Understanding the Regional Variation in Charging Behaviour across Germany

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ABSTRACT

As Germany advances towards widespread electric vehicle (EV) adoption, understanding regional disparities in charging patterns is critical for optimising infrastructure, policy design, and grid stability. This study examines regional differences in EV charging behaviour across Germany, analysing factors such as urbanisation levels, grid capacity, socio-economic conditions, and renewable energy integration. Using the data from EV driver survey conducted in Germany, we identify variations in charging frequency, duration, and preferred time slots between urban and rural areas. The study also explores the impact of socio-economic factors, including income levels and vehicle ownership patterns, on charging behaviour. Higher-income regions tend to have a greater share of private home charging, whereas lower-income urban areas depend more on public infrastructure. Furthermore, regional differences in transportation habits, such as the use of EVs for long-distance commuting versus short urban trips, influence the timing and intensity of charging demand. Policy implications include the need for tailored infrastructure investments, dynamic pricing models, and incentives to promote off-peak and renewable-based charging in different regions. The study contributes to the broader discourse on electrifying the transportation sector by providing perceptions into how localised factors shape EV charging behaviours, aiding stakeholders in designing region-specific strategies for an efficient and equitable transition to electric mobility in Germany.

Keywords: Electric Vehicle, Charging Behaviour, Survey, Regional Differences.

1 INTRODUCTION

As EV adoption accelerates in Germany, understanding the regional variation in charging behaviour is crucial for optimising charging infrastructure, ensuring grid stability, and enhancing user experience (Jochem et al. 2022). Germany's diverse geography, economic landscape, and urban-rural divide contribute significantly to differences in EV charging behaviour. Germany covers an area of approximately 357,684 km², with a wide variety of urban, suburban, and rural regions. The country's geography ranges from the densely populated Rhine-Ruhr metropolitan area, home to over 10 million people, to sparsely populated regions such as Mecklenburg-Western Pomerania, with only 69 people

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per km² (German Federal Statistical Office, 2025; Zensus, 2022). These differences impact the distribution of EV charging stations, with urban areas like Berlin (4,112 public charging points in 2023) and Munich (2,325 public charging points in 2023) boasting extensive networks, while rural regions often struggle with accessibility (Statista, 2025). Germany has a strong economic divide between industrialised western and southern regions and structurally weaker eastern states. The GDP per capita in Bavaria (over €50,000) and Baden-Württemberg (around €48,000) supports higher EV adoption, as wealthier households are more likely to afford EVs and home charging stations (German Federal Statistical Office, 2025). In contrast, states such as Saxony-Anhalt (€31,000 GDP per capita) and Mecklenburg-Western Pomerania (€29,000 GDP per capita) see slower adoption due to lower purchasing power and fewer incentives for private EV infrastructure investment (German Federal Statistical Office, 2025). Germany's population is 77.5% urban and 22.5% rural, affecting EV charging behaviour significantly. In cities like Hamburg, where 91% of residents live in apartments, reliance on public charging stations is high, whereas rural areas, where single-family homes make up 80% of housing, tend to favour home charging with private wall boxes (German Federal Statistical Office, 2025). Factors such as the availability of public and private charging stations, regional energy policies, population density, and commuting patterns all influence charging preferences. Understanding these regional disparities enables policymakers, energy providers, and urban planners to develop targeted strategies that improve charging accessibility and efficiency. This study analyses regional trends in EV charging behaviour across Germany, identifying key factors driving differences.

2 METHODS

This study employs a survey-based approach to investigate regional variations in EV charging behaviour across Germany, focusing on urbanisation levels, grid capacity, socio-economic factors, and renewable energy integration. Descriptive statistics were used to identify regional disparities and derive policy implications.

2.1 Survey Design

The survey was designed to collect 8 sections detailed information on EV users' demographic profiles, personality traits, EV ownership and usage, charging patterns, experiences with regional charging infrastructure**,** user preferences, route planning, traffic and parking**.** The general questionnaire comprised 51 questions in total, a mix of multiple-choice, Likert scale, and open-ended formats, allowing for statistical analysis and a combination of quantitative and qualitative insights. 841 responses were retained for analysis. Key survey items included public charging points usage ("How often do you use public charging stations for your electric vehicle?") which related to public charging, the charging duration ("How long does charging take on average?"), and the time of charge ("What time of day do you usually start charging your electric vehicle?") are reliance on public and private infrastructure. The survey was conducted using LimeSurvey and distributed via the professional panel provider Bilendic, ensuring a diverse sample of EV users from urban, suburban, and rural regions across Germany.

