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Charging Stations for electromobility: from regional to nationwide

Use-case of a German energy supplier

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Summary

Since the beginning of our engagement in charging infrastructure in 2012, we have found that the establishment of charging infrastructure has led to an increase in company reputation as well as an increase in revenue in EnBW's core business. In this paper, we argue that a charging infrastructure will in future be one of the most essential products complementing the regular household electricity product. Therefore, EnBW's plans to expand its charging infrastructure from regional to national and eventually to international level is expected to be associated with a massive positive impact on EnBW's core business.

Keywords: business model, case-study, fast-charge, infrastructure, market development

1 Background

The energy revolution, that means the transition from non-sustainable usage of fossil energy and usage of nuclear energy towards a sustainable energy supply with the help of renewable energies, changes the strategy of energy utilities tremendously. For EnBW, electromobility is a core element to succeed in an ongoing business transformation process and to help managing the energy revolution in Germany.

EnBW has begun building AC-charging infrastructure in 2012 with a regional focus on the south of Germany; in the state capital of Baden-Württemberg, Stuttgart, EnBW has been installing and operating AC-charging stations, which, in particular, has been used by the carsharing fleet of Car2Go.

In the following it is described, how EnBW uses electromobility to help going through a process from supplying energy to a company that manages energy in any manner whatsoever.

1.1 Electromobility as part of the energy revolution

Electromobility, especially battery electric Vehicles (BEV), has to be seen in a wider perspective than just a key enabler for a soon-to-be mobility.

By the use of BEV instead of petrol cars, since there are no exhaust gases, the local CO2- emissions can be reduced significantly. Thus, e-mobility is the main driver for the decarbonization of the transport sector as

one of the political targets. This can only be ensured if the electricity used for charging BEVs is generated from renewable energies [1].

Reversely, renewable energies bring along a certain volatility with regard to the power input. In order to cope with issues like surplus energy, electric cars could be part of a storage system for electricity grids, the so-called power-to-mobility technology [2]. As said in the EnBW annual report of 2016: "Electromobility is connecting the energy and transport sectors, while private households with their own generating capacity and a desire for autonomy are joining together in communities to share their energy and thus form virtual power plants [3]."

Also, there are certain consequences coming along with this new mobility behaviour. If many electric vehicles are charged simultaneously, high peak loads can occur in local areas. Certain difficulties for a grid operator come up in the private sector due to a rapid increase of electricity demand through charging BEVs. Since the grid is not designed for these cases yet, grid operators need to be prepared to avoid an overload or a costly expansion of the grid. This seems to be one of the most decisive challenges for grid operators to get the grid ready for e-mobility [4].

Electromobility is a crucial element on the way to an emission-free future in the transport sector. In fact. it takes more than a wide range of electric vehicles and a sufficient amount of charging infrastructure; e-mobility requires along different value adding areas, a cross-linking between energy systems, storages and changes in demand and consumer behavior. That will be a main success factor of tomorrow's e-mobility as well as the energy revolution as a whole.

1.2 Electromobility as driver for internal transformation process

As part of the energy revolution, electromobility is also a core element for the future alignment of companies coping with energy supply and grid operation.

The energy sector is facing a radical change. This change is justified by the climate protection and its associated trends like decentralization and decarbonization forcing energy companies to rethink their business model. Due to the technical advancement as well as the trend of decreasing costs, the proportion of renewable energies is increasing steadily. Also, the changing demand of customers (e.g. municipalities, industry, households) and their striving for self-sufficiency and sustainability have been contributing to the transition of an energy supplier to an energy company, managing all types of energy related issues.

EnBW was one of the first energy companies in Germany that decided to change drastically. As a crucial measure against the changing macro- and company environment, the Strategy 2020 has been compiled by chosen employees in tandem with the board. With a new group structure and a new management model as the core elements of this strategy, EnBW AG is transforming from an investment-based organization to a customer-oriented company.

