## New technologies for battery charging

# Magnetic Field Wireless Power Transfer

### A presentation in the frame of the European Project FABRIC

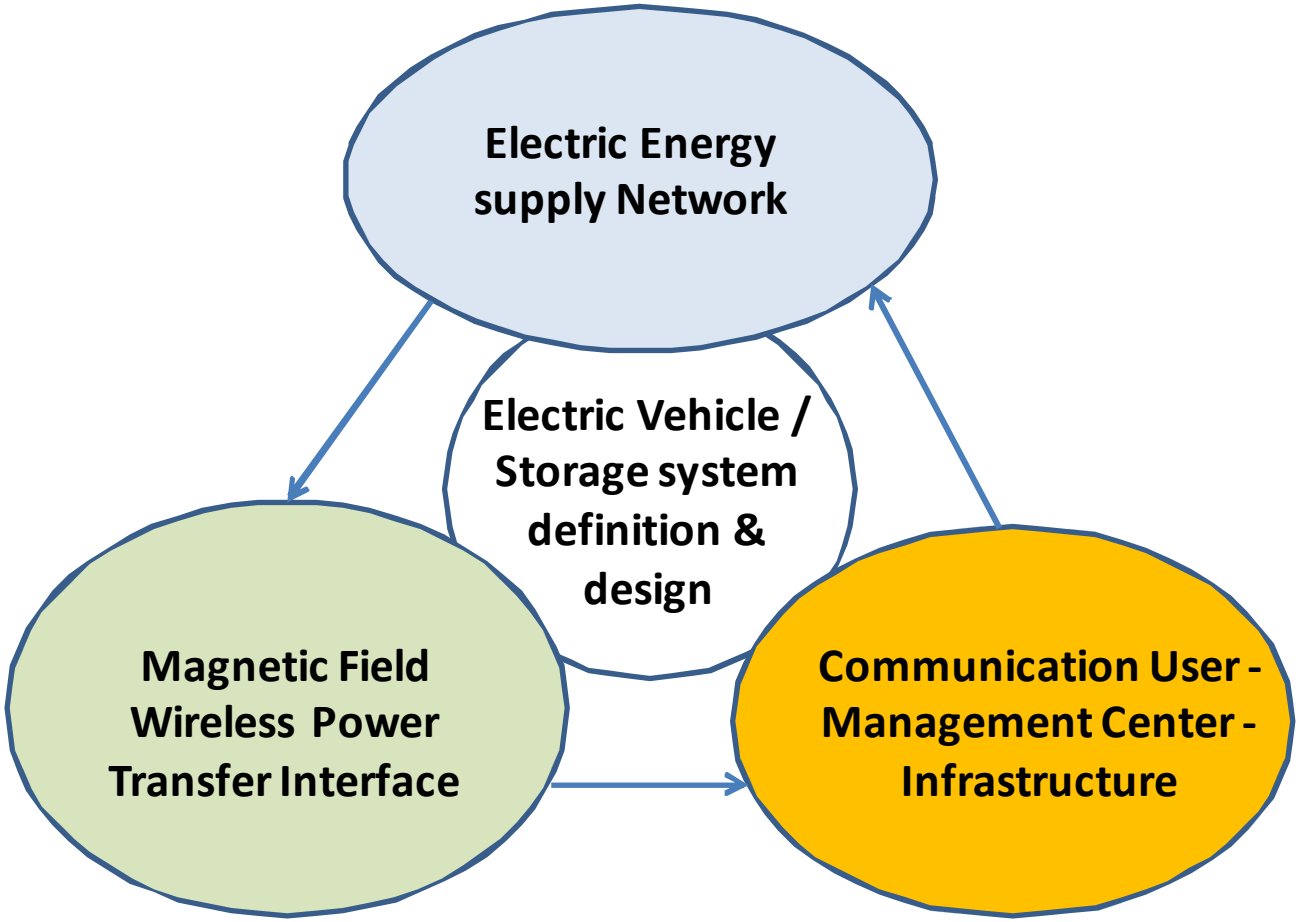
FABRIC

Feasibility analysis and development of on-road charging solutions for future electric vehicles

# Summary

- **The Electric Vehicles in the frame of the Intelligent Transport System**
- **Toward an integrated vehicle – infrastructure system design**
- **User – Vehicle – Infrastructure: the impacting factors**
- **The European Project FABRIC: Magnetic Field Wireless Power Transfer**
- **Operational modes – Testing program - Standardization**
- **Toward «hand-free» battery charging**
- **An invitation to a design exercise**

## Shaping an Electric Vehicle in the frame of the city mobility system




The key elements of the system

# Electric Vehicle Harmonization wthin the eMobility system

## addressing the best use of the energy and the user convenience

- The design of the vehicle system with particular regard to the on board storage and to the vehicle use can be considered in relation with the possible application of the new technologies on Wireless Power Transfer, the Information and Communication Technology and the functional support of the Service Providers acting in the Hyper Network
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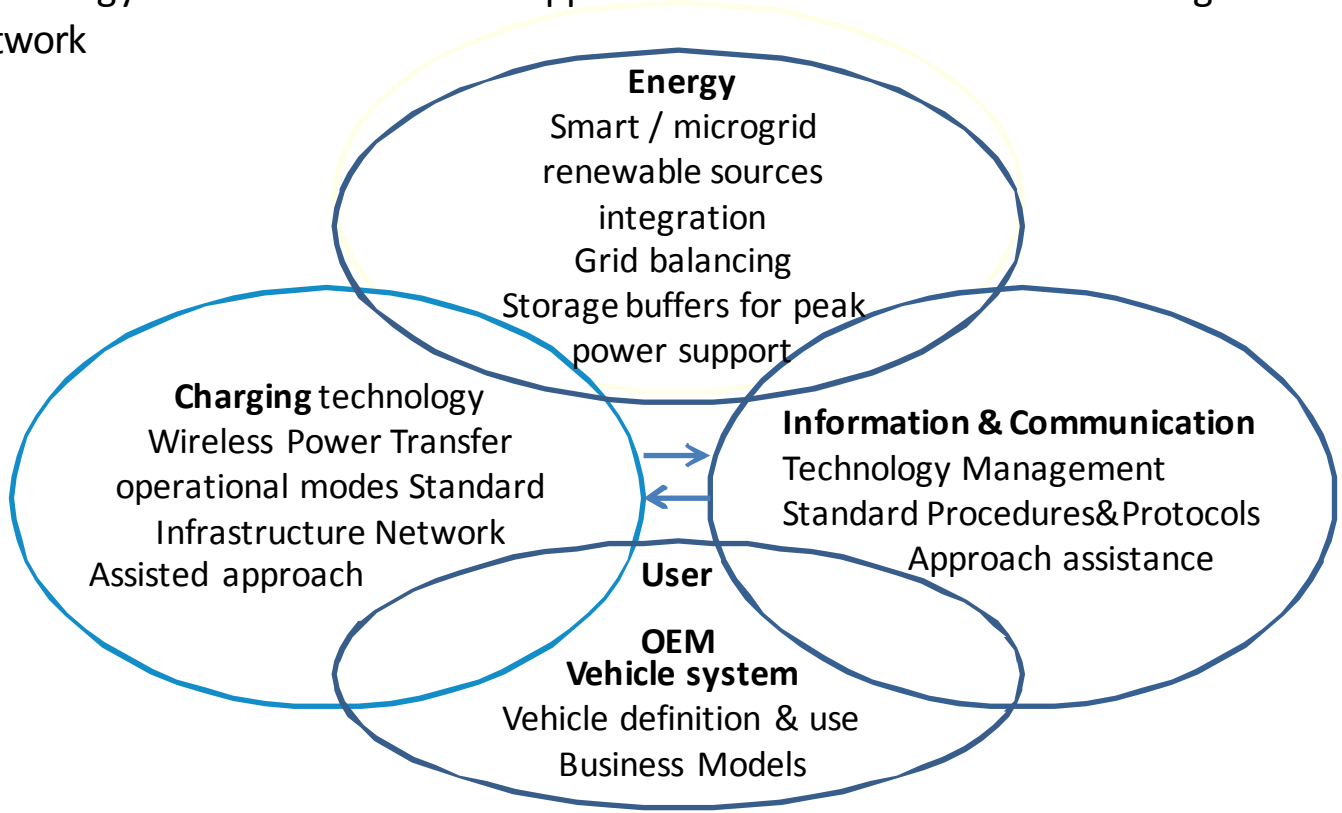
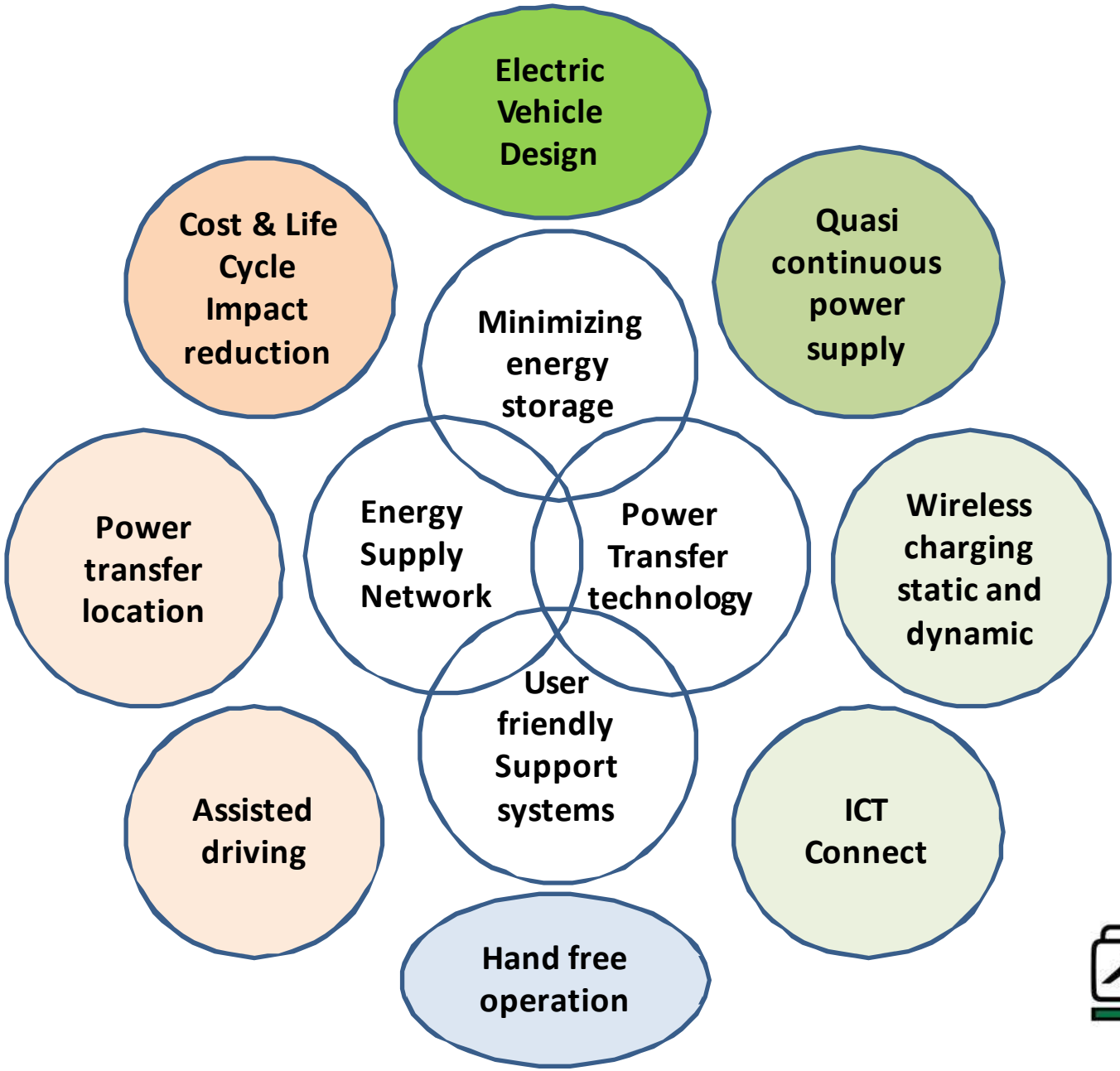


