NATIONALE PLATTFORM ELEKTROMOBILITÄT

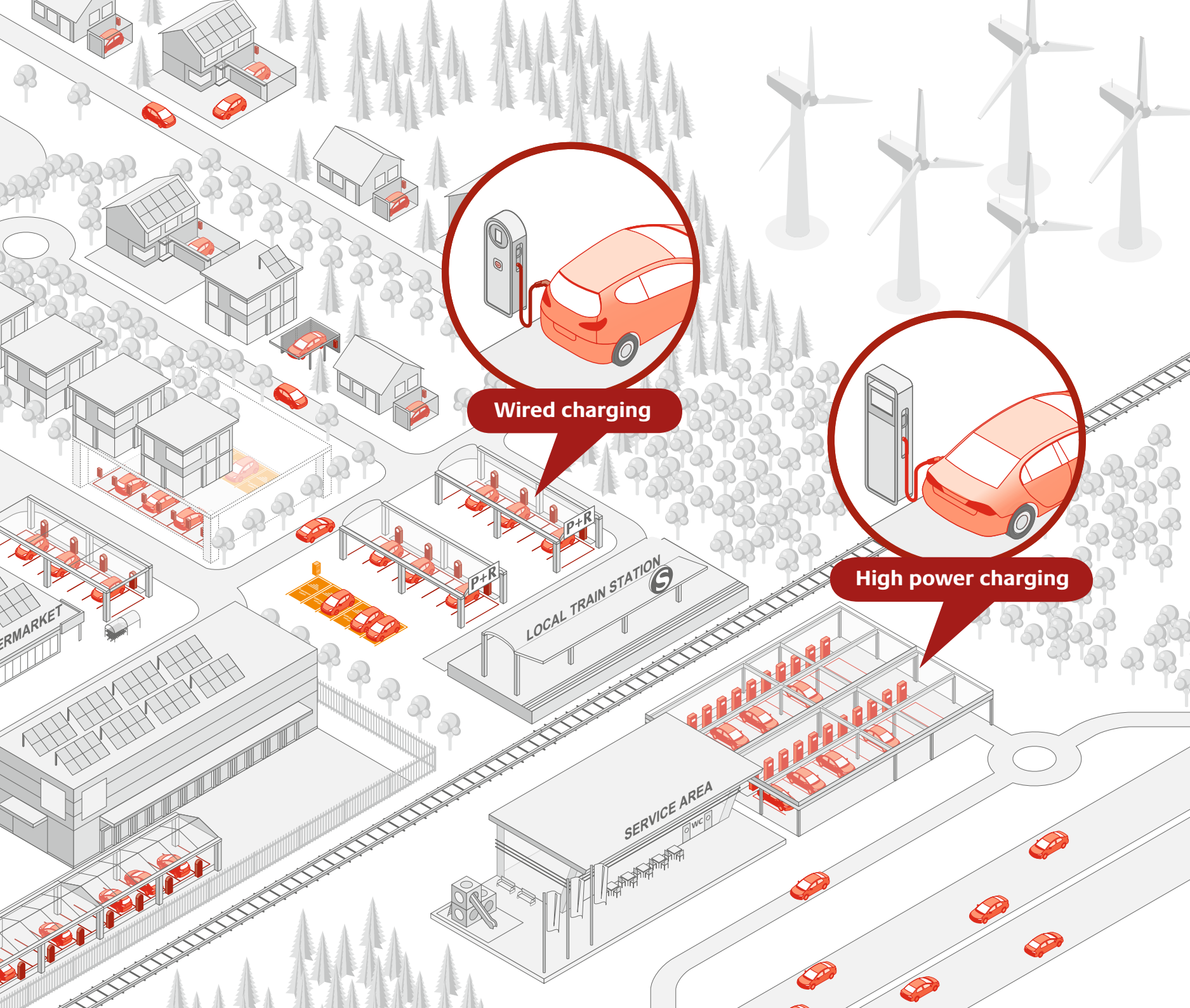
The German Standardisation Roadmap Electric Mobility 2020

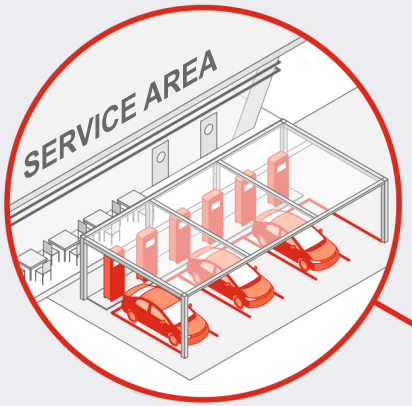
WG 4 – Standardisation and Certification

NATIONALE PLATTFORM ELEKTROMOBILITÄT

The German Standardisation Roadmap Electric Mobility 2020


UNIVERSITY
P
Kabelloses Laden
Wireless charging
Information and communications technology
ICT


Wired charging
High power charging
P+R
P+R
LOCAL TRAIN STATION
S
SERVICE AREA
wc
ERMARKET

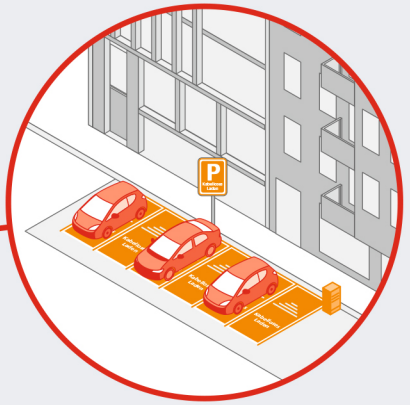


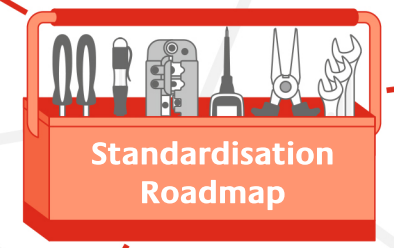
Wired charging:

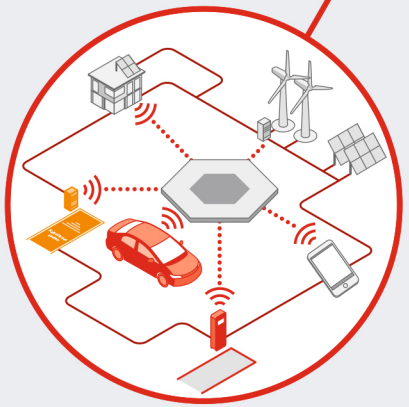
- Funding and needs-based establishment of a charging infrastructure for capacities from 150 kW to 400 kW
- Higher charging capacities should be used by future electric vehicles and provided by future charging infrastructure

Wireless charging

- Start preparatory actions to ensure the availability of a public wireless charging infrastructure by 2020
- Aiming at a market launch of vehicles with interoperable inductive charging technology by 2020







Information and communications technology

- Create consistent roaming platforms and establish internationally networked mobility services with open communication interfaces
- Create a uniform ID-allocation structure throughout Europe

» With a view to the mass market, we need to embed the categories considered in the NPE Vision 2020 into a user-orientated overall system. This includes automotive engineering as well as charging infrastructure, energy and environmental issues and urban planning aspects. For this, the German Standardisation Roadmap Electric Mobility 2020 provides the necessary **tools**. The Electric Mobility Act and the German Charging Station Provision established the necessary legal framework for electric mobility in Germany. A Federal Government funding programme supporting the expansion of charging infrastructure and the general expansion of electric mobility in Germany took effect in 2016. Now, we face the challenge of bringing the familiar fields of action to a successful conclusion. «

Prof. Henning Kagermann | President of acatech – National Academy of Science and Engineering | Chairman of the German National Platform for Electric Mobility NPE

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1
Introduction

Standards and specifications are indispensable for a successful market ramp-up of electric mobility. For: Consistent standards connect the world! They ensure safety and quality, thus fostering the users' confidence. They create security for investments and foster economic viability. Standards form the basis of a global, self-sustaining market. Hence, the strategic orientation and promotion of standardisation is central to the work of the German National Platform for Electric Mobility (NPE).

The NPE's objective is to connect those sectors most important for electric mobility as closely as possible. Only if experts from the fields of automotive engineering, electrical engineering, energy technology and information and communications technology work together, electric mobility can succeed in the long term.

The NPE's standardisation strategy for electric mobility is the result of the cooperation of such experts in Working Group 4 "Standardisation and Certification". The strategy is introduced in the present German Standardisation Roadmap Electric Mobility 2020.

The Standardisation Roadmap provides a comprehensive overview of completed, ongoing and future standardisation activities in the field of electric mobility. The time frame is set by the three stages Market preparation (until 2014), Market ramp-up (until 2017) and Mass market (until 2020). In line with the guiding principle "Consistent standards connect the world", the Standardisation Roadmap invariably examines both national and international standardisation activities.

