Electromobility Standards: Driving the Future

An Executive Summary of the study "Determining the Medium- to Long-Term Standardization Requirement for Electromobility Based on Socio-Economic Developments" has been created on behalf of DIN. The study is part of the DIN's programme for setting the standards of electromobilty mandated by German Federal Ministry of Economics and Technology.

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Executive Summary

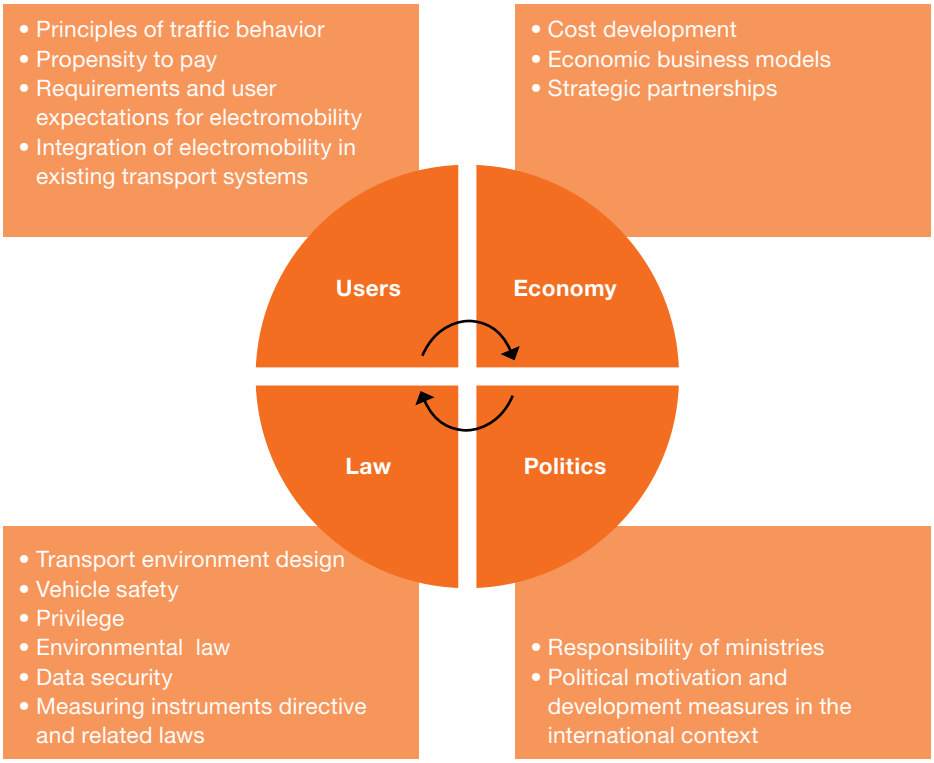
The German Federal Government has specified the objective of ensuring that Germany becomes the leading provider and leading market for electromobility.

One of the major aims which has been specified is to ensure that Germany has one million electric vehicles on the road by 2020. In order to ensure that this objective of the German Federal Government can be met, subjects which are particularly relevant for electromobility have been defined; these subjects are currently being considered in the working parties of the National Platform Electromobility (NPE). A key issue is the field of standardization and certification which is the responsibility of working group 4. If electromobility is to become a viable concept, user acceptance is a key factor of success in addition to technological progress. National and international standards encourage the convergence of technology, guarantee a defined level of quality and promote competition. Standards create transparency and establish trust among users.[2] Accordingly, standards make a direct and indirect contribution towards ensuring that user acceptance of electromobility is enhanced.[3] Whereas the technical component in the field of electromobility has already been extensively detailed in the German standardization roadmap Electromobility[4], the socio-economic component relating to standardization-specific questions of electromobility has not yet been investigated.