Moreover, EnBW decided to put more emphasize on infrastructure aspects of existing business areas but also to seize the chance of new growth opportunities beyond the energy sector. The extensive knowledge gained in the core competences operation and management of critical infrastructure can be used optimally in other areas such as charging infrastructure for electric cars. It connects the energy and transport sector and gives rise to new markets and therefore new business models [5].

The target growth of EnBW is intended to happen in the fields of renewable energies, regulated grid business and through new and innovative services in accordance with the three D's: decarbonization, digitalization and decentralization. E-mobility is complying with all three principles on the way to a sustainable change of the transport sector and can play a decisive role in the matter of self-sufficient energy supply as mentioned in chapter 1.1. Complementing the e-mobility offer, EnBW facilitates the access to charging stations including the payment handling by offering digital solutions to end-users. Therefore, digitalization plays a key role for electromobility regarding e-mobility related services as well as customer retention [6].

Hence, e-mobility is an important component for the transformation of the energy and the transportation sector. This upcoming change needs strong players that made it to their mission. EnBW as today's innovative partner of infrastructure gets in on the act to contribute to a sustainable future.

1.3 Getting started with AC charging infrastructure in southern Germany

EnBW got started with AC-charging infrastructure in 2012 with a regional focus on the south of Germany; in the state capital of Baden-Württemberg, Stuttgart, EnBW has been installing and operating AC-charging stations, which, in particular, has been used by the carsharing fleet of Car2Go. Up to Mai 2019, 1.000.000 charging sessions, around 6.000.000 charging hours and 8.5 TWh (=8.500.000 kWh) delivered energy are expected. This shows the experience gained with building, operating and billing charging stations for the last 7 years.

In the early history of electromobility at EnBW, several research activities along with field tests have been conducted. The results could be transferred into products and services for customers and end-users. The initial focus was on AC-charging infrastructure in Southwest of Germany within first projects such as the "living-lab BWe mobil". A region-wide charging infrastructure with 500 charging points had been established and, furthermore, the acceptance and dissemination of e-mobility by the public should be facilitated. Apart from these main targets, EnBW has also pursued the design of new business- and tariff models and innovative developments for the breakthrough of electromobility, such as inductive charging [7].

The experience with operating AC-charging infrastructure was a major driver to come to a decision for a new focus on fast-charging. However, not all challenges were clearly visible at that point.

2 Challenges

Thinking about entrepreneurial challenges in the context of emerging technologies and innovative markets, this might bring you immediately to missing regulations, vague political orientation and a fuzzy picture of consumer demand. However, on the issue of electromobility, those challenges seemed to be overcome, due to long-lasting research funding programs that have already been started a few years ago. In fact, there are still challenges in regulatory terms, but they will not be considered further in this paper. Instead, the focus will be on internal strategic alignment and economical challenges that has been occurring during the 'electromobility journey'.

One of the challenges of electromobility, and especially charging infrastructure is that it is not a regional but instead a nationwide or even a pan-European task when it comes to travelling by EV. Without possibilities of extending the range of current EVs by intermediate charging in a very short time, EVs will not be seen as suitable for daily use. This can only be realized by DC-fast-charging infrastructure. How can an energy utility like EnBW help to overcome those still existing challenges?

2.1 Entrepreneurial Alignment

First of all, it has to be stated that EnBW is a regional energy supplier, native in the southwest of Germany. That means, original activities of EnBW commonly stopped at the boarders of Baden-Wuerttemberg. As long as the company operates AC-charging-infrastructure in a regional context and with a strong focus on municipalities, EnBW does not have to change a lot and could act in a usual manner.

