GIS-driven analysis of e-mobility in urban areas: An evaluation of the impact on the electric energy grid

Abstract:
This paper investigates the potential of electric vehicles to meet the mobility demand currently met by conventional fuel vehicles and explores the application of GIS datasets to geo-reference the electric energy demand resulting from their deployment on large geographical areas. The study is based on driving patterns collected from conventional fuel vehicles in the Italian provinces of Modena and Firenze by means of on-board GPS systems. The analysis is carried out over one month, considering approximately 28,000 vehicles and 36 million kilometres. Two types of battery electric vehicles and five recharging behavioural models are considered, to evaluate the trips and the fleet share suitable to be served by EVs, by following all the trips and parking sequences in the databases. This allows deriving the impact on the electricity grid of the electrification of urban vehicles in terms of additional electric energy demand and its geographical distribution. The results show that more than 80% of the urban trips can be covered by electric vehicles and that an urban fleet share between 8% and 28% could be replaced by the current generation of electric vehicles without any change in their driving patterns. The derived electric energy demand increase remains below 5% of the total electric energy demand, and below 20% of the domestic electric energy demand in the analysed areas. The geographical analysis shows in detail how this additional demand is distributed over the areas analysed, and how it compares with the already available recharging infrastructures in the two provinces. A complete description of the model developed is provided, focusing on the potential of GIS datasets to address the integration of electric vehicles in urbanised areas.


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