In this context, DIN Deutsches Institut für Normung e.V. (DIN), Berlin, has engaged the services of PricewaterhouseCoopers AG Wirtschaftsprüfungsgesellschaft (PwC), Frankfurt am Main, to prepare a "study for determining the medium- to long-term standardization requirement in the field of electromobility on the basis of socio-economic developments". PwC has carried out the engagement jointly with the Fachhochschule Frankfurt am Main – University of Applied Sciences, Frankfurt am Main, and the Fraunhofer-Institut für Betriebsfestigkeit und Systemzuverlässigkeit LBF, Darmstadt.

The socio-economic component is becoming an increasingly significant factor for the development of electromobility. For instance, extensive investigations have been carried out in the model region Rhein-Main regarding the mobility patterns of users and regarding the user acceptance of electromobility in order to take account of mobility requirements and the wishes of existing users in relation to the continuing development of electromobility. Four areas, which are mutually interrelated, are essentially considered under socio-economic aspects of electromobility:

Fig. 1: Socio-economic areas of electromobility



Source: PwC, Fraunhofer LBF, FH FFM (2011)

1 The use of the masculine forms of user, purchaser, commuter, etc. also includes the female form.
2 DIN Deutsches Institut für Normung e.V. (15. 11 2004). Die deutsche Normungsstrategie. Berlin, Deutschland.
3 DIN Deutsches Institut für Normung e.V. (26. 11 2009). Die deutsche Normungsstrategie aktuell. Berlin, Berlin, Deutschland.
4 NPE. (30. 11 2010). Die deutsche Normungs-Roadmap Elektromobilität - Version 1. Berlin, Berlin, Deutschland.

An analysis of secondary literature has been carried out for the areas of users, economy, politics and legal. Key subjects regarding the development of electromobility have been developed in this context (see Figure 1).

The corresponding technological factors and developments have been detailed on the basis of the analysis of secondary literature. The following SWOT analysis has been prepared using the results:

Fig. 2 SWOT analysis

Strengths
- Carbon-free travel possible
- Electric vehicle can significantly support the smart home concept, can be integrated in the smart grid
- Low noise emissions
- Fun to drive (acceleration)
- High level of comfort in urban areas
- Recharging activity can be combined with parking activity (no separate re-fueling activity)
- Low costs of operation and maintenance
- Improved active safety
- Ongoing standardization projects are supporting the process of overcoming various technical problems and the definition of safety questions

Weaknesses
- Insufficient range for longer journeys
- Days when vehicle is not available are a key decision-making factor in the purchase decision
- Interior air-conditioning is a limiting factor for the range
- Long recharging times
- High cost of purchase
- Low maximum speed compared with equivalent conventional vehicles
- Reduced mobile flexibility
- Technology and rescue chain hardly tested in practice
- Still a lack of convergence of standardization activities in different countries

SWOT analysis

Opportunities
- More ecological mobility behavior due to the use of inter- and multi-modal transport (public transport networks, Pedelecs, etc.) to compensate for range problems
- Reduction of emissions of fossil-fuel individual transport (noise, exhaust gases)
- Efficient use of fossil resources
- Transport costs decoupled from the international oil price development (after the energy industry converts to renewable energies)
- Considerable improvement in efficiency technologies
- Increasing comfort due to inductive recharging
- Petrol prices might rise more rapidly than electricity prices
- Creation of new services (e.g. mobility concepts) and revenue possibilities, e.g. for car infrastructure and IKT
- Uniform standardization boosts marketability

Risks
- The percentage of recharging electricity from renewable energies is too low to make electric vehicles more ecological (delay in the energy turnaround)
- Costs of purchase will continue to be too high
- Battery does not provide the performance which was originally promised (e.g. considerably reduced cycle stability, much reduced capacity under unfavorable climate conditions)
- Costs of “high-end” infrastructure are too high and have a significant impact on the TCO balance
- Savings effects in terms of operation and maintenance are eliminated by other costs
- Electricity prices might rise more rapidly than petrol prices
- Efficiency gains of conventional vehicles
- Other innovative technologies might become established
- Accidents with an electric vehicle (e.g. electric shock, collision with pedestrians) might lower user acceptance
- Lack of international standardization (e.g. as a result of different national interests) might reduce marketability due to insular solutions

Source: PwC, Fraunhofer LBF, FH FFM (2011).