In the case of DC-fast-charging, the rules may change. For a start, sales and distribution have to be adjusted to a new target group of customers, which are in addition to municipalities; whilst AC-chargers are indeed very frequently found on communal property as charging and parking spots concurrently, the usage of DC-chargers is thought for a shorter stay; that is why sales and marketing activities, concerning fast-charging products, aim at site operators where a typical customer (and therefore the user of the charging station) stays between 15 – 60 min. Hence, depending on the site operator, his kind of business and the type of product needed, there is a focus on strong advisory sales forces and on classical sales offers simultaneously. The products as well have to be aligned, appropriate for the new target group and adjusted to a variety of new requirements. Furthermore, acting in a broader distribution area forces a regional player like EnBW to extend the network of construction service provider and other providers as well.

Apart from these points, there is a central question about how EnBW is willing to interact with the market; is it sufficient to act as charge point operator (CPO) or is it important for a successful business to embody further roles, e.g. providing access to charging infrastructure via charging card or digital access medium? That role is called electromobility service provider (EMP or EMSP) and its necessity is discussed further in

chapter 3.1. Nevertheless, when you decide to establish a business division with several key tasks, it is elemental to intelligently mesh those activities to increase a joint leverage.

2.2 Market Challenges

While internal challenges have to be solved in-house, market challenges affect the whole business ecosystem of electromobility. Since the beginning of national research funding programs, the moderate number of EV-users has just slightly been increasing over the years (see table 1). Business activities normally base on expected values of investments; in this case, the expected value draws upon a scientific based market ramp-up curve. However, in matters of EV users, numbers are still catching up with reality (see figure 1).

Table 1: EV registration and total stock 2014 – 2019 in Germany [8,9]

	New approval	Percentage change on prior year	Total stock	Percentage change on prior year
2014	8.522	40,8%	12.156	70,9%
2015	12.363	45,1%	18.948	55,9%
2016	11.410	-7,7%	25.502	34,6%
2017	25.056	119,6%	34.022	33,4%
2018	36.062	43,9%	53.861	58,3%
2019*	9.285	-74,3%	83.175	54,4%

Considering business cases, there is a second obstacle that has to be overcome: high expenses for DC hardware and grid connection. Savings potential is even at high scaling just minimal, as grid connection is always a new project at each location and therefore hardly scalable in terms of costs [10].

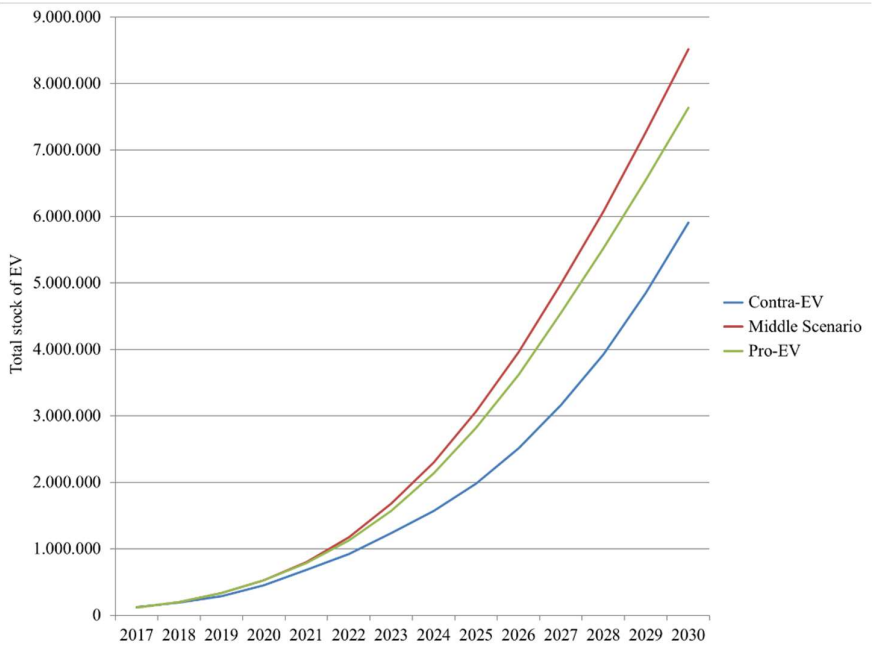

Figure 1: Three Scenarios for the electromobility vehicle ramp-up until 2030
(Source: own calculation based on [11])

