Private Providers of Climate-Neutral Electric Vehicle Charging Services – Enabling Remote Access to Self-Produced Energy at Other Peoples’ Charging Points

Extended Abstract

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Abstract

Unresolved technological and societal challenges hamper the widespread practical adoption of electric vehicles (EVs). Despite calls for systemic approaches, research tends to focus specific obstacles in separation. This article reports on how two publicly funded research projects—both dedicated to developing a specific EV service offering—cooperate and work on bundling the two services: “providing public access to private charging spots” and “transferring self-produced energy through public energy grids to other peoples’ charging spots”. We argue that via bundling the value proposition of the single services can be elevated. This conceptual research describes use cases, processes, and supportive IT infrastructure needed to bring the service bundle into action. The contribution of this work lies, first, in discussing and outlining the bundling approach, which merges the outcomes of the two research projects. This approach can make a small step towards achieving the socially accepted goal of propelling EVs as a more sustainable means of transport. Second, the paper is novel for that it introduces a set of models, methods, and tools taken from the academic discipline of service science into the strands of research related to EVs.

Introduction

The growing body of scientific evidence for anthropogenic climate change (Hoffert et al. 2002; Tripati et al. 2009) sparks heated debates by general public, media, and academia about the consequences of unsustainable human actions in terms of emissions, pollution, and the overall degradation of the natural environment (Oreskes 2004). Private and public transport contribute to the environmental damage. Besides emissions of noise and fine dust, studies have found that transportation’s share of the total carbon emissions amounts to approximately 20 % in the European Union (European Comission 2014), 28 % in the United States (US Environmental Protection Agency 2012), and 23 % globally (Independent Evaluation Department 2010). Therefore, tomorrow’s societies will need to reduce fossil fuel combustion in road transportation as part of the drive to decrease their carbon footprint (Yang et al. 2009).

Electric vehicles (EVs) have been discussed as alternative means of transport, which help achieving sustainability goals related to private road traffic (Faria et al. 2013). However, studies have also described a number of challenges that at the moment slowdown the diffusion of EVs and that hinder exploiting the EVs potential for achieving the sustainability goals fully (German National Platform...
for Electric Mobility (NPE) 2012): EVs have a lower range; EVs are made from rare materials; coherent area-wide charging infrastructure is lacking; public EV charging spots do not allow for choosing energy sources.

In this paper, we focus on the latter two challenges—the insufficient charging infrastructure and the missing control over electricity sources—because both are major and logically connected obstacles to achieving sustainability goals through EVs. First, according to Yilmaz & Krein (2013) and Schroeder & Traber (2012), the consumers’ demand for EVs will remain low if a coherent area-wide charging infrastructure is not available. If the growth of the EVs’ market share remains sluggish, EVs cannot help mitigating the environmental impact of road traffic. Second, previous research has described that EVs can realize their sustainability potential only if charging current will be generated entirely from renewable resources (Faria et al. 2013). Otherwise, driving an EV would cause as much harm to the environment as driving a car with a conventional combustion engine (Samaras & Meisterling 2008).

Scholars have discussed numerous approaches to these two individual challenges. In order to increase the widespread availability of public charging spots, Chasin et al. (2015) suggest making privately owned charging stations available to public access. Another approach is to equip street lamps with small charging spots in order to make charging infrastructure comprehensively available (Lev-enstein 2015; Rubin 2015). In order to address the second challenge, the national legislators could regulate national energy charging infrastructures so that only renewable energy sources are allowed to be tapped (Menanteau et al. 2003). One way to place control over the energy sources into the hands of the EV drivers is to enable private individuals to charge their EVs with renewable energies produced by sources such as solar panels that are installed at the drivers’ private own-home and that is passed through to remote charging spots via the public electricity network.

Voices from general public and academia have become loud that the diverse set of academic and industrial research and development initiatives requires for concerted integration into more holistic and systemic approaches to achieve climate-neutral EV charging services that are both economically competitive and socially accepted (Kley et al. 2011). However, specific projects geared to achieving this goal are rare with the work of Lützenberger et al. (2014) being one of the few instances.

This research therefore joins forces of two individual publicly funded research projects of two different research groups that both develop process innovations for the EV sector. Each project addresses one of the two before mentioned challenges: to make widespread EV charging infrastructure available and to enable the transfer of home-produced energy to remote charging spots. We describe how both approaches can be integrated by a single systemic approach. We envision marketable services being offered as the outcome of both research projects in the near future, which than can be bundled into an integrated customer solution for climate-neutral EV charging through small private and business providers.

