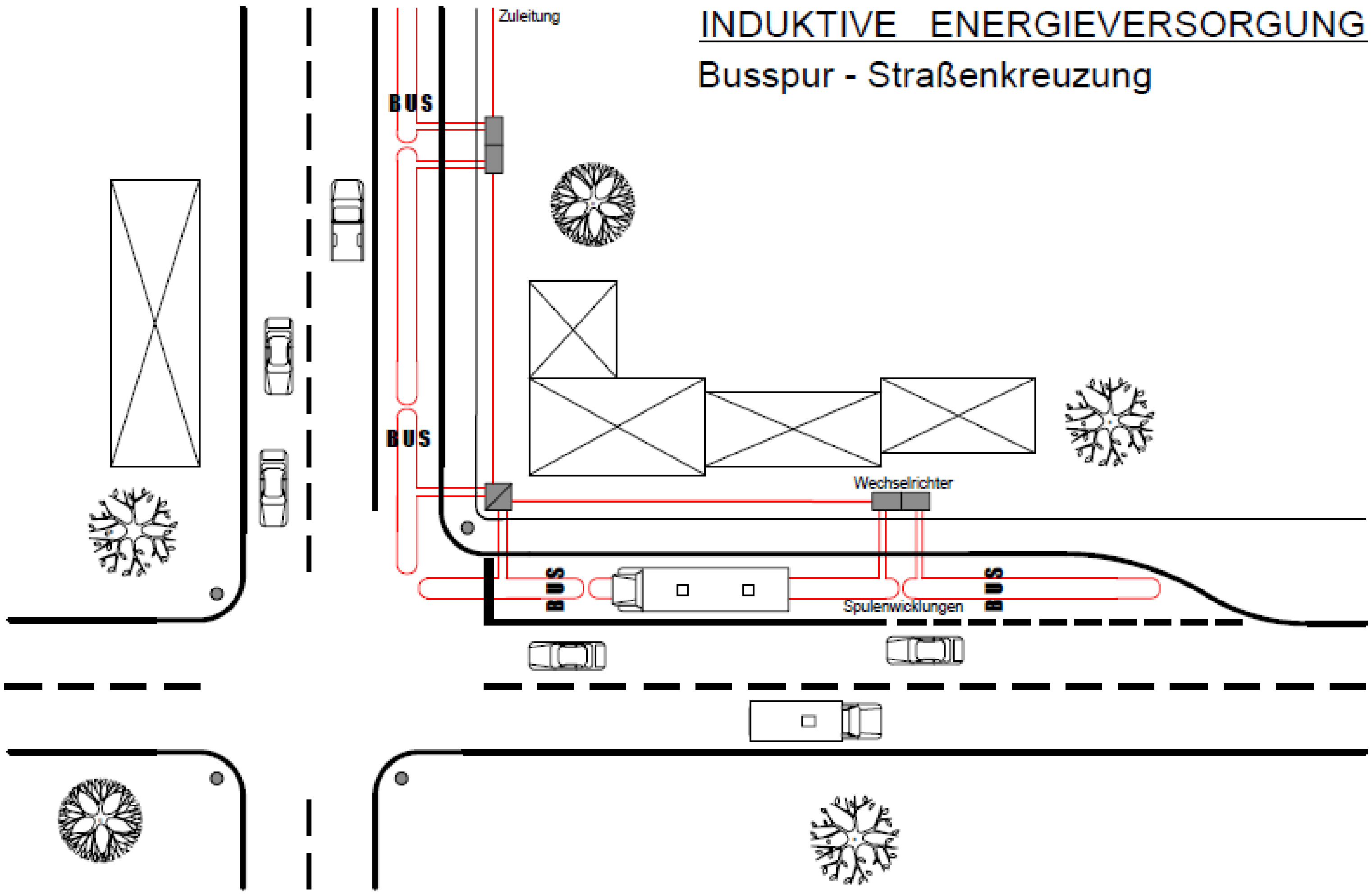
Our application focus: semi-dynamic charging – bus stop and adjacent areas



<u>users</u> …

as many as possible ….

