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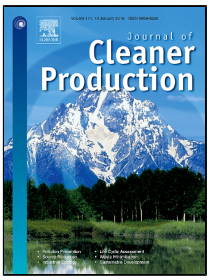

Techno-economic analysis of sustainable mobility and energy solutions consisting of electric vehicles, photovoltaic systems and battery storages

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Techno-economic analysis of sustainable mobility and energy solutions consisting of electric vehicles, photovoltaic systems and battery storages

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Abstract

Electric vehicles, photovoltaic systems and battery storages are promising components of sustainable mobility and energy solutions for private households. A fast marked diffusion of these technologies requires their cost competitiveness against conventional technologies such as internal combustion engine vehicles and fossil-fired power plants. System Dynamics is hypothesized to advance the development of sophisticated business models for sustainable solutions as it makes mental models of a business explicit and thus better assessable on the basis of simulation studies. While pursuing the main aim of ensuring the cost advantage of sustainable solutions over conventional ones, three crucial issues are addressed: First, the economic benefit depends on the customer specific driving profiles and load profiles of the households, so a differentiated consideration of the mass market is needed to identify suitable target customers for sustainable solutions. Second, the cost advantage is affected by the volatility of environmental factors such as electricity prices, feed-in remunerations and fuel prices. Therefore, a regular view of the cost competitiveness of sustainable solutions has to be conducted in order to run a viable business. Third, the technological synergies between electric vehicles, photovoltaic systems and battery storages allow customers to be more independent from electricity prices. Hence, a prudent technical design of sustainable solutions is essential if the economic benefits for the customers are to be fully leveraged. Based on System Dynamics, a newly developed techno-economic model of mobility and energy solutions depicts the technological synergies between the three components and the resulting costs for mobility and energy. Through parameter variations, the model user is able to modify the customer needs, the environmental factors and the technical design options in order to gain an immediate feedback concerning the change in costs. Exemplary simulation runs including ideal-typical customer profiles and solution designs within the German market demonstrate that the realizable share of photovoltaic energy among the driving current holds strong economic benefits besides the ecological ones. The model is validated with a German utility company and serves as a scientific basis for their business development and their future marketing programs.

Key words

System Dynamics, Electric mobility, Renewable energies, Diffusion of innovations, Business models