

Evaluation of the Impact of Local Regulatory Requirements on the Usage Behavior of Public Charging Infrastructure

Master's Thesis of Maaz Hussain

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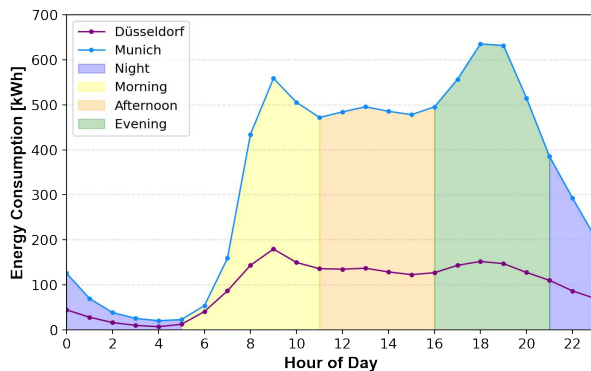


Figure 1. Energy Consumption Profile

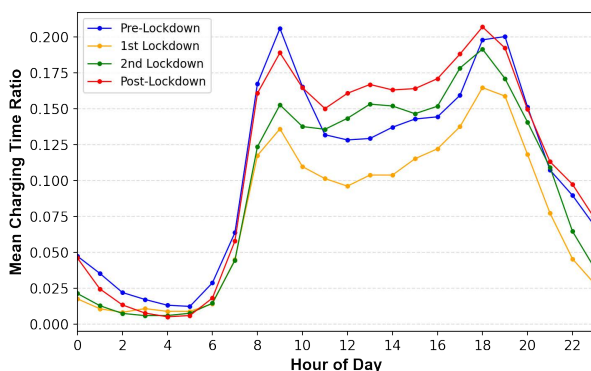


Figure 2. Charging Time Ratio During Different Lockdown Periods

Analysis on the City and Neighbourhood Level

On the city level, the changes in the charging pattern is analyzed for the city of Munich and Düsseldorf. It also examines the impact of the COVID-19 pandemic on EV charging behavior by studying changes in occupancy, charging & idle time ratio, and energy consumption patterns during different lockdown periods. Furthermore, the study delves into the charging infrastructure in both cities at the neighbourhood level, categorizing it into different regions based on occupancy and charging patterns. The study identifies four major distinct charging patterns and proposes criteria to optimize the performance of the infrastructure in each neighbourhood.

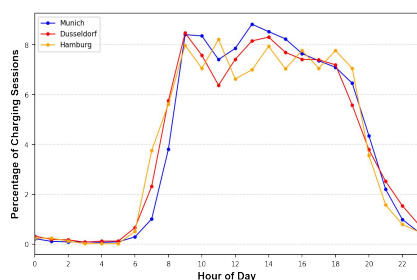


Figure 5. Distribution of Start Time until 6 Hours Connection Duration

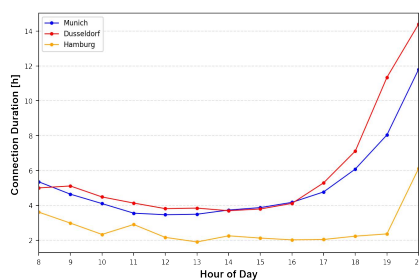


Figure 6. Average Connection Duration During Restricted Hours

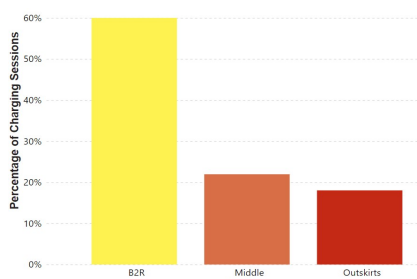


Figure 7. Rules Violations in different Neighbourhood Regions of Munich

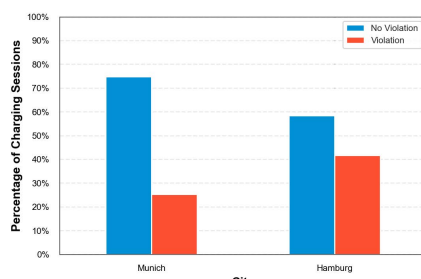


Figure 8. Compliance with Maximum Allowable Charging Limit in Munich and Hamburg

Background and Goal

The effective use of EVs relies heavily on the availability of public charging infrastructure. To make electric vehicles accessible to everyone, it is essential to optimize the charging infrastructure based on the charging behaviour. This study presents a comprehensive examination of the charging behavior of electric vehicles (EVs) at public charging stations in Munich, Düsseldorf, and Hamburg. The primary objective is to explore the impact of rules and regulations on charging behavior by analyzing the changes in key performance indicators (KPIs) over a two-year period from January 2020 to December 2021. The KPIs include the number of charging sessions, total connection time, charging and idle time ratio, and energy consumption. The study emphasizes the importance of adhering to rules and regulations and provides valuable insights for policymakers and stakeholders to develop targeted strategies to improve the charging infrastructure and promote sustainable transportation.

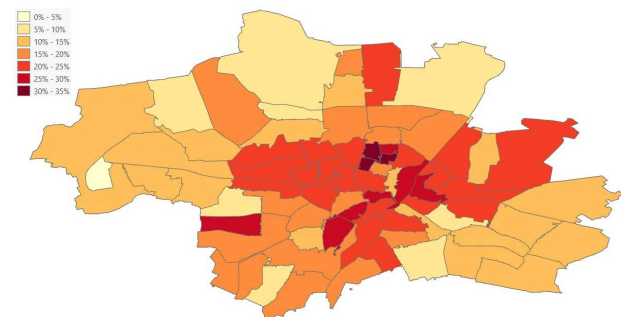


Figure 3. Charge Point Occupancy of Munich during 2021

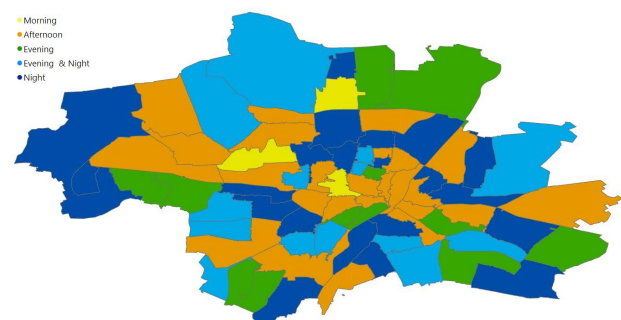


Figure 4. Spatial distribution of Occupancy Pattern of PC5 Areas of Munich

Impact of Rules and Regulations

The impact of rules and regulations on charging behavior was a significant finding of this study. Restrictions on charging time were found to significantly affect the duration of charging connections, with shorter connections likely to occur during the restricted time period of 8 am to 8 pm. The study also found that regulations on the maximum charging time allowed during the day played a crucial role in shaping the distribution of connection start times and charging behavior in different cities. The analysis of rule violations in residential and commercial locations revealed that the placement of charging stations and demand for charging in each area can also influence compliance with regulations. Overall, the study provides valuable insights into the factors influencing EV charging behavior, which can help policymakers and stakeholders to optimize the development and deployment of public charging infrastructure.