## Toward an integrated vehicle – infrastructure system design: the key factors



# Steps toward the development of the intellige integrated vehicle- infrastructure system

**Acting synergically in accordance to the EU Mandate of Energy Saving ad Environment Conservation**

**Creating a strategically established energy supply infrastructure network**

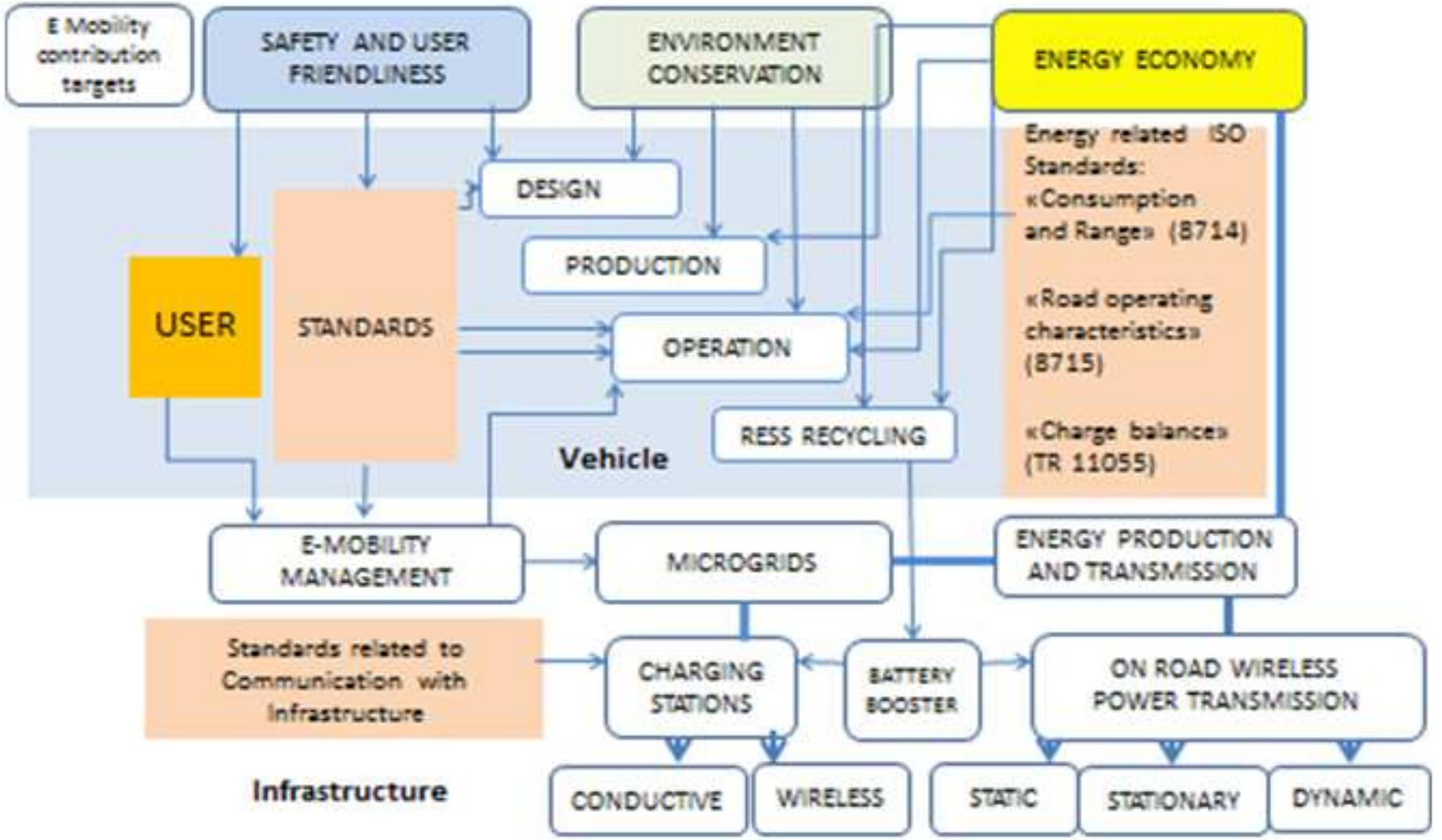
**Developing an user friendly interface vehicle – infrastructure for energy transfer**

**Establishing an interactive management for grid balancing against the flexible demand of Electro mobility**

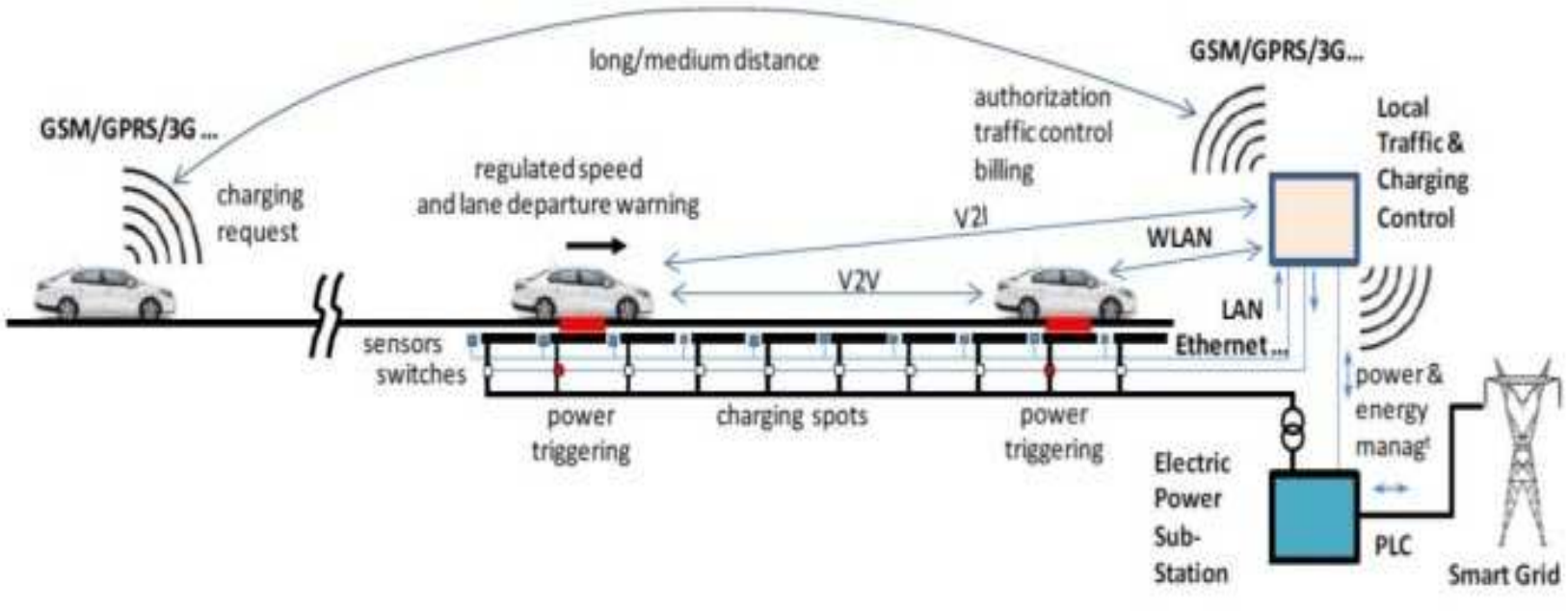
**Developing informative and operative support means for the user in the routing and the approach to the power supply infrastructure**

