32nd Electric Vehicle Symposium (EVS32)
Lyon, France, May 19 - 22, 2019

CharIN e.V. – High-Power Charging and Harmonization for a global EV charging standard

Claas Bracklo[1], Michael Keller[2]

1) BMW AG, Verband Deutscher Automobilhersteller (VDA) e.V., CharIN e.V., Schiffbauerdamm 12, 10117 Berlin, Germany, coordination@charinev.org

2) Volkswagen AG, CharIN e.V., Schiffbauerdamm 12, 10117 Berlin, Germany, coordination@charinev.org

Summary

As an international standard for a reliable, safe and powerful charging system to support basic charging as well as long range driving, many international stakeholders in the E-Mobility business support the Combined Charging System (CCS). To harmonize and further develop the holistic system approach of CCS, the CharIN e.V. was initiated by OEMs and market leaders in the E-Mobility value chain. With over 160 international members the association is continuously growing and fostering CCS as *the* global charging standard. The holistic approach offers a solution for all charging use cases: from Alternating Current to Direct Current in different power classes, conductive charging as well as automated and wireless charging. It also addresses all kinds of vehicles: from bikes to cars to trucks.

Keywords: BEV, EVSE, fast charge, V2G, wireless charging

1 The path to high-power charging and harmonization

A comprehensive high-power charging infrastructure, an adequate level of grid integration and the advancement of electric vehicles to a higher range play a pivot role in the further establishment of electric vehicles on our streets and in the worldwide sustainable mobility progress.

Offering people to go on a long-distance trip (> 400 km) with an electric vehicle and having a comprehensive high-power charging infrastructure with a charging time of roughly 4 minutes for a 100 km electric range will open the opportunity to drive purely electric to additional user groups like business travelers.

Therefore, the CharIN e.V. focuses on the requirements specification of a reliable, safe and powerful high-power charging system to support long distance E-mobility – the Combined Charging System (CCS). The challenge is to charge as fast as possible with high power and also with normal charging power for home and workplace recharging, covering all aspects within the overall one system for all approach.

2 The CharIN e.V.

2.1 International Initiative

The Charging Interface Initiative (CharIN) e.V. is a registered association founded by Audi, BMW, Daimler, Mennekes, Opel, Phoenix Contact, Porsche, TÜV SÜD and Volkswagen in 2015 to promote CCS as a standard worldwide. In 4 years, the association has grown to over 160 international members along the whole value chain. 16 out of the top 20 car brands are already represented within CharIN, as well as the top 5 semiconductor companies and the leading EV charging station manufacturers.

Regional offices in Germany, Hongkong, China, India, Japan, Korea and the US are supporting the positive membership development. That means organizing regular meetings and calls, giving presentations at events and facilitating workshops as well as member meetings with respect to local requirements of the specific areas.

Figure1: CharIN Offices around the world

2.2 Worldwide Solution

Most market leaders within the electromobility sector joined the CharIN e.V. and support the rollout of CCS as *the* charging standard worldwide. In most parts of the world, CCS is the only charging standard for combined AC and DC charging.

The Japanese and Chinese governments are supporting regional and country specific charging solutions. As Japan promotes the ChAdeMO DC charging technology in Japan and other countries, China is demanding the GB/T charging technology for its local EVs. Currently, a government driven Japanese and Chinese joint activity for defining a new charging solution for its countries is established. Compatibility with the existing systems ChAdeMO and GB/T will need to have different market specific adapters.