This fourth edition of the Standardisation Roadmap continues the previous editions. The introduction to national and international standardisation efforts (chapter 2) is followed by a presentation of the advances in standardisation and of intended activities in the fields of "General requirements", "Automotive engineering" and "Charging interface" (chapter 3). The visions Working Group 4 has elaborated for each of these fields can equally be found in Chapter 3.

This overview is followed by a closer examination of a few central topics. Firstly, the already completed basic standardisation of wired charging is described (chapter 4). The focus, however, is on the following chapter (chapter 5), dedicated to the focal points of future standardisation efforts: "High power charging", "Wireless charging of electric vehicles" and "Information and communications technology". For these fields of action, the paper does not only present the completed, ongoing and future standardisation activities but also gives specific recommendations.

With view to the integration of electric vehicles into the Smart Grid, to the use of value-added services and to the personal data involved during the charging and billing processes, electric mobility needs to consider questions of IT-security – both on the vehicle and the infrastructure side. However, since IT-security issues are not specific to the electric mobility sector, they are not discussed in this Standardisation Roadmap. They are examined in other publications, e. g. the DIN-DKE Roadmap "IT-Security".

With the German Standardisation Roadmap Electric Mobility 2020, the NPE outlines visions, presents specific standardisation results and gives clear recommendations to decision-makers in industry and politics. Depending on the target group, the roadmap can be used in many ways: as operational planning basis, as strategic reference, as basis for action planning or as a general information document.

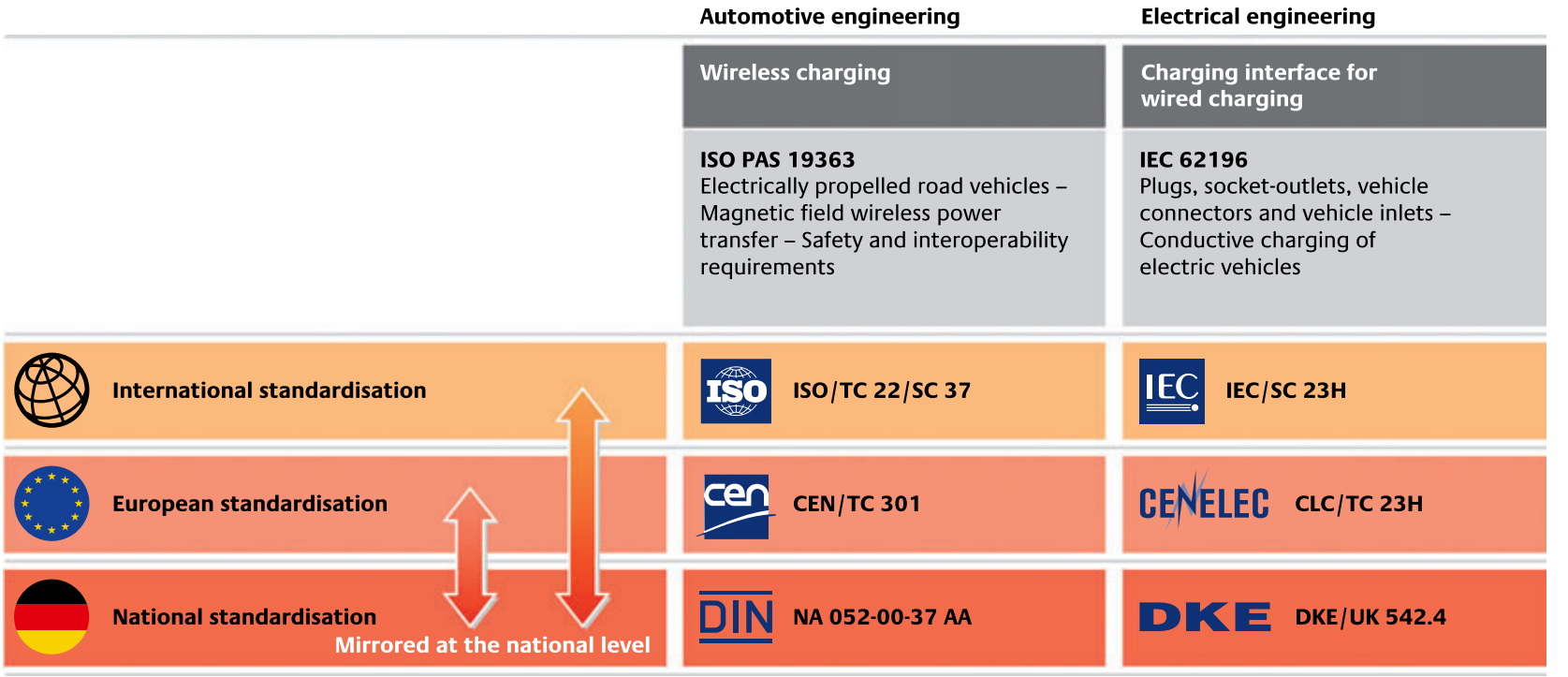
2
Overview of national and international standardisation activities

Electric mobility

cannot be successful unless it is internationally

standardised.

National and international standardisation activities – the example of two specific standardisation projects



Standards are the result of the work of different organisations at the international, European and national level, organised according to the principle of national delegation. Frequently, international and European standards are incorporated into German norms. As soon as they are mentioned in a regulation or law, they acquire legal force.

The figure shows two cases exemplifying how the delegation principle is used to devise standardisation. By ensuring that all stakeholders are duly involved, this principle bases international standardisation efforts on wide-ranging expertise. Thus, global standards can be consensually coordinated on a broad scale.

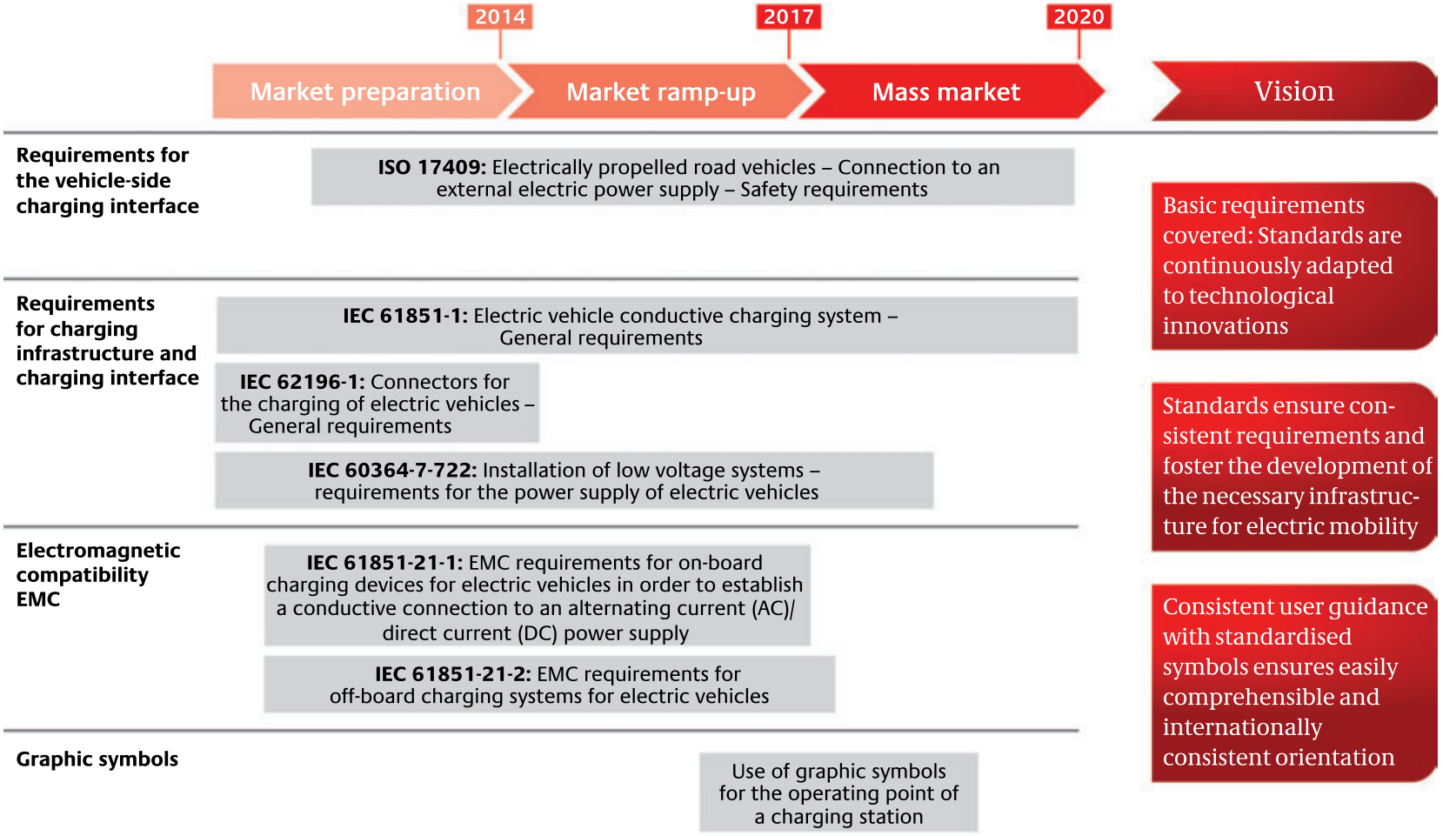
The first example relates to the wireless charging of electric vehicles. The international project selected for the example, ISO PAS 19363, describes the on board part of the charging system, the specific safety requirements in the vehicle, and the vehicle-side charging requirements. Since it is an international project, the International Organization for Standardization (ISO) is managing the entire operating process. The responsible committee is ISO/TC 22/SC 37. A European edition is planned for this project, for which committee TC 301 of the European Committee for Standardisation (CEN) will be responsible at the European level. The German interests are pooled in the German Institute for Standardisation (DIN)'s relevant mirror committee, NA 052-00-37 AA. This body is also responsible for delegating the German experts to the bodies of the CEN and the ISO.