**Tayloring the vehicle design consistently with the energy exchange supportive structure**

# User – Vehicle – Infrastructure: the impacting factors



# EU Project FABRIC: Dynamic Wireless Power Transfer

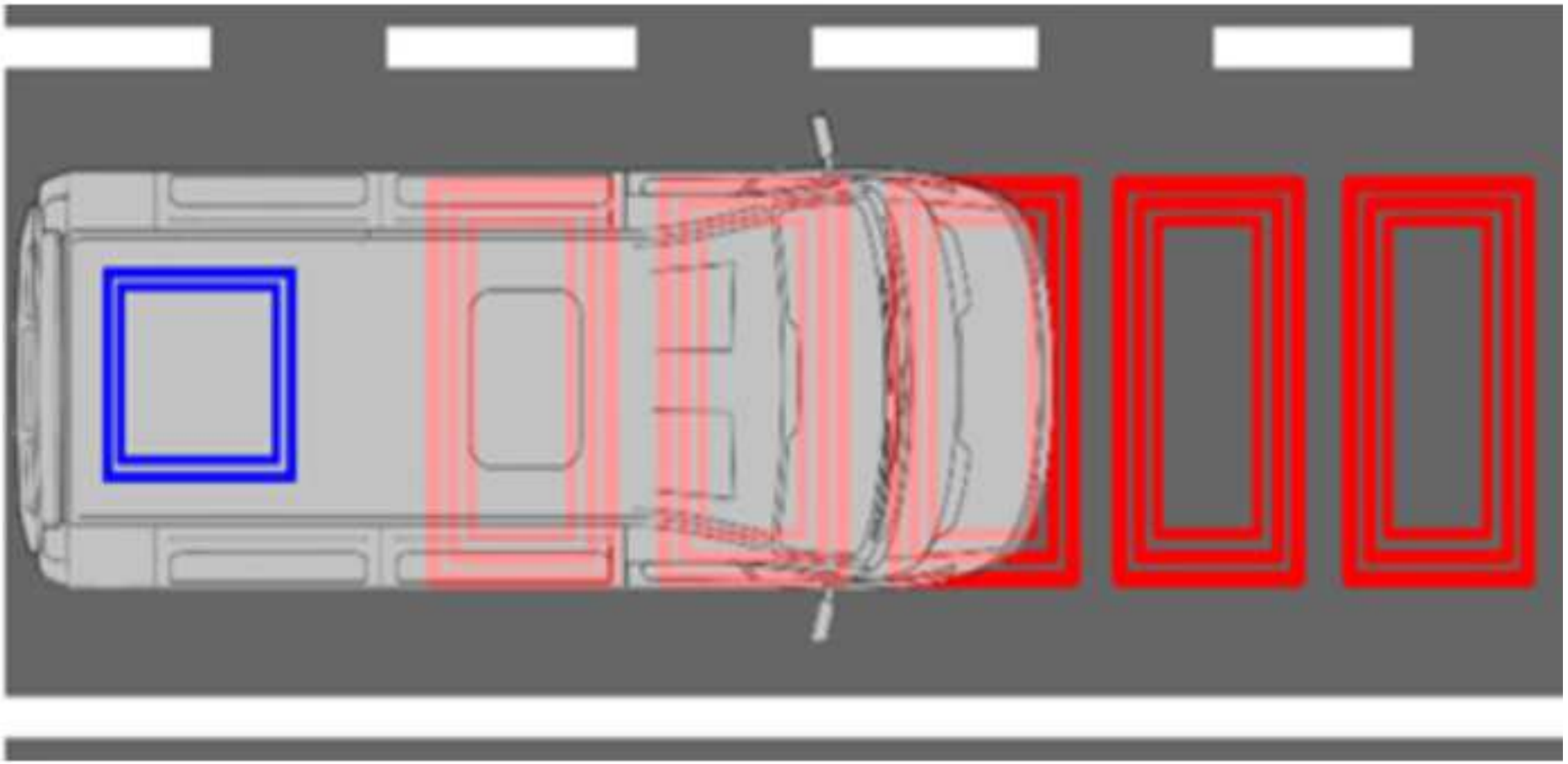


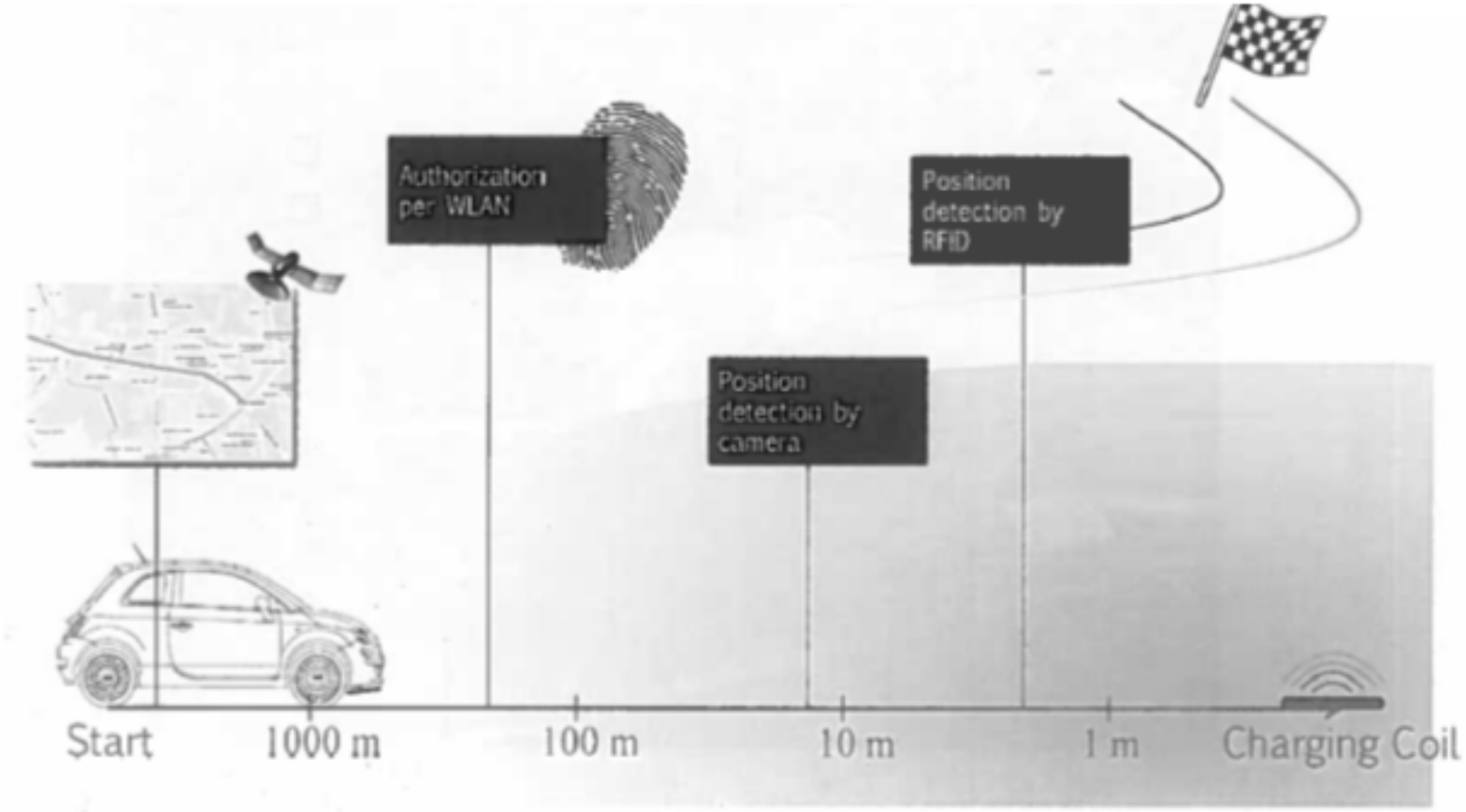

**The concept: Power transfer by activating segments of inductive infrastructure during vehicle transit**

# Italian test site: PoliTo solution: 20-200 kHz, 20 kW

## Vedecom/QUACOMM solution: 85 kHz,20 kW, to be tested in France

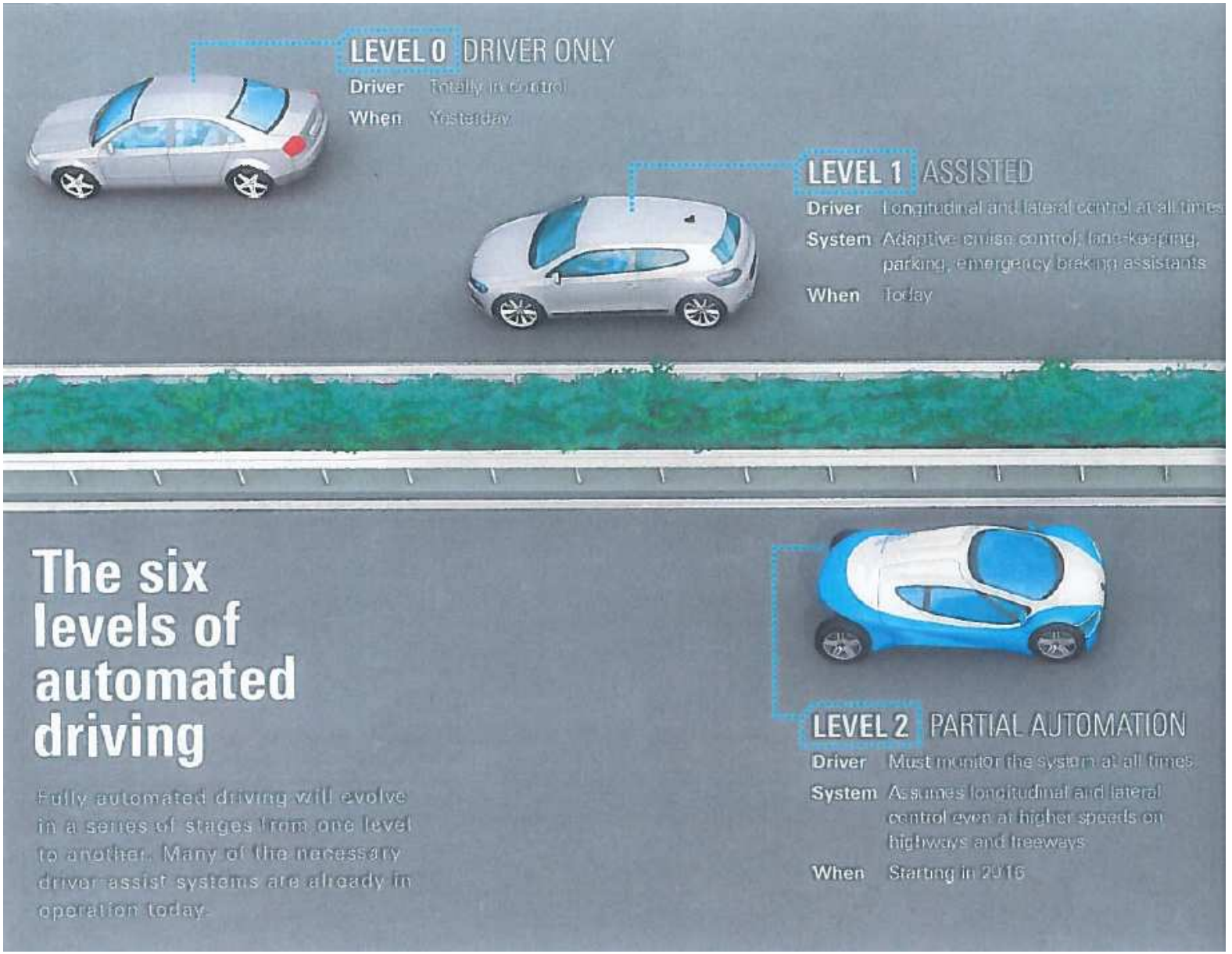
**SAET solution: 80 – 100 kHz, 50 kW,**
**to be tested in Italy**






