Product-Service Systems across Life Cycle

Business Models for Electric Mobility

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Abstract

Which business models successfully compete in the electric mobility market? High initial costs for electric vehicles and a slow adoption to the mass market result for many companies in almost insurmountable barriers to entry. The presented article introduces a framework for the analysis of e-mobility business models by defining central business model patterns, customer segments and essential key values of electric mobility. Thereby, the aim is to systematically identify e-mobility business model potentials. From the perspective of all stakeholders involved, this helps to overcome existing barriers to entry. Interviews with several mobility, energy and infrastructure providers have been conducted to apply the theoretical framework and to ultimately answer the opening question as follows: Those business models which at least address one aspect of the so called "multifunctional utilisation of electric vehicles" or a high service orientation have the best chances to successfully compete in the electric mobility market.

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1. Introduction

Currently, the lifecycle costs of electric vehicles are high [1]. However, there is the potential of cost savings during the operation time [2]. The high initial price for the electric vehicle with its integrated traction battery raises the lifecycle costs, but the required energy for electrical driving is less expensive than gas for conventional cars. Consequently, business models which increase the utilisation of electric vehicles and therefore reduce the costs per kilometre are needed. This demand is met by the multifunctional utilisation of electric vehicles which includes the following three aspects:

- The cooperative utilisation of electric vehicles enables the collective and coordinated usage of the same electric vehicle by heterogeneous user groups.
- The cooperative energy management comprises the aimed integration of electric vehicles in the energy supply as controlled loads as well as decentralised energy storages.
- The supra-regional charging increases the user-flexibility and supports the cooperative utilisation as well as the energy management.

The innovation adaption curve by Rogers [3] describes how new technologies are accepted by customers. Presently, electric mobility can be located in the transition of the innovators to the early adopters phase [4] where just a few companies make offerings, and only for a small market.

Figure 1: Typical Innovation Adoption Curve for a new Technology following [3,5]

Hence, a precise understanding of existing business models and their potential to enhance the multifunctional utilisation of electric vehicles is required in order to lower the barriers to entry for companies willing to invest in electric mobility. For this reason, the presented paper introduces a framework for the
systematic analysis of e-mobility business models. Based on this analysis, energy, infrastructure and mobility providers are empowered to methodically define new business model potentials which close the initially described gap. In chapter 2 and 3 the framework’s elements are theoretically derived. Chapter 4 defines the framework for e-mobility business model potentials in detail, whereas the framework’s actual application is shown in chapter 5. Chapter 6 sums up the central findings and gives an outlook on future research.

2. E-Mobility Business Models

In section 2.1 the central findings of the literature review of electric mobility business models are presented. Based on this review five identified business model patterns are described in detail in section 2.2. A closer look on these patterns results in six so called key values for electric mobility, which are introduced in section 2.3.

2.1. Literature Review

This section constitutes the essential findings of the literature review on electric mobility business models and their associated frameworks. The basic parameters of the literature review are:

- 27 key words in English and German language (e.g. e-mobility business model; electric car business; electric car-sharing; e-mobility framework etc.)
- search engines: Elsevier, ScienceDirect and google scholar
- 230 suitable literature sources
- mainly considered publication period from 2009 to 2016

A detailed investigation of different business model types and e-mobility frameworks for business models reduces the amount to 67 relevant publications. They are distinguished into 18 monographs, 17 journal papers, 16 conference papers, 2 working papers and 14 other sources (including project reports and surveys).

Figure 2 shows the total number of often described e-mobility business models in the selected literature. One literature source can be assigned to various business model patterns. In addition, one column presents existing e-mobility frameworks.

![Figure 2: Central E-Mobility Business Models and existing E-Mobility Frameworks in the analysed Literature](image)

2.2. Central Business Model Patterns for E-Mobility

Subsequently, the identified business model patterns from literature review are described in detail.