Third challenge, which is more a showstopper at all, is the available – or rather not available - grid capacity. When cities were built, they were not designed for electromobility and its charging demand. Residential areas that are mostly supplied by a low-voltage grid, struggle with providing charging capacity with access at any time. Even medium-voltage grid which can mainly be found in suburban areas and next to motorway highways sometimes reach its limits when very high-power capacity is needed for fast-charging. Fortunately,

grid operators are about to extend the grid step by step and in a needs-oriented way. Also, there are further options, e.g. the usage of buffer storages which also complies with the expansion of renewable energies [12].

To sum up, there are some obvious difficulties that have to be observed and assessed correctly to accurately judge the risks. Therefore, strategy has to be chosen wisely.

3 Strategy Focus

First of all, it is important to understand how people are going to use their EV, in particular where and when it will be charged in future. Considering physical limits and technical practicability, it is hard to believe that a battery-electric vehicle can be equally fast charged as a car with combustion engine. However, there is one crucial benefit of BEVs: users do not have to go necessarily to a service station; charging is supposed to be integrated in a daily routine. So, it should be available at home, at work, at public places, during shopping trips and on the road [13]. Though, at each location type the length of stay differs and therefore each one of those locations has a specific usage potential. These characteristics also decide whether DC-fast-charging or AC-normal-charging can reasonably be applied at a specific location [14].

