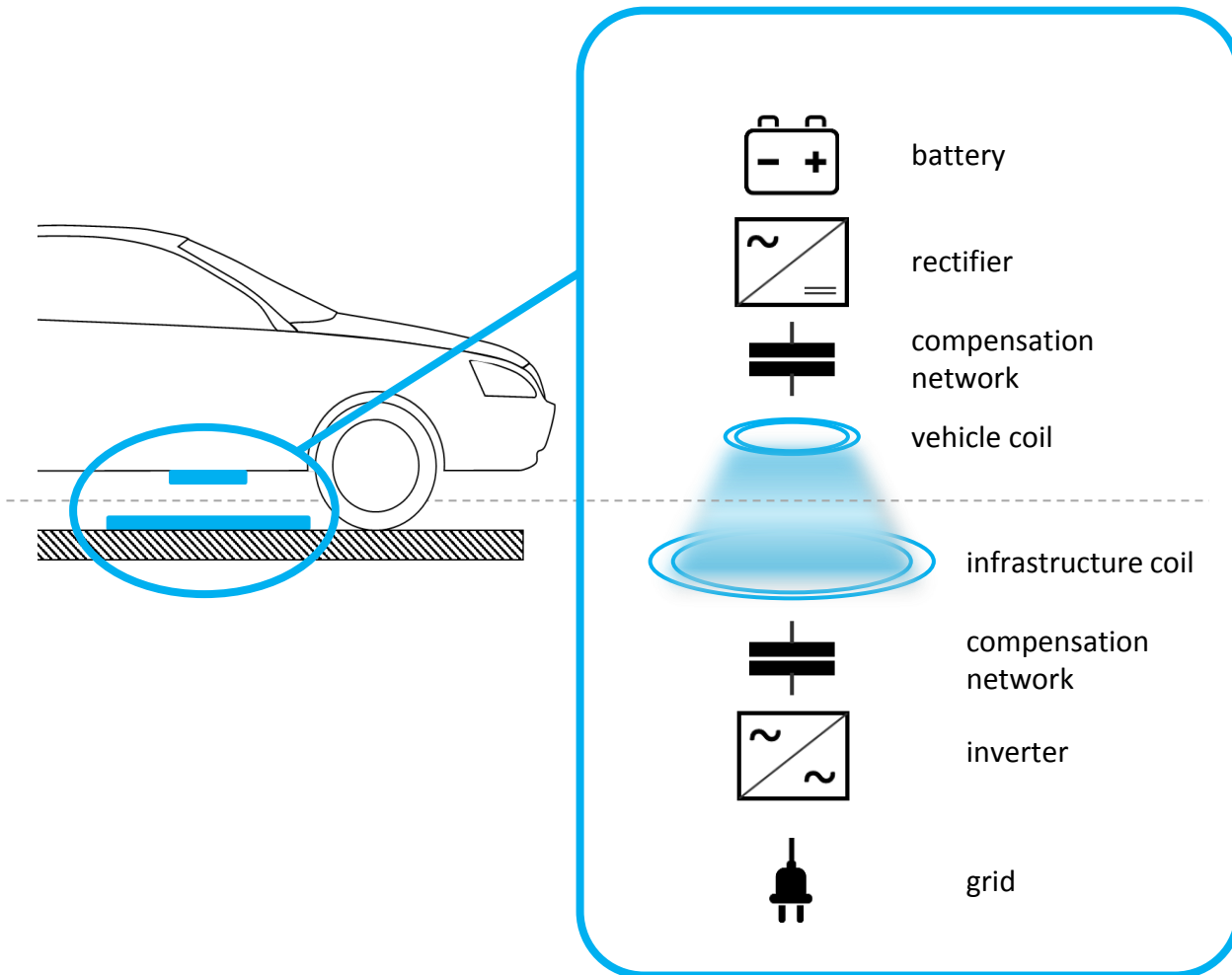


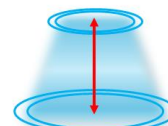
# Functioning principle of inductive charging systems for electric vehicles



## Core functions

- Transfer of power via magnetic field to charge the vehicle battery
- Power gets transferred at 85kHz over an air gap
- Efficiency of power transfer ~85 – 90 %
- Control of power transfer via WiFi communication

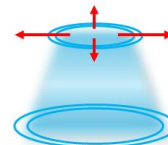
### COIL DISTANCE



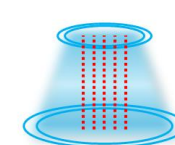
### COMMUNICATION



### POSITION TOLERANCE



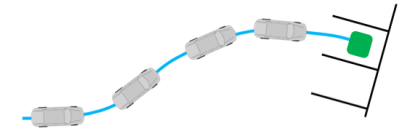
### POWER AND EFFICIENCY



## Auxiliary functions

Supporting functions beyond power transfer to ensure safe system operation.