E-Car-Sharing

High fixed costs for power-driven vehicles, few parking space in urban areas [6] and the behavioural change from property to use [7] as well as the loss of importance of a vehicle as a status symbol [8] are significant driving forces for e-car-sharing. E-car-sharing contains an electric vehicle fleet which is offered to a closed user-group in a defined business area. Normally, the application time of the vehicle is clearly shorter than in rental business [9]. A crucial advantage is the value co-creation between the customers and the car-sharing provider. For instance the customer has the possibility to earn extra bonus when loading an electric vehicle [10].

Intermodal Transport

Intermodal transport is the combination of individual and collective transport. The customer makes use of different transportation modes and services to manage the distance. In that case the electric vehicle is always a part of an intermodal transportation solution. An intermodal mobility provider bundles the transportation offerings from other providers [9] on one platform and runs the central billing. Furthermore, the route planning and combination of transportation modes is organized by the provider and offered as a service.

Vehicle-to-Grid (V2G)

Private vehicles are actively in use in an average of 4% of the time. In consequence, vehicles are potentially available 96% of the time [11]. In the V2G business model pattern the mentioned standstill times of electric vehicles and ultimately the capacity of the integrated transaction batteries are used in return for payment of a fee. Battery owners can earn money while the electric vehicle is connected to the grid. Grid operators are able to purchase battery capacities for regulating short term load peaks and storing renewable energies [12]. Normally, an aggregator is needed who bundles the connected capacities of the vehicles to one megawatt units for the grid operator [11]. This means, connecting the electric vehicle to the power grid has benefits for the owner of the battery, the aggregator and the grid operator.

Battery Swapping

Primarily, this business model pattern compensates the high cost component of the traction battery compared to the full electric vehicle price. Equally, the risk of early ageing batteries and technological leaps [9,13] as well as long charging times can be reduced through battery swapping. Battery swapping requires a compatible interface between electric vehicle and swapping station [13]. Under this prerequisite, the battery swapping provider has a contract with the customer, which contains the automated swapping of discharged to charged batteries for the electric vehicle. As the owner of the battery pool, the provider follows his own optimised charging strategies [13], whereas the customer possesses a battery only temporarily. The swapping principle is similar to the gas station
system for conventional vehicles, but limited to compatible electric vehicles and participants with contracts. The process of battery swapping is very short (circa 5 min.) and much faster than supercharging [14].

E-Roaming

User acceptance of electric mobility is shaped by a high driving range of electric vehicles and consistent access to charging infrastructure. Currently, a short driving range does not satisfy the customer and stand-alone solutions from local charging infrastructure provider inhibit the progress of electric mobility. Due to the business model pattern e-roaming, charging infrastructure providers are connected to a roaming platform [15,16] by which customers have unified access to related infrastructure. The roaming platform provider manages the required process for clearing the power units and payment. In general, this model is called a multi-sided platform [17] and contains in this case two central value propositions: Firstly, the utilisation of charging stations from charging infrastructure provider increases. Secondly, supra-regional charging without provider dependencies is created for the customers.

2.3. E-Mobility Key Values

Every identified value proposition from the business model patterns in section 2.3 includes one or more of a so called e-mobility key value which describes the essential part for using electric mobility. Six key values (see Figure 3) are necessary parts for the customer to use electric mobility and can take shape in products or services.

- mobility needs describe the customer driving profile
- requirements constitute the present situation of the customers
- acceptance of the customer includes the personal attitudes towards electric mobility

3. Customer segments for electric mobility

Customer needs and preferences play an important role in the development of business models, because they define whether a business model fits for them and is going to be successful or not. Customer segments contain the needs and preferences in the shape of different characteristics. These characteristics stretch the corresponding space of requirements for fitting value propositions for the multifunctional utilisation of electric mobility.

