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Future Digital E-Mobility Services

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Summary

The energy market is currently changing dramatically and so are the established business models. This is a big challenge for energy supply companies in Germany. Besides our core business – supplying households with electricity, gas and water – customers expect more sophisticated products. In the rising field of e-mobility, customers still face many challenges and complexities. "Where can I charge my car?" and "how can I pay for it?" are not yet easy questions. This paper aims to give an answer to these questions and explains how charging at home, in the office, and everywhere in Europe come together to one digital energy platform. E-Mobility shall be used as example to outline the challenges of digital energy platform. The learnings can be applied to other product categories like smart home or virtual power plant (VPP). In this context, this paper wants to provide a neutral and academic view on the evolution of future energy products from a customer perspective, analyse the challenges of providing such a portfolio and use specific EnBW products as examples.

Keywords: digitalization, market development, mobility concepts, smart charging, user behaviour

1 Public charging

1.1 Handling public infrastructure: charging made easy

The topic of public charging seems to be a challenge for many (future) e-mobilists. A major criticism in this regard is lacking expansion of charging infrastructure, inadequate connection of various charging operators, as well as the resulting "tariff jungle". Moreover, various customer surveys and market analyses found that a significant proportion of EV drivers and e-mobility enthusiasts describe the process at charging stations as complicated and unintuitive. Our goal is to tackle these pains by taking away the "fear" of the charging procedure and by creating an interconnected and convenient charging experience.

The EnBW is continuously expanding the public charging sector not only throughout Germany, but also in Switzerland, Austria and in further European countries. In doing so, our goal is to operate 1,000 fast charging locations by 2020. Concerning this infrastructure, we developed an app that serves as a co-pilot – not only in the decision-making process but moreover, it accompanies customers through the entire charging process.

Starting at the beginning: Before deciding on whether to buy an e-car, app users can test if an electric vehicle is suitable for their journeys. Via a driving simulator, which is integrated in the app, users can record journeys with their combustion vehicle and evaluate consumption, distance and the average speed

afterwards. Based on this, the app analyses to what extent an electric vehicle is suitable for the distance covered. In terms of total statistics, which indicates how high energy consumption and emissions savings are, the app shows all suitable e-cars. This selection is made from a catalogue in which all cars currently available on the market are included. Afterwards, the app shows in a ranking to what extent the different models are suited for the distance travelled. The driving simulator therefore supports those customers who are still in the decision-making process and provides targeted support.

Once the purchase decision hurdle has been overcome, the app continues to support in the following charging process. The first possible struggle that EV drivers have to face is finding charging stations – especially when travelling outside familiar surroundings. To cover this, we furthermore implemented a charging station finder which allows customers to find any stations across Germany and further European countries that are connected via e-roaming platforms. Currently, only commercial charging stations are included within the app. Prospectively however, we are striving to integrate also those stations that are free of charge. This way, we offer an expanded charging network and consequently contain the associated fears among (future) e-mobilists.

When choosing a charging point, app users find detailed information about its availability and access. Furthermore, they see which types of plugs are in the field, plus the corresponding tariffs. By simply selecting the desired charge point, the charging session can be started. In the further procedure, EV drivers get an overview of the current charging status and the incurred costs within the app. Prospectively, we are ambiguous to integrate additional digital services into the app. By this means, customers looking for a charging option can immediately see if they can get any benefits at the chosen charging station. These added features can be provided in the form of coupons, vouchers etc.

The overall goal in designing our app was intuitive operation: App users are guided step by step through the charging process, starting from finding a suitable charge point, up to completing sessions via a payment method. Concerning the latter, payment information can be stored in the app and customers receive a separate bill at the end of the accounting period. This enables our customers to experience an effortless charging process. As added features, the app shows the customer's charging history and already billed sessions. This creates transparency and app users can manage their charging processes at any time.