The second example illustrates the efforts of the standardisation organisations in the field of electrical engineering. For this purpose, the series of standards IEC 62196 was chosen, which specifies the connector systems for wired charging. This standard is dealt with by the Panel IEC/SC 23H at the international level and by the Subcommittee CLC/TC 23H at the European level. As the figure shows, the international work is here mirrored by the committees of the DKE/UK 542.4.

3
Standardisation roadmaps and visions for basic elements of electric mobility

Standards mean
safety, quality
and **resource** efficiency.

General requirements



The main focus of the roadmap as regards **general requirements** is electric safety, as can be seen in the figure opposite. The vehicle-side safety requirements for the connection to an off-board power supply are defined in ISO 17409. The first version of this norm was already published in late 2015. The standard is to be evolved continually until 2020, in order to adapt it to the technical innovations. A first version of standard IEC 61851-1, which describes general requirements for wired charging systems, was completed as early as 2002. This standard is likewise continually adapted to technological innovations. The general requirements for connector systems for the charging of electric vehicles are laid down in IEC 62196-1.

The requirements for the electromagnetic compatibility (EMC) of charging units installed in electric vehicles are set forth in IEC 61851-21-1. Part 2, i.e. IEC 61851-21-2, describes these requirements for charging units operated outside the vehicle. Both standards determine the tests to be performed under defined charging conditions and regulate the requirements for interference immunity and interfering emissions. From today's point of view, the standardisation of the EMC requirements is largely completed. There are, however, further general basic standards of EMC to be considered.

Requirements for the connection of charging stations to the electrical distribution grid are specified in IEC 60364-7-722 "Installation of low-voltage systems". A first edition of this international standard, important for the secure connection of charging stations, was already published in 2014 and was incorporated into the German standard DIN VDE 0100-722 (VDE 0100-722).

Graphic symbols are used for e. g.:

- **User interface;**
- **Human-machine interaction;**
- **Safety labelling.**

Graphic symbols are standardised by various committees. With regard to vehicles, the WG 5 of ISO / TC 22 / SC 13 is prominent at the international level. The IEC, too, has various bodies committed to the standardisation of electrotechnical symbols. In Germany, these efforts are mirrored by the German Commission for Electrical, Electronic & Information Technologies (DKE) and the DIN standards committee for automotive engineering. At the European level, the European Commission issued mandate M / 533, assigning the identification of charging stations to CEN and CENELEC. Here, CEN / TC 301, in close cooperation with the international level, will take action in the coming years.

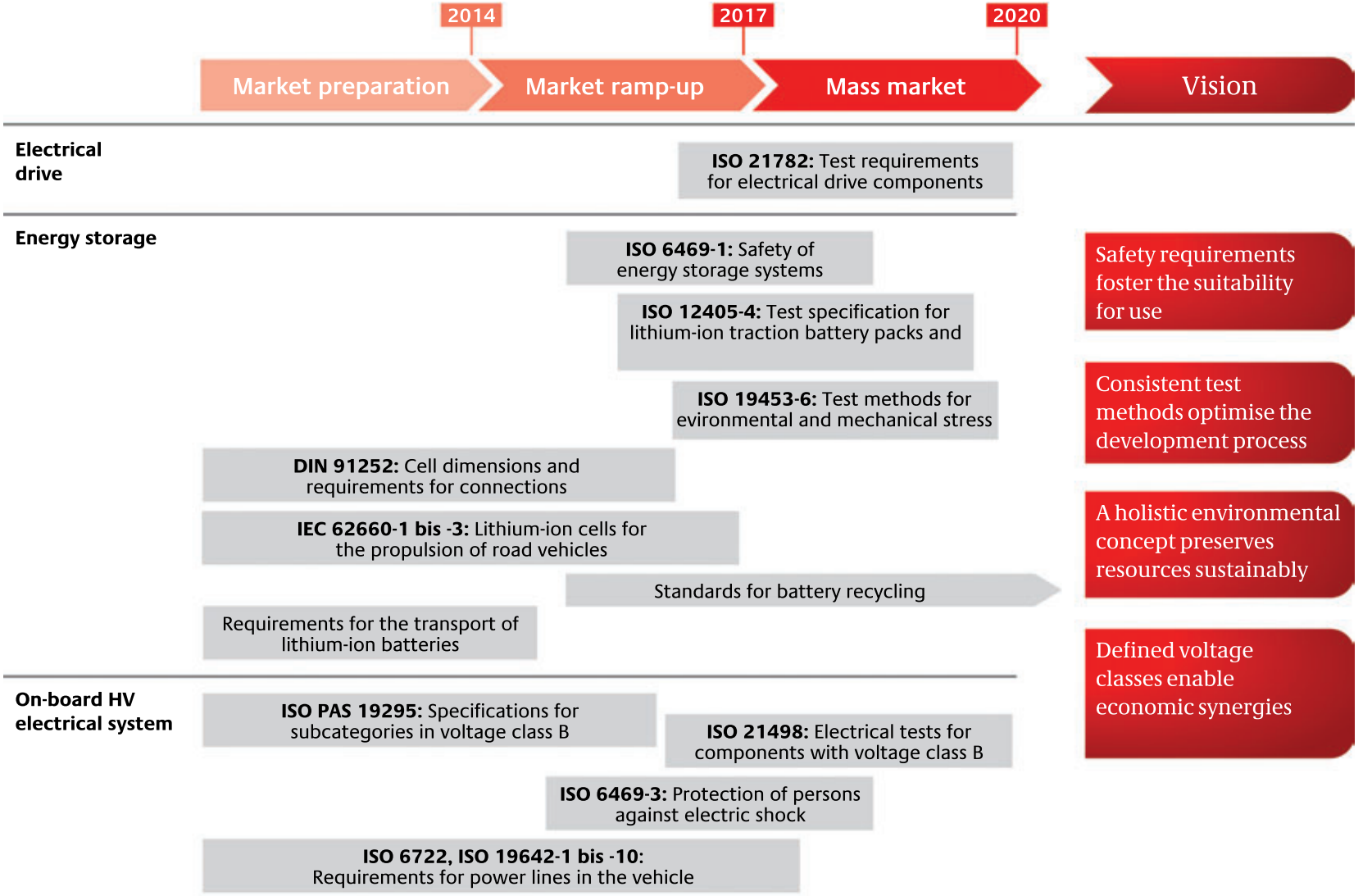
Vision:

- **Basic requirements covered: Standards are continuously adapted to technological innovations**
- **Standards ensure consistent requirements and foster the development of the necessary infrastructure for electric mobility**
- **Consistent user guidance with standardised symbols ensures easily comprehensible and internationally consistent orientation**

Further information on this topic can be found here:

www.din.de/en/innovation-and-research/electromobility

Automotive engineering



The Roadmap for Standardisation in **automotive engineering** supports the development of safe and user-friendly vehicles.

Electrical safety is also the main focus in automotive engineering. Although the use of electric motors is known from other branches of industry, specific requirements will have to be defined for the use of electric motors for vehicle propulsion. These experiences will be included in ISO 21782, which will specify the requirements for the electrical drive train's power electronics and on-board DC / DC converter.

Battery systems and cells are a further focus. Many vehicle manufacturers resort to the lithium-ion technology for the drive train. Parts 1 and 2 of ISO 12405, published in 2011, set forth consistent tests to assess the performance and lifetime of such battery systems according to their application area in the electric vehicle. In 2013, part 3 ("Safety Tests") was added to this series of standards. At the same time, the corresponding series of standards IEC 62660 for the requirements and tests at cell level was elaborated.