Our application focus: dynamic charging – bus lane



INTIS DWPT Test Facility – Milestones (1)

<u>Project Kick-Off</u>: November 2011

- … after setting-up of:
  - project consortium (several private companies and institutions (Fraunhofer))
  - financing: 50% private, 50% public
  - project leadership: INTIS

Gefördert durch:

Koordiniert durch:

INTIS DWPT Test Facility – Milestones (2)

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Design Phase: Nov 2011 – April 2012

- setting-up of criteria for technology selections
- assessment of existing technologies concerning:
  - coil topologies (power transfer)
  - road installations
  - vehicle localization
  - road-coil switching and process control
  - vehicle to road bidirectional communications
  - vehicle side communications, power electronics
- HARA → safety concept
- selection of technologies to be implemented

INTIS DWPT Test Facility – Milestones (3)

Installation Phase: May 2012 – May 2013

- road preparation work
- installation of power supply and - electronics, vehicle localization, & communication equipment, control station
- integration of DWPT-equipment into vehicles (passenger car and bus)
- commissioning: May 2013

Testing Phase (first project – passenger vehicle & bus): May 2013 until May 2014

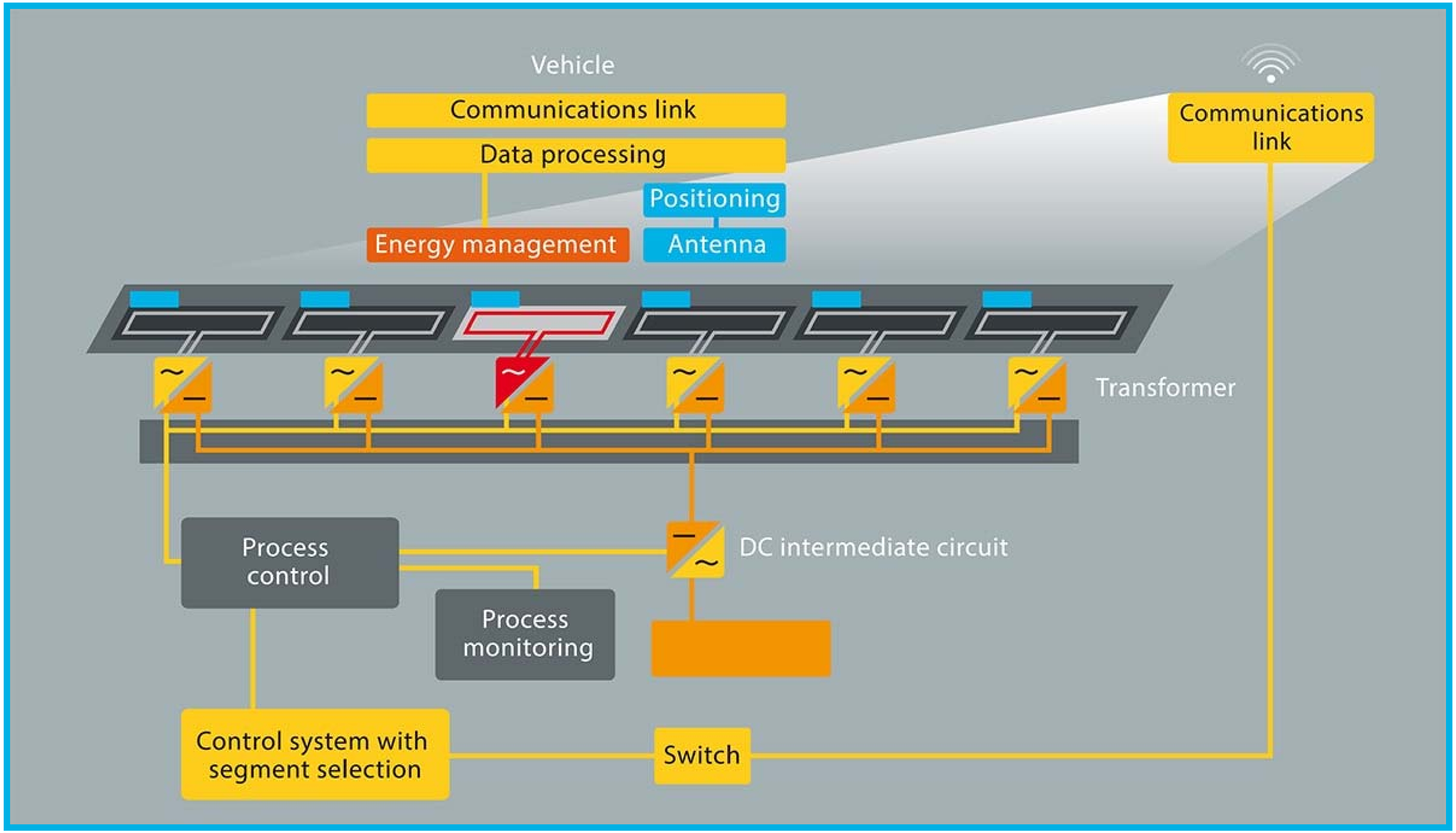
Current activities:

- use of the facility for own (INTIS) developments (including stationary charging interop.)
- use of the facility for external projects/ customers
- DWPT performance demonstrations

INTIS DWPT Test Facility (1)

INTIS DWPT Test Facility (2)

INTIS DWPT Test Facility – system overview



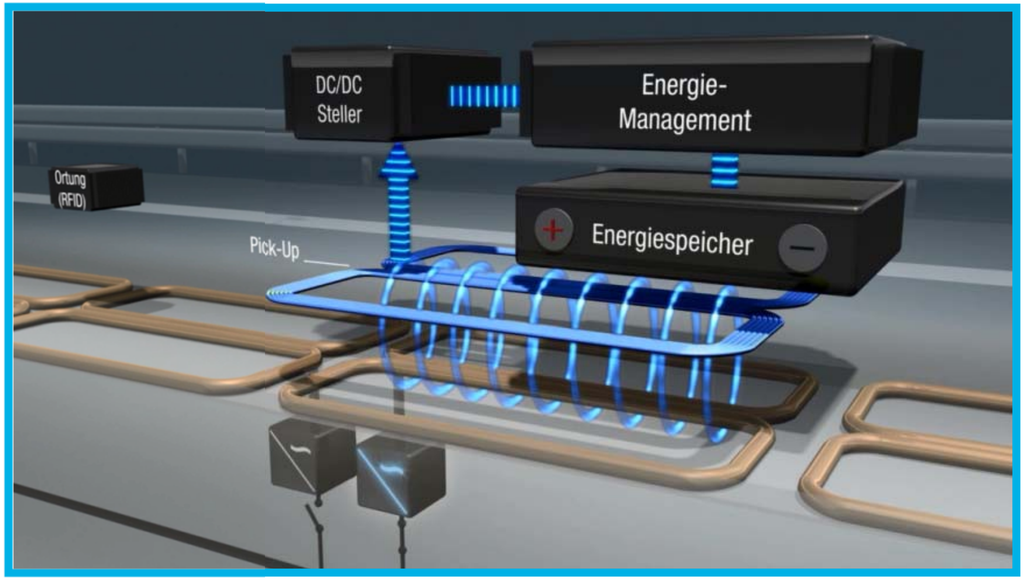
INTIS DWPT Test Facility – main parameters

general:

- 36 – 40 kHz operating frequency
- transfer power: up to 200 kW
- airgap (copper-copper) ≤ 25cm
- lateral tolerance: ±10cm
- communication: WLAN, 2.4 GHz

primary installation:

- buried installation
- coil section length: 1.5 … 12m
- 6 power inverters
- vehicle localization: RFID

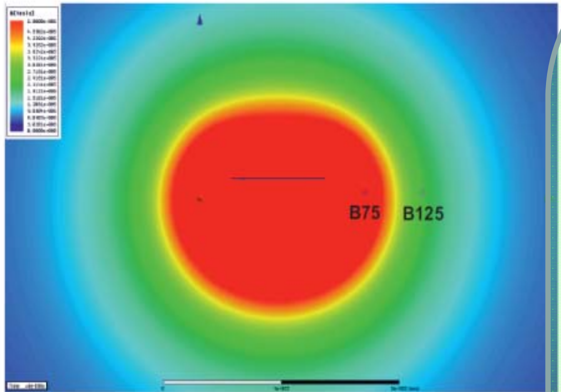


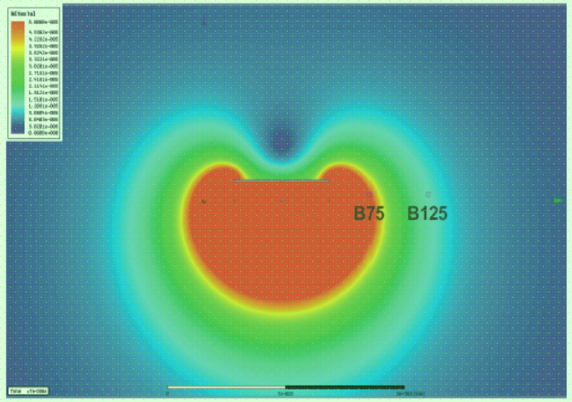
secondary installations:

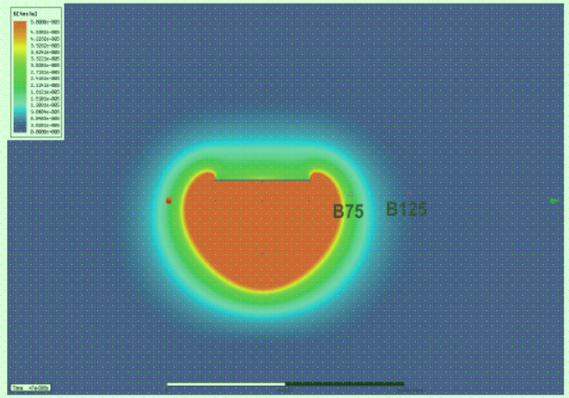
- 30 kW (passenger vehicle)
- one or more coils a 60kW (bus or truck)

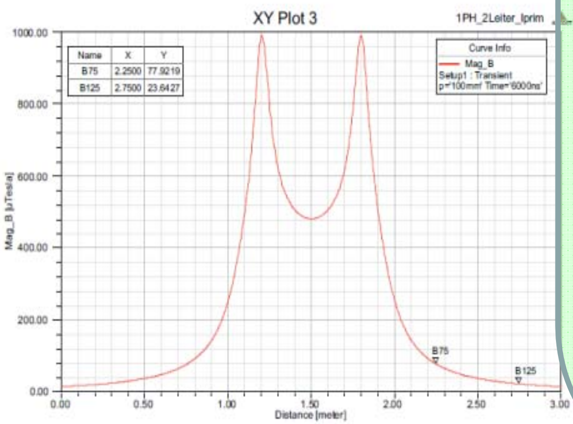
Technology selection (example: coil topology)

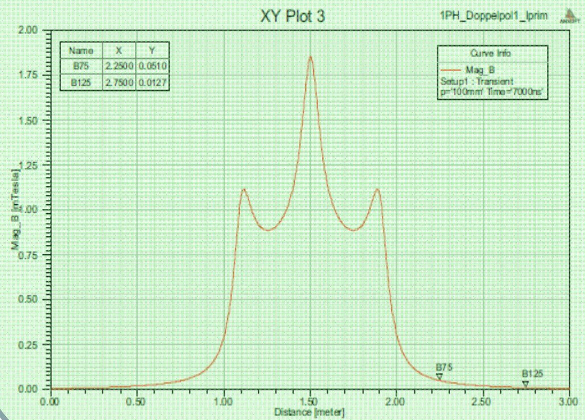
18 different coil topologies have been investigated (simulations) prior to design freeze, two double-flat topologies (transversal) were finally chosen:

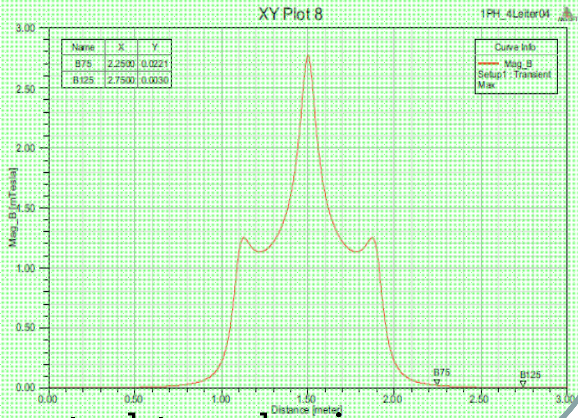












chosen/ implemented topologies

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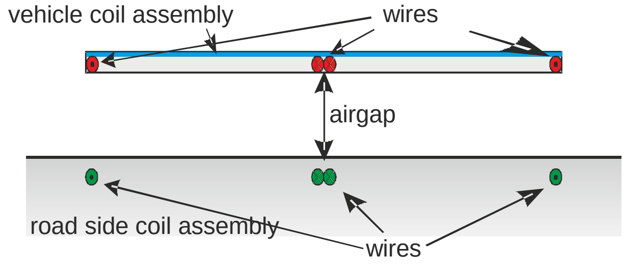
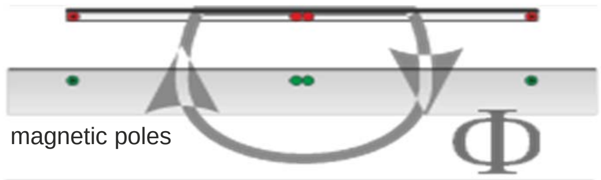
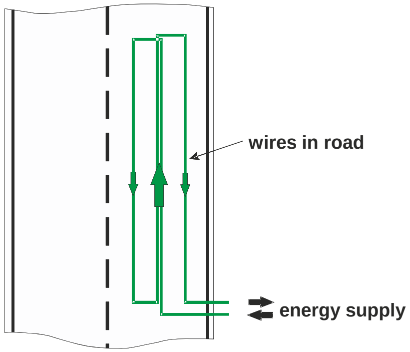
Technology selection (example: coil topology)

„double-flat- topology"

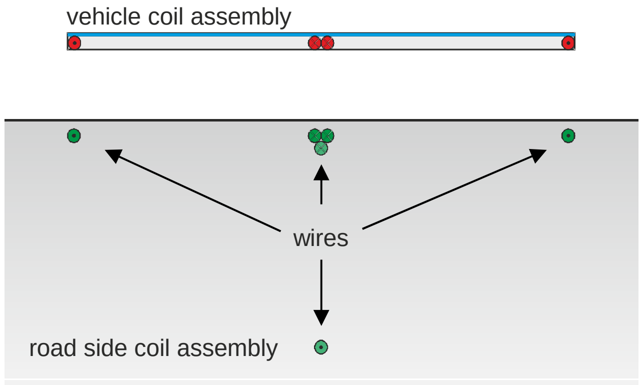




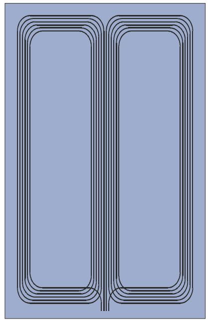
„Road side wiring topology (top-view)



alternative topology „double-flat+"



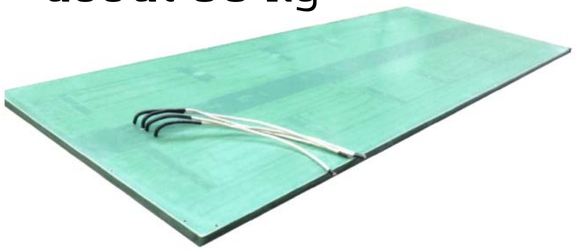
vehicle side wiring topology



Technology selection (example: coil topology)

60 kW DWPT pick-up:

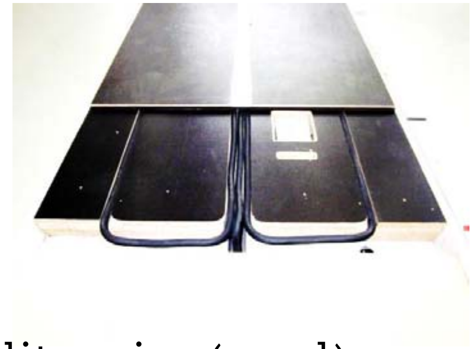
- 200cm x 80cm x 2.5cm (L x W x H)
- about 60 kg



30 kW SWPT pick-up:

- 90cm x 80cm x 2.5cm (L x W x H)

coil segment (road):



litz wire (road):