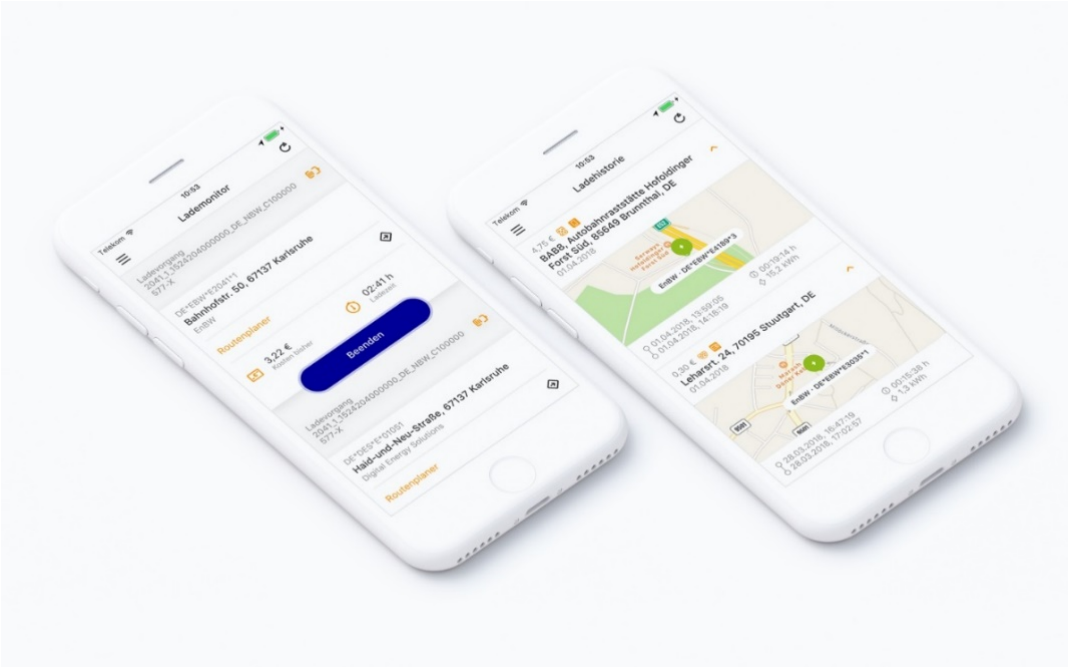

Figure1: EnBW mobility+ App

We are continuously optimizing the EnBW mobility+ App: A major point of criticism that is repeatedly referred to in the context of e-mobility, are complicated and time-consuming charging processes, lack of connectivity, and island solutions. Thus, our overarching objective is to create a holistic charging experience by connecting different products and digital services.

Concerning the app prospectively, this should not only be used in the area of public charging, but we are working on connecting it with smart home systems such that energy optimization in combination with a home wallbox can be managed easily within our app. Moreover, by equipping companies' park space systems with infrastructure, an interconnected charging experience can be created and managed by only using one medium – the EnBW mobility+ App. Setting new standards in usability, our app has already won numerous customer experience awards such as the red dot award in communication design.

1.2 E-Roaming

Through e-roaming platforms, various players – such as charge point operators (CPOs) and e-mobility service providers (EMPs) – are connected within the electric mobility market. EV drivers have the option to charge their vehicles at any station within the platform, regardless of contracts with operators. In addition, e-roaming platforms provide B2B information for the realization of advanced services within the areas of traffic management, energy management, intelligent charging, car sharing, vehicle reservations and intermodal mobility [1].

As already mentioned, a major pain that has been indicated in the infrastructure context is the lack of charging stations and insufficient connection among operators. Additionally, the provider side has become very obscure: there are numerous CPOs and EMPs nowadays, each with own pricing models and access media. This poses an enormous challenge for EV drivers – especially for those, who are not yet familiar with the market. As a result, electromobility is partially seen as a complex and opaque topic. Current hurdles seem even more impenetrable and consequently, potential e-mobilists might be discouraged.

This substantial coordination problem needs to be tackled – also to contain future reservations. Against this background, our goal is to think from a customer's point of view: precisely because e-mobility is still a relatively young area and a large part of society is not yet familiar with it. Hence, we are striving for making charging as easy as possible. Prospectively, EV drivers should be able to charge at any station at common known tariffs. To achieve this, e-roaming platforms serve as mediators between CPOs and EMPs. Through a unified contract framework, EV drivers have the possibility to charge at any station that is connected within the platform. Different pricing models can be implemented, and through guaranteed transparency, users know exactly the prices that are being charged and unexpected increased costs can be excluded.

Concerning e-roaming platforms, EnBW takes on both roles: providing charging infrastructure and accommodating access to EV drivers from other operators at the same time. In order to drive forward network connection, EnBW is not only co-founder of the e-roaming platform *Hubject* but is also connected to further platforms that cover infrastructure in many European countries. The interconnected electric mobility market thus provides a cross-provider charging infrastructure, making customer-friendly charging a reality – and in addition, helps overcome limitations of local island solutions.