Source. IKA presentation of EU Project UNPLUGGED

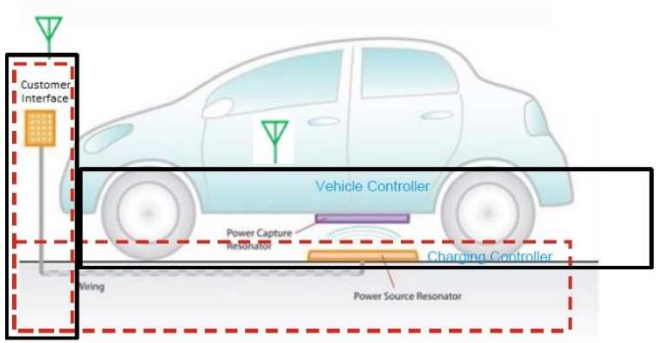
Wireless charging assisted approach concept procedure


LEVEL 0 DRIVER ONLY
Driver Totally in control
When Yesterday
LEVEL 1 ASSISTED
Driver Longitudinal and lateral control at all times
System Adaptive cruise control, lane-keeping, parking, emergency braking assistants
When Today
The six levels of automated driving
Fully automated driving will evolve in a series of stages from one level to another. Many of the necessary driver-assist systems are already in operation today.
LEVEL 2 PARTIAL AUTOMATION
Driver Must monitor the system at all times
System Assumes longitudinal and lateral control even at higher speeds on highways and freeways
When Starting in 2016

# Standardization

SAE TIR J2954* standardizes:

- Frequency band (81,39-90kHz)
- Safety
- Interoperability
- EMC/ EMF limits
- Coil definitions
- For WPT 3.7kW, 7.7kW, 11kW, 22kW




UL 2750: Verification of Wireless Charging Base Safety

MOU Between SAE and UL

SAE J2954: Wireless Charging and Alignment

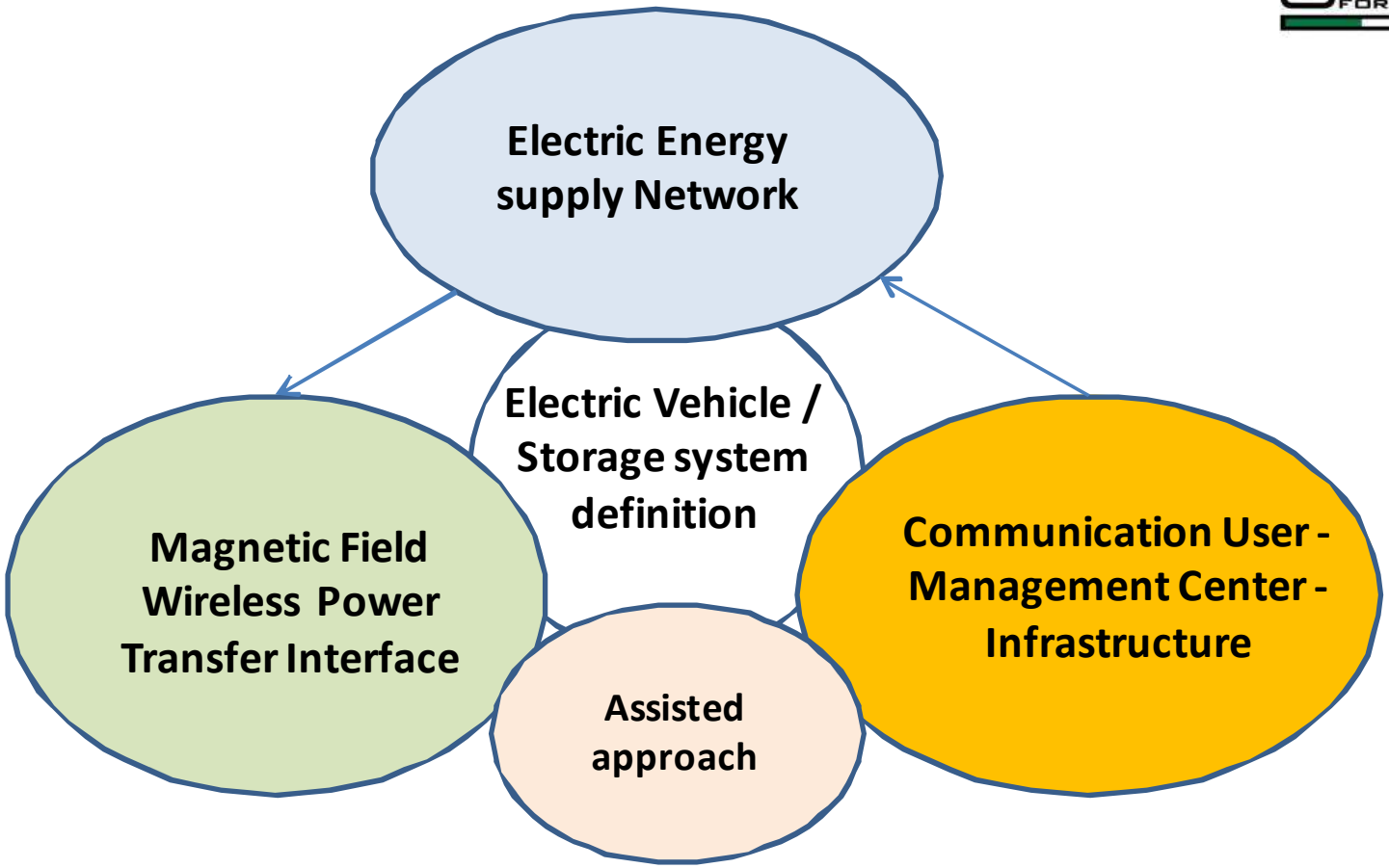
IEEE Standards Organization has initiated a Electrical Vehicle Wireless Power Transfer Industry Connections Activity.

**Motivation and goal:**

This IEEE Standards Association Industry Connection Activity is related to pre-standardization efforts in the domain of Electric Vehicle Wireless Power Transfer with a particular focus on **dynamic wireless charging** as these efforts address the range limitation of electric vehicles as well as the cost aspect of the vehicle energy storage and complement the current standardization activities of the SAE (TIR J2954) which is centered on static charging.

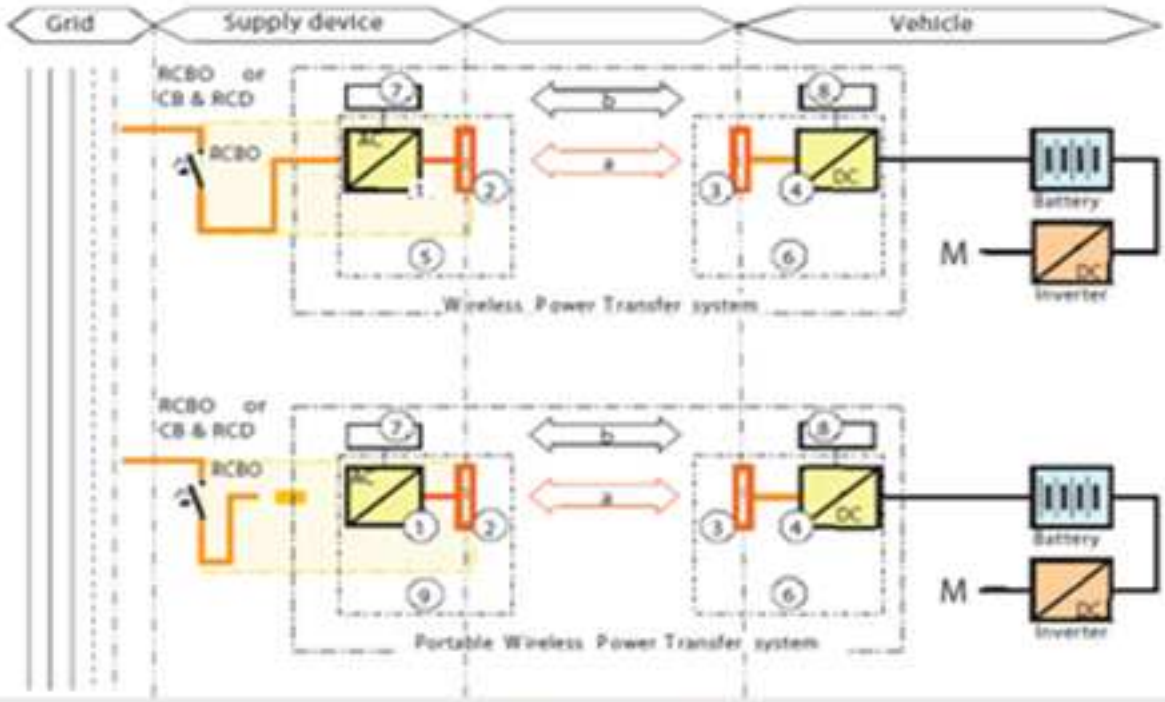
* available from the SAE website since May 31st