2.2 Participant Screening

To ensure data relevance, participants were required to be current EV users with experience using public or private charging infrastructure in Germany. Screening criteria were implemented to exclude incomplete or inconsistent responses. Participants were categorised based on their residential locations (urban, suburban, or rural) to promote regional comparisons. In addition, the survey collected demographic information including participants' gender, age, education level, and living situation (household size and housing type), enabling a comprehensive analysis of how socio-demographic and regional factors influence charging behaviour.

2.3 Data Analysis and Descriptive Statistics

Descriptive statistical methods were applied to analyse key variables, including charging frequency, duration, and preferred time slots.

2.4 Regional Variation Analysis

Participants were classified into geographic zones (0–9) and a four-tier urbanisation region (1 – Very Central to 4 – Very Peripheral) based on urbanisation levels and regional characteristics (BBSR, 2025). This analysis helped identify variations in charging accessibility, reliance on public infrastructure, and charging demand patterns. Furthermore, regional differences in transport habits—such as long-distance commuting versus short urban trips—were assessed to understand their influence on charging demand.

3 RESULTS AND DISCUSSIONS

Initial findings from the survey are presented below. These qualitative and illustrative results are preliminary and not yet statistically validated but suggest emerging trends. Building on this data, future work will involve more rigorous statistical analyses to identify quantitative differences between user groups. Figure 1 illustrates the zones and population density in Germany. Zones 4 to 7 have higher population densities compared to other zones, while zones 1, 2, and 8 feature distinct central areas with particularly intense population concentration. Zones 0, 3, and 9 have lower population densities with a more even distribution across their areas. The survey data indicate that zones 4 to 8 lack very peripheral areas, with zone 4 being the most urban and zone 1 the most peripheral.

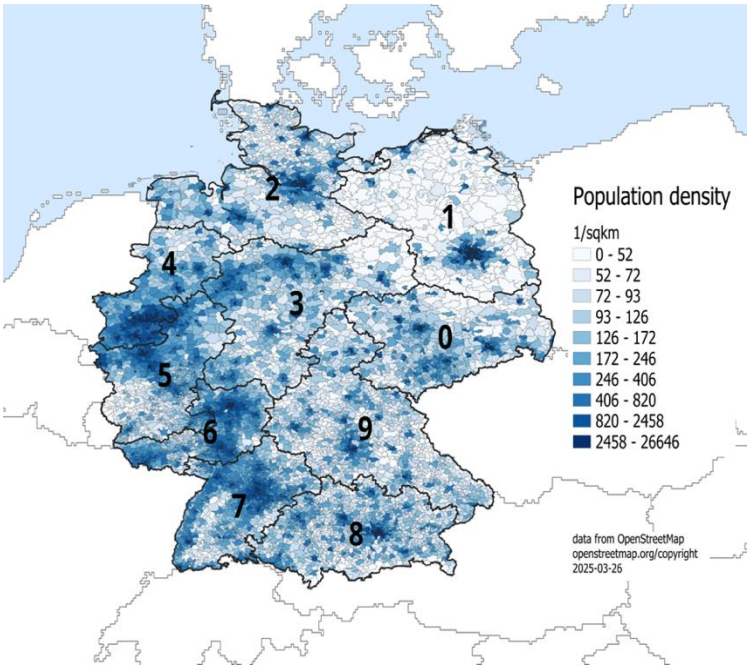

Figure 1 - Zones and Population Density in Germany

Respondents were asked about the frequency of using public charge points. As shown in figure 2, very central areas in high population density zones (4–7) show strong reliance on public charging, with a high proportion of weekly and daily users (58.2%). Medium-density zones (1, 2, 8) exhibit moderate dependence, particularly in central regions. In contrast, low-density zones (0, 3, 9) rely less on public charging, especially in peripheral and very peripheral regions. This suggests that public infrastructure is more critical in dense, urban cores than in suburban or rural outskirts.

