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Establishing a comprehensive residential/workplace charging solution provider

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Summary

Alongside the emerging electric vehicle market, the according challenge of providing complementary charging solutions becomes clear. Unlike today OEMs will be required to fulfill customer demand for a residential or workplace based charging solution. The business models of companies currently active in this market don't fully meet the needs and challenges of OEMs as well those of their customers. From this starting point a new comprehensive charging solution is being developed. This end-to-end solution is built on a three pillar approach of charging hardware, installation and smart services for the customer.

Keywords: electric vehicle charging, business model, charging services, home charging

1 Introduction

E-Mobility is on the rise. Policy makers the world over are developing plans to abolish ICE-Powered vehicles, and electric vehicles are foreseen as the leading means for future personal transportation that will fill the gap. Today, beside the still limited availability of vehicles, charging is seen as key to the industry's future. Whereas the debate focuses on the lack and possible future of public fast charging stations, studies show and experts forecast that the overwhelming majority of range will be charged at home or work [1]. Therefore, a comprehensive charging solution provider is needed. The following paper aims to give insights how to establish a successful partner for customers in the field of residential and workplace charging.

The paper is structured as follows: The second chapter will provide information about the current market situation of electric vehicles and charging solutions, and the problems and questions end customers as well as OEMs are facing with regard to workplace and residential charging. Chapter three answers the questions that arose from the previous chapter and shows how to establish a comprehensive charging solution provider for home and workplace charging by using an end-to-end charging solution approach. The paper ends with a short conclusion.

2 Electric vehicles and charging solutions

2.1 Market assessment

One of the main drivers for European car manufacturers towards E-Mobility is the European union. In order to reduce pollution the regulation (EG) Nr. 443/2009 with its latest change (EG) Nr. 333/2014 has been decided. The goal of this regulatory action is to reduce the fleet consumption of a car manufacturer towards a value of 95 g CO₂/km from 2021 on [2]. Similar actions are conducted in China, where from 2018 on 8% of all sold cars have to be electric or hybrid vehicles [3]. Thanks to those eco-friendly policies and several initiatives, the market for electric vehicles is rapidly growing. From approximately 500 000 cars worldwide in 2015, the number of cars with an electric engine is forecasted to reach the 7 million mark in 2023 [4].

Like Henry Ford, who had to face the problem of missing petrol stations when selling his Model T, nowadays the charging infrastructure has to be put in place to support mass adoption of EVs. The positive development of sales caused problems with regard to charging solutions, as providers couldn't keep the pace of OEMs. Today's charging solutions market is widely fragmented with many players involved, depending on the segment and country. Whereas most optional equipment and accessories for new vehicles are sold directly by the OEMs, charging solutions are nowadays very often sold via various alternative sales channels. These players are pushing to establish charging ecosystems, including roaming, billing, entertainment and add-on offerings. This leads, from a customer perspective to a market that lacks of transparency. This presents an issue, particularly with respect to the future development of electric vehicles. It's estimated that in the future with every sold vehicle one residential or workplace charging solution will be sold.

2.2 Characteristics of charging

Compared to ICE fueling, customers buying a car with an electric engine face a whole charging options universe. Once the user has gained a clear overview what the market offers and the solution that fits perfectly for him and his car, he will experience a new level of comfort. In comparison to an ICE fueling at a petrol station, filling up the "electric tank" is much more convenient. The owner of an electric vehicle has the petrol station, which is then a charging station, at home, office or car parks and therefore saves time and spares nerves.

In general, there are two approaches with regard to charging. The concept of conductive charging and the inductive charging approach. The paper just describes the characteristics in conductive charging, inductive charging is still under development and not yet relevant for home and work charging. Within conductive charging the driver of an EV can choose between alternate current (AC) charging and direct current (DC) charging. AC charging is compared to DC charging a rather easy technology. On the one side the charging process takes longer but on the other side it is much more cheaper for the customer, who faces prices of DC Wallboxes that are up to 20 times higher compared to those of AC Wallboxes. Within AC charging there are several charging plugs, depending on the car used and the country the car is driven. In the US with single-phase grids the IEC 62196-2 Type1 plug is used, whereas in Europe with a three-phase grid, the IEC 62196-2 Type 2 is common. China uses a completely different charging plug with the GB/T. The same variety of charging plugs holds for DC charging. At the moment there are three different charging solutions used, namely the Combined Charging System (CCS) for Type1 and Type2 plugs, as well as the CHAdeMO system and the GB standard. Table 1 summarizes the charging plug

Table 1: AC / DC Charging Plugs

Standard	AC Charging			DC Charging				
	IEC 62196-2 Type 1	IEC 62196-2 Type 2	GB/T	CCS Type 1	CCS Type 2	CHAdeMO		GB
Country	USA, Japan	Europe	China	USA	Europe	Japan	Europe	China
Max. Phases	1 to 2	3	1					
Max. Voltage	250 V	500 V	250 V	600 V	1000 V	600 V	500 V	750 V
Max. Current	32 A	70 A	32 A	200 A	200 A	200 A	200 A	250 A