Market penetration of electromobility will only be possible if the users accept the new technology and perceive it to be equivalent in comparison with other conventional and alternative drive technologies. Users will probably not discover electromobility in their entirety, and instead will in practice discover electromobility in a sequence of groups. Various factors, e.g. age, sex, education, background and upbringing, financial status, current life situation and surroundings (address and place of work) are relevant in this connection.

Existing studies regarding the classification of user groups have been used as the basis of defining different user groups and making comments regarding their attitude with regard to various subjects of electromobility:

Tab. 1: Profiles of different user groups

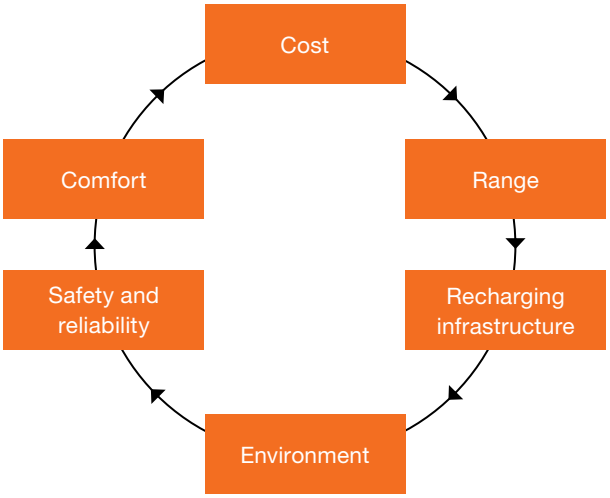
	Technology enthusiasts	Environmentally aware	Cost-aware	Safety-aware	Conservative
Cost	o	o	++	+	++
Range	++	o	+	++	++
Reliability	o	+	+	++	++
Electricity mix instead of petrol	++	—	o	o	o
Electricity from renewable energies	+	++	o	o	o
Recharging with cable	+	++	o	–	+
Inductive recharging	++	—	—	o	—
Comfort	+	o	+	++	++
Design	++	o	o	+	+

++ Very important
+ Important
o Indifferent
– Relatively unimportant
— Completely unimportant

Source: PwC, Fraunhofer LBF, FH FFM (2011).

It can be seen that technology enthusiasts and the environmentally aware in particular will be among the first movers of electromobility.
The existing results have been used to identify six factors which might potentially have a crucial impact on user acceptance and thus the market penetration of electromobility. Range, recharging infrastructure and costs are the factors which pose obstacles to the market penetration of electromobility. Specifically in the case of costs, most users will not be prepared to accept a significant mark-up on the purchase price compared with a comparable combustion vehicle. On the other hand, it is possible to counter the range fears of most users, even in the near future, by means of suitable public relations work/marketing, the range of hybrid concepts, an intelligent process of establishing a recharging infrastructure at suitable points and also appropriate business models (e.g. combined models, mobility card). In addition to these drivers, users expect that factors such as safety, reliability and comfort will not be affected by changing over to an electromobility solution. Many users consider that "green" mobility is an advantage of electric vehicles compared with conventional vehicles. Although this factor is very important for the image of electromobility, it has only limited scope to compensate for the disadvantages resulting from the factors of range and costs.

