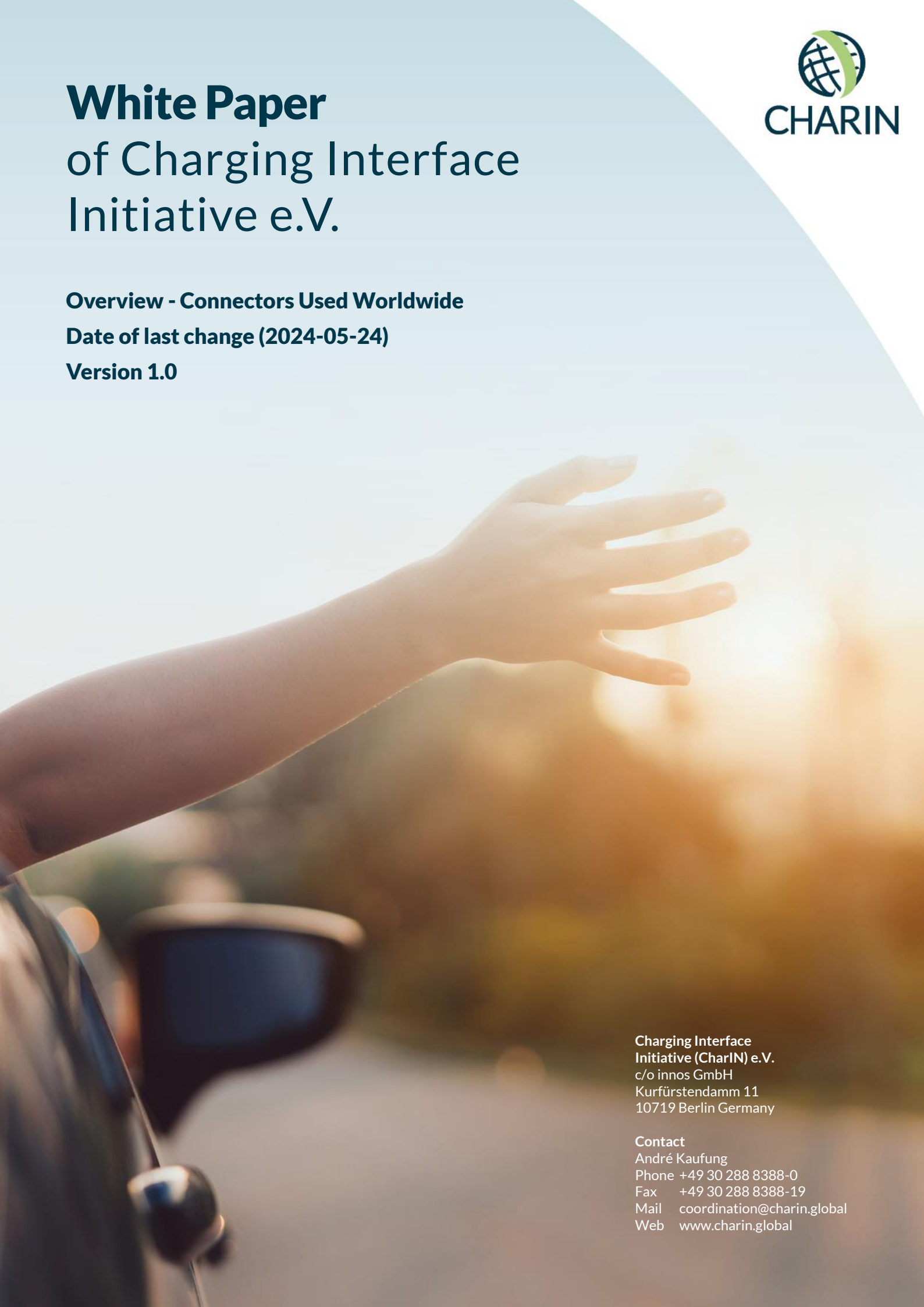


White Paper of Charging Interface Initiative e.V.

Overview - Connectors Used Worldwide

Date of last change (2024-05-24)

Version 1.0



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A harmonized connector approach per geographical region facilitates EV market uptake

CharIN is dedicated to support and establish the Combined Charging System (CCS) as the global standard for charging Battery Electric Vehicles (EVs) of all kinds including SAE J3400, for example, for North America.

In Europe, the mandatory solution is the Type 2 /CCS Combo 2 connector for AC and DC charging. In North America, the Type 1 / CCS Combo1 and/or SAE J3400 connector are available. Based on announcements from the majority of EV OEMs, SAE J3400 is expected to increase in penetration for North America significantly in the near to mid term future. There are many countries that have already integrated Type 1 / CCS Combo 1 and Type 2 / CCS Combo 2 into their regulatory framework, however there are exceptions to this which has led to a mix of connector types in use globally. CharIN recognizes that use of appropriately OEM-designed-&-tested adapters will be necessary during market transition to harmonized SAE J3400 in North America. However, unvetted adapters could cause high safety risks with potential quality issues and do not support a customer friendly charging interface.