In perspective, activating a charging process is going to be automated with Plug&Charge via ISO 15118. Up until now, EV drivers usually need a smartphone app or RFID card to start the charging process. Through an inductive charging concept that is based on installed IT-certificates in cars, an autonomous seamless and secure communication with the charging station can be realised [2]. This way, charging can be made even more convenient and the "fear" of public station charging, due to complex processes, can be antagonized even further.

2 Private charging

2.1 Combination of smart energy solutions

In pursuance of creating a holistic charging experience, we are striving to connect public charging and home charging procedures in the second step. With wallboxes, customers can charge their electric vehicle from home – a convenient alternative to public charging. This home-based charging solution can be combined with various energy solutions and thus creates intelligent networking of different products.

In (single) family houses, the wallbox can be connected with PV power plants, combined with an energy management system, and integrated in the smart home [3]. This enables customers to regulate electricity consumption themselves and charge their electric cars autonomously. Through intelligent power storage and energy management systems, EV drivers will be able to determine suitable charging modes for themselves. In perspective, they will be able to choose between several options: On the one hand, electric vehicles can be charged to one hundred percent with the self-generated electricity. On the other hand, the own electricity consumption can be optimized and electricity can be drawn partly from the self-produced PV electricity, and partly from power storage and power grid.

Customers, who do not own a PV power plant are also able to control for power consumption and home charging sessions. By simply combining the home wallbox with an energy management system, current power consumption can be viewed at any time and charging processes can be managed and scheduled.

In this respect, our goal is to integrate a PV- and energy-optimization software as an added feature to our app. This way, customers can easily monitor their charging processes and current electricity consumption via app. Furthermore, they will be able to choose between the different charging modes within the app.

Prospectively, the EnBW mobility+ App serves an intersection between the areas of public and private charging: customers can manage all charging processes via one medium at any time; wherever they are, benefitting from maximum flexibility and transparency.

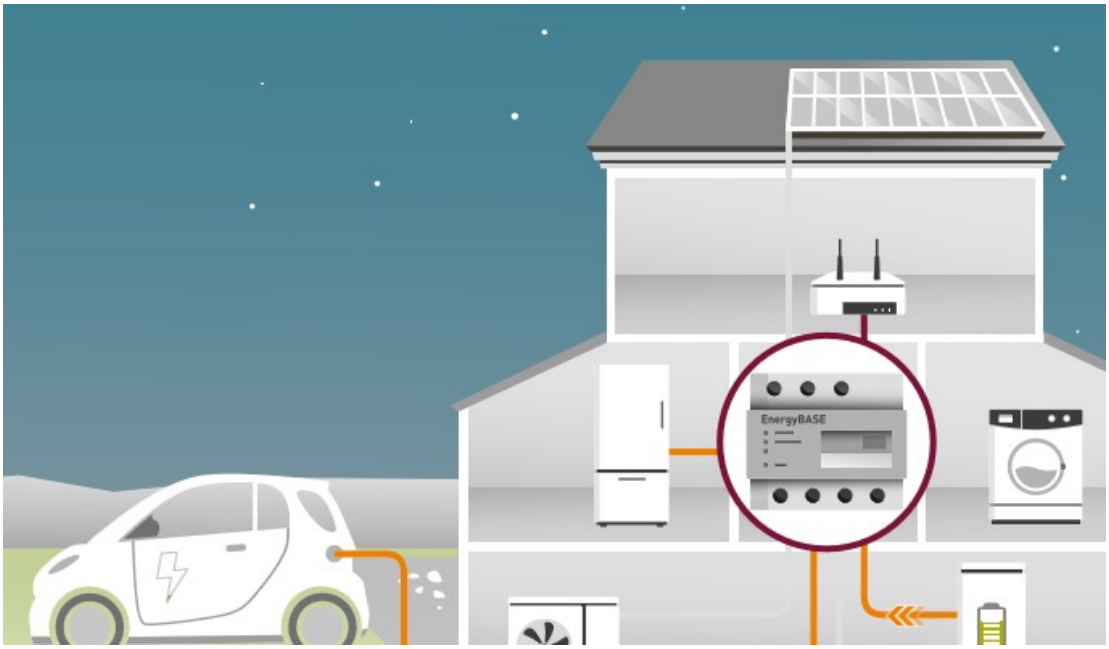

Figure2: intelligent networking of energy solution systems

2.2 Apartment complexes – challenges and opportunities

When it comes to apartment complexes, we are striving for equipping underground parking spaces with private charging stations soon.