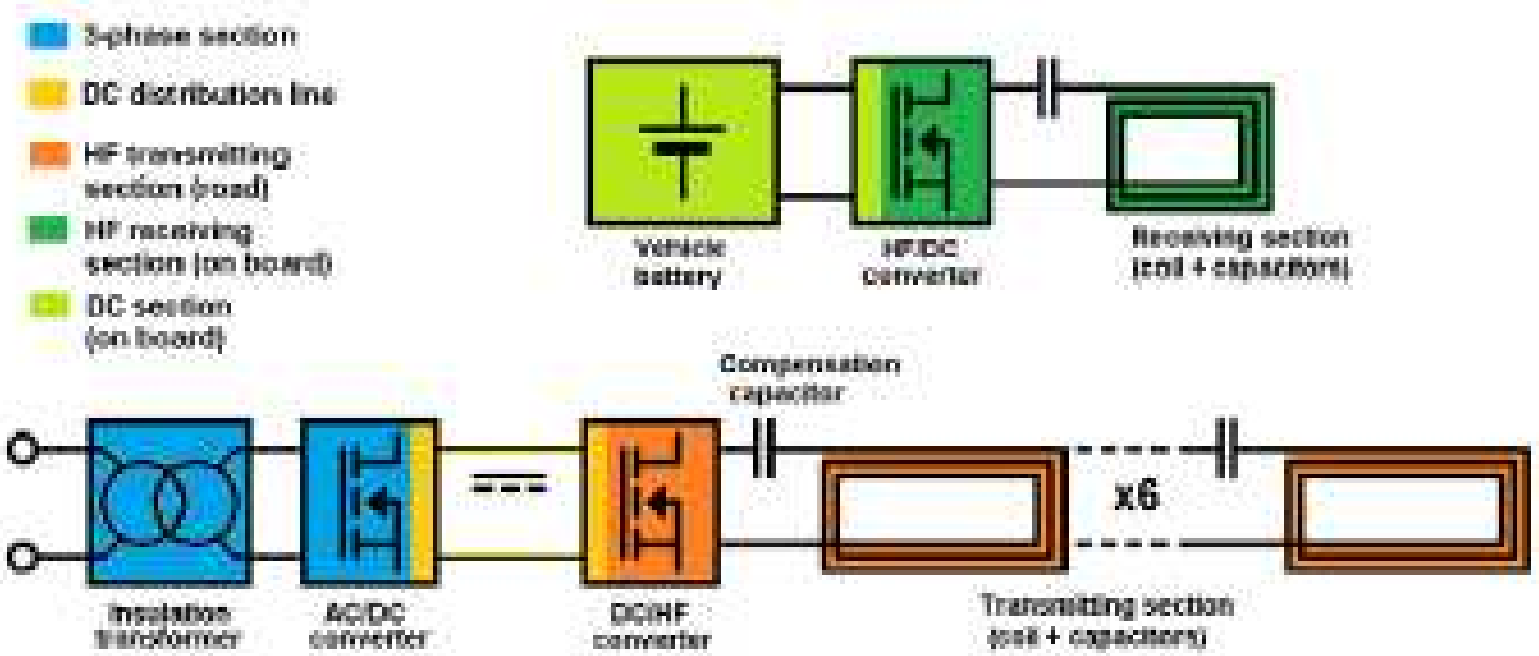
# System optimization User – Vehicle -Grid

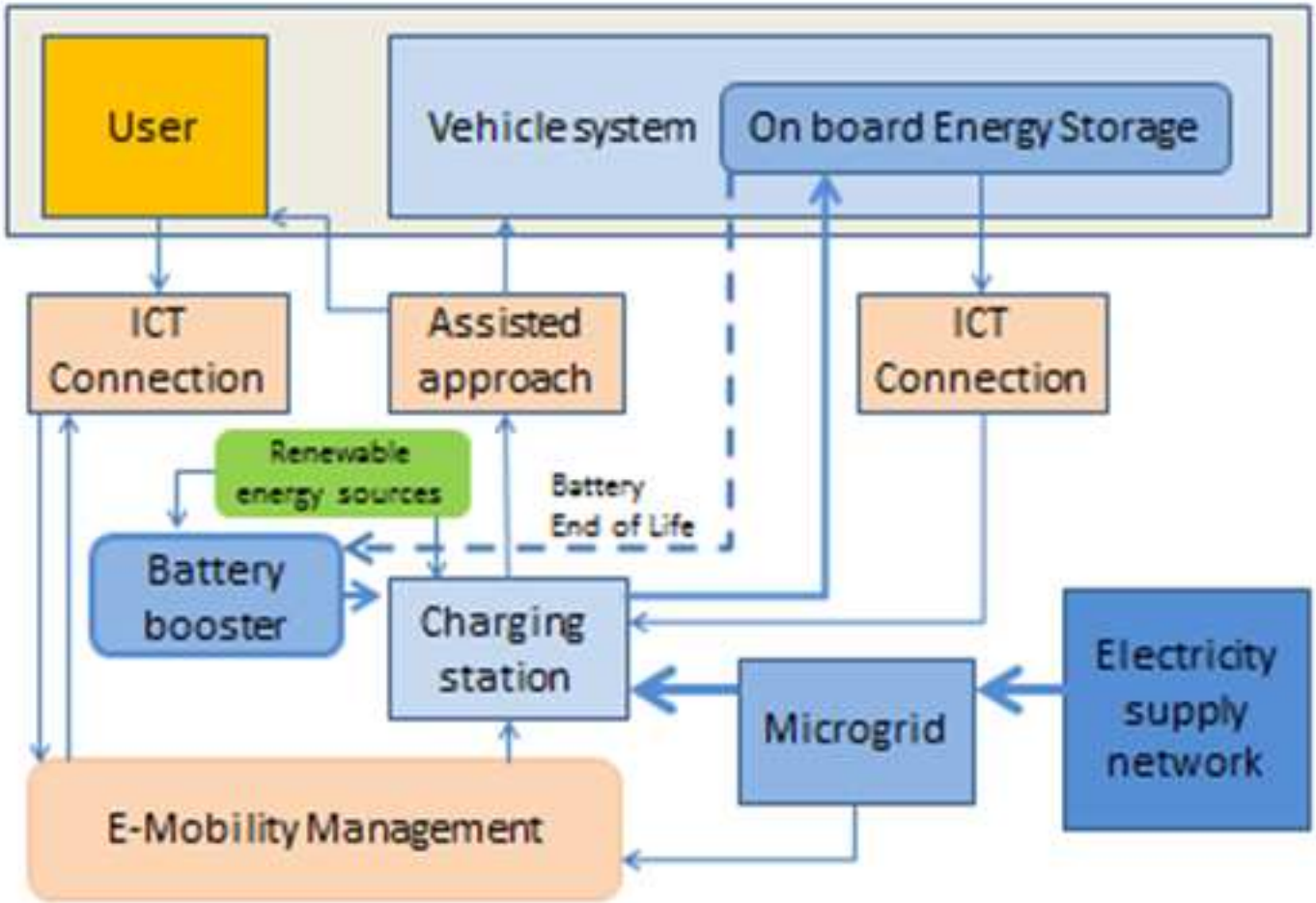


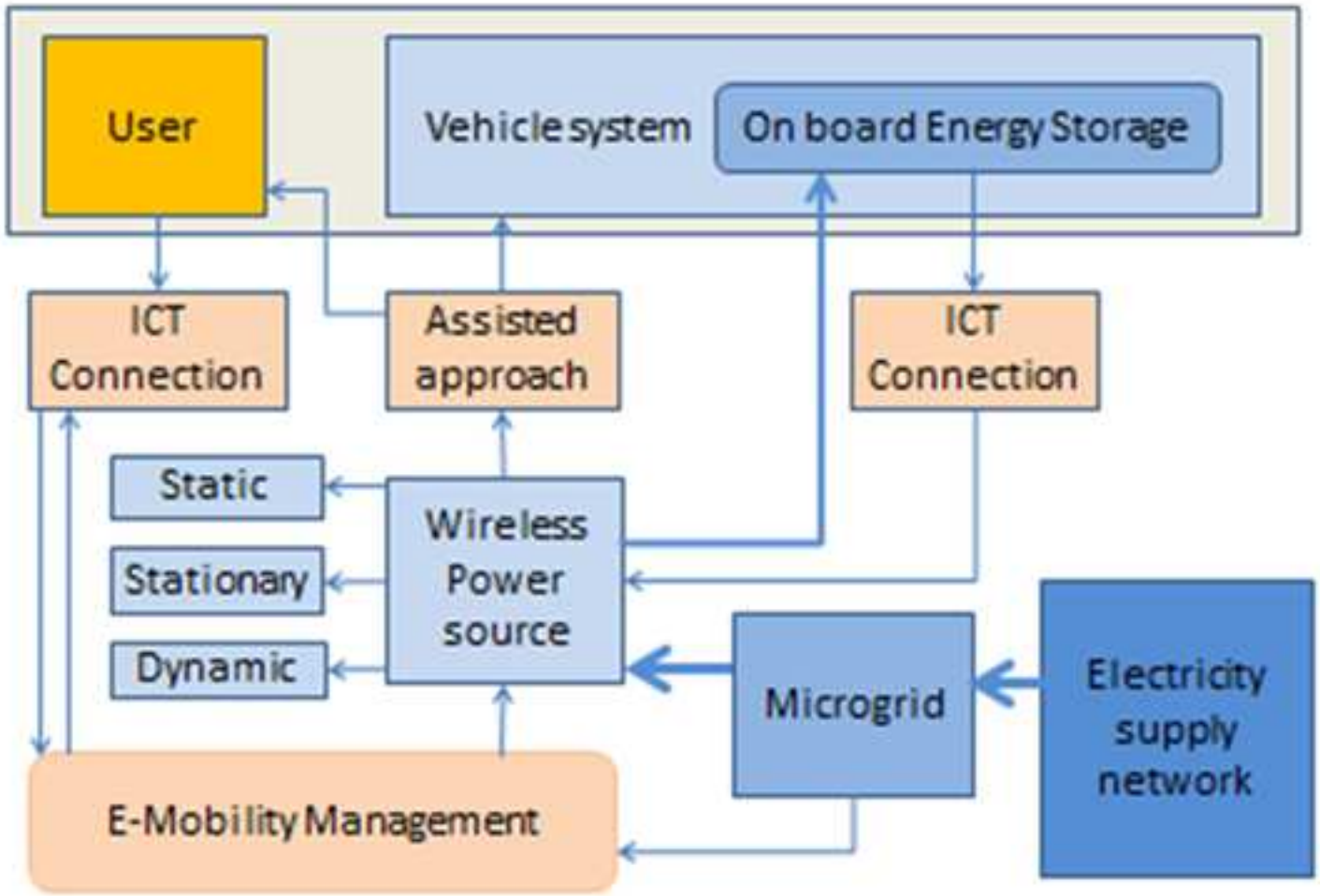

**The key elements of the Electric Mobility system impacting the vehicle use and the definition of the on board storage system**