Coils/ inverters set-up / road

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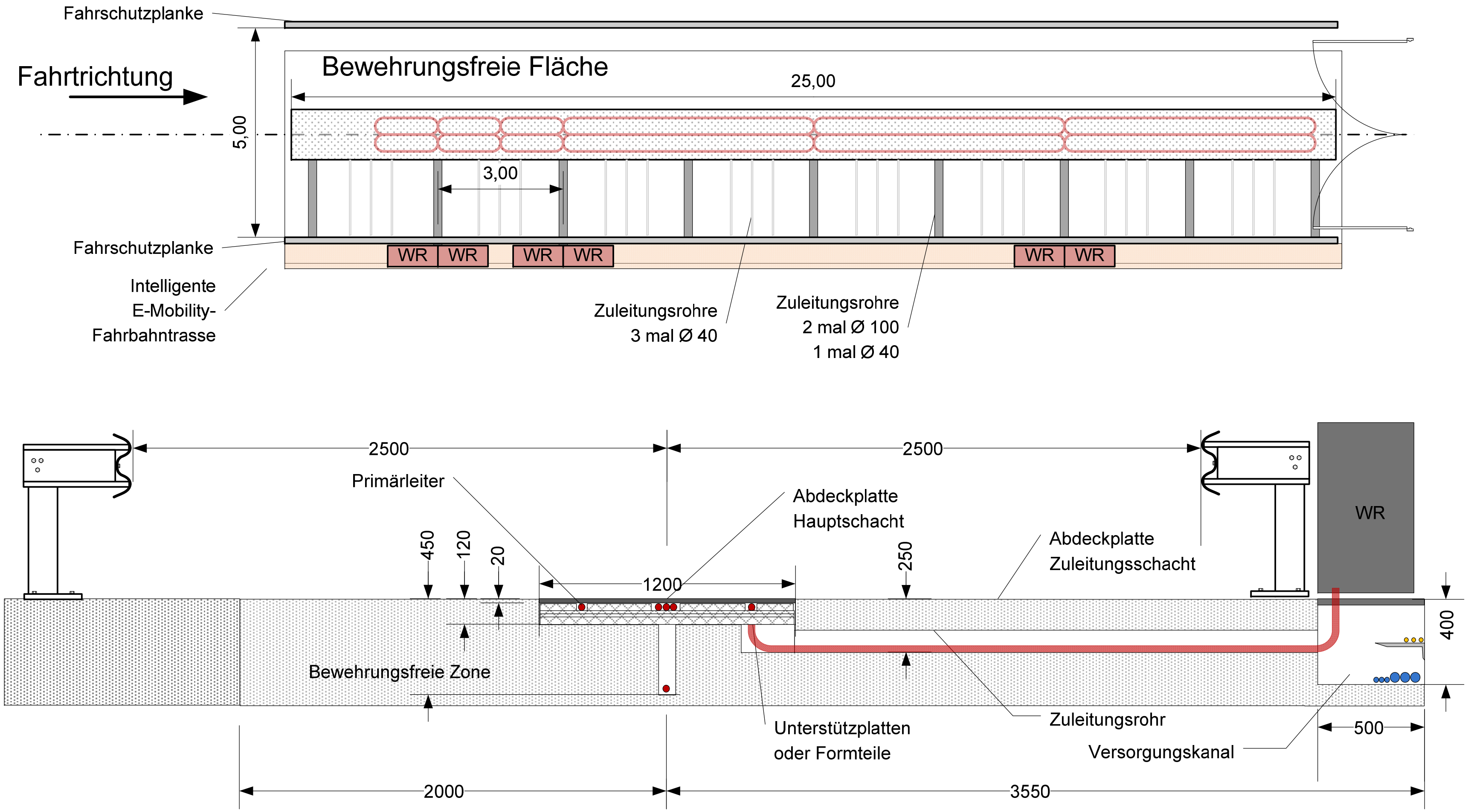
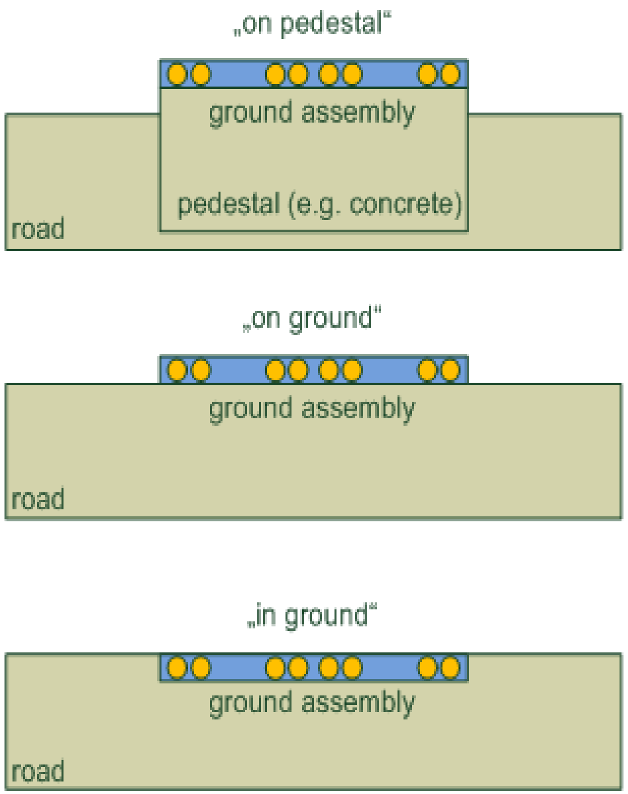
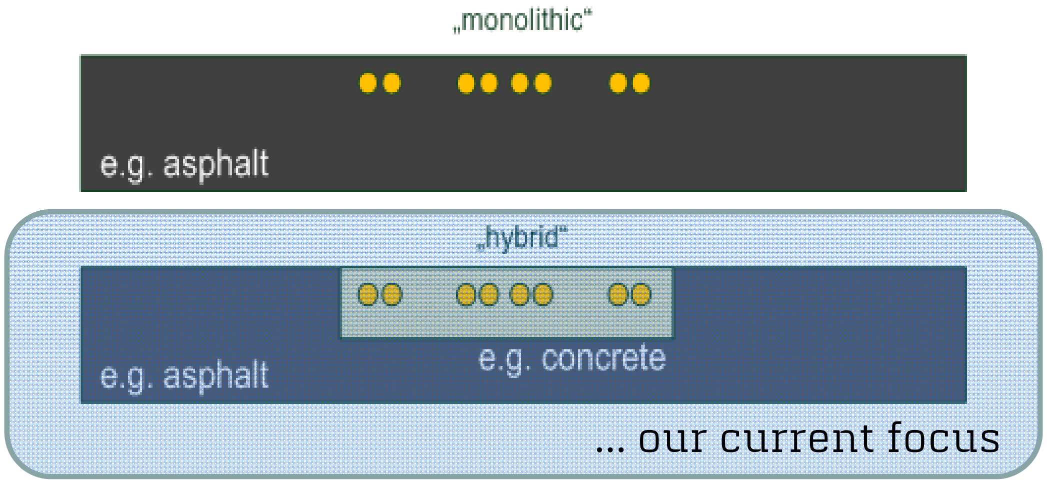