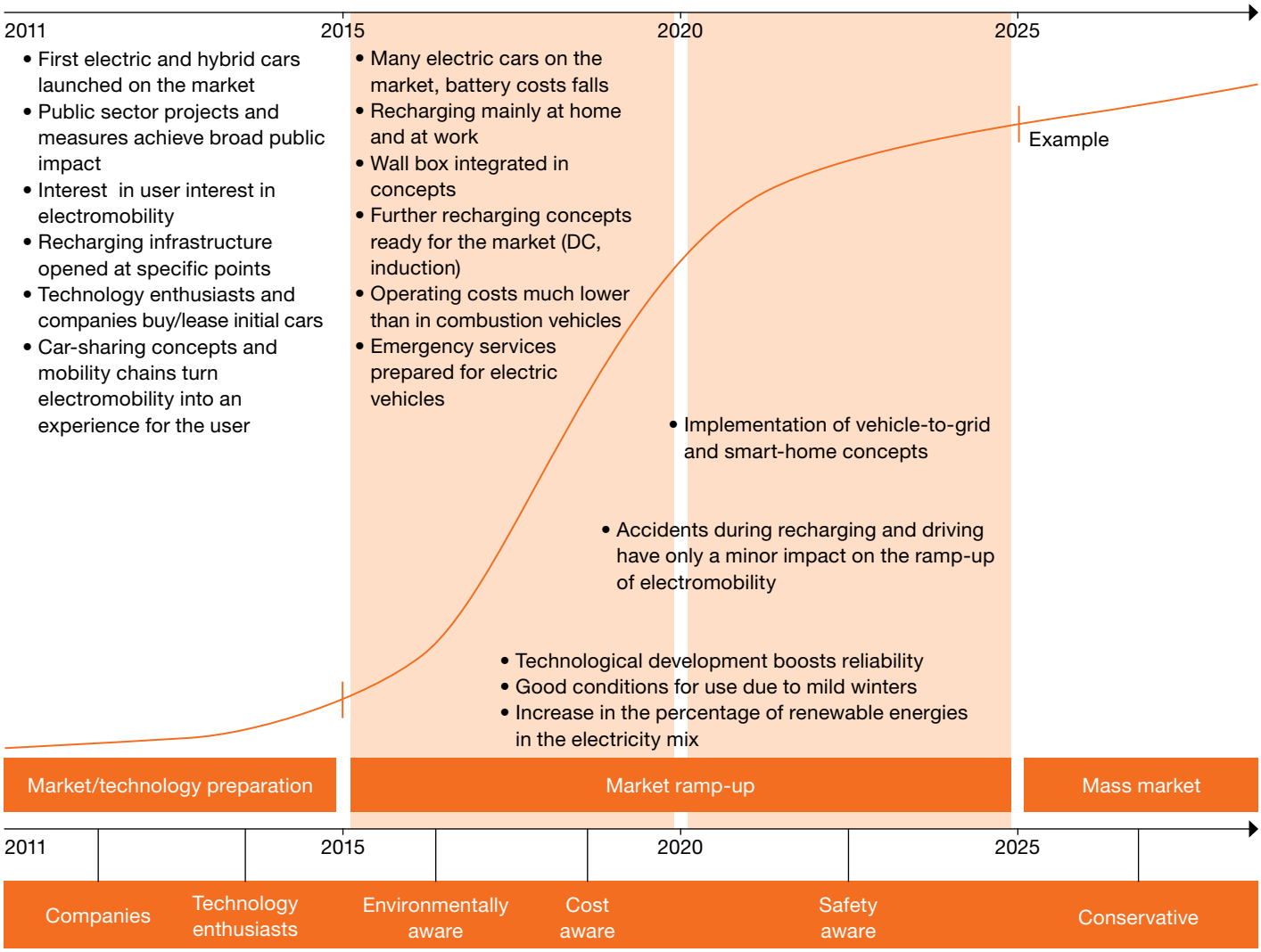
Fig. 3 Critical factors of electromobility



Source: PwC, Fraunhofer LBF, FH FFM (2011).

These six critical factors constitute the starting point for the development of two scenarios in the period of investigation (2015 to 2025). The expected time at which the user groups described above are prepared to convert to electric vehicles is also detailed. With the exception of the conservative users, all user groups detailed above will become electromobile during the basic scenario:

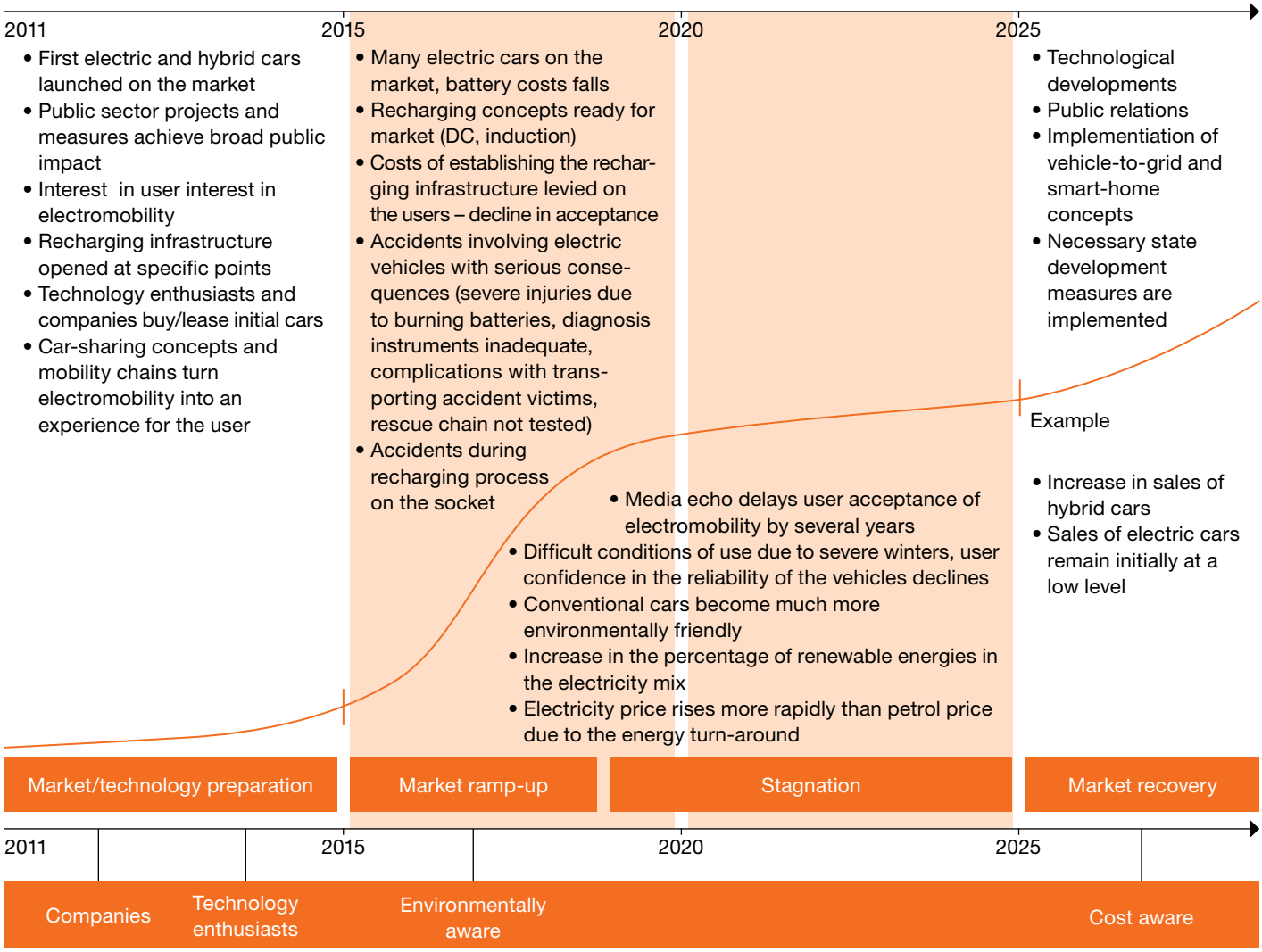
Fig. 4 Scenario 1 - Base case



Source: PwC, Fraunhofer LBF, FH FFM (2011).

Whereas market penetration of electromobility in the period covered by the investigation is assured in the basic scenario detailed above, a negative scenario is used to detail specifically those cases which might pose a threat to the market penetration of electromobility in the period covered by the investigation:

Fig. 5 Scenario 2 – Negative scenario



Source: PwC, Fraunhofer LBF, FH FFM (2011).