The analysis of 20 scientific surveys and 7 basic publications about customers for electric mobility in the publication period from 2010 to 2015 delivers 32 general characteristics for potential e-mobility customers. However, the literature provides no appropriate customer segments which can be used for the multifunctional utilisation of electric mobility. Therefore adequate customer segments have to be created from the amount of characteristics from the review. An extract of them is presented in Figure 4. Furthermore, the characteristics are categorised in the following main groups:

- mobility needs describe the customer driving profile
- requirements constitute the present situation of the customers
- acceptance of the customer includes the personal attitudes towards electric mobility

The identified characteristics can be used as a collection to generate specific customer segments. Default customer segments would not fit on every company-specific value propositions so that every key value provider has to build their individual segments. This means, that depending on the core competences of the provider, some characteristics carry more weight than others. For instance, an energy provider does not care that much about the customer acceptance of electric vehicle features like design, acceleration or high-end speed. More important are characteristics such as acceptance of renewable energies or installed smart-meters.
A first broad division of the customers into commercial and private segments is possible. The two main segments have basically different requirements on mobility. Whereas commercial users often have circular tours and own entire vehicle fleets, private users have very individual mobility needs like short or long commuting drives to the workplace or irregular drives in the evening or at the weekend. Figure 5 shows the distinction and gives examples for potential customer segments.

The illustration of the respective business models describes the current situation of the company in relation to their customer segments and the provided key values for an e-mobility solution. New business model potentials can be detected in further customer segments or in the delivery of additional key values.

For this purpose, the business model which is to be analysed has to be entered in the centred box of the framework. It can be derived from the central business model patterns which are located in the left side of the framework and linked by an arrow. Another arrow connects the considered business model with the addressed customer segments, which are located in the upper area. In regard to section 3, the analysed company has to build their specific customer segments with the proposed characteristics. Additional arrows in the lower area point to the key values which are primarily delivered by the chosen business model pattern.

The questions is, which key values are directly delivered by the analysed business model. The following statements on the key values for electric mobility help to clarify their role in the presented framework. First, the key values represent which components are necessary for end customers to use electric mobility for their purposes. Second, a business model wraps the deliverable key values in the value proposition and provides them in a company-specific shape. Third, in order to utilise electric mobility, all six key values are necessary for the customer. On the basis of changing value creation from established players in the field of mobility and energy, in most cases not every key value can be delivered by one single company. Accordingly, other providers supply the remaining key values.

Mapped business models often contain one or more of the left-sided business model patterns in a specific design of a single business model. For instance, one provider could offer different business model patterns such as e-car-sharing and intermodal transport in a single business model. The two different patterns could just as well be implemented in several business models from different providers. The area with central patterns is expandable with further business models patterns, which e.g. can result from the analysis of existing e-mobility solutions (see chapter 5). This possible expansion is indicated by the empty boxes with three dots.

The proposed framework is a structured tool which is applied to analyse e-mobility business models from innovators in the next section.

5. Application of the theoretical framework

To apply the introduced theoretical framework, semi-structured interviews with 10 responsible persons from different companies have been conducted. Four companies have electrified vehicle fleets, three are regional energy providers, one producer and one provider of charging infrastructure as well as an authorised vehicle dealer were interviewed.

Hereby, it could be determined that the business models from this companies can be mapped adequately in the presented framework. As a result, it is demonstrated how the pioneering companies have used their potentials to run appropriate
business models. In the context of the interviews, five salient business models have been identified which can be considered as innovative for the mass market. Two of them are exemplarily presented in the framework, whereas the other business models are described in the following short summaries.

Figure 7: Exemplarily filled Framework with the Business Models ‘Full-Service Mobility’ and ‘Park & Charge with renewable Energies’

**Full-Service Mobility Provider**

An innovative business model in the automotive industry is the sale of an almost sustainable produced and compact electric vehicle with a program of supporting services. The offered service packages are optional and can support an entire mobility solution for the customers. The individual offerings are summarised in superior groups which are performed by several business partners of the main provider.

Charging services support the construction and launch of home chargers as well as the access to an e-roaming provider for supra-regional charging. Mobility services like discounted car rentals and a membership for e-car-sharing are needed to extend the limited range of electric vehicles, to increase flexibility in urban areas or for purposes in which another vehicle category is needed. Electricity services contain an electricity contract for delivering renewable charging current for supra-regional charging. Mobility solution for the customers. The individual offerings are summarised in superior groups which are performed by several business partners of the main provider.

**Park and charge with renewable energies**

Electric vehicles only enable zero emission mobility when they are charged with renewable energies. Hence, especially car park owners with an existing photovoltaic system next to their parking area can benefit from that correlation. By simply constructing a charging station they can offer solar power to their customers and thus they can improve their image.