While drafting a second edition for this series of standards, the experts decided in ISO TC 22 / SC 37 to restructure the standards regarding electrical energy storage systems. Hence, all safety requirements for rechargeable energy storage devices for electric vehicles will be pooled in standard ISO 6469-1, independent of the battery chemistry or application field. Works on the now third edition of this standard are to be completed by 2018 at the latest. Standards ISO 12405-1 and -2 are replaced by ISO 12405-4. The new project ISO 19453-6 is to be completed without delay. The known test methods must be adapted to the high weight and the considerably larger dimensions of the future battery systems for traction generation. DIN 91252 was developed with the aim of reducing the costs of battery cells.

It contains a list of the lithium-ion cell sizes used by the vehicle industry and specifies the position and strength of the connections. In order to ensure sustainability, standards for the resource-efficient recycling of battery systems are required.

Electrical safety requirements for the on-board high-voltage electrical system are specified in ISO 6469-3. This standard describes measures and tests for the protection of persons against electric shock. The third edition is currently being elaborated. This includes adapting the safety requirements more closely to the subclasses of voltage class B (on-board HV electric system) now defined in ISO PAS 19295. Project ISO 21498 launched a standardisation process laying down requirements for the components of the on-board HV electric system and describing the necessary tests. Requirements for the electric lines in the on-board HV electric system are specified in the series of standards ISO 6722 and ISO 19642.

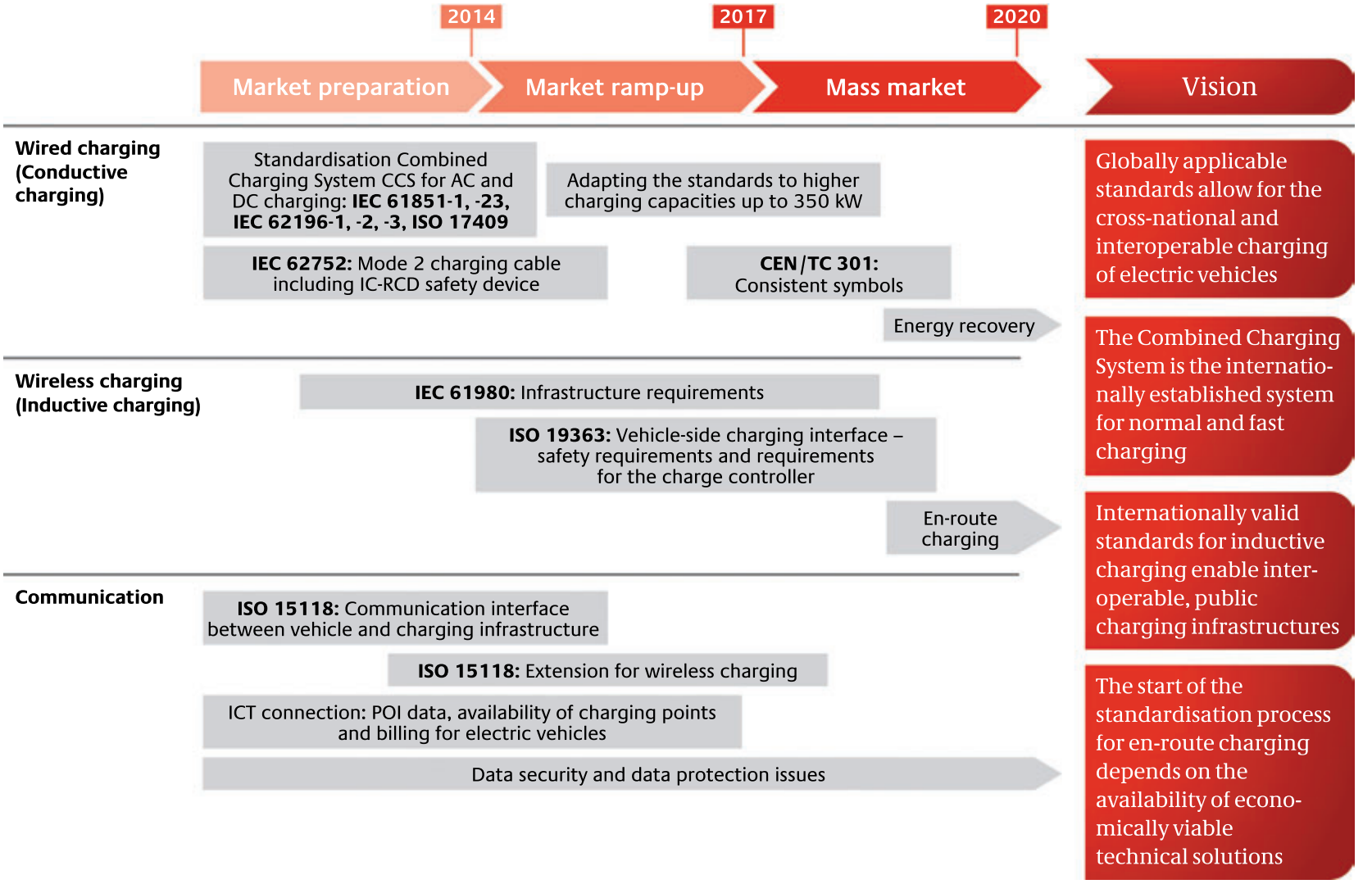
Vision:

- **Safety requirements foster the suitability for use**
- **Consistent test methods optimise the development process**
- **A holistic environmental concept preserves resources sustainably**
- **Defined voltage classes enable economic synergies**

Further information on this topic can be found here:

www.din.de/en/innovation-and-research/electromobility

Charging Interface



The customer has different, standardised charging options at his command. The according standardisation activities are presented in the roadmap for the **charging interface** on the opposite page. The roadmap shows the progress and future standardisation activities in the field of wired and wireless charging and in the area of communication between electric vehicle and charging infrastructure. For wired charging, the NPE recommends the Combined Charging System CCS, which basically comprehends AC charging, DC charging and the respective communication interface between the electric vehicle and the charging station.

The standardisation of the CCS connector systems and communication has already been concluded. It has been laid down as a minimum standard in the EU Directive 2014/94/EU on the installation of charging infrastructure.

The requirements for charging cables for mode 2 charging are described in IEC 62752.

In order to further shorten the duration of the charging process, especially with regard to the vehicle's long-distance cruising ability, the existing standards are being adjusted. The power spectrum for wired charging is to be expanded to 400 kW. The according roadmap and a more detailed description of the standardisation work for high power charging can be found on page 28. The according symbols for the charging stations are standardised by CEN/TC 301, ensuring an easily comprehensible, customer-orientated labelling.

The standardisation work for wireless charging was already started in the market preparation phase. Technical specifications, which will include the choice of the technology to be used for inductive charging, will be available in late 2017. They will be incorporated into the series of standards IEC 61980 and the ISO 19363. Further information can be found in the chapter on "Wireless Charging" on page 32.

The communication between charging infrastructure and vehicle is covered by ISO 15118. As far as wired charging is concerned, the according standardisation activities have been finalised, paving the way for the creation of a mass market. The field of wired charging is dealt with in ISO 15118, which is currently being refined.

Standardisation activities for the backfeeding of energy into the grid are in preparation. En-route wireless charging is still at the research stage. Standardisation works will be taken up as soon as the development has progressed towards marketable technical solutions.

Vision:

- **Globally applicable standards allow for the cross-national and interoperable charging of electric vehicles**
- **The Combined Charging System is the internationally established system for normal and fast charging**
- **Internationally valid standards for inductive charging enable interoperable, public charging infrastructures**
- **The start of the standardisation process for en-route charging depends on the availability of economically viable technical solutions**

Further information on this topic can be found here:

www.din.de/en/innovation-and-research/electromobility

4
Overview of the standardisation efforts in the field of wired charging of electric vehicles

Standards open up the market.
They ensure **interoperability**
and create
security for investments.