# General scheme of WPT between primary and secondary element (infrastructure and vehicle)




3-phase section
DC distribution line
HF transmitting section (coil)
HF receiving section (on board)
DC section (on board)
Vehicle battery
HF/DC converter
Receiving section (coil + capacitors)
Compensation capacitor
x6
Insulation transformer
AC/DC converter
DC/HF converter
Transmitting section (coil + capacitors)

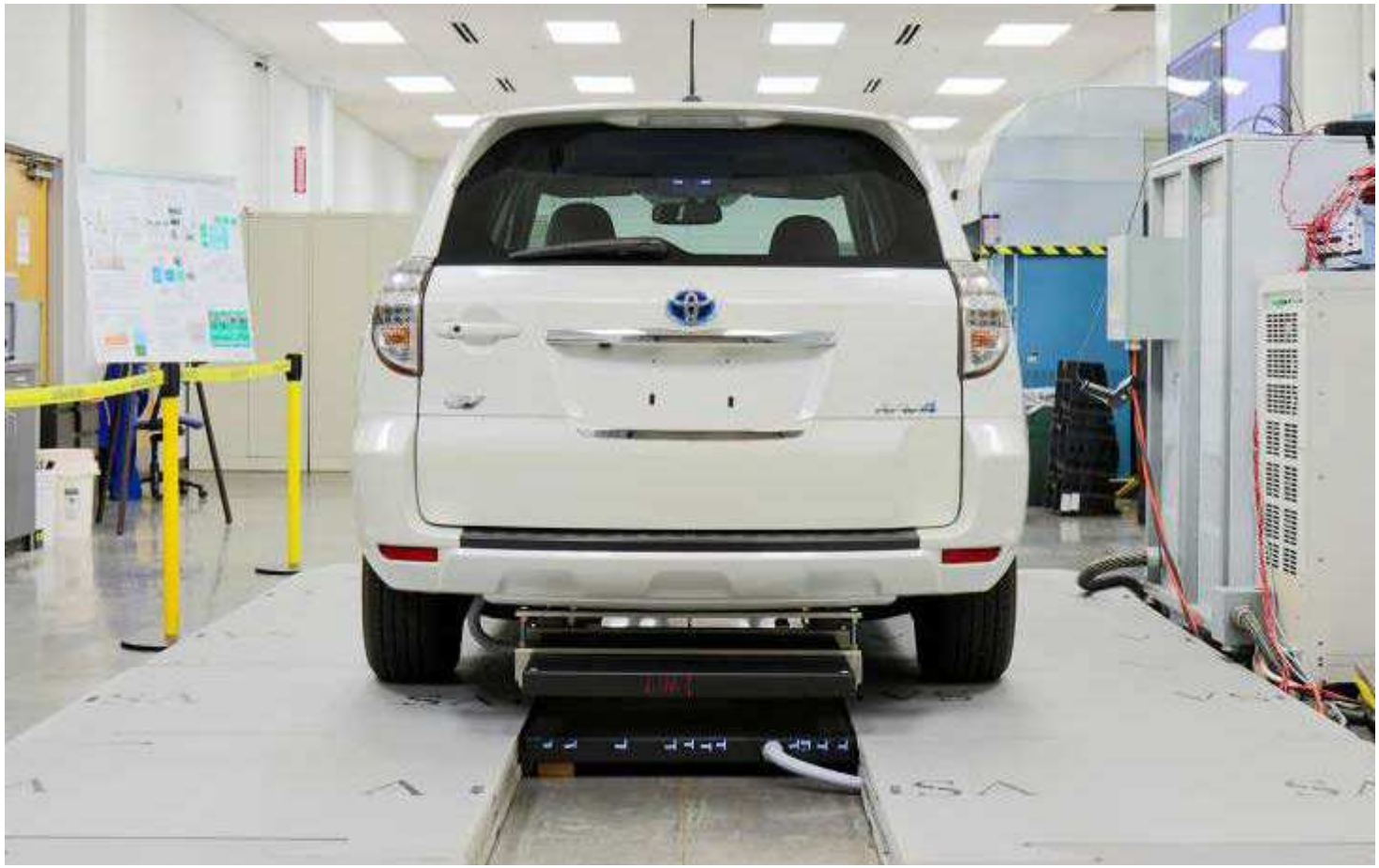

User
Vehicle system
On board Energy Storage
ICT Connection
Assisted approach
ICT Connection
Renewable energy sources
Battery End of Life
Battery booster
Charging station
Microgrid
Electricity supply network
E-Mobility Management


User
Vehicle system
On board Energy Storage
ICT Connection
Assisted approach
ICT Connection
Static
Stationary
Dynamic
Wireless Power source
Microgrid
Electricity supply network
E-Mobility Management

