OPTIMIZING EV FLEET CHARGING STATIONS ACCESS WITH MATSIM

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Abstract: The demand for electric vehicles is increasing day by day. The future-peak power demands may also be increased by the rise in the demand for EVs, along with its impact on the demands for charging infrastructure. [1] Although several papers primarily focus on optimizing the charging stations with user convenience, temporal and spatial energy demand with accessibility-driven charging optimization are less frequently analyzed. In this paper, energy system-implications of the algorithm designed to minimize the walking distance from activity locations to charging stations are analysed, together with changes in charging accessibility parameters like walking distances and charging events, while the spatial and temporal energy demand with the accessibility driven-optimization across the Hamburg districts is investigated. So in this study, mainly charging accessibility is optimized by minimizing the average walking distance (in meters) between activity locations and charging stations in the Hamburg districts.

The 2025 base case-scenario of Hamburg city is used, and its GTFS data have been utilized to simulate EV charging behaviour using MATSim-based framework to model agent behaviour and charging demand. The detailed energy and spatial evaluations in this study are focused on a sample workday that is neither a weekend nor a public holiday, even though the full year simulation with a 50% downsampled population is done. This enables the examination of regular daily charging patterns while anomalies from atypical mobility behavior are eliminated. For every charging event, the walking distance from activity to the charging station selected by the accessibility optimization algorithm is calculated, along with the kind of activity that is associated with that stop (i.e. work, leisure, shopping etc.) is recorded. Energy-related metrics, such as district peak loads, temporal demand profiles, and activity-based charging patterns in the Hamburg-districts are calculated for accessibility-driven EV charging optimization. A spatial-temporal perspective on the energy impacts of accessibility-driven EV charging optimization is given by this study through the combination of district-wide energy demand, hourly peak loads, and activity-based charging behavior.

According to analysis, reducing walking distance improves charging accessibility and results in a redistribution of city’s temporal and spatial energy demand and peaks throughout the city districts. Some districts experienced reduction in peak load, while other district‘s-peak loads are increased, shows that total peak loads are not uniformly reduced but rather redistributed across locations and time periods. Also, some charging patterns are affected by this walking distance minimization, as seen by the distribution of charging events among districts.

To create sustainable urban EV infrastructure, the significance of combining user-centric accessibility optimization with an integral energy system perspective is highlighted by these new findings. With analyzing energy demand and peak loads with accessibility based-optimization, insights can be derived, that can support grid-charging infrastructure planning and identification of districts where and when local grid stress may occur.

Keywords: charging infrastructure, EV charging behaviour, MATSim-based framework, accessibility optimization algorithm, user-centric accessibility optimization, grid-charging infrastructure planning.

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References

[1] K. K. a. P. M. S. Deb, „Impact of electric vehicle charging stations on reliability of distribution network," *2017 International Conference on Technological Advancements in Power and Energy (TAP Energy), Kollam, India, ,* Bd. doi: 10.1109/TAPENERGY.2017.8397272, pp. 1-6, 2017.