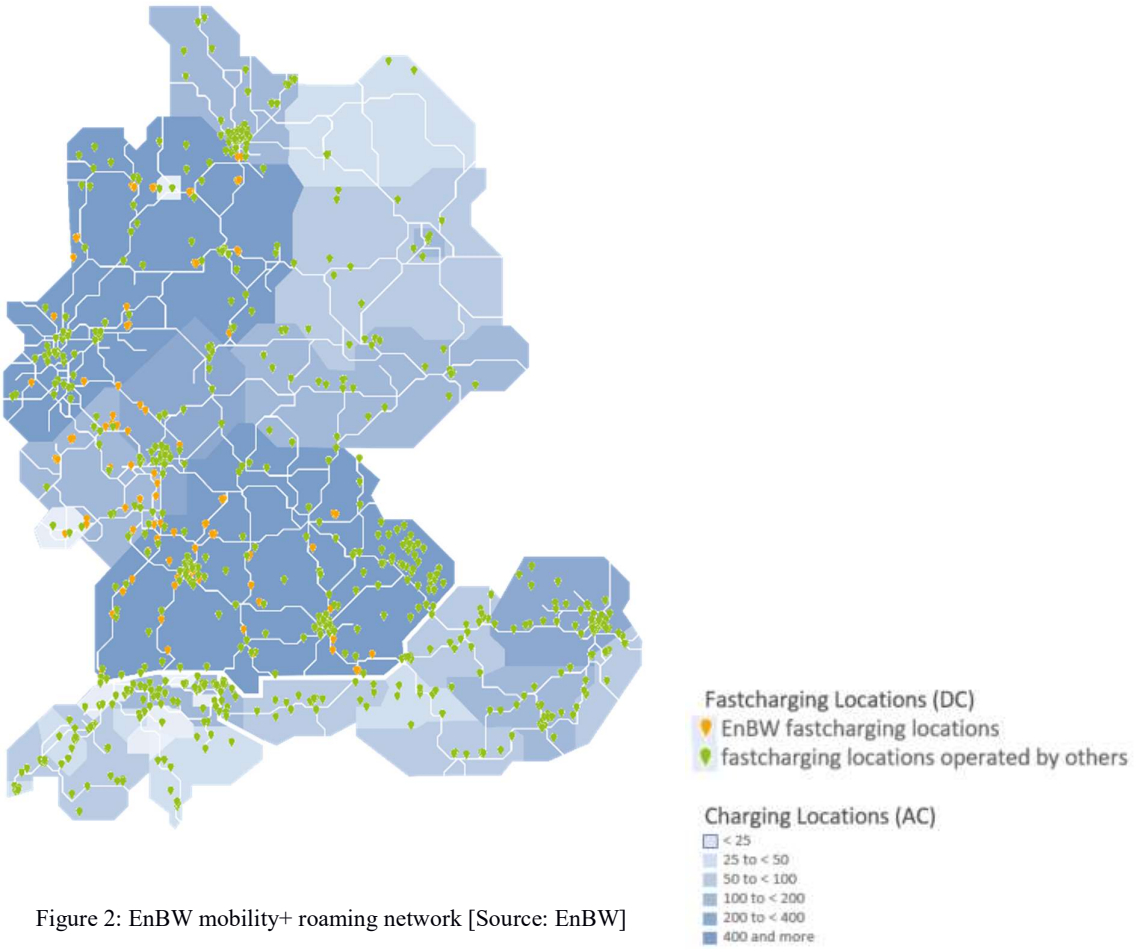

Figure 2: EnBW mobility+ roaming network [Source: EnBW]

Therefore, the EnBW strategic focus lies on the one hand on building up a strong network of partners with attractive locations, such as supermarkets, electronic markets, motorway service stations, etc. At those locations, retention time is at least at 20 minutes due to planned activities such as shopping, resting and leisure activities. Depending on time spend at locations, charging power and number of charging points must be selected accurately to avoid unoccupied time and unnecessary expenses. Especially in the case of DC-fast-charging, frequently connected to a medium-voltage grid via

transformer, costs might go through the roof. As long as the number of EV-drivers is developing slowly, such ventures are at high risk.

Furthermore, those high costs and the long pay-off time, generally diminish the willingness to invest in such a venture. Nevertheless, Dr. Frank Mastiaux, CEO of EnBW, declared in 2017 that EnBW is going to invest in, to build and to operate up to 1,000 Locations with DC-fast charging infrastructure until the end of 2020 [15].

That offer, combined with an easy access to EnBW-Chargers via app, is highly appreciated by companies who want to make their location more attractive for EV-drivers. End-costumers who choose the mobility+ App as their key medium for public charging, can have access to more than 25,000 charge points directly and via roaming, which is a nearly nationwide coverage in Germany (>> 90%) and neighbouring countries [16].

However, why is it a strategic decision for EnBW to act as a charge point operator (CPO) and as an electromobility provider (EMP) as well? Those two roles are not inseparably linked together, there are in fact several companies who embody just one of those two roles.

3.1 Fast-Charging Infrastructure: why it is important to be CPO and MSP

There are several valid reasons to embody both roles, CPO and EMP, especially when your focus lies on a nationwide field of activity. At first, being an electromobility provider leads to visibility of your business to end-users, because you can offer access to charging stations [17]. In addition, electricity contracts are a core task of an energy supplier like EnBW. This also enables further possibilities when thinking about bundle products, e.g. one contract for household electricity combined with public charging. Being partner for all tasks can lead to positive interaction with existing, but also with new customers.

EnBW decided to commit itself to the topic of electromobility, so it strives for a leading position in the German market. This, of course, can be rather achieved with two different business activities that mutually leverage each other. As EMP, it is a significant advantage when you automatically have access to a great network of charging infrastructure which is in fact operated by yourself. Whenever contracts with other CPOs and EMPs must be negotiated, e.g. for roaming contracts, this dual role ensures a strong negotiating position. This in turn is comfortable for end-users who have access to a big network of public charging stations. The increase in customers, on the other hand, allows to develop new business models with cooperating site operators; the more an EMP product is used, the better it fits for cross-selling and other businesses at locations and its surrounding POIs [18].