### POSITIONING



### LIVING OBJECT PROTECTION



### FOREIGN OBJECT DETECTION

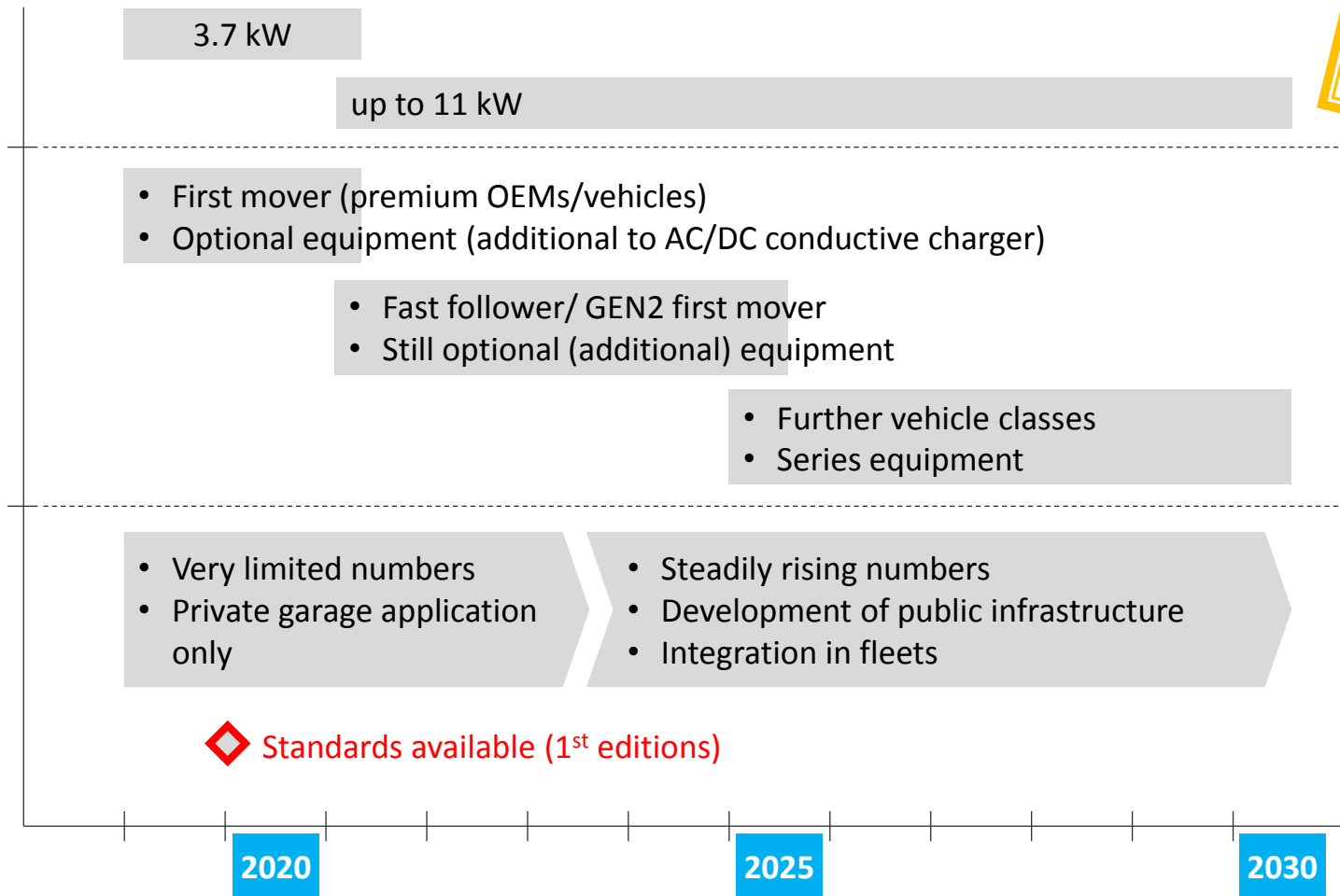


# Status of technology deployment and potential future scenarios

POWER LEVELS

INDUCTIVE CHARGING SYSTEM GENERATIONS

MARKET DEPLOYMENT









*General assumptions on potential technology deployment*

## Prospect (after 2030)

- **Semi dynamic** inductive charging; e.g lanes at traffic lights or taxi-lanes
- **Higher power (22kW)**; power currently limited due to available package space
- **Bi-directional charging**; investigations of technological feasibility and implementation started