Wired charging of electric vehicles

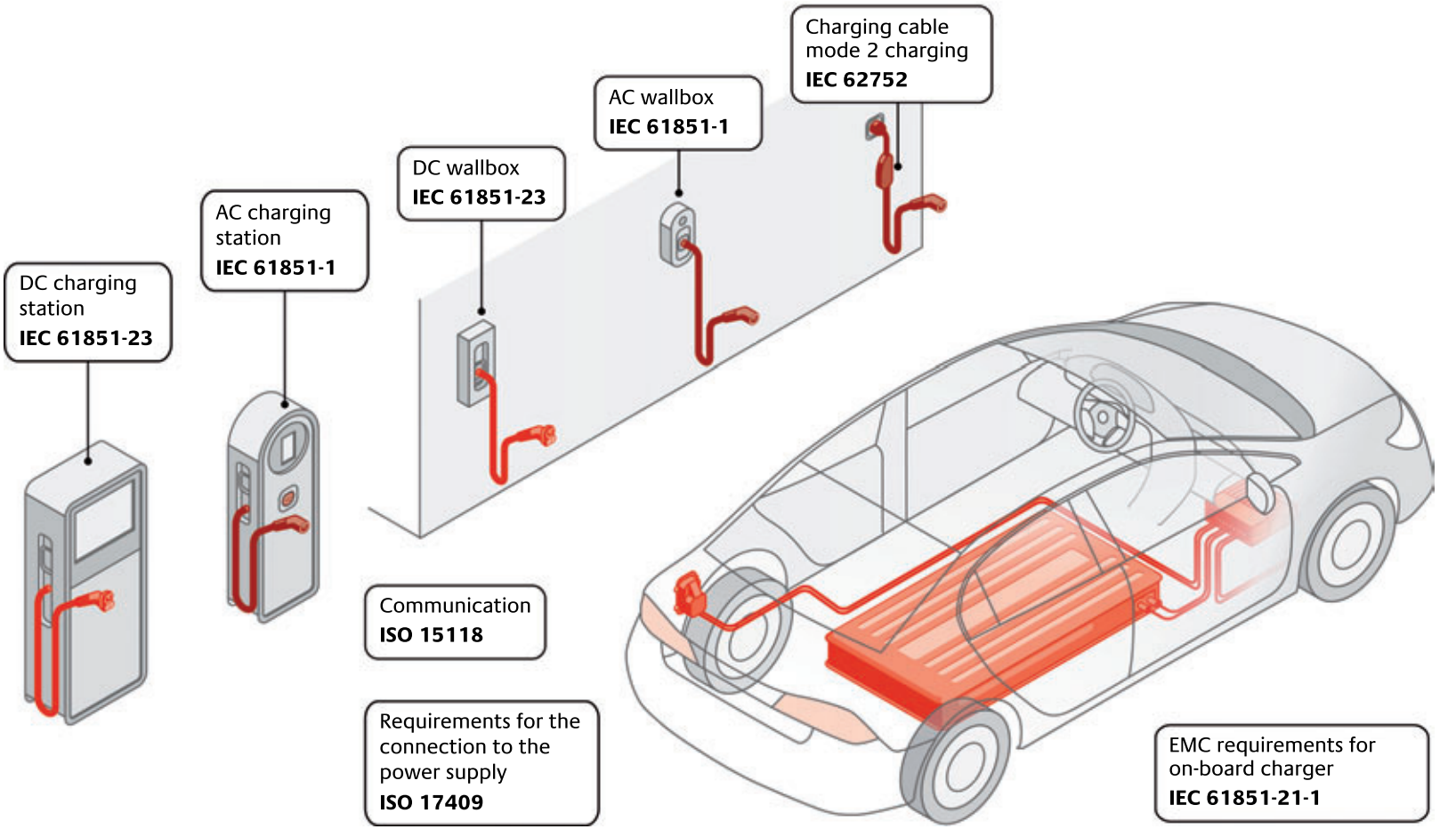
Conductive charging systems – general requirements
IEC 61851-1

EMC requirements for external charging systems
IEC 61851-21-2

Charging connectors
IEC 62196

Charging cable
IEC 62893

Connection charging infrastructure
IEC 60364-7-722



The illustration opposite gives an overview of the standards regarding **conductive charging** with alternating current (AC) and direct current (DC) and assigns them to the corresponding technical components.

The general safety requirements for the charging infrastructure are described in norm IEC 61851-1. This standard applies to all components used for the charging infrastructure, such as the charging cable, the AC and DC wallboxes, the AC and DC charging stations as well as the connector systems.

For DC charging devices, the standard IEC 61851-23 was developed, describing the charging procedure and other special requirements.

The connector systems for AC charging required for connecting an electric vehicle to the infrastructure are specified in IEC 62196-2. DC connector systems are regulated in IEC 62196-3. Both norms are subject to the general requirements listed in IEC 62196-1. The connector systems described in these standards are part of the Combined Charging System CCS and were already set forth as the minimum equipment for charging points in publicly accessible areas in EU Directive 2014/94/EU.

In the series of standards ISO 15118, the required hardware and procedure for the communication between vehicle and charging infrastructure, as well as the communication protocol, are specified for different application scenarios. These include load management issues, automatic customer authentication and the transfer of data for the invoicing process.

ISO 17409 specifies the requirements the vehicle must fulfill to be connected to the power grid for charging.

The IEC 62752 standard describes the requirements for the charging cable for mode 2 charging, including the integrated control and protection device for charging from household and industrial power outlets.

Requirements for charging cables are set forth in the series of standards IEC 62893.

The requirements for EMC and the connection of the charging infrastructure to the electrical installation have already been discussed in the chapter on “General requirements”.

The basic standardisations for conductive charging are finalised. This gives private and commercial customers security for investments. The interoperability obtained with the standardisation also makes electric mobility more attractive. This is the basis for the emergence of a mass market.

Further information on this topic can be found here:

www.din.de/en/innovation-and-research/electromobility

5
Standardisation roadmaps with recommendations for selected fields of action

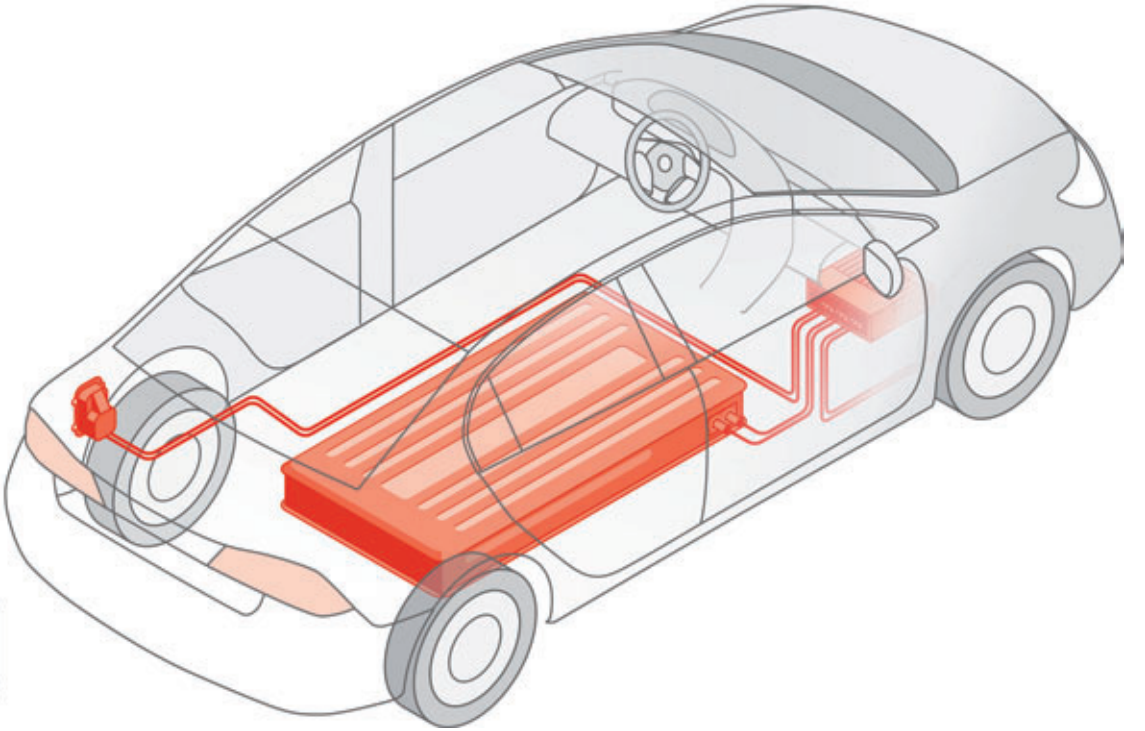
Standards in
electric mobility
form the **basis** for a
self-sustaining **market**.

High power charging

Charging cable
IEC 62893-4

Charging connector
IEC 62196-3-1

DC charging station
IEC 61851-23



Communication
ISO 15118

Requirements for the grid connection
ISO 17409

The customer request for greater long-distance reliability entails the use of higher capacity battery systems and the need for faster recharging.

