

Institutional dimension

The institutional dimension represents the rules that govern the interactions between the system components. Institutions can be formal or informal, and they can apply to different levels of the system. Institutions are not to be confused with physical or social structures. It is all about the rules that *define the game and how the game is played*. Informal rules may be derived from the generally accepted norms and values of a society, which are linked with persistent customs and traditions. Formal rules may be embedded in law and regulation. Formal rules may dictate, for example, that power grids are regulated networks under public ownership, and that energy services are to be provided in a competitive market. Formal rules also define whether charging infrastructure provision is a regulated public utility service or a commercial service. Institutions are man-made rules, in contrast with the laws of nature that largely define the behavior of the physical system.

Standardisation

However, even in the physical system institutions play an important role. Prominent examples are operating and maintenance procedures, and technical standards. In the world of electric vehicles multiple standards exist for charging infrastructure. For fast charging, four major standards are currently being used: The European CCS standard, the Japanese ChadeMo, the Chinese GB/T and a standard developed by Tesla. All four standards deliver the same electricity to the car.



Multiple standards lead to additional hardware costs or to reduced accessibility of charging infrastructure for EV drivers, since charging stations do generally not provide for all four standards. The *setting of standards*, however, is not a straightforward matter of technical optimization for safety and user comfort. Standard setting is generally a lengthy process of negotiation between public and private stakeholders, in which huge economic interests may be at stake. It should therefore not surprise you that many infrastructure systems are still a long way from the ideal situation of a single standard. Think for example of the different railway gauges around the world.



• CCS Europe



• Chademo



• Tesla US/EU



• China GB/T standard

Charging transactions

Another example of how institutions matter is concerned with the processing of *charging transactions*. As can be seen in the image below, the transaction at a public charging station involves many different actors, which communicate through



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a large variety of *technical standards*. In this emerging market, the roles of each actor are not yet set in stone. This image shows a situation in which a charging station can be operated with a charging pass owned by a mobility service provider.

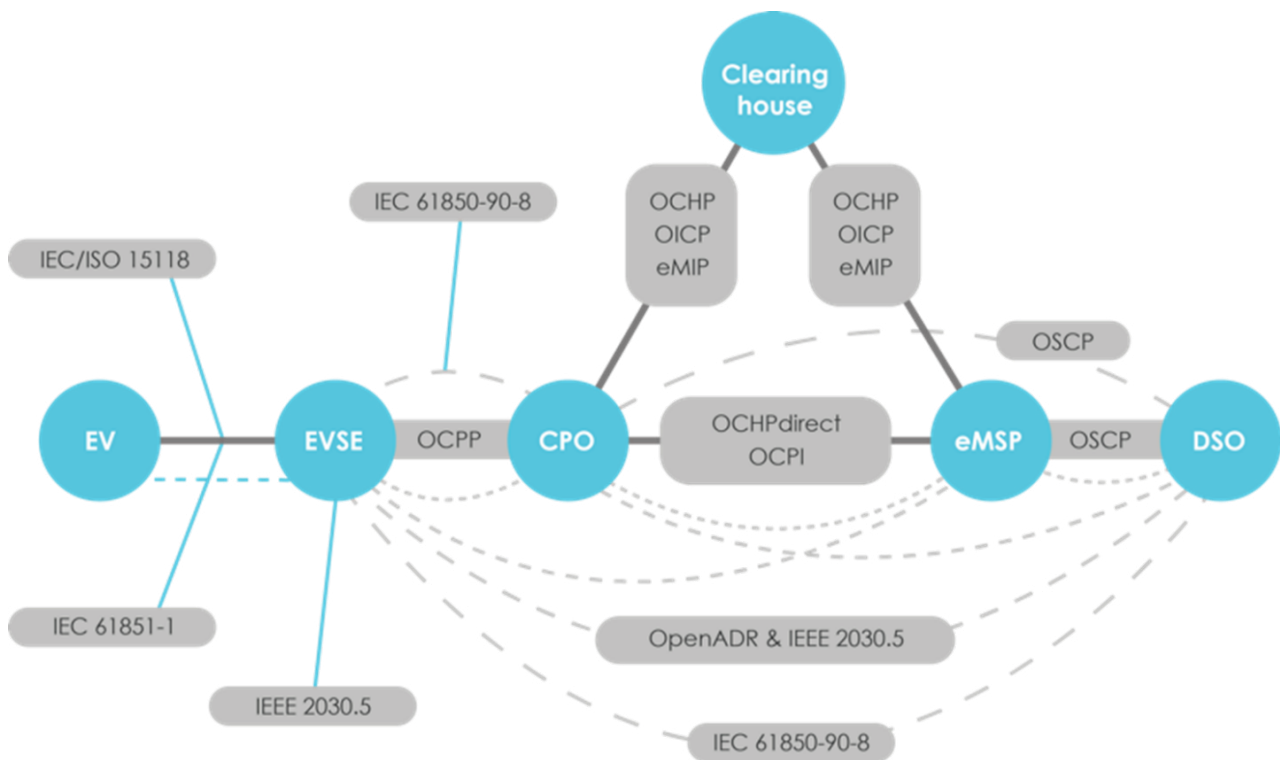


Figure: Protocols needed for a charging transaction at a public charging station.

Source: ElaadNL

The charging point operator and the mobility service provider communicate via a clearing house to validate the transaction. Some actors in the field, however, are advocating the use of ad-hoc payment solutions in which different actors are involved, while others prefer using a mobile phone app which replaces the role of the mobility service provider. At this point in time, it is still uncertain which of these options will be the winning one.



Smart charging

Similarly, there are still *many unknowns* in smart charging. As previously discussed, smart charging entails the alignment of battery charging with the supply of cheap electricity during times of low demand or abundant supply from renewable resources. The role of aggregators is to aggregate the charging demand of a collection of electric vehicle owners to the extent that they can bid in different markets, ranging from local load management to the provision of balancing services to the regional or national transmission system operator. It is not yet clear which rules and communication protocols shall apply to the interactions between these actors. It is evident that institutions are needed to ensure that all actors are treated fairly and that the system delivers positive outcomes for society.



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