By doing so, we are faced with an exceedingly energy- and load management. In general, houses as well as apartment complexes are equipped with enough energy to conveniently charge multiple cars. However, there are energy peaks, particularly in the early evenings, where household energy consumption is very high: cooking, laundry, TV etc. Forecasting this load and energy production is crucial for effectiveness of power system planning and operation. A basic assumption made in this context is the non-linearity between power load and factors influencing power prediction – therefore it is difficult to identify this relation by using traditional prediction methods. Due to renewable energy sources that are associated with its stochastic and dynamic structure, the complexity of charging scenarios has increased. Consequently, it is our goal to develop an optimal management system and include advanced forecasting techniques in order to reduce peak load and enhance grid stability and reliability [4].

Way forward, we are striving to motivate and include our customers, so they become active in optimizing their energy consumption plan, control peak load and scheduling charging sessions if necessary. Smart grid therefore has the capability to fundamentally change the social dynamics of energy systems [3].

Based on this, we motivate our customers to only charge their cars during the critical time span if necessary. Furthermore, we will trial financial and price incentives to make customers aware of this issue: charging overnight will be significantly cheaper.

Concerning the integration of home charging procedures in the app, same holds true when it comes to apartment complexes: prospectively, consumers are capable to manage their charging sessions within the app and overview energy consumption.

3 Workplace charging

3.1 Future mobility for companies

Finally, to round off the interconnected charging scenario, we are working on a concept of equipping charging stations within companies. This way, EV drivers have the option to charge their cars during office hours – accessing and paying with their usual medium. Moreover, with this solution, we offer companies a basis when considering the electrification of their fleets and provide targeted support.

When talking from companies' point of view, there are numerous reasons for switching from the combustion vehicle to the sustainable alternative. The number of electronic vehicles in Europe is rising by leaps and bounds and charging technologies and batteries are becoming increasingly powerful. Thus, electric vehicles can particularly be the better choice when it comes to short-term traffic. Moreover, the network of charging stations is becoming denser and the EnBW is playing a pioneering role in the construction and operation of these facilities. As part of this "movement", companies can differentiate themselves, come forward as an innovative institution, reach attractive target groups and attract customers who expect charging possibilities in the equipment.

In line with this, we are striving to provide and operate work-based charging stations, allowing the use to any target group: employees, customers and company's own fleet. Depending on the company's requirements and application, a fast charging station, a DC wallbox, an AC charging station or an AC wallbox can be used as hardware.

Any charging station can be connected to the company's house connection – this way, implementation and installation are convenient. Guests and customers have the possibility to charge their own electric vehicle and pay with their usual access medium, e.g. with the EnBW mobility+ App. Companies' electric fleet, as well as electric vehicles of special guests can be charged by using the companies' charging cards. Concerning invoicing, the company receives a regular distribution of the charging proceeds for all invoiced processes, which roughly cover the energy costs.

Expanding this business model, we are currently working on a concept which allows employees to charge their electric company's car at home. In this context, we equip the homes with our wallboxes – which in turn means more flexibility for employees and easing charging situations at the company's park spaces. Accounting of home charging sessions will be carried out by EnBW: electricity consumption caused by charging processes is transmitted electronically to us. At the end of the accounting period, we will send the company either bundled or separate invoices – depending on the requirements. Concerning energy optimization, same holds true here: wallboxes can be integrated into smart home systems and energy consumption, as well as management of charging sessions can be controlled via app.

3.2 Load management

Optimal regulation of energy consumption plays an important role when it comes to company-based charging. In order to avoid peak situations where many users are charging at the same time while electricity is not available in this quantity, load management can ensure the supply security. In this context, we apply the same guidelines as for charging at home: With our smart portfolio we help customers to optimise their energy costs.