To recapitulate, for an energy supplier with a broad client base, it is a matter of course to seek for a strong market position and customer satisfaction as well.

3.2 Investment in public infrastructure

Considering the line of arguments in chapter 3.1, we need to go into detail how it will be done. To fill the role of an EMP means to offer all customer-related services around a service station, such as simple seek and find, access and billing. These tasks are easily scalable and easy to offer to a large customer base. The role of a CPO, however is not comparable to an EMP, regarding effort and resource input, as it is mentioned in chapter 2.2. On the other hand, your position as EMP will gain importance by concurrently operating many charging locations. Actually, these two roles mutually influence each other.

To be successful in the CPO business, you need to have staying power as it develops its full impact only over a period of years. Due to today's status, the market ramp-up remained far behind the forecast figures, as it can be seen in chapter 2.2 (see figure 1 and table 1). EnBW keeps investing in fast-charging stations and still believes in a successful market penetration of electric vehicles, as soon as a wide selection of models is available in the market. But even if there are not too many users now, the future market position is entirely influenced by important partnerships that are set today. Prime locations, like big retail chains or rather chain stores in general, are a solid argument when negotiating with MSPs; actually, no MSP wants to ignore a CPO that operates hundred of locations of big and well-known companies. On the other way around, the CPO benefits from numerous MSPs, because the chance of a high customer frequency increases. Each CPO that wants to play a major role in the business of operating charging infrastructure, tries to stake out its claim now,

and so does EnBW. A CPO increases its value with the importance of the operated sites on axis and metropolises, where most people commute on a regular basis.

4 First Achievements

4.1 Set-Up of Infrastructure

After having gained experience with AC charging infrastructure in a regional context, and the strong commitment of the EnBW board of directors, the next logical step seemed clear: installing DC-fast-charging infrastructure on axis and metropolises. The first 34 locations in Baden-Württemberg where built up in 2016 as part of the BMWi funded project SLAM [19]. After experiencing a great success by being able to demonstrate an outstanding performance in realizing these 34 locations in a very short period of time, 29 of the 34 locations were managed to be up in running within three and a half months. EnBW received an opportunity through its location partner to build even more locations in other areas of Germany. One of the main reasons of EnBW's success in rolling out the first locations was the great experience EnBW had as an infrastructure manager out of the electricity-, gas- and water-supply of southern Germany. It was an obvious move to expand the activities throughout the whole country in a further step to achieve the goal of 1,000 DC-fast charging stations in Germany until 2020. EnBW is expanding its network with cooperation partners since 2016 in order to set up further charging stations on important traffic axes. Through cooperation with retail chains, hardware stores and electronics retailers, around 200 locations across the country have been equipped nowadays with DC-fast charging infrastructure. This results in a variety of new charging points throughout the country, which can be used by EV-drivers. As a result, the amount of charging points makes it possible to travel long distances with the EV without restrictions. In addition, dialogues are already taking place with potential cooperation partners in neighbouring countries in order to facilitate DC-fast charging stations on cross-border routes. Therefore, EnBW's plans in expanding to Czech Republic, Austria and Switzerland are most likely to take first steps already within 2019.

4.2 Digital Access

Together with roaming partners, the EnBW charging infrastructure represents a Europe-wide charging network, which enables charging at more than 25,000 charging points [16].

