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New business models for electric cars—A holistic approach

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ABSTRACT

Climate change and global resource shortages have led to rethinking traditional individual mobility services based on combustion engines. As the consequence of technological improvements, the first electric vehicles are now being introduced and greater market penetration can be expected. But any wider implementation of battery-powered electrical propulsion systems in the future will give rise to new challenges for both the traditional automotive industry and other new players, e.g. battery manufacturers, the power supply industry and other service providers. Different application cases of electric vehicles are currently being discussed which means that numerous business models could emerge, leading to new shares in value creation and involving new players. Consequently, individual stakeholders are uncertain about which business models are really effective with regard to targeting a profitable overall concept. Therefore, this paper aims to define a holistic approach to developing business models for electric mobility, which analyzes the system as a whole on the one hand and provides decision support for affected enterprises on the other. To do so, the basic elements of electric mobility are considered and topical approaches to business models for various stakeholders are discussed. The paper concludes by presenting a systemic instrument for business models based on morphological methods.

1. Introduction

1.1. Development of electric vehicle market concepts

As a consequence of climate change and increasing global resource shortages, alternative propulsion concepts are becoming ever more important. Due to rising oil and gas prices and the advances made in battery technologies, greater attention is now being directed at battery-powered electrical propulsion concepts (see also Barkenbus, 2009; Kalhammer et al., 2007; Bandivadekar et al., 2008). Even though the attention from science, policy-makers and industry has increased only recently, battery-powered vehicles actually have a much longer history. The first electric car was developed as early as 1834 and enjoyed increased popularity towards the end of the 19th century; thousands of them were made by firms from America and Europe and in 1900 they accounted for more than one third of the total number of vehicles produced (Chan, 2007). However, the problems encountered with combustion engine technology at that time were able to be overcome due to the rapid progress made here in the early years of the 20th century. In addition, the combustion engine became the more cost-efficient solution due to the improved access to oil which then spurred mass production of this technology. These developments led to the battery-powered vehicle disappearing more or less completely as an alternative propulsion technology by 1930 (Chan, 2007). The electric car only became a matter of interest again for some countries due to the first oil crisis at the beginning of the 1970s and the accompanying oil shortage. However, once the crisis was resolved and the oil price had fallen again at the end of the 1970s, the interest in battery-powered electric vehicles also waned (Rajashekara, 1994). Following the dominance of the combustion engine over the last century, the electric car is now experiencing enhanced public interest for the third time in its history. Once again, this interest is being triggered by external factors: climate change and global resource shortages. The difference to the two previous hypes, at the end of the 19th century and in the 1970s, however, is that there has been considerable progress made in battery technologies due to mass production in other sectors and this can now also be used for battery applications in electric vehicles. In spite of these developments, there are still obstacles to the wider introduction of electric vehicles. These include the long charging times, on the one hand, as well as the shorter driving range and the skepticism among potential end-users, which is being expressed in surveys (Tate et al., 2008). The major obstacle to rapid market penetration at the moment, however, is the higher initial investment required when compared to conventional combustion

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engine vehicles (Chéron and Zins, 1997; Nemry et al., 2009; Brooker et al., 2010). In contrast, the running costs of electric cars are actually lower, but these do not stand out sufficiently on a total cost basis (Thiel et al., 2010). Regardless of these problems, what counts mostin the automotive industry is recognizing what final customers need and fulfilling these needs with the relevant offer in order to be able to generate competitive advantages compared to rivals (Chojnacki, 2000). That these insights are also being practiced is shown, for example, by the Car2Go concept implemented by Daimler, which is based on the concept of car-sharing and has already been introduced in Ulm, Germany and in Austin, Texas in the US.[1]

1.2. Challenges and opportunities for new business models

Since the premise made in the literature is that these kinds of new business model are suited to increasing customer benefits through innovative offers (Matzen et al., 2005), the topic of business model seems to be taking on a central role in the context of electric mobility. This is even more valid if new value added architecture manages to lower the costs for the customer and improve customer acceptance by promising suitable benefits. Therefore, new mobility concepts and business models are required which transform the technological advantages of electric vehicles into value added for the customers. New, promising approaches concerning reducing costs and increasing acceptance tend to follow one of the four main directions:

1. *Better utilization of vehicle capacity*: New, innovative mobility concepts such as car-sharing or company vehicle fleets exploit the strategy of extending the user base at the lower operating costs of electric cars and in this way spreading the capital costs over a greater number of heads. The same thing applies to electric cars in multiple car households; due to its lower consumption, it makes sense to use the electric car more often and to save the combustion engine-powered car for other, less frequent trips. Instead of resorting to a vehicle with a conventional motor, electric mobility services could also be integrated into public transport systems which are then used for longer journeys.
2. *Extended utilization concepts*: These attempt to improve the economic efficiency of the overall system through new applications. For instance, batteries can be charged cheaply with energy during off-peak periods and can then feed power back into the grid during peak periods. Systems services such as load shifting or back-feeding energy reduce costs at the same time as helping to balance the grid load and increasing grid quality.
3. *Secondary usage*: Another possibility is to use components which are no longer being used in the vehicle, such as the battery, for other, secondary applications in order to increase their residual value, e.g. a possible approach could be to use batteries as stationary energy storage and as such help to improve the vehicle's overall economic efficiency (see Williams, 2010).
4. *Increasing acceptance*: Obstacles such as a comparatively restricted driving range can be overcome by offering so-called "mobility guarantees". For instance, when purchasing an electric car, the occasional use of a combustion vehicle could be offered for longer journeys, or information of the next available charging pole could be integrated in the vehicle's navigation system. Customer-oriented infrastructure solutions offer customers a reasonably priced and reliable infrastructure through a sensible mix of services.

These approaches can indeed help to promote the market penetration of electric vehicles, but at the same time it becomes clear how complex these concepts are. For example, these would have to integrate completely new stakeholders, who have not been part of the value chain for combustion vehicles so far. Alongside car and battery makers, energy utilities would have to be integrated, for example, as well as new mobility service providers. The consequence is that a variety of potential business models result for the different application cases, for which the participating companies and their share in the value creation have to be newly defined. In addition, the individual stakeholders are uncertain as to which business models are really effective with regard to targeting a profitable overall concept and should therefore be pursued. Alongside these uncertainties, on the other hand, new business models for electric vehicles are also being demanded. The pressure to act on companies from the automotive, energy and battery sectors is growing because first movers are entering the field and changes in the traditional business relations are expected. Currently, the existing business models are still usually pilot ventures, of an explorative nature, or the roles of the individual stakeholders are still unclear.

1.3. Structure of this paper

This paper is aiming to deliver a structured approach to designing business models based on strategic decisions to companies which can expect to experience changes in their traditional business relations due to the introduction of electric vehicles. The analysis follows a holistic approach and is made from economic perspectives. In order to meet this requirement, the following approach is taken. Section 2 looks at the existing views of business models in the literature and transfers their propositions to the field of electric mobility. Based on this terminology, a structured approach is developed in Section 3 to more precisely define existing business models with regard to their structure on the one hand and, on the other hand, to serve as decision support for the development of future business models. Subsequently, current electric vehicle applications are shown from different fields of electric mobility based on real life examples in Section 4. Finally, the stability of the approach developed is tested and examined using the example of the Better Place business model, which operates on a holistic and strategic level. In spite of the aspired holistic view, this article does not claim to deliver detailed solutions for all the decisions on different business levels. Instead it aims to create a structured approach which can be used as decision support when developing strategies for concrete business models in order to more sharply define approaches and be able to consider potential alternatives.

2. Types of business models

In industry, suppliers have already been offering new business models to their clients for some time (Wise and Baumgartner, 1999; Fähnrich and Opitz, 2006). Such new business models try to utilize additional services to design the product in such a way that increases the benefits for the client and gives the supplier's product the competitive edge (Matzen et al., 2005). This basic idea can also be transferred to innovative business models for electric mobility. For example, Afuah (2004) defines: "A business model is the set of which activities a firm performs, how it performs them, and when it performs them as it uses its resources to perform activities, given its industry, to create superior

[1] For more information see the Car2Go web page under http://www.car2go.com.