In addition to the requirements that apply to load management in the private sector, there are further criteria in the workplace area. In this context, the company pays a performance-based network fee (depending on the maximum capacity utilization per year). Each grid connection point has its own connected load and a fixed upper limit for load by vehicle charging is determined. The (global) upper limit can be temporary increased by local PV generation, which reduces the performance-based grid charge. If several vehicles are connected at the same time, power consumption is equally distributed to all vehicles – and, in the first step, without phase symmetry consideration. This concept can be expanded by integration of additional energy meters, and by consideration of phase symmetry specifications. Furthermore, an adjustable global limit can be set to avoid peak load windows, which allows for optimization according to energy market prices. As we are continuously optimizing load management, prioritization of connected vehicles via hardware or software will prospectively be possible.

4 Conclusion

4.1 Customer needs: A central perspective

In order to establish electric mobility in society, it must not only be intuitive and convenient, but also satisfy the needs of users.

Our goal is to make the charging process as easy as possible. Since electromobility is a relatively new field in the market, it is important to identify challenges from the customer's point of view and design processes accordingly.

Let's take the situation of refuelling combustion vehicles. The procedure at the gas station is always the same and drivers do not have to think about what to do during the refuelling process: it works intuitively. Our goal is to achieve the same instinctive handling for charging electric vehicles. In this context, we identified the pooling of various charging situations in the everyday life of users as an important point in advancing the establishment of the market.

Furthermore, when deciding on an electric vehicle, not only does the vehicle's features matter, but its use and the associated expenses are important criterions. In this context, we see the challenge in designing a process that the customer combines with expenditure of time and costs in such a way that it nevertheless meets the needs of the customer. We divided these needs into basic and advanced ones. In this respect, we identified transparency, security, and stability as basic needs. The EV driver expects a tightly connected network of charging infrastructure: In the event of a charging situation, the user wants to find the closest possible charging station quickly and easily. Once there, the driver expects a transparent cost overview – and in the best case – charging at the usual tariff. To satisfy these basic needs, e-roaming plays an important role and through these platforms, network connection can be taken onto a whole other level.

As advanced needs we identified autonomy, flexibility, and intuitive handling. EV drivers want to determine charging processes and regulate power consumption self-constrainedly. In doing so, we assist with our smart home solution: prospectively, electricity required for charging can be independently controlled. This way, not only transparency can be created, but furthermore, autonomy will be promoted. Moreover, EV drivers expect flexibility not only on the road – that means: in the public area – but also in terms of home charging. With the mobility+ App, we will soon be giving our users the opportunity to schedule, start and end their charging sessions via app – without having to be there physically. When it comes to tackling pains, intuitive handling plays an overriding important role. According to various customer surveys, a significant proportion of EV drivers strongly criticize complicated procedures at public charging stations. Against this background, we created our app in a way, that charging processes can be started and ended with just a few clicks – without users having to deal intensively with it.

4.2 Connecting everyday life charging scenarios

The intuition behind our digital mobility services is to provide targeted support in everyday life charging situations. In line with this, the focus of our various solutions is on simplicity. Our goal is to design digital products and processes in such a way that customers are picked up in a targeted manner, having the spotlight on time efficiency and achievement of the greatest possible customer benefit.

Therefore, we created the EnBW mobility+ App. Originally, it only served as a co-pilot in the decision-making process of an electric vehicle and in public area charging scenarios. Via GPS, users can find charging stations and see immediately if they are available and what charging points are on site. In addition, the entire charging process can be carried out in the app with just a few clicks: Processes can be started, stopped and billed within the app. With the identification of different needs in terms of charging situations we will prospectively give our customers the opportunity to also manage and overview home charging- and work-based sessions via app. In terms of home charging sessions, this enables the customers to combine wallboxes with the smart home thus create intelligent networking of different digital products.

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Authors

Christoph Ulusoy heads up the products and digital services area of EnBW's E-Mobility department. In his role he oversees the product-portfolio from hardware to software focussing on an excellent customer experience. After launching several corporate as well as start-up businesses he is well aware of the challenges of inventing a brand new and innovative business model while absolutely focussing on customer pains. Christoph Ulusoy holds a bachelor's degree in business and a master's degree in philosophy, politics and economy. He lives in Munich.

Lena Ehmann is a working student in the department of digital mobility products, dealing primarily with e-roaming and the EnBW mobility+ Wallbox. She is currently studying Economics (M.Sc.) at the University of Hohenheim, focusing on environmental economics and environmental valuation. At this university she worked as a researcher examining sustainability and firm performance, while analysing differences between emerging and developed countries.