The park and charge business model is not based on any patterns (see Figure 7) and obviously shows, that not all of the key values are offered through this business model. Therefore, it constitutes a complementing business model for customers who already have an electric vehicle. Consequently, the overall success of this business model depends on the licensed electric vehicles. For instance, providers of the park and charge business models address customers from shopping centres who get additional incentives to visit the shops.

**Mobile Charging Interface with E-Roaming**

High costs for public charging-stations and heterogeneous billing and identification-systems can be compensated by a mobile charging interface with an integrated electricity contract. Only less expensive charging points with low requirements are needed. The mobile charging interface takes the necessary intelligence and billing systems. This interface enables charging at every charging station or socket which can be assigned to an electricity provider. The billing follows with the personal contract and will be settled between the different electricity providers of the charging points.

**Contracting of Charging Stations**

Because of missing instant revenues, the construction of charging stations solely for marketing purposes appears unattractive to many energy providers. Thus, contracting models for charging stations have already been implemented. Here, the energy provider supplies, installs and maintains the charging station for his customer. In return, the customer pays a fixed monthly rate to his energy provider. The customer avoids high acquisition costs and the provider profits from continuous revenues.

**Consulting Service for Fleet Electrification**

Companies that want to substitute their fleet of internal combustion engines for a fleet of battery electric vehicles face a comprehensive change process which includes several challenges. The fleet electrifier offers consulting services including the composition of the electric fleet, the design of the charging infrastructure on the business premises, and the selection of an appropriate information system for the management of the fleet. Especially, in the case of electric mobility the fleet management gains in importance to ensure the availability of ready to run electric vehicles.

**Electric vehicle car sharing for employees**

In this case, electric vehicles are already integrated in a firm fleet. To maximize the utilisation intensity of the electric vehicles, they can be made available to employees for private use after end of business hours and at the weekends. In this way, the low operating costs of electric vehicles can be fully exploited.
6. Conclusion and Outlook

Through the comprehensive literature review on electric mobility, an illustrative framework based on six key values, five business model patterns and a collection of characteristics for customer segments is derived.

The application of the framework has shown the following aspects: First, the framework for e-mobility business model potentials is appropriate to systematically map implemented e-mobility business models. Especially, the six key values help to clarify existing value propositions and to uncover opportunities for new offerings. Second, the pool of characteristics helps to capture existing customers and to shape new potential company-specific customer segments in the field of electric mobility. Third, not all business model patterns from literature are already implemented by the considered interviewees. For instance, business models for battery swapping and vehicle-to-grid are currently only theoretical concepts which again specifies new business potentials.

The descriptions of pioneering business models for innovative customers demonstrate which business models are already running. With regard to the opening question of which business models successfully compete in the electric mobility market, it can be stated that at least one of the following two factors are central: On the one hand, successfully implemented business models have to comprise at least one aspect of the multifunctional utilisation such as the sharing of vehicles, the grid-integration of the electric vehicle as a controllable load and the supra-regional charging based on e-roaming. On the other hand, the pioneering business models are extremely service-oriented which increases the attractiveness for electric mobility as an entire mobility solution. The ’product’ electric vehicle needs supporting services, for charging, navigation and reservation of parking space, to be a competitive alternative for combustion engine vehicles. However, only the sum of all six key values or rather their related business models allow the successful entry of the electric mobility market. In turn, this means that the described pioneering business models are always part of a solution which covers all six key values.

The presented framework for e-mobility business model potentials builds a basic work for the first phase of a systematic development process for innovative business models. The customer centred view on value propositions for electric mobility will be theoretically supplemented with methodical tools like the Value Proposition Design [18] or the Business Model Navigator [19], which both support the development of innovative business models.

In practice, the framework will be used in workshops with companies of the e-mobility field to initially identify their business potentials in reference to the customer segments and the unattended key values. Furthermore, the presented insights of pioneering business models are a valuable contribution to face the challenges of high lifecycle costs in the electric mobility and the expansion on the mass market.

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References