Electric vehicles sold today are commonly delivered with an ICCB (In cable control box), that is capable of power up to 3,6kWh if attached to the right socket. Even in markets with high EV penetration rates, like Norway, those cables are used by more than two thirds of BEV and nine out-of-ten PHEV owners. This type of vehicle charging bears two major flaws: charging speed and safety. Generally residential or workplace charging processes are not as time critical as public charging, since the car is normally parked for at least eight hours. The bigger problem is that today's available charging products do not commonly have any connection to the grid nor the ability to control the amount of power delivered. This may not be a problem now, but with raising numbers of EVs local grids may not be capable of the drawn energy. Certain policy that will make communication and remote power control mandatory by governments/PCB is already foreseen. Even today some countries and power suppliers won't allow EVSE, which is incapable of load balancing on several levels. In response to those safety requirements, a sustainable and a future-orientated charging station has several safety features to protect the user from potential electrical and fire hazards while connecting, charging and disconnecting the electric vehicle. The charging station gives information about the amount of power available to the vehicle connected. After that, the vehicle takes over the full control of the charging process. In case of an electrical fault, the charging station stops the power transfer immediately.

Whereas most optional equipment and accessories for new vehicles are sold directly by the OEMs, charging solutions are very often sold via various alternative sales channels. It is a typical multichannel business enabling a variety of business models: Hardware sales with or without installation services, solution providers, distribution or manufacturing. With evolving EV quantities and progressing commoditization of both charging hardware and their installation, sales via the OEM will massively increase. Charging solutions will be sold as a part of the EV – a complete package for the customer. While selling hardware isn't too different to selling accessories, the selling and packaging of services isn't necessarily a key competence of OEMs

2.3 Questions customers are facing

With regard to the points mentioned above, buying a car that contains an electric engine isn't over at the car dealer. For most customers the exhausting search for a comprehensive charging solution begins. During this process the several questions need to be answered:

- *Which charging solutions fits for my EV?*
Regarding the charging solutions, customers have to take into account the different charging plugs and charging modes that are currently available.

- *Which charging solution do I need for my requirements?*
The customer has to consider how much time he has to charge his electric vehicle and in consequence he needs to choose the most appropriate charging solution.
- *Which charging solution can be installed in my house or garage?*
In relation to the installment the customer has to know for example the power connection of his residential area and the different possibilities arising from those conditions.
- *Who installs my charging solution?*
In order to grant the best quality and trouble-free charging, the customer needs support to install the charging solution at his place.
- *Who is there in case I need help with my charging solution?*
In case of problems the customer faces the question where to address those issues to.

At the moment the customer doesn't have a single contact partner to answer all those questions. From this starting point the need for a more comprehensive and easy approach towards charging in the residential and workplace area emerges.

2.4 Questions OEMs are facing

In times of constant change, OEMs have to cope with a bundle of different and new fields of innovations. Current developments like E-Mobility, digitalization, autonomous driving or new business services/cases are the main trends car manufacturers have to grapple with. In this context, charging solutions do not really signify a business model for OEMs. The biggest part of currently offered charging solutions are semi-professional, non-automotive, local, low volume and not yet integrated. The market is not transparent and inhomogeneous so far, the standards for hardware and software are just being set. Furthermore, pricing is far away from mass adaptation.

Following questions are relevant for the OEM in order to charging solutions:

- *How to ensure brand recognition as a OEM at the customer's garage or parking lot?*
Are charging solutions part of the OEM strategy to provide new energy solutions as an OEM for electric vehicle customers?
- *What kind of "intelligent" or "non-intelligent" charging infrastructure is needed in the OEM Portfolio?*
Which kind of intelligent (smart) charging infrastructure or not-intelligent charging infrastructure is needed for the various customer groups and use-cases?
- *What next digital charging services have to be considered for charging hardware and software?*
What are the relevant requirements through the ISO 15118 standard in relation to digital charging solutions?

With respect to the difficulties faced by customers and OEMs, the following chapter presents a comprehensive charging solution that aims to solve those problems.

3 End-to-end charging solutions

In order to do so, a new approach towards residential and workplace charging is needed. With this background a charging solution, that is fully integrated into the OEMs processes, is the right approach. The goal is to seamlessly cover the entire charging value chain. That means being a charging solution provider, who offers a “one-stop-shop” solution, supporting the OEM in the field of charging and further providing answers to the questions customers are facing. The expected high volumes through that channel, combined with the desired seamless integration requires the solution provider to have strong knowledge of how the automotive industry and especially the OEMs work.