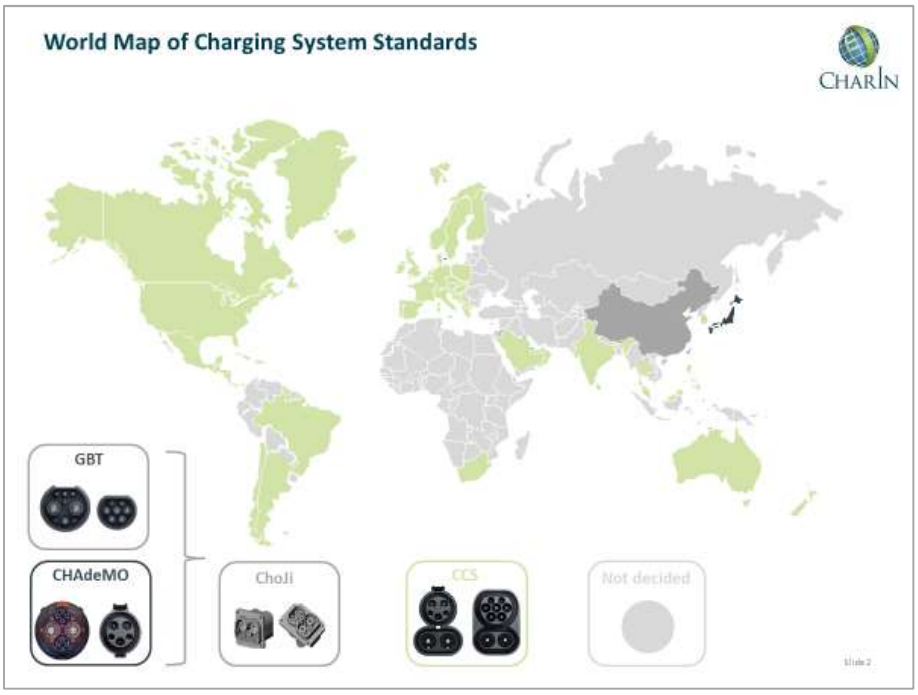

Figure 2: World Map of Charging System Standards

2.3 Harmonization

In five different international working groups, CharIN members compile and discuss current challenges and develop common requirements regarding different topics of Charging Communication, Charging Infrastructure, Charging Connection, Grid Integration and Conformance Test/Interoperability.

The path to EV fast charging includes an international standard of a reliable, safe and powerful charging system. A simple and consistent customer interface that is used all over the world from low to high power charging and that is applicable for bikes, cars, trucks as well as for ships and planes. The worldwide alignment of requirements for EVs, EVSEs and its infrastructure is creating added value which will lead electro mobility to a success.

The harmonization of requirements of the international charging industry with a clear recommendation on technology and customer interface is a major deliverable of CharIN. Previously, various position papers, recommendations and commitments were published and further will follow to promote the harmonization of requirements of the international charging industry.

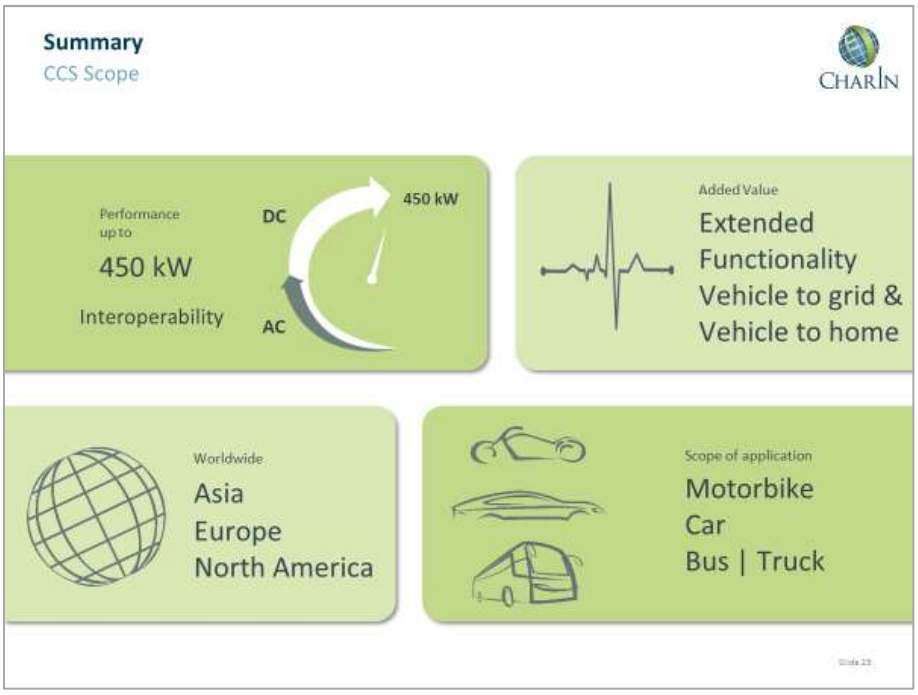

Figure 3: CCS Scope

2.4 The Holistic Charging System Approach

Charging infrastructure plays a pivotal role for the market uptake of EVs, and new technological developments need to be integrated quickly in order to shorten charging times.

The CCS charging communication standard between vehicles and the EVSE is ISO 15118. Current EVSEs are managing the compatibility with existing cars by supporting ISO 15118 ED1 and DIN SPEC 70121:2014.

An implementation guide for High Power Charging (HPC) based on ISO 15118 was developed by the CharIN Focus Group Charging Communication. The Plug & Charge Implementation Guide is available for all CharIN members. This customer feature strongly improves the charging experience and makes driving electric on distances more convenient.