## An example of application of the Magnetic Field Wireless Power Transfer


M ZN 4643

**Formula E Safety car equipped with MF WPT system for battery charging**



**20 kW Wireless Charging at D.O.E. Oak Ridge National Laboratory, U.S.**


Image source: Evatran

# CAPILLARITA'


PARCHEGGI

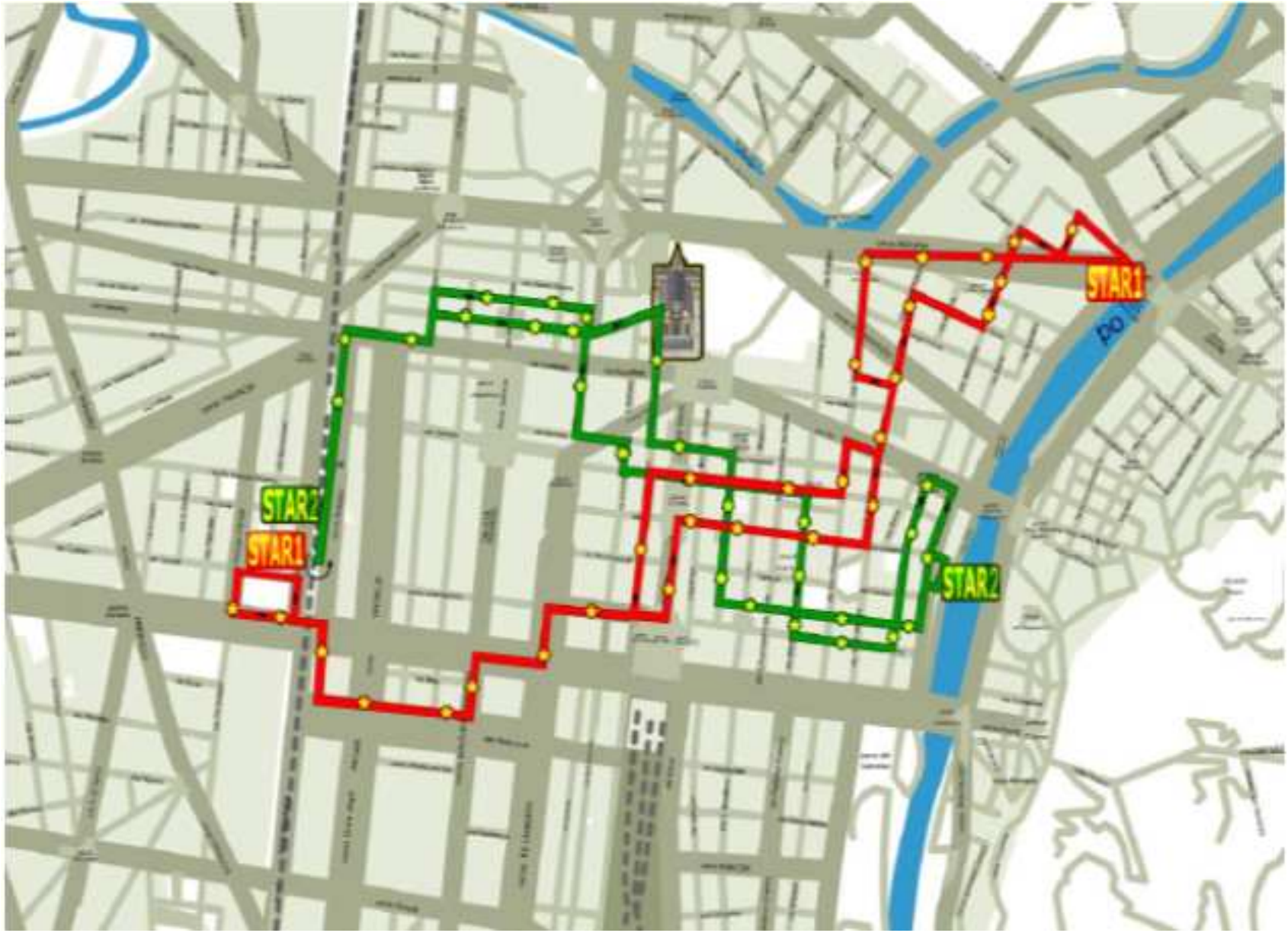
UFFICI PUBBLICI

SITI TURISTICI

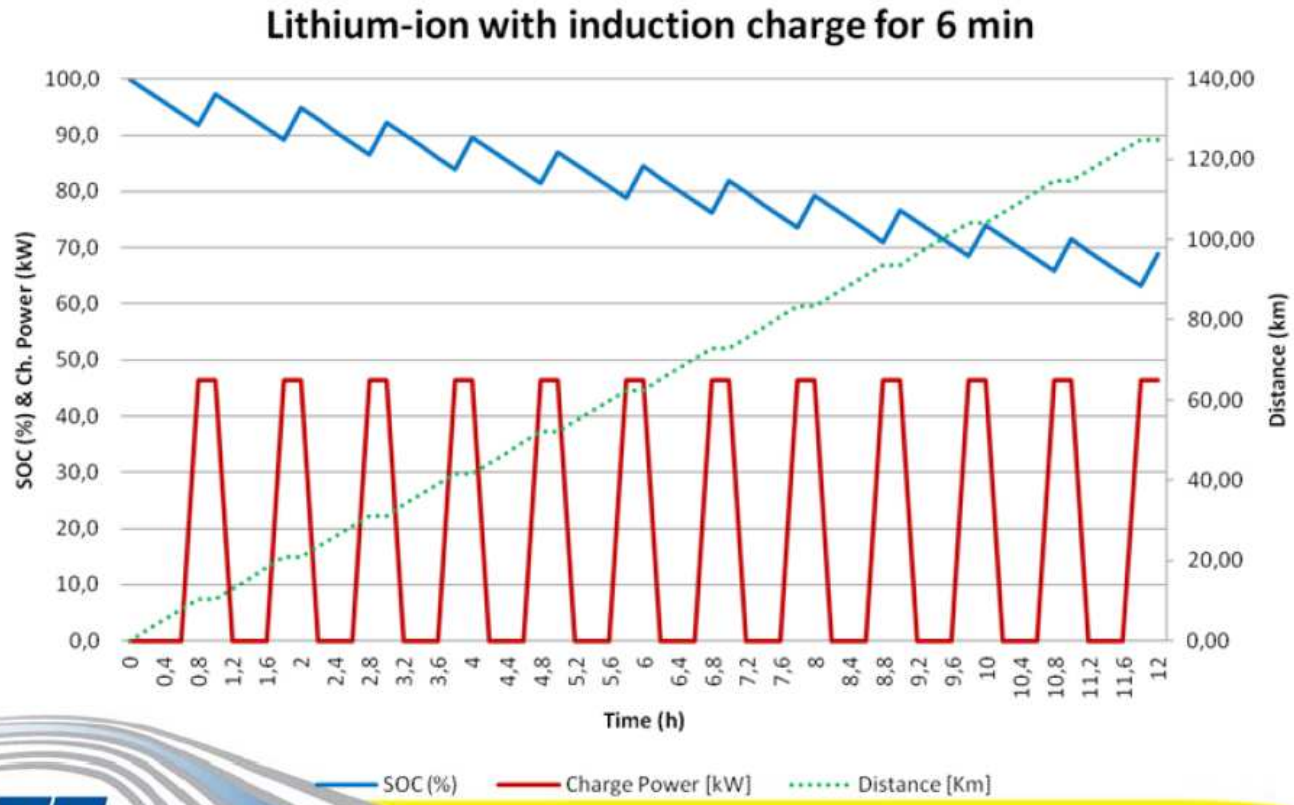

UNIVERSITA'


GRUPPO TORINESE TRASPORTI

# GTT bus lines operated with wireless charging in Torino



# Autonomia con Biberonaggio




GRUPPO TORINESE TRASPORTI

# RICARICA INDUTTIVA


# AVVOLGIMENTO DEL PICKUP




GTT
GRUPPO TORINESE TRASPORTI

## International Standards related to Wireless Power Transfer technology

**ISO 19363** (scheduled for 10-2016) Electrically propelled road vehicles – Magnetic field Power Transfer – Interoperability and Safety requirements

**IEC 61980** Electric vehicle wireless power transfer (WPT) systems

- Part 1: General requirements
- Part 2: Specific requirements for communication EV and infrastructure
- Part 3: Specific requirements for the magnetic field power transfer systems

**ISO/IEC 15118** (scheduled for 10-2016) Road vehicle to grid communication interface

- Part 6: General information and use-case definition for wireless communication
- Part 7: Network and application protocol requirements for wireless communication
- Part 8: Physical layer and data link layer requirements for wireless communication

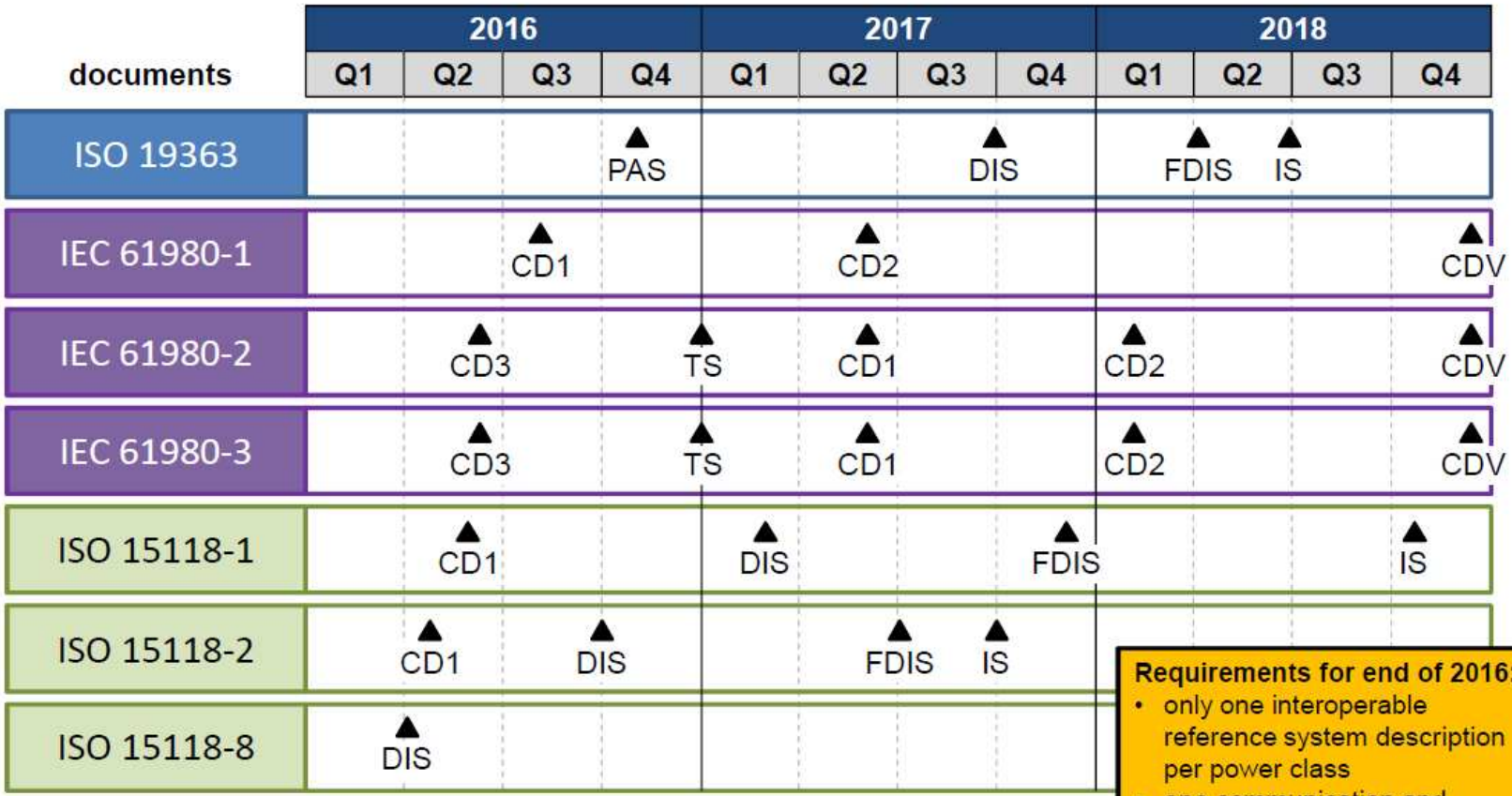
**SAE J2954** Wireless Charging of Electric and Plug-in Hybrid Vehicles (Guideline scheduled for 06/2014)

**SAE J2836/6 J2847/6 J2931/6** Communication for inductive charging (Guideline scheduled for 06/2014)

**SAE J1773** Electric Vehicle Inductively Coupled Charging (published as recommended practice)

**UL 2750** Wireless EV charging

# Proposal for timeline of ISO19363



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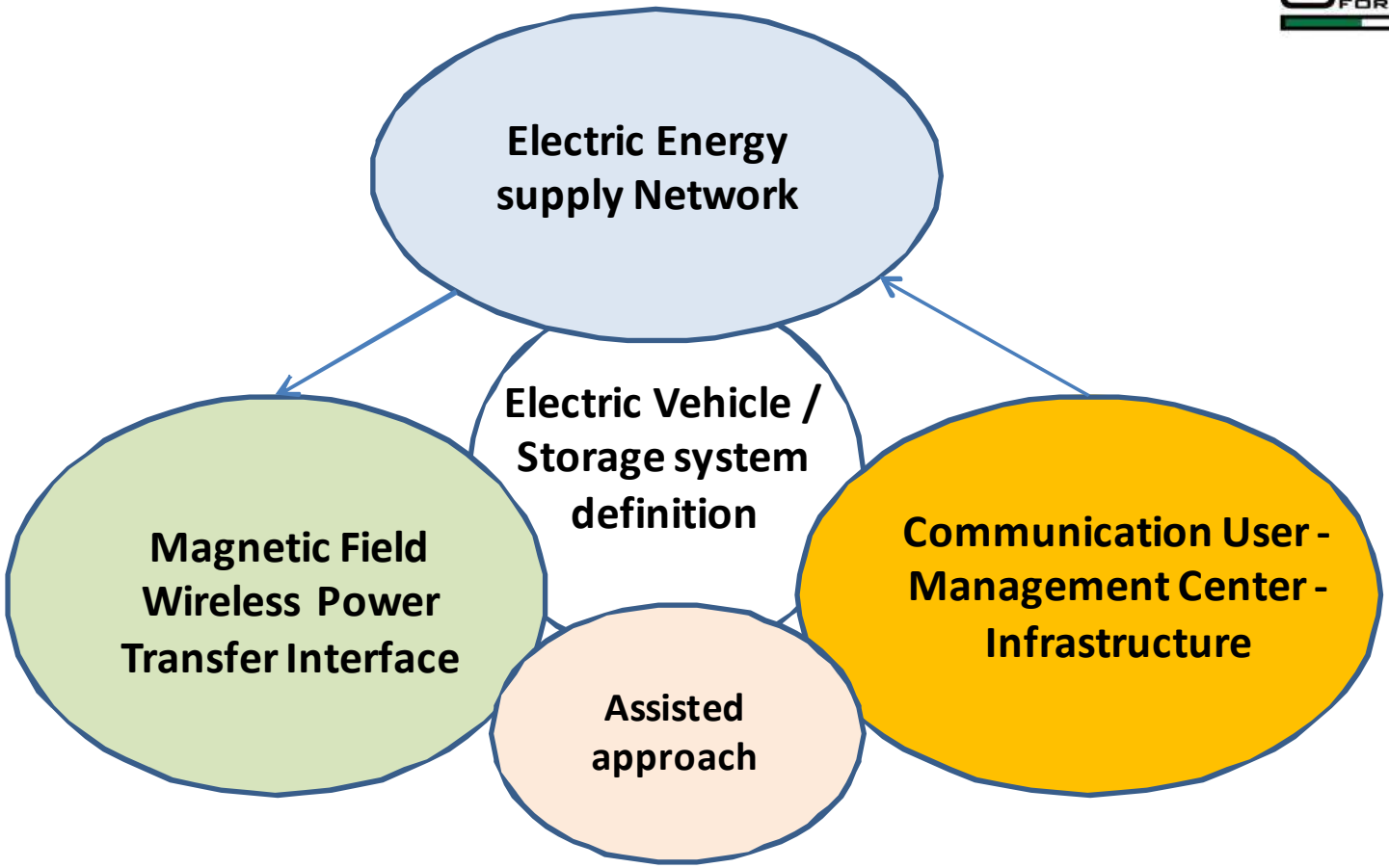