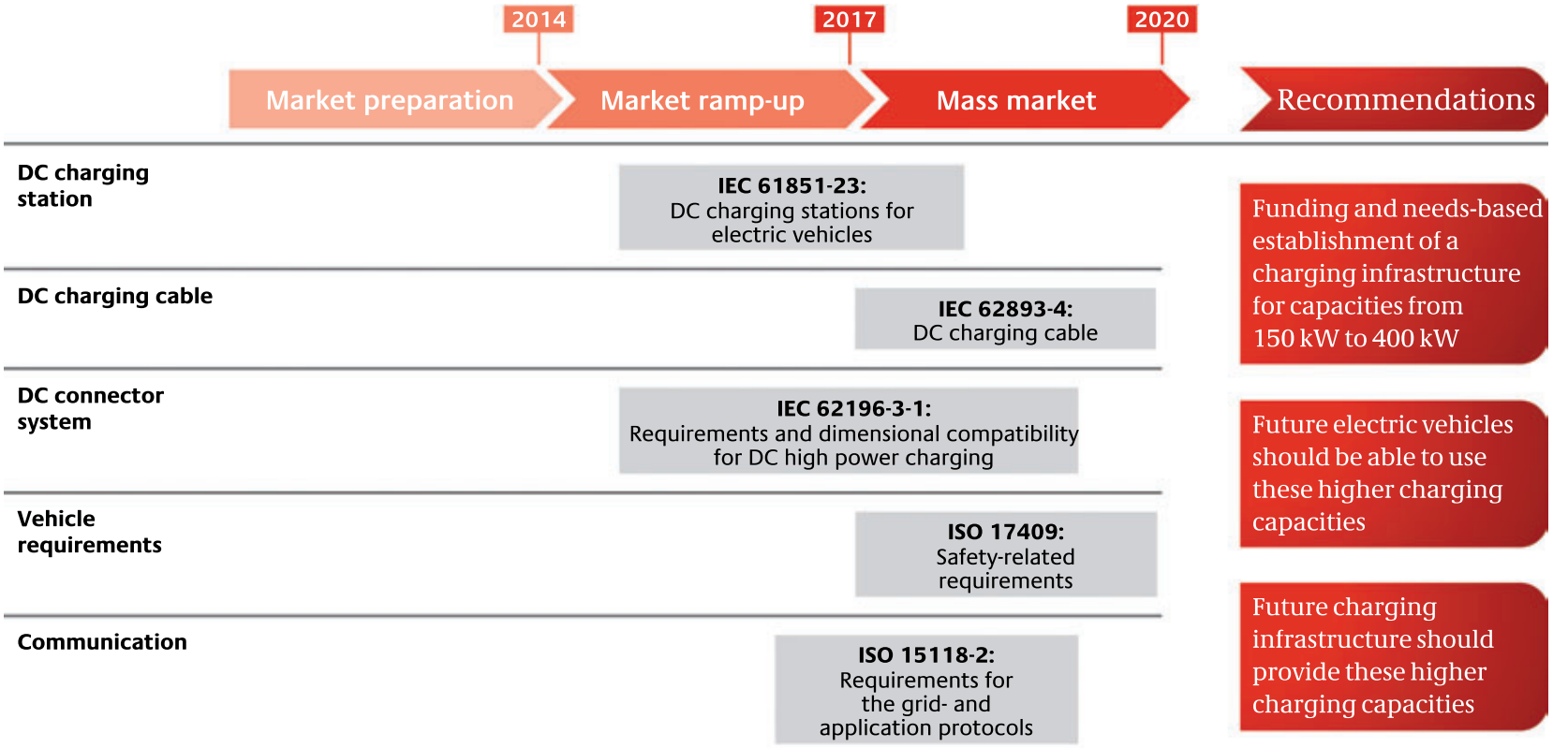
Based on the charging capacities of up to 350 kW announced in the previous version 3.0 of the German Standardisation Roadmap Electric Mobility, the current standardisation projects cover charging capacities of up to 400 kW (1000 V with 400 A). Moreover, it can be assumed that charging capacities will continue to increase in the future.

The increase in charging capacities presents a major challenge for the standardisation experts: The charging interface needs to be kept downward compatible to ensure that the existing charging infrastructure can still be used with the Combined Charging System CCS and the Combo 2 connector system. Connector systems should not become larger and heavier, in order to remain easy to handle for all vehicle users. Moreover, even with significantly higher charging capacities, all electrical safety requirements must be met.

To enable high power charging, the following standards have to be revised or drawn up from scratch:

- **IEC 62196-3-1 for the DC connector system is to be newly drafted,**
- **IEC 62893-4 for the DC charging cable is to be newly drafted,**
- **IEC 61851-23 for the DC charging station is to be revised,**
- **ISO 17409 for the vehicle-side requirements is to be revised and**
- **ISO 15118-2 is to be revised regarding the communication necessary to control the charging process.**

High power charging



The roadmap opposite shows the standardisation activities for the field of **high power charging**.

IEC 61851-23: Conductive charging systems for electric vehicles – DC charging stations for electric vehicles

In this standard, the terms “standard operating conditions” and “special operating conditions” are introduced to enable the normative description of the requirements for charging with cooled charging cables and cooled connector systems. It further contains a definition of how the charging station will react if critical temperatures are reached.

IEC 62893-4: Charging cables for electric vehicles – DC charging cables

This newly created standard defines requirements for charging cables for DC charging, including cables used for higher charging capacities.

IEC 62196-3-1: Connectors for the charging of electric vehicles – requirements and dimensional compatibility for DC charging connectors

Exposing the connector system to higher currents leads to increased heat development; hence, the norm introduces a reliable temperature management system for charging with higher charging capacities, including an according measuring methodology and corresponding tests. It also defines requirements for the contact coating and surface and the according tests.

ISO 17409: Electrically powered road vehicles – connection to an external power supply – safety requirements

The vehicles must be equipped with the prerequisites for the temperature monitoring system; also, technical adjustments have to be made.

ISO 15118-2: Road vehicles – communication interface between vehicle and charging station – requirements for the grid- and application protocols

The described communication must ensure that a charging process with higher charging capacity is only started if both the vehicle and the charging station are equipped with the necessary temperature monitoring system and can safely monitor the process.

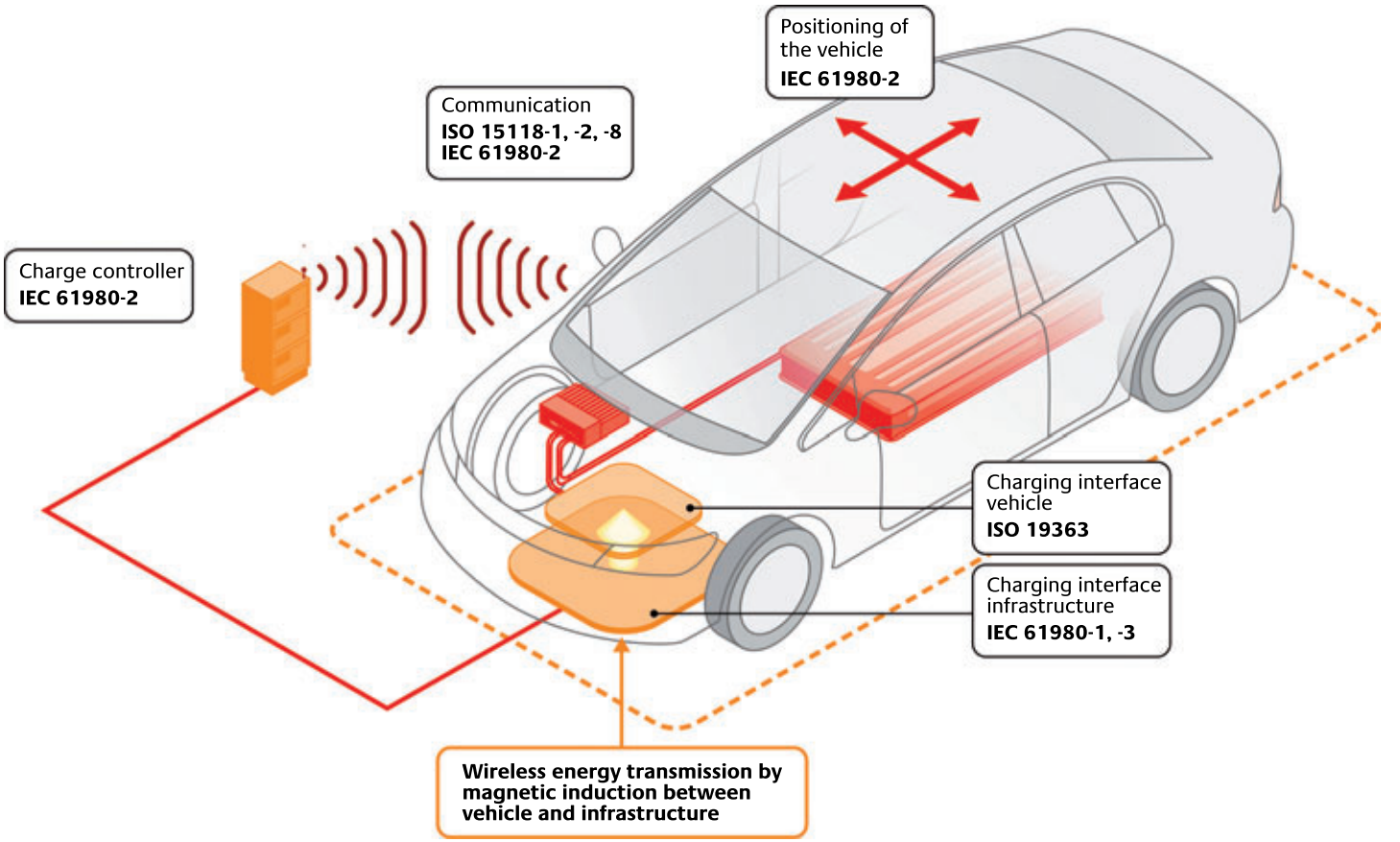
Recommendations:

- **Funding and needs-based establishment of a charging infrastructure for capacities from 150 kW to 400 kW**
- **Future electric vehicles should be able to use these higher charging capacities**
- **Future charging infrastructure should provide these higher charging capacities**

Further information on this topic can be found here:

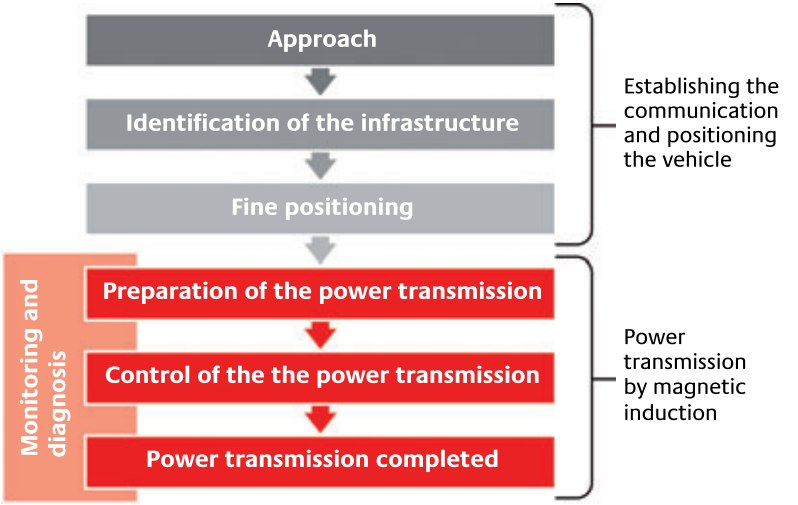
www.din.de/en/innovation-and-research/electromobility

Wireless charging of electric vehicles



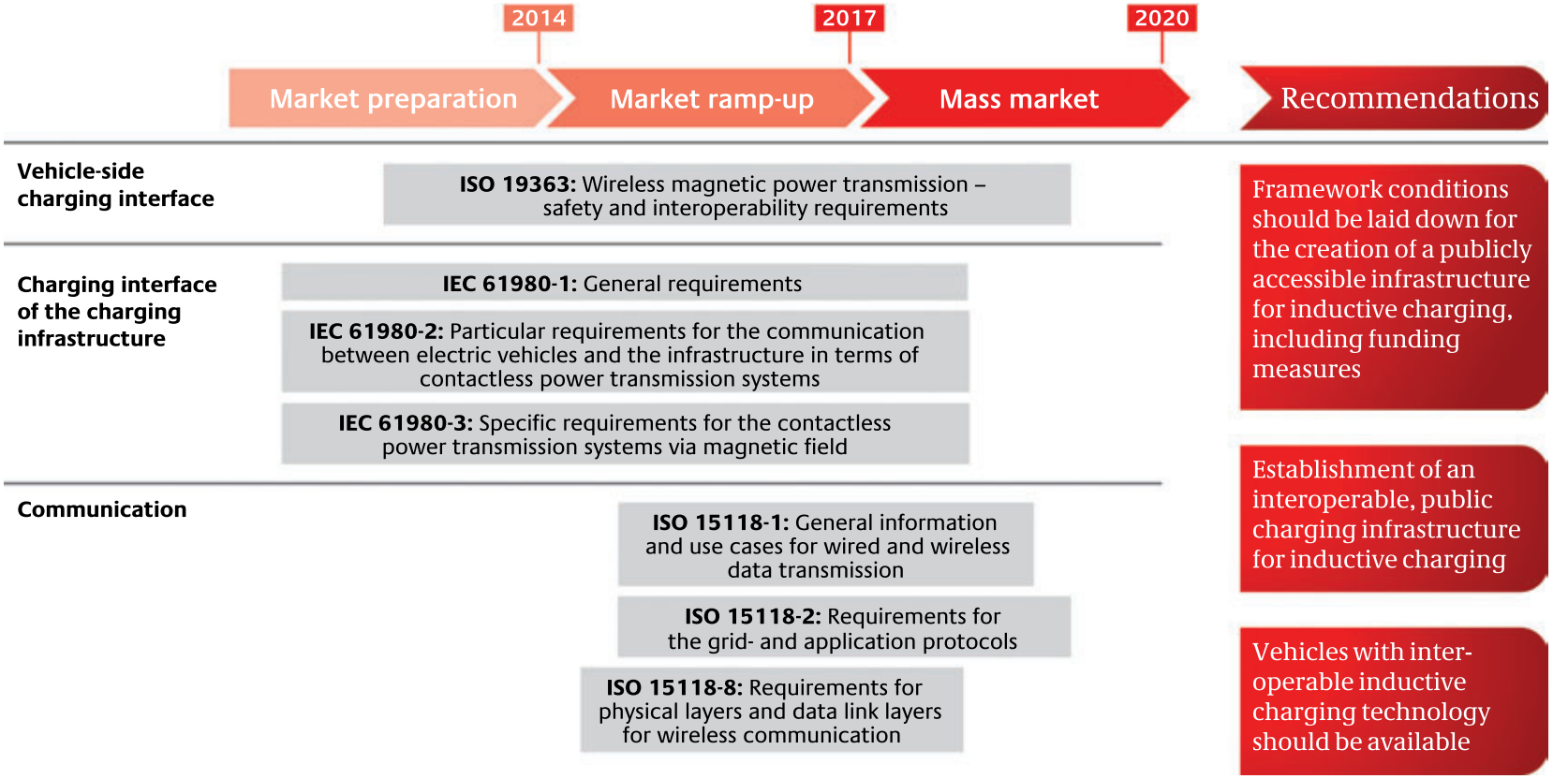
The **wireless power transfer** of electric vehicles is another customer requirement aiming at making the use of the electric vehicle as comfortable as possible. Obtaining this objective poses great challenges. For one thing, the space available in the electric vehicle for a inductive charging system is limited; for another, the different vehicle types have very different ground clearances, further varying according to the individual vehicle's loading condition. Electromagnetic energy transmission is only reliable and efficient if the two corresponding coils are optimally positioned to each other. The figure opposite shows the process specified in standard IEC 61980-2, from the approach of the vehicle to its fine positioning over the infrastructure-side charging device and the subsequent control of the energy transmission.

Flow chart for wireless charging according to IEC 61980-2



The standardisation projects presented in the illustration were designed in the standardisation committees in order to describe the system requirements and specify the function, safety and compatibility of the systems. The standards further contain requirements for a recognition mechanism for objects between the interacting coils.

Wireless charging of electric vehicles



The figure shows the roadmap for the standardisation of **wireless power transfer**.

Power transmission by magnetic induction, IEC 61980-3, ISO 19363:

In order to obtain an interoperable and efficient energy transmission, requirements for compensation and resonance conditions on the vehicle- and infrastructure side must be coordinated and specified. It is also necessary to define the position of the coil in the parking space, taking the possible positions of the coil in the vehicle into consideration. ISO 19363 describes the respective vehicle-side requirements for wired charging while IEC 61980-3 deals with the corresponding infrastructure issues.

Infrastructure requirements for the charging system and safety issues, IEC 61980-1, -2, -3:

In addition, the publicly accessible space requires particular robustness and operability under all reasonably expectable weather and utilisation conditions. The standards must take account of this aspect by providing for appropriate test procedures.

Positioning of the vehicle, IEC 61980-2:

Requirements for the fine positioning of the vehicle relative to the primary coil are set forth in the standards. It can be assumed that the fine positioning will be effected by means of an additional magnetic or electromagnetic signal emitted by the vehicle and detected by the infrastructure unit.

Communication, IEC 61980-2, ISO 15118-1, -2, -8:

The application scenarios in question are described in IEC 61980-2 and ISO 15118-1. While IEC 61980-2 explains the according charging process, ISO 15118-2 specifies the corresponding communication protocol and requirements. The data transmission is effected by means of the WLAN technology according to IEEE 802.11n, as laid down in ISO 15118-8.

In addition, the technical EMC limits for wireless charging systems set forth in EN 55011 must be observed. The limits for electromagnetic fields (EMF) will be defined in IEC 62764-1.