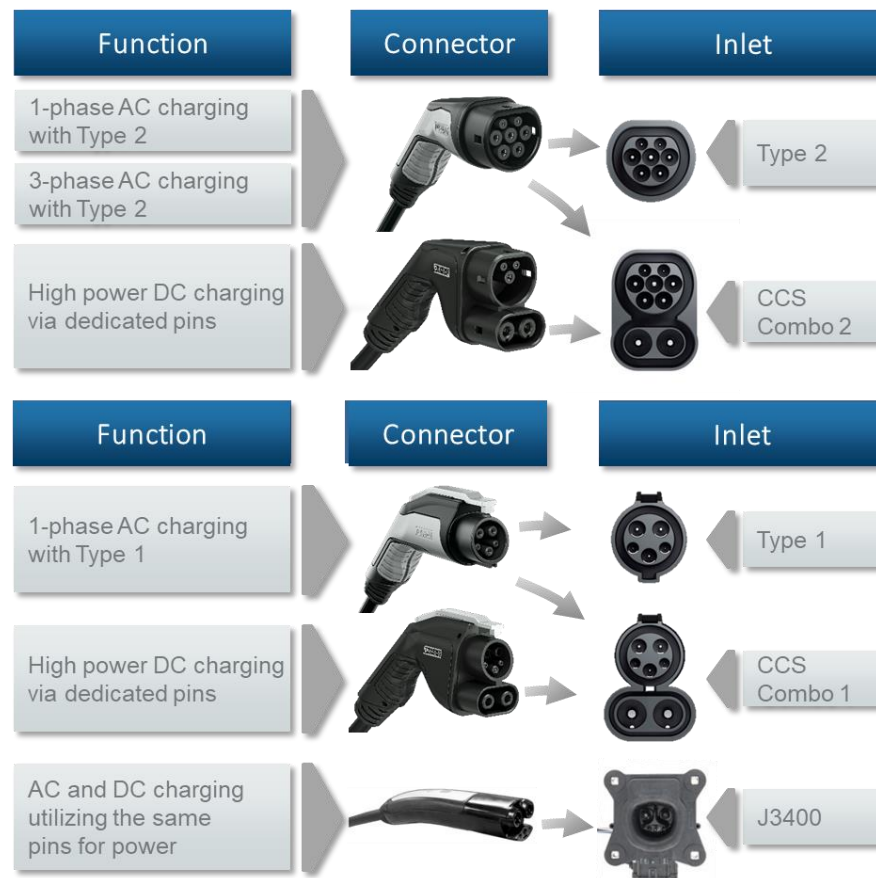


Figure 1: CCS and SAE J3400 coupling devices.

To speed up the market uptake of Electric Vehicles, cross-border travel and charging for commuters, deliveries, and tourists as well as interregional trade of (used) EVs must be possible.

Market Map

CharIN therefore recommends a **harmonized connector approach per geographical region** as outlined in the below map:

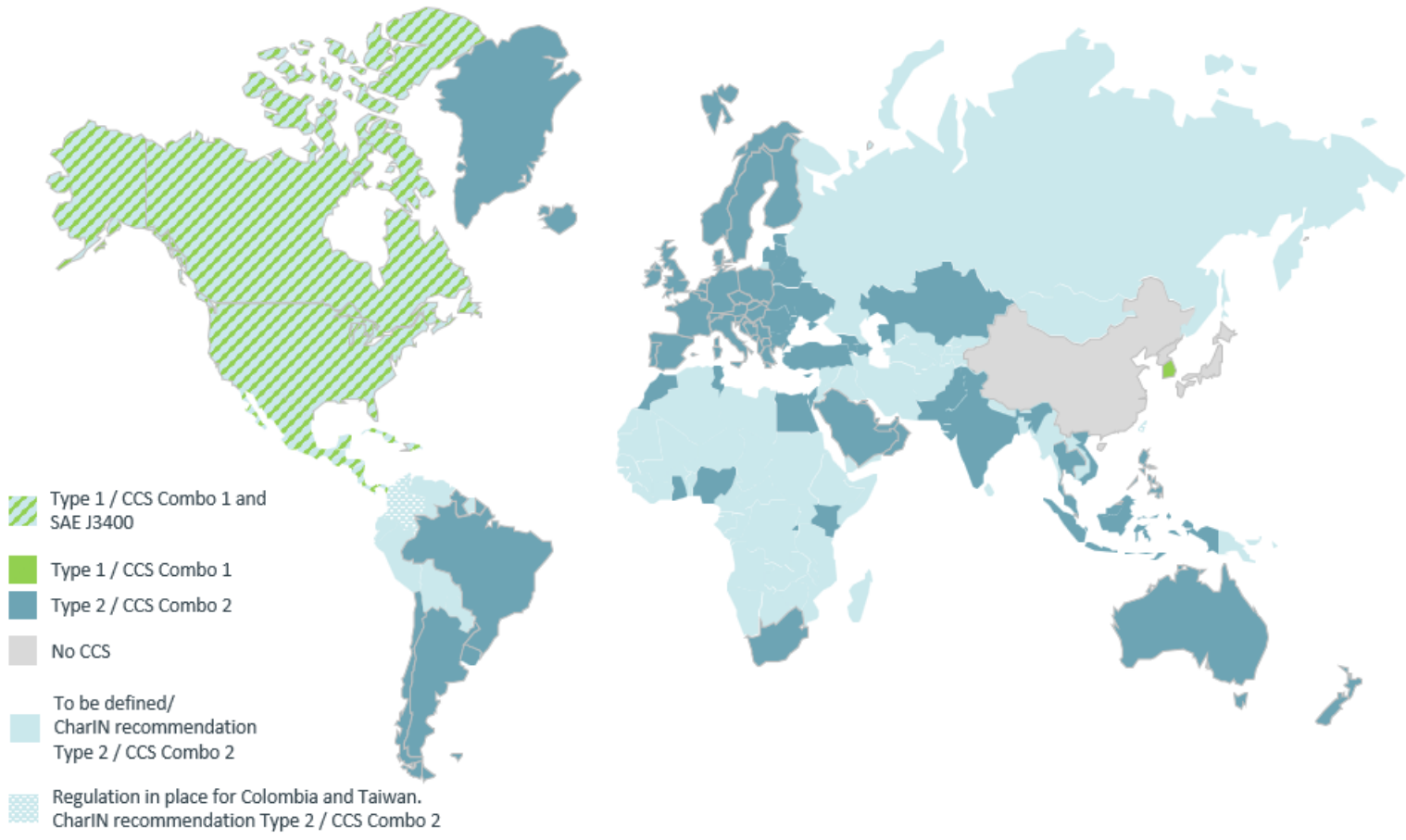


Figure 2: Connector World Map.

Specific Markets

Country	Comment
Colombia	Regulation requires minimum CCS Combo 1 to be installed in public places. CharIN sees benefits using CCS Combo 2 for easy cross border travels and avoidance of adapters.
Mexico and most likely countries from Mexico south to Panama	With regard to cross-border travel, Type 1 / CCS Combo 1 and SAE J3400 is recommended, but there is a lack of three phase support with this connector.
Singapore	Regulation requires minimum CCS Combo 2 to be installed in all places.
Indonesia	Regulation requires minimum CCS Combo 2 to be installed in public places.
Taiwan	Regulation requires minimum CCS to be installed in public places. (Note: both CCS Combo 1 and CCS Combo 2 are installed) With a tendency to go for CCS Combo 1.
Korea	CCS Combo 1 is the required standard.
New Zealand	CCS Combo 2 is the preferred standard. However, CHAdeMO are expected to be installed alongside CCS Combo 2 due to large volume of 2 nd hand EVs imported from Japan.

Opportunity for CCS Combo 2 as single connector for many markets (except USA/NA): Example South American Charging Standard.

Market arguments:

- ✓ Single phase markets on CCS Combo 1 need to decide for SAE J3400 or CCS Combo 2. Migration via "multi-outlet-charger" recommended (no adapters).
- ✓ We see a potential replacement of CCS Combo 1 by SAE J3400 in the medium term.
- ✓ Volume in the market is currently still manageable.
- ✓ Example: Brazil is on CCS Combo 2 which was driven by the vehicle supply side.
- ✓ Regulation only optional (less effort) if industry is following the CharIN recommendation.
- ✓ Currently SAE J3400 is not yet established in the market, thus less infrastructure is available.
- ✓ Only one inlet and only one charging architecture to allow low overall system costs.
 - CCS economy of scale (industry better prices).

Technical arguments:

- ✓ CCS Combo 2 is superior to CCS Combo 1 and SAE J3400, because of fundamental 3-phase support which allows interoperability between countries in the region, regardless of the grid phase configuration (grid-agnostic - also in America there are CCS Combo 2 depots/delivery vehicles) as well as single-phase application support.
- ✓ Safe AC/DC distinction in the ramp up phase.
- ✓ Easy migration based on existing standards.
- ✓ Charging voltage up to 1.000 V and current greater than 400 A (500 A installed already).
- ✓ State of the art communication via ISO15118 enables integration V2H and V2G.
- ✓ Clarity about Power Classes.
- ✓ Conformance test program to improve Interoperability already tested and in place.

Opportunity for MCS as single connector for all markets

- o CharIN is dedicated to support and establish the Megawatt Charging System (MCS) as the global standard for charging commercial Electric Vehicles with large batteries and high-power demand to be charged within a reasonable time. Besides the truck and bus industry MCS is recommended for other electric mobility applications in the maritime and aerospace industry.
- o As a demand driven technology defined by CharIN, MCS is in its final stages of standardization and has no legacy issues or regulatory restrictions and has strong support from the US and EU governments. A harmonized connector approach per geographical region is not needed for market uptake.



Figure 3: MCS coupling device.