# Key standardization activities

#	IS pub *	title	focus
IEC 61980-1	2019/20 (edition 2)	<i>Electric vehicle wireless power transfer (WPT) systems Part 1: general requirements</i>	
IEC 61980-2	2019/20	<i>Part 2: Specific requirements for communication between electric road vehicle (EV) and infrastructure with respect to wireless power transfer (WPT) systems</i>	
IEC 61980-3	2019/20	<i>Part 3: Specific requirements for the magnetic field wireless power transfer systems</i>	
ISO 19363	2019	<i>Electrically propelled road vehicles – Magnetic field wireless power transfer – safety and interoperability requirements</i>	
ISO/IEC 15118	2020 (edition 2)	<i>Road vehicles – vehicle to grid communication interface</i>	
SAE J2954	2019	<i>Wireless charging of electric and plug-in hybrid vehicles</i>	

\* Planned publication of next IS according to current timelines

# Potential hazards of inductive charging systems

## ELECTRIC SHOCK

Common electric hazard related to the usage of electrical equipment.



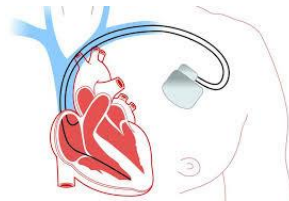
*Not further detailed in this presentation since covered by several existing standards (which are referenced in the inductive charging standards).*

## EXPOSURE TO ELECTROMAGNETIC FIELD / DISTURBANCE OF MEDICAL IMPLANTS

Heating of tissue or nerve stimulation due to exposure to electromagnetic field.



Impacts on functionality of medical implants (e.g. pacemakers) due to potentially induced voltages.



## OVERHEATING/ IGNITION OF OBJECTS

Objects exposed to the magnetic field heat up and can cause touch hazards. Heated objects might cause fire in combination with flammable material.



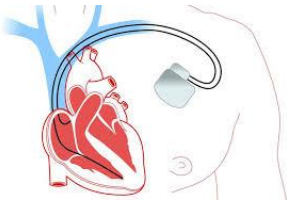
# Protection mechanisms and related inductive charging standards (1/2)

## EXPOSURE TO ELECTROMAGNETIC FIELD / DISTURBANCE OF MEDICAL IMPLANTS

Heating of tissue or nerve stimulation due to exposure to electromagnetic field.



Impacts on functionality of medical implants (e.g. pacemakers).



- ICNIRP Guidelines recommend maximum field strength as exposure limits for humans.
- These limits are applied in the standards for inductive charging systems: Persons may not be exposed to fields above the limits of ICNIRP Guidelines.
- This is either achieved
  - by keeping the field strength below the limits (limited transferrable power) or
  - by detecting a (part of a) body in areas where the field strength is above the limits.
- ISO14117 describes maximum field strengths to protect the functionality of medical devices.
- Also these limits are applied in the standards for inductive charging systems.
- Intense discussions on appropriate testing methods are currently ongoing between the experts of ISO14117 and the relevant inductive charging standards.

## *inductive charging standards covering/ developing the requirements*

IEC 61980-3

ISO 19363

SAE J2954

# Protection mechanisms and related inductive charging standards (2/2)

## OVERHEATING/ IGNITION OF OBJECTS

Objects exposed to the magnetic field heat up and cause touch hazards. Heated objects can cause fire in combination with flammable material.



- Maximum permissible surface temperatures are specified in existing standards.
- The inductive charging standards describe the specific requirements by determining appropriate test objects and test procedures.
- Protection mechanisms are
  - either to ensure, that objects do not heat up above the permissible temperatures by system design (limited field strength)
  - or to detect the objects before they heat up before the exceed the permissible temperatures.

*inductive charging standards covering/ developing the requirements*

IEC 61980-3

SAE J2954