With respect to market requirements, the CharIN e.V. and its members are currently working with high priority on the topics:

- higher charging currents (> 500A) and charging performance (up to 450 kW)
- vehicle to grid (V2G) and wireless charging
- conformance tests and a respective certification body

Figure 4: Charging System Standards

2.4.1 Increasing Charging Currents for Battery Electric Passenger Cars

As part of its ongoing process to provide guidance and support for the development of a battery electric vehicle charging eco system, the CharIN association endorses the initiative to increase the charging currents for battery electric vehicles, and specifically for passenger vehicles.

The currently specified DC Charging power is limited to 200kW. The CharIN association and its members have been the leading proponents for development of charging systems up to 450 kW. The results of which are currently being integrated into the international standards.

Following considerable performance testing, it has been demonstrated that current available charging systems are capable of charging currents over 500A. Therefore, CharIN is endorsing and supporting efforts to upgrade these standards from 200 A to over 500 A charging. CharIN will enhance the Combined Charging System 2.0 document to include > 500 A / 450 kW charging for Combo 1 and Combo 2 CCS charging connectors. This shall ensure the demands of future use cases.

Right now, several companies providing battery electric vehicles and charging infrastructure products are offering or announcing products, which can charge with a current of 500 A. Even though some manufacturers have already certified products for a charging current of 500 A, the national and international standards are not yet available for all necessary components and sub-systems. In order to ensure safety, interoperability and reliability, CharIN and its members are endorsing and working diligently with the respective standardization committees to expedite the publication of these important standards.

2.4.2 High Power Charging for Commercial Vehicles beyond 1 MW

To expand the scope of applications within the holistic system approach to CCS, the CharIN e.V. formed the High Power Charging for Commercial Vehicles (HPCCV) group to define a new commercial vehicle high power charging solution to maximize customer flexibility when using fully electric commercial vehicles.

The scope of the technical recommendation is to be limited to the connector and any related requirements for the EVSE, the vehicle, communication, and related hardware. The standard focuses on Class 6, 7, & 8

commercial vehicles, but could easily be used for buses, aircrafts, boats or other large battery electric vehicles (BEVs).

Separate subgroups were formed to explore the requirements from their unique point of view: customers, truck & bus OEMs, utilities, site selection and permitting firms, EVSE manufacturers, service providers, hardware manufacturers and cyber security experts. From those inputs, a single requirements document was created, which was further refined by the working group.

The CharIN e.V. made a public announcement and called for contributions to cover this set of requirements. CharIN members and non-members handed in submissions which were reviewed by the working group HPCCV. A CharIN supported common set of requirement proposals will be handed over to the related standardization bodies to enable the creation of a worldwide standard.

2.4.3 Grid Integration

One of the current major challenges is the integration of E-Mobility into the power grid. The energy network faces three major challenges in the years to come:

a. The increasing decentralized production of energy from renewable sources (as opposed to energy production in large central power plants)
b. The balancing of volatile renewable energy production, grid capacities, and energy demands
c. Increasing numbers of Battery Electric Vehicles (BEVs) of all kinds and charging them at locations where the grid was originally designed for much lower energy demand (e.g. in residential areas)

These challenges can be solved only partly by conventional grid expansion. It requires major investments in the electrical infrastructure and digitalization which will take considerable time. Short-term solutions for optimal use and the opportunity to use as much renewable energy as possible are needed.

CCS with its elaborated communication capabilities enables Grid Integration. It uses ISO/IEC 15118 as the communication standard and the upcoming next edition will provide the most advanced features for Reverse Power Transfer (RPT).

For secured, open and non-proprietary data exchange between driver/vehicle and infrastructure/energy system

- For charging execution: charging power can be restricted remotely during a specific time interval, thus allowing interventions from energy providers
- For charging planning: tariff tables and load profile registration allow EV drivers to benefit from demand-driven energy price advantages, and energy providers can use this information in advance for their load planning
- AC and DC charging is supported
- Ease-of-use with Plug & Charge for authentication and billing

