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Business model prototyping for electric mobility and solar power solutions

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Abstract

Which business models create maximum value for customers by leveraging the synergies between electric vehicles, installed batteries, photovoltaic systems, and the power grid? Both the solar power generation and the number of electric vehicles are massively increasing in the forthcoming years and thus they have to be respected as irreversible trends. Assuming that the combination of those technologies through a cooperative energy management approach allows entrepreneurs to make superior value propositions and to generate competitive advantages, a framework is proposed to figure out several business model prototypes. To quickly assess the dynamic behavior and the profitability of those prototypes in an innovation process the framework is complemented by a System Dynamics simulation model.

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Keywords: Sustainability; Solution thinking; System Dynamics

1. Introduction

Mobility and energy constitute elemental needs of private persons as well as companies. In the last century, these needs were met by two uncoupled industries: the automotive industry with its internal combustion engine vehicles and the energy industry as a supplier of electricity. Over time, both industries were increasingly put under pressure by legal requirements for a more environmental friendly way of value creation. Thus, in the last decade two disruptive technologies gained in importance: electric mobility [1] and solar power [2]. Enabling the customers to generate electricity by installing solar panels on their free areas enhances the attractiveness of purchasing an electric vehicle. Due to this coupling of technologies there is a merging of industries as shown in Figure 1. Nowadays, the energy suppliers as well as the car manufacturers are offering installed batteries, which maximize the self-consumption of the photovoltaic energy, and charging stations. In this way, former complementary players become competitors by expanding their industry boundaries in the same direction [3]. But who will be ahead of the game? Who is able to create the most valuable solutions for the mobility and energy needs of the customers?

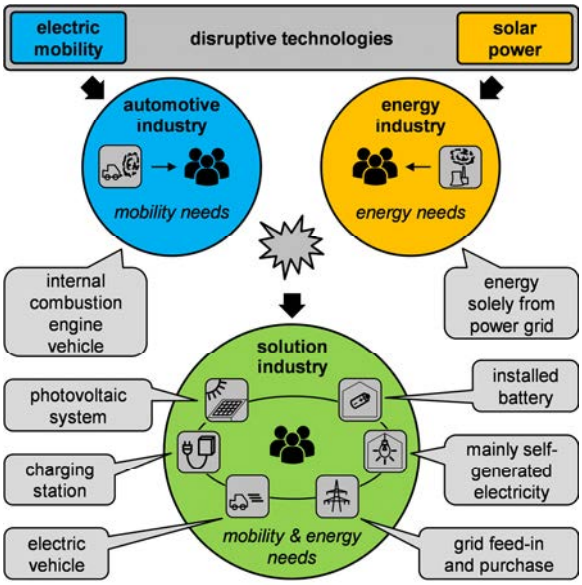

Fig. 1. Disruptive technologies cause a merging of industries

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Consider the entrepreneur Elon Musk, the co-founder of Tesla Motors and SolarCity. While the first company is a manufacturer of electric vehicles and installed batteries, the second company is an energy service provider with focus on the installation of photovoltaic systems. Through the synergies of the offerings of these two companies it is possible to offer integrated mobility and energy solutions. In this way, Elon Musk's companies are in competition with both the manufacturers of internal combustion engine vehicles and the suppliers of electricity. Obviously, a distinctive kind of solution thinking is a required prerequisite to be ahead.

Beyond, viable business models are necessary to capture value from new technologies [4]. Neither the physical behavior of cooperative energy management nor the business dynamics of complex value constellations are easy to assess. Thus, it is indispensable to prototype several options of solutions in a structured innovation process.

Focusing on the synergies between electric mobility and solar power this paper asks the following questions: Which building blocks and invariant inputs have to be considered to compose holistic solutions for mobility and energy? Which design opportunities exist to tailor these solutions for different customers? How can the fit between the technical system and the value constellation be analysed and ensured?

2. Business Model Prototyping with System Dynamics

Business model prototyping is a tool for elaborating and assessing new business model options during the business model innovation process. It makes abstract concepts tangible and facilitates the exploration of new ideas [5]. With regard to the overall business model design process it is classified in the design stage, as it is shown in the lower half of Figure 2.

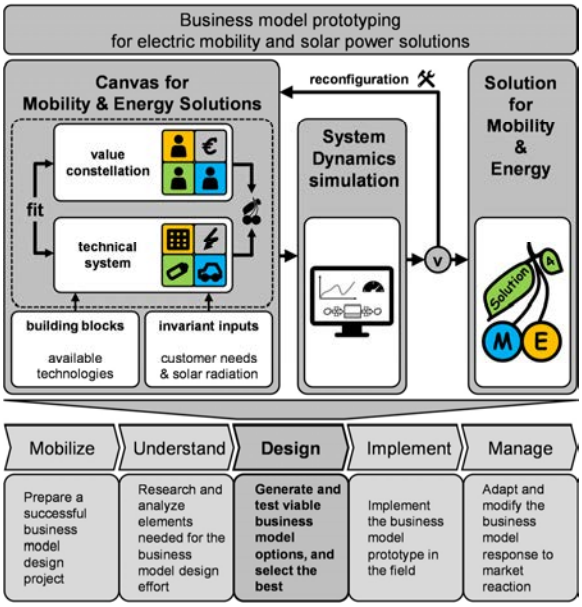

Fig. 2. Integration of business model prototyping for electric mobility and solar power solutions into the business model design process following [5]

Business model prototyping for electric mobility and solar power solutions comprises two phases which are passed through repeatedly in order to design the solution incrementally. First, the framework 'Canvas for Mobility and Energy Solutions' is used to analyze existing offerings regarding to both their technical and economic characteristics and to invent prototypes for innovative solutions by considering different possible design opportunities. It includes not only photovoltaic systems and installed batteries but also electric vehicles and thus complements the existing literature [6]. Second, the developed prototypes are subsequently simulated with the aid of System Dynamics, which has already been used in solution design [7], to get an instant feedback of how well the solution works. If necessary, the prototype will be accordingly reconfigured. The outcome is a well-matched solution for mobility and energy. This outcome is symbolized as two cherries obtaining their energy from a common leaf, the photovoltaic system, and finally from the sun. An overview is given in the upper half of Figure 2.

Section 3 gives an overview of the Canvas for Mobility and Energy Solutions and describes its elements in detail. Section 4 presents the generic structure of the Systems Dynamics model and illustrates the prototyping process on the basis of a specific example.

3. Canvas for Mobility and Energy Solutions

The Canvas for Mobility and Energy Solutions is a framework enabling the innovation team to get a shared mental model of a customer tailored solution for his mobility and energy needs. First, the canvas helps to clarify the technological building blocks which can be included in holistic solutions and the invariant inputs such as the customer needs and the solar power profile. Second, the canvas makes it possible to discuss the different options of configuring the technical system of the solution. Third, the canvas helps to make clear, which players are involved in the customer's solution, which value propositions they make, and which cash flows between them and the customers exist. These three points are explained in detail in the following subsections.

3.1. Building Blocks

The technical system is modelled as a combination of sources, sinks, storages, and valves. Figure 4 gives an overview of the considered building blocks for mobility and energy solutions.

The conventional building blocks are the power grid and the residential and industrial energy consumers. The power grid constitutes the interface to the energy provider. The residential and industrial energy consumers represent common devices and machines that need electricity to be operated. The building blocks of electric mobility are the electric vehicle, the traction battery and the charging station. As an entire electric vehicle is an energy storage and an energy consumer at the same time, the electric vehicle and the traction battery are regarded separately. The main characteristic of the electric vehicle is its consumption per kilometer.