**Research approach**

This conceptual research discusses the case of bundling innovative service offerings for EV charging into integrated customer solutions. Tapping into recommendations provided by the extant literature in the field of service science, we discuss how two services which are currently being developed in the context of two research projects that are sponsored by the German Federal Ministry of Education and Research (BMBF) and the German Federal Ministry of Transport and Digital Infrastructure (BMVI) complement each other.
The first service facilitates a crowd-sourcing approach that enables individuals to share privately owned charging stations with other people while receiving a small payment in return. The research project develops a technical platform that enables the participants to register their charging stations, to discover charging stations shared by others, to reserve the stations and to process the payments. The second service is based on a new method for charging electric vehicles. Using a special synchronized mobile smart meter (SMSS), the service enables EV drivers that have solar panels installed at their private houses to charge their EVs at other people's charging spots situated away from their homes with their home-produced electricity.

Both services share characteristics beyond being potential pillars for the realization of sustainability benefits, which makes them particularly suitable for the composition of a service bundle. First, they are located in the same domain of electric vehicles and both aim at accelerating the diffusion of EVs. Second, both services address private persons instead of businesses or communal bodies and by that are manifestation of the concept “act local, think global” (Devine-Wright 2013). Third, from the user's perspective both services help increasing flexibility regarding the charging location and the perceived value for money when it comes to charging an EV. The financial aspect is especially important as the extant literature argues that it plays a significant role in in the most socially- or environmentally-driven behaviors (Bardhi & Eckhardt 2012).

This research takes as input the use cases, business processes, and technical architectures of both research service prototypes. We deduce research and development activities needed for implementing the additional processes and IT support that could facilitate the additional use cases resulting from integrating the two projects. We then derive service components that are required to combine both services by analyzing the use cases, processes, and the technical architecture of both services. As a last step, based on the identified research activities, we derive synergies that emerge from the cooperation between the two research projects and thus create additional value for both projects.

**Research results**

The research includes two main sets of results that relate, firstly, to the elevated service offering achieved through service bundling and, secondly, to improved opportunities for research that is dedicated to ensuring the service bundle’s economically competitiveness and that it wins customers’ acceptance.

The first set of results encompasses the description of five integrated use case scenarios that depict how IT-enabled services for providing public access to privately owned charging stations and for enabling remote EV charging with energy originating from solar panels installed at the driver’s home are combined into sustainable integrated value propositions. These use case descriptions are complemented by the description of the three major processes required for bringing these use cases into action: authentication, charging, and payment. Based on the individual services’ processes, the description uncovers the additional coordinating activities required for their bundling. Finally, the article sketches in brief the supportive technical infrastructure needed to facilitate the execution of these processes. A web application comprised of a front-end system for private providers of charging spots and the EV drivers, a back-end system to account for administrative tasks, mobile phone applications that provide access points to the bundled services on the go, and the SMSS devices that are the means to measure dislocated consumption and provision of electricity.

The second set of results offers new vistas for EV-related research drawing from connecting the research endeavors. The willingness of private households to invest into equipment is a premise that
needs to be understood for both scenarios alike—either for the case of producing energy or for facilitating the EV charging process. Implementing both approaches in conjunction is likely to increase their overall economic efficiency. Therefore, the article outlines how sharing data between the two projects sets the stage for studies needed to ensure economically appropriate service designs. Furthermore, research activities concerning the private households’ acceptance to use EVs as well as to provide public access to private charging spots respectively to use privately owned charging spots share common grounds that motivate the need for the research outlined in this article.

Discussion and outlook

This conceptual research synthesizes the work of two previously unrelated research projects. The article reports—by means of the description of use cases, processes, and supportive IT infrastructure—on the concept of a service bundle that empowers private providers to offer climate-neutral electric vehicle charging services by enabling other people to remotely access their self-produced energy.

This concept renders two practical implications. First, each of the services bears potential to help achieving sustainability goals associated to EVs. If the services will be combined they may exploit their potential fully. Second, this article presents recommendations for linking the major shared processes of EV charging and routing private energy through public electricity grids: authentication, charging, and payment. We have to admit as one of several limitations of the research, that only parts of the individual services have been implemented yet and that the approach for integrating them is pure conceptual work. Accordingly, evaluating specific results from applying the approach and estimating its success must unfortunately be beyond the scope of this paper.

This paper further extends the service science literature and the academic work in the field of EV charging infrastructure because it introduces models, methods, and tools developed by researchers from the service science field into a novel domain: EV charging.

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References


\(^1\)http://www.crowdstrom.de/