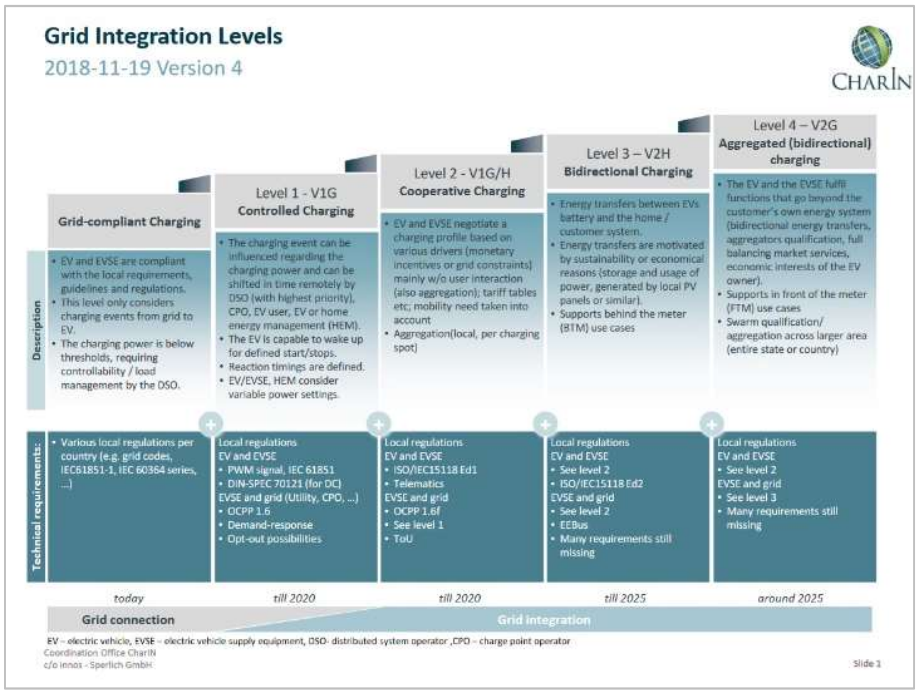

Figure 5: CharIN's five levels of grid integration

2.4.4 Vehicle to Grid Communication

By today's CCS definition, the vehicle to grid communication optimally includes a unified AC/DC Charging Control system, an optimized load management system as well as a simple payment/billing method and additional customer services. The seamless integration of a wireless charging control system, reverse power flow as well as extended smart grid functionalities will make charging of electric vehicles even more comfortable and offer additional business opportunities.

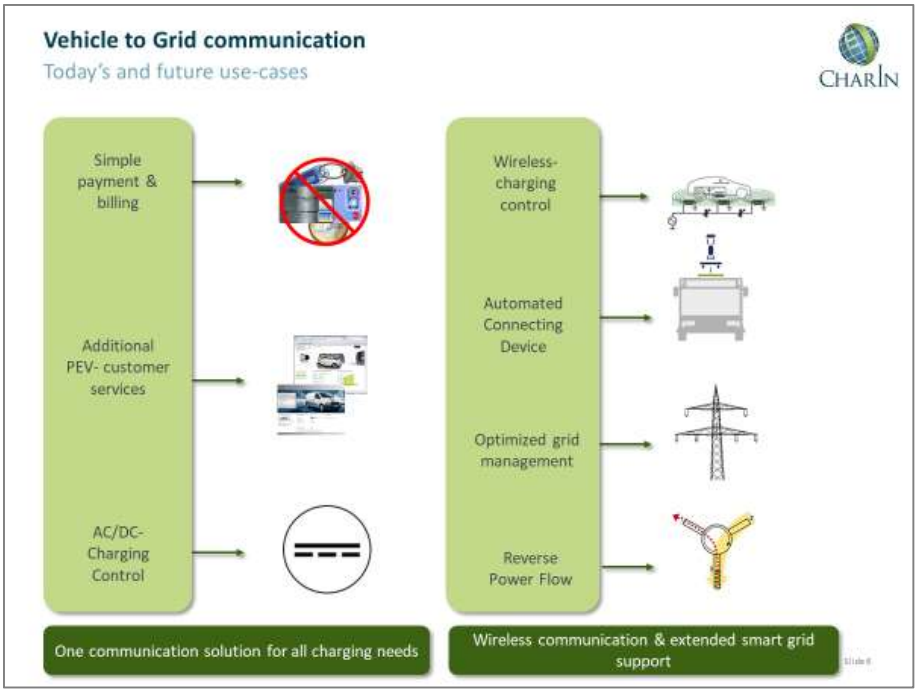

Figure 6: Vehicle to Grid communication

2.4.5 Interoperable wireless power transfer (WPT)

The CharIN e.V. and its members worked out an open specification sheet for an interoperable wireless power transfer system for electric vehicles within the scope of CCS. This industry statement covers the most relevant technical objects to define the requirements for an interoperable wireless power transfer for inductive charging of electric vehicles. Therefore, magnetic and electric interoperability testing as well as test systems referenced in SAE J2954 are described. The positioning, the safety concept and a common ground assembly position in the parking slot is considered. The document will be the baseline for an open specification for all involved parties.

2.4.6 Conformance Tests, Certification and Standardization

The worldwide distribution of the global CCS standard is supported by the activities within the international standardization bodies as well as local governmental regulations. The engagement of universities and research institutes in the field of interoperability and conformance helps to develop it further.