Seamless integration to fulfill the customers’ expectation requires the supplier to be able to completely cover the OEMs’ desired product portfolio. Therefore an end-to-end charging solution based on three pillars has to be developed, making it possible for the customer to choose the system which fits best to the specific requirements. The three pillars, hardware, installation and services are described in the following.

3.1 Hardware

The first pillar a comprehensive charging solution provider needs to build, is a premium hardware solution. Derived from the different demands of charging solutions, which are described in chapter 2.2, a wide range of charging products from ICCB, AC and DC charging solutions is needed. To fulfill customers and OEMs requirements, any charging solution provider should be able to deliver those hardware systems. With respect to future developments, the integration of wireless communication to enable charging services such as load management or billing is a decisive factor. Another important factor is that the charging solution resembles the OEMs CI, because the charging solutions are mainly distributed via the OEM channel. A high-quality design-to-cost hardware will enable OEMs to sell their branded solutions at a very attractive price-point, or even deliver it as series equipment. With a strong charging solution provider at its side, the OEM can fully focus on the customer sales process.

3.2 Installation

The installation of the offered charging solution is as vital as the hardware itself. To get the full advantages of charging the electric vehicle at home or at work, the right and professional installation is needed. At the moment, most providers do not offer an sufficient installation service. The proper installation of the charging hardware is a complex process because every installation is different depending on the circumstances given - there are no installations, that are exactly equal. In consequence, the installer has to react to specific surroundings, thus the installment is usually expensive. Any charging solutions provider aiming to offer a comprehensive solution should therefore offer a premium installation, conducted by trained installers, knowing the surroundings and the charging solution installed. In order to make charging at home or at work as convenient as possible an understandable training of the end customer is necessary. For the solution provider, the high amount of conducted installations will enable the process to be industrialized and thereby lower the costs significantly.

3.3 Services

Value added services and data access are key to sustainable revenue streams. Therefore, the establishment of a connected charging ecosystem to provide the OEMs, the utilities and the customer with information and controllability regarding their charging stations is key. Load management is one of the most important services enabling simultaneous EV charging without the problem of blackouts while charging the EV. This service manages and balances the available power amongst the charging stations. Another very important issue in services is transparent billing of charging services. As the majority of electric vehicle owners wants to charge at home or at work, companies face two major challenges. If the driver has a company car and charges at home, his expenses need to be refunded. This is similar to the use of a fuel card. Another use case is the tracking of charging activities at the company site. With the right billing services, companies can track the persons that are using their charging stations and can therefore decide how to handle the payment

of the charging service. Basic requirements to all of those services are the information about the static and dynamic status of the charging station, authorization to charge, the reservation of the charging stations in advance as well as the delivery of charging transaction data (charge detail record) via backend systems. For the interoperability between various digital charging and service systems, Roaming technology is essential. Therefore, a charge point operator (CPO) enable customers of another E-Mobility provider (EMP) to use its charging solution, while the interaction between the backend systems of EMP and CPO is ensured by Roaming platforms. All of these services are relevant for public and semi-public charging solutions, but even for private persons who want to offer their charging solution to others, the named services are indispensable.

These are all services a charging solutions provider needs to take into account when thinking about a comprehensive charging service.

The importance of charging services is increasing significantly, as the ISO 15118 standard laid the foundation for the communication between electric vehicles and charging infrastructure. Digital services for electric vehicle charging will be improved thanks to the new communication standard and certificate based interaction between charging stations and electric vehicles.

Those three pillars, namely hardware, installation and services are necessary for a fully integrated charging solution. By successfully covering all aspects, a sustainable business model and consequently a successful provider will be established in the field of charging solutions for residential and workplace charging. A comprehensive charging solution provider, as a result, helps the OEM to focus on their core business and makes charging more easy for the electric vehicle owner.

4 Conclusion

The automotive sector is on its way towards E-Mobility. Regulations as well as advanced and attractive vehicles are the drivers of strong and steady growth. However, this development is not sufficiently covered by charging solution providers. Today's market is still fragmented and not yet transparent, resulting in customer dissatisfaction with respect to charging solutions. With regard to current developments and future requirements of charging solutions, only partners that are able to deliver high quality products and professional solutions will satisfy the requirements of OEMs as well as those of end customers. Therefore it's necessary to establish a comprehensive charging solution provider for residential as well as workplace charging. In order to do so, an end-to-end solution is the most comprehensive approach. Via advanced and smart hardware, the customer shall be well prepared for future developments such as smart communication. In a second step, correct installation by a trained installer ensures security and convenience for the user. The last feature that is essential to a comprehensive charging solution is the provision of services, such as load management or billing. Any supplier of EVSEs able to manage those requirements will be in a position to offer a charging solution that covers the needs of both car manufacturers and electric vehicle drivers.

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