Charging durations (Figure 3) vary by region, with very central areas in mid to high-density zones (4–7) showing the most users charging between 1 to 6 hours. Peripheral zones in outer and rural areas (0–3, 8–9) tend to have longer charging sessions, while very peripheral zones consistently show the fewest users and shortest charging activity. This suggests that rural areas are more dependent on private charging facilities, which are perceived as more convenient for long-distance travel. The longer charging durations in peripheral areas may be due to both slower charging infrastructure and lower travel frequency, leading to less usage.

Charging patterns also vary based on the time of day across zones and regions (Figure 4). In urban zones (4–7), charging sessions are concentrated in the evening (6 pm to midnight), especially in very central areas, possibly due to greater availability of public charging stations near work or retail areas. Medium-density zones (1, 2, 8) show more varied usage across midday and evening. Low-density zones (0, 3, 9) also favour evening charging but with greater dispersion. Overall, denser, central zones exhibit more consistent evening charging behaviour. These behaviours align with the infrastructure availability and lifestyle differences, as rural areas typically have fewer public charging stations, leading to more home-based charging, which is typically done during less busy hours to avoid grid overload.

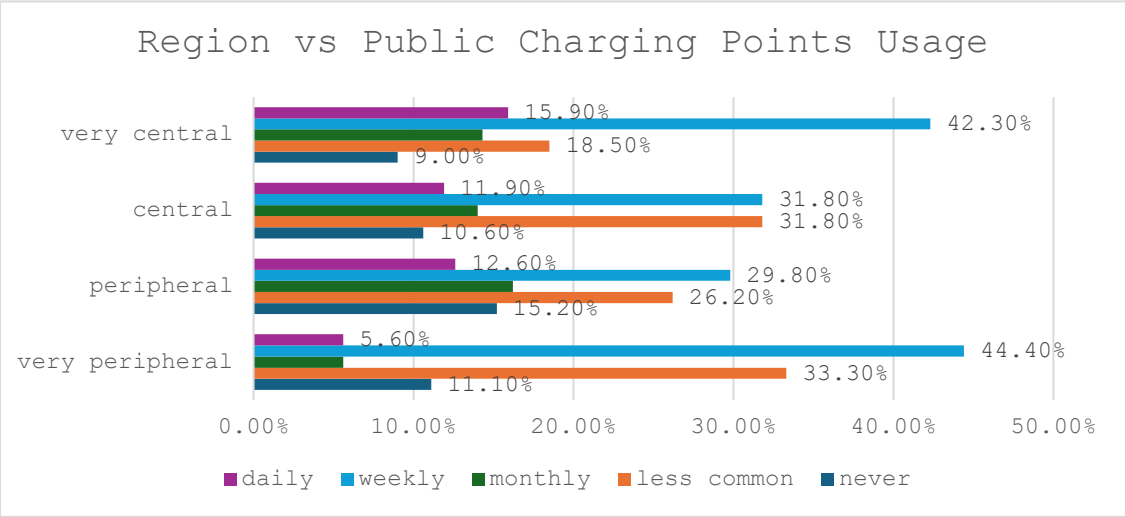

Figure 2 - Frequency of Public Charging Points Usage in Regions

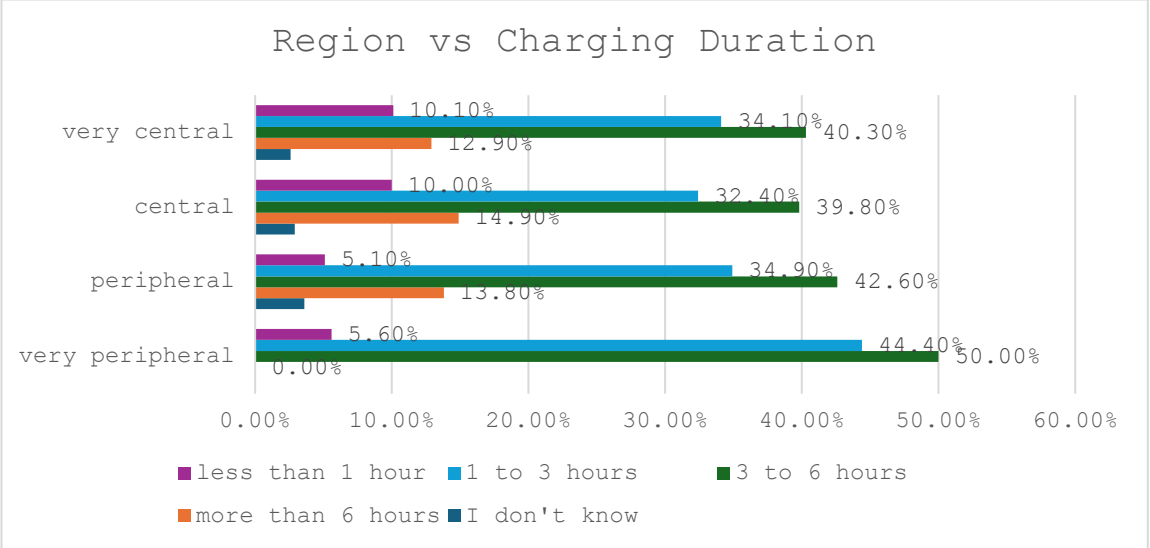

Figure 3 - Frequency of Charging Duration in Regions

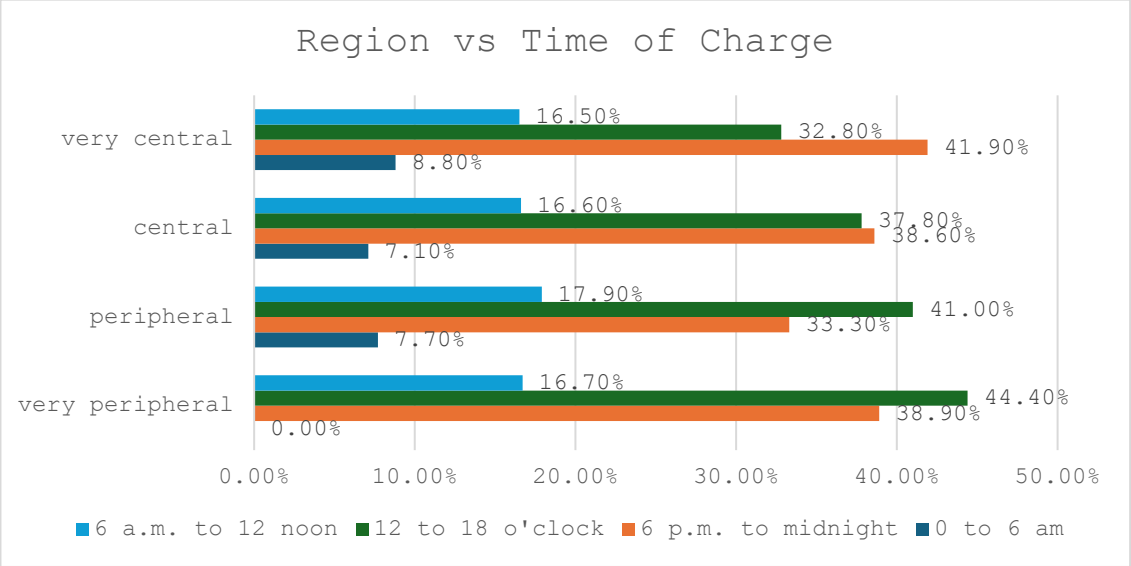

Figure 4 - Frequency of Time of Charge in Regions

4 CONCLUSION

This study presents qualitative findings from a comprehensive online survey conducted in Germany on EV charging patterns. Preliminary results suggest that urban EV users tend to prefer evening charging and often experience shorter charging durations, likely due to limited access to private wall boxes and greater availability of public fast-charging infrastructure. In contrast, users in rural areas commonly report longer charging times, indicating greater reliance on private home-based charging. Charging behaviour in rural regions also appears more varied, with a higher incidence of early morning or daytime charging, potentially influenced by self-generated electricity from photovoltaic systems. To further explore the underlying factors shaping these patterns, the research will be extended using advanced econometric modelling, incorporating variables such as personality traits, socio-demographic characteristics, travel behaviour, and vehicle usage across different regions of Germany.

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