Especially the CharIN supported international “CCS Testing Symposium” format, initiated and organized by the University of Dortmund, brings major stakeholders together to improve the systems quality for a secure customer interoperability. Other similar events are organized by CharIN North America and the Korean Smart Grid Association

The Joint Research Centre (JRC) as the European Commission's science and knowledge service and the Argonne National Laboratory (ANL) as the American science and engineering research center are supporting the system evaluation and enhancement with their broad expertise.

3 Summary

CCS is currently the world’s only charging system that covers all charging scenarios with a single product. Drivers of any type of electric vehicle can choose between normal and fast charging as well as AC and DC and they only need a single interoperable system for all these options. The CCS has the advantage of being used and supported by a significant number of major global companies from different industries.

The CharIN association is unique, as it is comprised of multiple experts across a variety of international industries who work together as a team to make this future oriented system design possible. The association itself is non-profit and open to all interested parties.

Rather than reinventing the wheel, the CCS team focuses on an innovative approach: rethinking existing systems and defining requirements while incorporating and supporting the relevant international standards. The result is an ingenious and future-proof solution that is universal for all electric vehicles and charging scenarios while remaining safe and easy to use. That’s what makes the CCS as the global standard.

The vision of the CharIN e.V. is to develop and establish the Combined Charging System (CCS) as *the* global standard for charging battery powered electric vehicles. Therefore, the association continuously works on expanding its worldwide network by integrating companies on each level of the defined value chain to support and promote CCS. Moreover, drafting requirements to accelerate the evolution of charging related standards plays an important role. Base on this, defining a certification system for all manufacturers implementing CCS in their products is an additional ongoing topic the association is working on together with its members from all over the world.

4 References

[1] *CharIN e.V., www.charinev.org, accessed on 2019-03-05*

[2] *CharIN e.V. - CharIN implementation guide to Plug and Charge in the context of ISO 15118,* https://www.charinev.org/fileadmin/Downloads/Papers_and_Regulations/190130_Announcement.pdf , accessed on 2019-03-05

[3] CharIN e.V. - CharIN endorses increasing charging currents for EVs up to 500 A, https://www.charinev.org/fileadmin/Downloads/Papers_and_Regulations/CharIN_endorses_increasing_charging_currents_for_battery_electric_passenger_vehicles.pdf, accessed on 2019-03-05

[4] CharIN e.V. – High Power Charging for Commercial Vehicles, https://www.charinev.org/hpccv/, accessed on 2019-03-05

[5] CharIN e.V. - Grid Integration Levels, https://www.charinev.org/fileadmin/Downloads/Papers_and_Regulations/CharIN_Levels_Grid_Integration.pdf, accessed on 2019-03-05

[6] CharIN e.V. - Mission Statement Grid Integration, https://www.charinev.org/fileadmin/Downloads/Papers_and_Regulations/Grid_Integration_Mission_Paper.pdf, accessed on 2019-03-05

[7] CharIN e.V. – Industry Statement Interoperable wireless power transfer (WPT), https://www.charinev.org/fileadmin/Downloads/Papers_and_Regulations/CharIN_Industry_Statement_-_Wireless_Interoperable_Power_Transfer_v02.pdf, accessed on 2019-03-05

5 Authors

Claas Bracklo is currently Senior Consultant Electromobility at the VDA, Chairman of the Charging Interface Initiative (CharIN e.V.) and Manager in the power train engineering division of BMW.

He joined BMW in March 2005 and held various senior management positions in research and development with focus on E/E-architectures, system design, hardware/software components and in car networking. Before his current position in the innovation field electromobility he was in charge of body electronics development.

He started his career with Mercedes Benz and Daimler in the development of bus systems technology and introduced the CAN and LIN in car networking. He led several teams in the area of system test, architecture and ECU-development. He was initiator and founding member of the LIN, Autosar and FlexRay consortium and acted as the FlexRay spokesperson in the initial phase.

Claas Bracklo holds a degree in Electrical Engineering from the University of Dortmund.

Michael Keller is heading the Volkswagen Group development coordination for Charging and charging infrastructure. He has more than 18 years' experience in the automotive industry at suppliers and OEMs.

Before he joined Volkswagen in 2010 as head of "energy systems and functions development", he was heading the traction battery technology and battery development at a Tier 1 (Continental).

Michael Keller received his engineer degree for electric in Karlsruhe and was awarded with the "Professor Ferdinand Porsche Preis" of the Technical University in Vienna in 2009 for the "first automotive application of a lithium-ion hybrid battery"