Subjects for which there might be a standardization requirement have been identified by using a filter developed for this purpose:

1. The subject is fundamentally relevant for electromobility
2. The subject will probably be relevant for electromobility in the period 2015–2025
3. The subject is not (or not comprehensively) considered in the German standardization roadmap

The standardization requirement has been defined on the basis of detailed observations of the identified critical factors and by applying the method of use cases for relevant sub-areas. Overall, it can be stated that many major issues – and in particular those issues which are relevant for safety purposes – have already been addressed in the German standardization roadmap and that standardization projects in many cases have already been actively processed or completed.

The six identified factors which will have a crucial impact on the market penetration of electromobility in the period under consideration have been subjected to a detailed analysis in order to identify those points at which standards might be of assistance. This has specified only suggestions which have previously not been the focal point of standardization activities regarding electromobility. Because the critical factors are crucial for the success of electromobility and user acceptance, the suggestions which are described should be included at an early stage in the individual standardization committees, where the contents should be set out in detail. The following table shows the critical factors to which the identified suggestions for standards have been allocated. The standard proposals cover a wide range of issues relating to the subjects of electric vehicle, (recharging) infrastructure and background conditions.

Tab. 2: Critical factors and standards

	Cost	Range	Recharging infrastructure	Environment	Safety and reliability	Comfort
A standard procedure for determining the current status and the expected outstanding capacity of used batteries	x	x			x	
Standard and reliable measurement process for SOC/range prediction		x	x		x	x
Standardized user interfaces		x	x		x	x
Standardized model for Life Cycle-Cost/Total Cost of Ownership and Life Cycle Assessment	x		x	x		
Noise catalog				x	x	x
Basic status in the event of problems during the recharging process			x		x	x
Periodic monitoring of home installations.			x		x	
Rescue guidelines					x	
Measuring procedure/guideline for determining the residual risk due to batteries involved in accidents				x	x	
Definition of minimum requirements for quality in production processes	x			x	x	x
Safety requirements for information and communication technology					x	
IKT safety requirements			x		x	x
Structural integration and barrier-free design of recharging infrastructure			x		x	x
Guarantee of safety functions and other important functions when the main energy storage facility is empty. E.g. warning lights, eCall, safety facilities, door locking …					x	x
Driving cycles adapted to electromobility		x				
Location of the recharging connector			x			x

Source: PwC, Fraunhofer LBF, FH FFM (2011).

The use case describes events from the point of view of the respective market roles and abstracts technical details. Defining the players, allocating them the respective roles, detailing the activities and limiting the system are major tasks which have a significant impact on the process of establishing a use case. The method of use cases thus logically breaks down an event into its individual steps. The purpose of a use case diagram is to understand the user requirements for a clearly definable event and to define interfaces.

The work of the standardization committees involves using the respective use cases to identify technical requirements for their particular area and to translate them into standards. At an early stage, use cases are thus able to detail events and describe plans which still have to be implemented in the relevant systems.

The issues detailed at this point have been chosen by applying the filter and also be comparing the standardization requirement of different use cases in order to avoid reduplications in this way.

The method of use cases has been applied for six subjects, and the standardization requirement has been identified accordingly:

- Preparation of batteries for secondary use
- Home energy systems
- Authentication – RFID card, on demand
- Maintenance by remote diagnosis
- Rescue chain – accidents with personal injuries
- Self-diagnosis vehicle recharging infrastructure

Tab. 3: Standardization requirement use cases "Preparation of batteries for secondary use", "Home energy systems"

Standard	Preparation of batteries for secondary use	Home energy systems
Serviceability standard	no standardization requirement identified (n. s. r. i.)	Ergonomic functionality and reliability of the recharging station
Delivery standard	n. s. r. i.	n. s. r. i.
Dimension standard	n. s. r. i.	Connections, connecting elements, devices for recognizing identification data, measurement of the state of charge of the battery
Planning standard	n. s. r. i.	n. s. r. i.
Quality standard	Test of performance	Long-time behavior of technical components and software (under normal and abnormal use)
Safety standard	Test of safety	Protection against manipulation, data security
Materials standard	n. s. r. i.	n. s. r. i.
Communication standard	Evaluation of test results	Declaration of the recharging point, functionality of the interfaces between the communication module and recharging point, data format, protocols, interfaces

Source: PwC, Fraunhofer LBF, FH FFM (2011).