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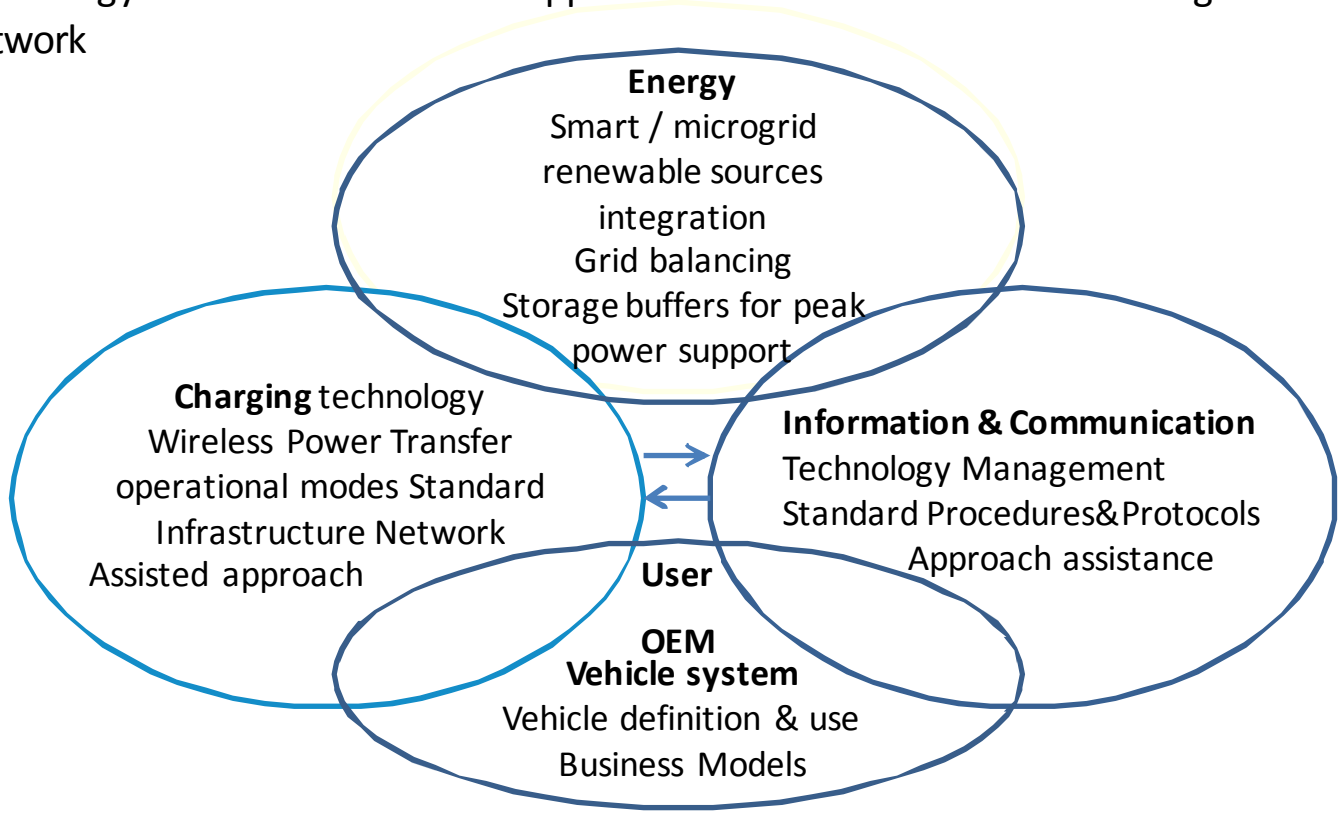
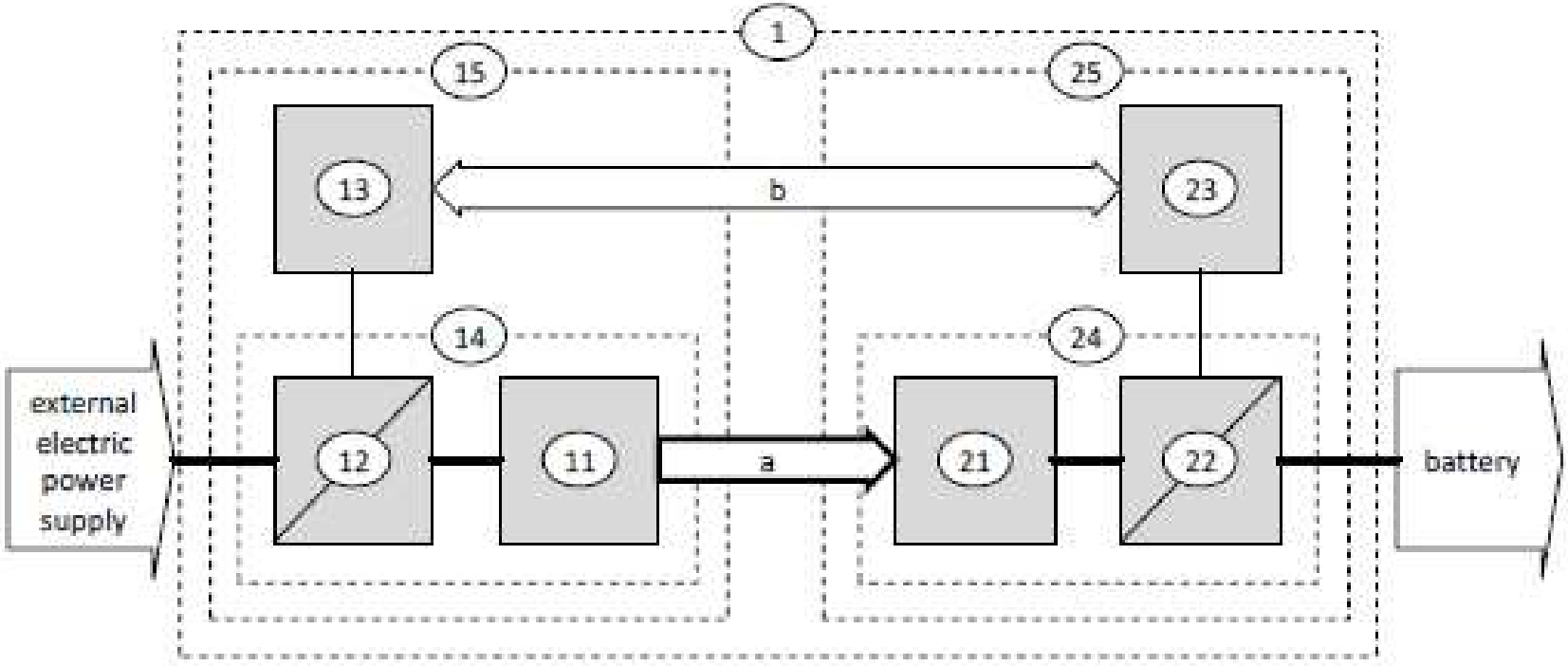


# Designing a Wireless Power Transfer system for a car of Formula Electric Italy

# Engineering design on a Magnetic Field Wireless Power Transfer system

Structure of MF-WPT system (from ISO PAS 19363)




1 MF-WPT system a MF-WPT b communication

11. Primary device (off board)
12. Off-board power components
13. Supply equipment communication controller
14. EV supply equipment
15. Supply device

21 Secondary device
22. On board power components
23. EV communication controller
24. MF-WPT vehicle power circuit
25. Electric Vehcle device

# Standards ISO, IEC, SAE, UL on wireless charging (source VDA)

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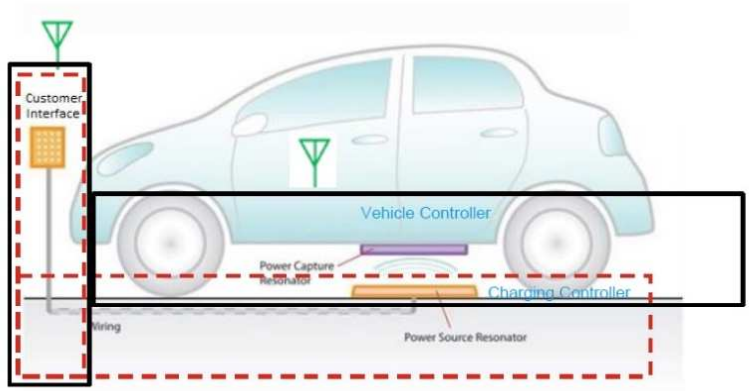


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MOU Between SAE and UL

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* Available from the SAE website since May 31

ISO PAS 19363** Magnetic Field Wireless Power Transfer – Interoperability and Safety requirements

**Expected availability by End 2016

Source: presentation at IA-HEV TASK 26 Workshop of IEA, by A.Amditis, G. Brusaglino, Rotterdam, 28-29 June 2016


Demonstration of Wireless Power Transfer at IEA workshop in Rotterdam on 29 July 2016


Demonstration of Wireless Power Transfer at IEA workshop in Rotterdam on 29 July 2016


opladen
elektrische
auto's
75-ZSB-7
79-PXG-7


P
opladen
elektrische
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75-ZSB-7
79-PXG-7

# Thank you for your attention!

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