Figure 3: functions of EnBW mobility+ app (Source: EnBW)

EnBW grants access to charging stations via RFID-Card and her digital counterpart, the mobility+ app. The mobility+ app is more than just an access medium, it features a lot of more important functions (see figure 3). Initially, the app was provided with a simulator, so that each interested tester could make an electromobility-fit; driving your car while running the app, you can get a first impression if the chosen route could also be achieved by a specific electric car. The intention is to reduce the range anxiety and to bring

electromobility out from the niche. Of course, the simulation of EV-driven routes was not the main goal. Actually, users can find charging stations, operated by EnBW and by her roaming partners. After having found one of the 25,000 charging points, the charging session can be started by app, while all incidental costs are fully transparent. If not taking the app, you can also use more analogue applications, such as RFID card, credit card or PayPal (soon to be). Advantage of our digital solution is of course, that besides starting and ending the charging session, you have the possibility of monitoring the current charging session and tracking preceding ones. Also, statistical information about costs, travel time and so on, can be retrieved. Mobility+ works as the pocket knife for EV-drivers and all those interested. The focus totally lies on simplicity, reliability and availability [20].

4.3 Business Model Approaches

When talking about business models, it is obvious to consider electromobility as a further distribution channel for energy suppliers. However, due to different aspects mentioned before (see chapter 2), it might be a tremendous miscalculation to solely rely on electricity sales via charging infrastructure. In the following two further approaches that are either in development or in testing are shown below.

Considering the length of stay while charging, the potential of cross-selling becomes apparent. In the case of EnBW, the strategy lies on building up a strong partner network (see chapter 3), which can be utilized for business concepts with coupons; that can be interpreted in both ways: a customer in a store can get a discount for a charging session, or the other way round, a person who charges its EV can get a benefit in an adjoining store. This is a well-known possibility to address customers that are already within reach or to improve customer loyalty.

A second, more current approach, is to use digital technologies for customer contact. This, though, does not need necessarily bilateral partnerships. With a certain number of charging stations in operation and a digital platform where nearby POIs could place offerings. As example, a shopping centre with numerous shops might be a cooperating partner. EnBW provides the location with charging infrastructure at its own expense and buys the lease for a period of several years. For each charging session, participating shops pay a referral bonus. The charging station is a marketing tool and shops can use it to promote their products or their brand. Another example takes a similar track but shows a not so obvious concept. EnBW maintains a staff restaurant that can also be visited by external guests. The charging infrastructure in front of the EnBW building, which is retrievable in public directories and navigation systems, can display this very information about the restaurant.

In conclusion, there are several options to add extra value when thinking about business models for charging infrastructure. Some of these options are in testing phase right now, others are in consideration and might be implemented in sooner future. The charging station itself is the starting point, digitalisation builds the bridge to other business opportunities.

5 Conclusion

5.1 Prospects

As part of the energy revolution, EnBW, as an energy utility, looks not only at electromobility but also at the challenges that arise in other sectors. The subject of electromobility forms an interface between the automotive industry and energy utilities, which is viewed and managed holistically by EnBW. The further development of electric vehicles and the provision of grid capacity must be compatible with the future charging infrastructure. Taking these aspects into consideration, EnBW is working on the installation of even more powerful DC-charging stations at its locations or its partner locations. High power charging should minimize the load time considerably in the future. For this reason, existing locations will be upgraded, and new sites will be equipped with High Power Chargers to give customers an even more comfortable charging experience and therefore an additional argument in favor of electromobility.

Electromobility represents a core component in the overall context of the energy revolution. For electric vehicle users, electromobility should go far beyond simply driving an electric car. Linking a photovoltaic system with the battery of an electric vehicle forms an innovative energy solution for the homestead. The vehicles represent mobile storages, which can soon use Vehicle2Grid applications to directly influence the

supply networks. Thus, an innovative charging infrastructure can play its part in the successful energy revolution.

5.2 Statement

EnBW is taking charging infrastructure seriously and expanding its network in order to supply the customer with a 360-degree approach of "always charged". Having started only two years ago to be active as charge point operator (CPO) of fast charging locations and providing EV drivers a most satisfying experience with an innovative mobility service provider service (MSP), EnBW has become one of the most relevant players in Germany in this short period of time. The learnings of this fast-paced development of DC fast charging locations and services shall be the main aspect of EnBW's contribution to EVS in Lyon.

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