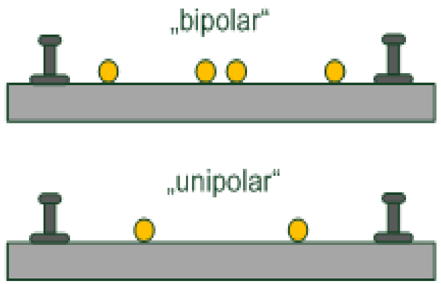
Some ways to install coils in/ on road/ rail ...

stationary WPT (road)



in- motion WPT (road)



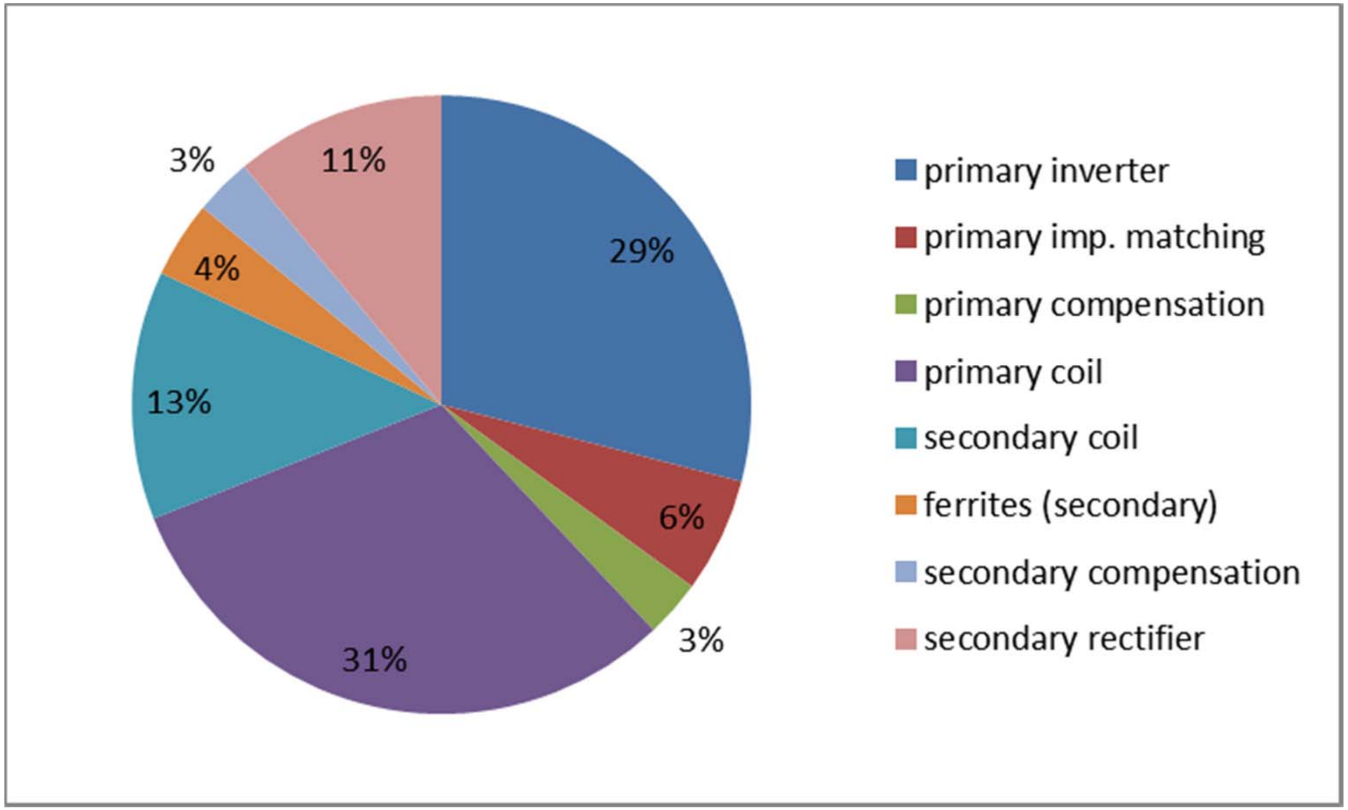


Test results – overall efficiency

overall efficiency:

- ≥ 89% @ 60 kW, y = 10cm, z= 20cm

estimated distribution of electrical losses:



Test results – temperatures underfloor area/ foreign objects

<u>maximum temperature in underfloor area (vehicle with combustion engine, without WPT-provisions) :</u> 55°C (steady state after about 20 minutes)

<u>max. temperatures of foreign objects (examples):</u>

- object 1: magnetic steel 100 x 70 x 10 mm
- object 2: 5 €-cent coin
- object 3: aluminum paper (chewing gum)
- object 4:aluminum paper (cigarette packet)
- object 5: aluminum paper (chocolate paper)

time [min]	T [°C] object 1	T [°C] object 2	T [°C] object 3	T [°C] object 4	T [°C] object 5
0	22	22	22	22	22
1	52	47	70	22	24
5	122	75	106	24	25
10	>150	86	107	24	25
15	-	89	107	24	25

blue: to hot when getting in contact with, red: risk of fire → FOD provisions required?: tbd, e.g. depending on the coils switching-on/off pattern!

Test results – magnetic fields

passenger vehicle @ 30 kW: some spots in “public area”

… using initial (designed) shielding provisions around the secondary coil

Measurement location	Max. mag. flux w.r.t reference values (ICNIRP:2010)
passenger area/ foot space	13%
passenger area/ headrest	3%
passenger area/ seat (horizontal area)	14%
passenger area/ door sill	31%
outside vehicle/ close to front-door sill	96%
outside vehicle front/rear (center line)	10% / 40%

measurements done with NARDA ELT400 in accordance to VDE-AR-E 2122-4-2

bus @ 60 kW: lower values compared to passenger vehicle measurements

lessons learnt: slight modifications of shielding provisions in underfloor area did change magnetic flux density values (both directions!)

→ vehicle specific shielding assessments/ provisions are a must!

Contact

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