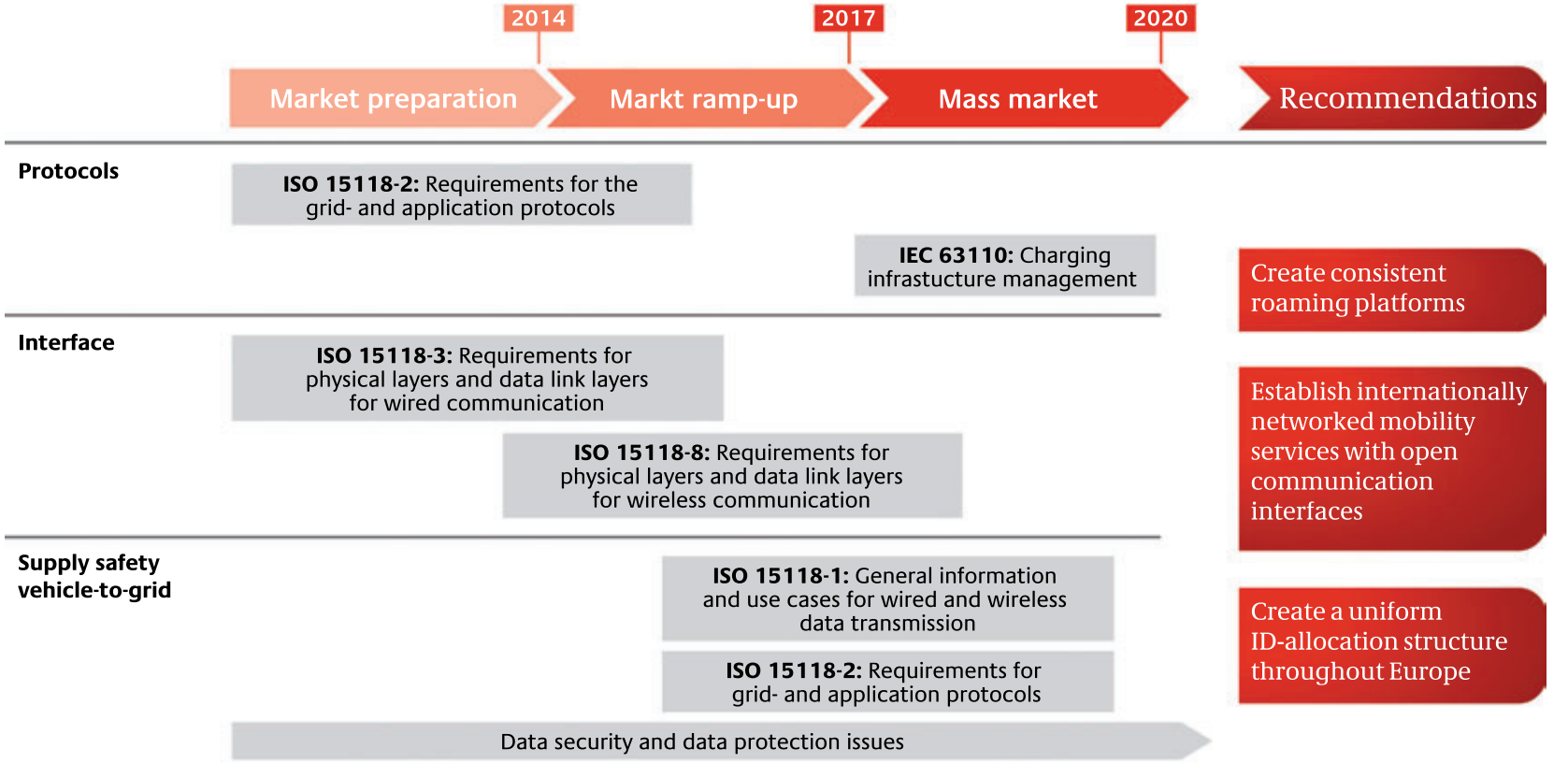
Recommendations:

- **Preparatory actions to ensure the availability of a public wireless charging infrastructure by 2020**
- **Aiming at a market launch of vehicles with interoperable inductive charging technology by 2020**

Further information on this topic can be found here:

www.din.de/en/innovation-and-research/electromobility

Information and communications technology



Information and communications technologies (ICT) constitute the link between vehicles, charging infrastructure and energy system. They control the charging at private and public charging points and enable the communication of electric vehicles with Smart Grids and the Smart Home. Moreover, ICT ensure that users have comfortable and comprehensive access to publicly accessible charging infrastructure. Car manufacturers and suppliers of charging infrastructure and energy are interconnected on so-called roaming platforms. They offer cross-provider authentication and billing procedures: via an app on the smartphone, charging card or the plug & charge system.

Roaming platforms are indispensable to enable interoperable cross-vendor charging. The creation of such platforms requires consistent technical framework conditions that will serve as a basis for according legal provisions and can be included in the business models of the different market players. The objective must be to determine a common and open basic IT protocol to interconnect the providers of charging stations and of electric mobility systems. Such a roaming protocol will give the user access to all charging stations alike: even if he uses stations of different providers, the costs he incurs will be billed centrally.

Alongside this contract-based charging, all charging stations are likewise to enable ad-hoc charging. To this end, it is recommended to limit payment methods at all charging stations to digital payment, such as Mobile Payment, SMS, smartphone apps or credit cards.

In order to internationally enable barrier-free charging at all charging stations both for contract customers and ad-hoc charging, a uniform authentication concept must be elaborated.

Therefore, the EU Commission should adopt a consistent European structure for the allocation of IDs on the basis of the procurement procedures already established at the national level in several countries.

Basically, ISO 15118 describes the communication between charging infrastructure and vehicle. It specifies the communication protocol for the automatic load management and the automatic payment processes in the vehicle.

The project IEC 63110 was launched to standardise the communication between the charging infrastructure and its respective operator with view to the management of the infrastructure.

In the fields of authentication, metering for DC charging and billing, and with view to the placing and availability of charging infrastructure, standardisation activities are due.

Recommendations:

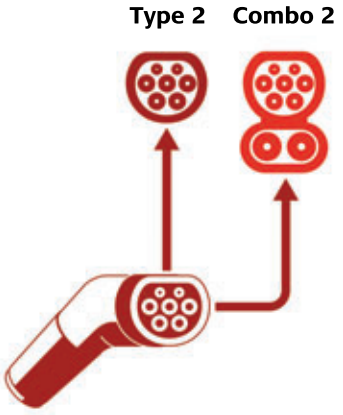
- **Create consistent roaming platforms**
- **Establish internationally networked mobility services with open communication interfaces**
- **Create a uniform ID-allocation structure throughout Europe**

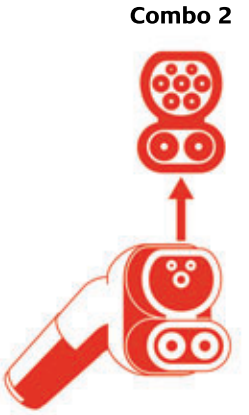
Further information on this topic can be found here:

www.din.de/en/innovation-and-research/electromobility

Overview of the charging options and their typical charging capacities

Magnetic induction	AC charging	DC charging
3,7 kW	3,7 kW	
7,4 kW		
11 kW	11 kW	
22 kW	22 kW	
	44 kW	
		50 kW
		150 kW
		400 kW





ISO 15118 as basis for consistent communication for all charging technologies

The illustration opposite presents the three charging options: conductive AC charging, conductive DC charging and inductive charging. Along with the typical charging capacities, it also shows the maximum performance values possible under the present normative specifications:

- **Currently, the inductive charging of passenger cars and light commercial vehicles can reach performance values of up to 22 kW.**
- **conductive AC charging with a Type 2 connector can currently achieve performance values of up to 44 kW (charging with up to 22 kW being defined as normal charging and charging with over 22 kW to 44 kW as fast charging).**
- **conductive fast DC charging with the Combo 2 connector will hence be able to transmit up to 400 kW.**

The communication for all these charging technologies is described in the series of standards ISO 15118.

6
Outlook

Electric mobility

must be economically efficient

and suitable for **everyday use** –

both for the suppliers and the users.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- There are consistent standards and specifications that are continually developed according to the requirements.
- The existing standards provide security for investments and allow for cost reductions through standardisation.
- Electric mobility becomes significantly more attractive, as interoperable charging is internationally possible – without difficulties.
- Standardised test procedures and safety requirements for electric mobility along with a holistic environmental concept from production to sustainable recycling preserve the environment and are resource-efficient, thus forming the basis for the acceptance of electric mobility in the market.
- The finalised standards and specifications substantially promote the objective of becoming lead market.

Imprint

Author
German National Platform for Electric Mobility (NPE)
Berlin, April 2017

Publisher
The Federal Government's Joint
Office for Electric Mobility (GGEMO)
Scharnhorststraße 34–37, 10115 Berlin

Editor
WG 4 – Standardisation and Certification

Typesetting and design
www.heilmeyerundsernau.com

Charts
www.infografiker.com

Printing
www.druckerei-vogl.de

Translation
Henrike Wöhler

Further information and publications of the NPE:

www.nationale-plattform-elektromobilitaet.de/en

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