Towards sustainable regions: the spatial distribution of electric vehicles' recharging stations from a socio-economic perspective

The last decades have witnessed a growing interest in electric vehicles (EV) as an integral part of the vision for sustainable regions. The main reasons include the acknowledgment of the necessity of auto-mobility, the technological advancements of electric vehicles, and the interest in petrol-free, low-emission vehicles due to the rising oil prices and global warming. Adequate on-road EV recharging infrastructure is essential in the transformation of EV into a practical transport option and the wide-scale market penetration of EV. Nevertheless, the efficient spatial distribution of EV recharging is rarely explored.

The current study focuses on assessing the demand driven need for on-road EV recharging stations, and finding their efficient spatial distribution, while accounting for economic, social, environmental and land-use considerations. The analysis, conducted for Denmark, consists of four steps. Firstly, the demand for on-road recharging of EV's based on the national travel demand patterns is evaluated, while considering the existence of a city-wide slow recharging network. Secondly, the Edison model for the optimal deployment of EV recharging stations is applied. The model evaluates the need for recharging at the vehicle level, and seeks the optimal deployment of recharging stations on the basis of the distribution of the potential recharging points and the inventory of candidate sites. Thirdly, the EV market share is evaluated as a function of the number of EV recharging stations by employing a discrete choice model, estimated on the basis of a stated preference survey. Last, the feasibility of the optimal EV spatial distribution of the EV charging stations is analyzed, based on the Danish official socio-economic framework (TERESA).

Results show: (i) the number of required recharging stations for satisfying the travel demand, (ii) the optimal deployment of recharging stations, (iii) the change in travel patterns due to detours for EV recharging, (iv) the feasibility of the proposed infrastructure while considering economic costs and benefits for operators and users, impact on government budget as well as environmental externalities, namely pollutant emissions, carbon footprint, and noise exposure. The results demonstrate the applicability and feasibility of the proposed method for planning an EV recharging network in sustainable regions.

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