Tab. 4: Standardization requirement use cases "Authentification RFID card", "Authentification on demand"

Standard	Authentification RFID card	Authentification on demand
Serviceability standard	Ergonomic functionality and reliability of the interactive systems, barrier-free access, guarantee of compatibility between communication module and recharging point	Ergonomic requirements for interactive systems, barrier-free access to systems
Delivery standard	Technical supply conditions of RFID readers, recharging station	Technical supply conditions
Dimension standard	Connections, connecting elements, facilities for recognizing identification data	Connections, connecting elements, devices for recognizing identification data
Planning standard	n. s. r. i.	n. s. r. i.
Quality standard	Efficiency, functionality, availability and correctness of the systems, long-term behavior of the technical components and software (under normal and abnormal use)	Efficiency, functionality, availability and correctness of the systems
Safety standard	Protection against of the technical equipment, data security regulations for managing identities and master data	Protection against of the technical equipment, data security regulations for managing identities and master data
Materials standard	n. s. r. i.	n. s. r. i.
Communication standard	Identification of and operating instructions for technical components, communication protocols	Identification, interfaces, protocols, data formats

Source: PwC, Fraunhofer LBF, FH FFM (2011).

Tab. 5: Standardization requirement use cases "Maintenance by remote diagnosis", "Self-diagnosis vehicle recharging infrastructure", "Rescue chain accident with personal injuries"

Standard	Maintenance by remote diagnosis	Self-diagnosis vehicle recharging infrastructure	Rescue chain accident with personal injuries
Serviceability standard	n. s. r. i.	Maintenance of the diagnosis instrument, test device for the cable (contact resistance – cable break)	n. s. r. i.
Delivery standard	n. s. r. i.	n. s. r. i.	n. s. r. i.
Dimension standard	n. s. r. i.	n. s. r. i.	n. s. r. i.
Planning standard	n. s. r. i.	n. s. r. i.	n. s. r. i.
Quality standard	Completeness of transferred data (checksum, etc.)	n. s. r. i.	n. s. r. i.
Safety standard	Encryption	n. s. r. i.	Regulations for ensuring that power is cut off; protection and rescue of personal data; procedure for discharging batteries; security of data (protected against unwanted access)
Materials standard	n. s. r. i.	n. s. r. i.	n. s. r. i.
Communication standard	Definition of interface, protocol, data format, uniform coding of vehicle information (e.g. encryption)	Definition of interface, protocol, data format, form of signal for functionality in the vehicle, signal of functionality on the recharging station	For E-call: identification as electric vehicle, simple and clear identification EV, uniform identification of circuit breaker, uniform rescue guidelines for the emergency services, uniform guidelines for the procedure with an electric vehicle involved in an accident for the breakdown recovery service and for the workshop

Quelle: PwC, Fraunhofer LBF, FH FFM (2011).

The standardization proposals which have been drawn up are the result of a socio-economic and technical discussion. The first aspect in particular has only been recognized to a limited extent in the standardization discussion which so far has tended to focus on technical aspects. The results of the study may therefore be an important component and signpost for future discussions relating to the standardization requirement and also for initiating standardization processes in electromobility, because they take account of the interests of all players (users, industry, etc.) and the technical requirements to describe the relevant standardization fields – in addition to the German standardization roadmap Electromobility. By developing standards based on the various proposals and also taking account of future developments and factors in the field of electromobility, it will be possible in the final analysis to shape a successful mass market in accordance with the period considered in the basic scenario.

Imprint

Determining the Medium- to Long-Term Standardization Requirement for Electromobility Based on Socio-Economic Developments

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