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Simulation of Daily Charging Behaviour in MATSim: A Case Study of Das Neue Gartenfeld in Berlin

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Abstract

This study presents a simulation-based approach to assess electric vehicle (EV) charging demand at the neighborhood level, supporting infrastructure planning for climate-neutral cities. Embedded in the *Mobility2Grid* project, the primary goal is to explore how agent-based modeling can inform integrated transport and energy systems in urban environments. Using behavioral extensions of Multi-Agent Transport Simulation (MATSim), we simulate daily EV charging behavior in Berlin, focusing on the planned, car-reduced district of Das Neue Gartenfeld. The central research question is: *How much energy demand from EVs can be expected in Das Neue Gartenfeld, and how should the local charging infrastructure be dimensioned accordingly?* The model integrates strategic charging decisions, time-of-use tariffs, and geospatial data on EV ownership and infrastructure. Results contribute to the development of localized, scalable measures for managing charging load, guiding infrastructure rollout, and formulating policy recommendations—thus supporting Berlin's goal of climate neutrality by 2045.

Keywords: electric vehicles; charging infrastructure; agent behaviour; charging behaviour

1. Motivation

Background. The growing adoption of Electric Vehicles (EV), supported by national and regional incentives, places increasing demands on both transport and energy infrastructure. In urban contexts, understanding the spatial and temporal dimensions of charging behavior is key to ensuring reliable energy supply and efficient mobility. Accurate modeling tools are therefore essential to anticipate infrastructure requirements, support energy-efficient urban development, and inform public investment and policy.

This study is embedded in the context of the *Mobility2Grid* project, which focuses on integrated, networked systems for the climate-neutral city. A central objective is to assess the demands placed on future energy and transport systems. This includes understanding and modeling the interdependencies between vehicle charging behavior, grid capacity, and urban structure. The central research question here should be answered as far as possible as to how high the expected energy demand of EV in Das Neue Gartenfeld is and how the local charging infrastructure should be dimensioned accordingly. Thus it is possible to derive concrete measures for action at neighborhood, district, and city levels—supporting Berlin's climate neutrality target by 2045, as outlined in the Berliner Energie- und Klimaschutzprogramm 2030 (BEK). (SenMVKU, 2022)

Recent MATSim advancements. Multi-Agent Transport Simulation (MATSim) provides a suitable platform for this purpose, with its ability to simulate agent-based mobility behavior and infrastructure interactions, combined with a modular and extensible framework for simulating large-scale travel demand at regiional as well as city scale (Horni et al., 2016). The EV extension enables detailed modeling of energy consumption, recuperation, and charging events, with flexible definitions for vehicle types, charger configurations, and accessibility (Bischoff and Maciejewski, 2015). Recent advancements also allow agents to plan and adjust charging stops based on energy needs and pricing (Bakhtiari et al., 2023).

The recent simulation components for simulating charging decisions combine two complementary aspects: (1) managing charging activities (plugging, and unplugging vehicles) during an agent's daily plan, and (2) long-term decisions regarding chargers. The underlying EV simulation in MATSim uses a modular structure for defining chargers

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(via the ‘ev-charging-stations.xml‘ format), vehicles (in ‘vehicles.xml‘), and their consumption characteristics (in ‘ev-consumption-models.xml‘). Energy management, queueing behavior, and plug occupancy are simulated in discrete time steps, which enables precise estimation of infrastructure loads and vehicle readiness over the course of the day. (Hörl et al., 2025) [1]

Agents select among available chargers based on location, power level (Alternating Current (AC) or Direct Current (DC)), expected waiting time, and current tariffs. These factors are integrated into the MATSim scoring function, which allows agents to trade off time loss and monetary cost. From the infrastructure side, agents are assigned access rights to private home or workplace chargers based on their residential and occupational attributes. These decisions are fixed and reflect routine patterns such as nightly home charging or daily top-ups at work. The simulation logic also incorporates dynamic tariff information, enabling scenarios where agents respond to time-of-use price signals or employer-provided incentives (Hörl et al., 2025).

This study builds on and extends these capabilities to simulate daily EV charging behavior in Berlin, with a focus on the planned sustainable neighborhood of Das Neue Gartenfeld (DNG). As a neighbourhood that is likely to have a high EV density and is still under development, it serves as a test area for us to investigate future infrastructure needs and policy measures.

2. Case study

Das Neue Gartenfeld in Berlin. The study area of this analysis is a newly planned residential neighbourhood in north-western Berlin. It is conceptualised as an urban quarter whose sustainability is based on good public transport connections and electrification as the core principles of a new mobility concept. The focus here is therefore on traffic calming and convenient connections at the same time. However, it is also clear that the location of the neighbourhood means that EV will play a key role in residents’ mobility. Although not yet constructed, DNG is expected to serve as a blueprint for future car-light, electrified neighborhoods in Berlin (SenStadt, 2024).

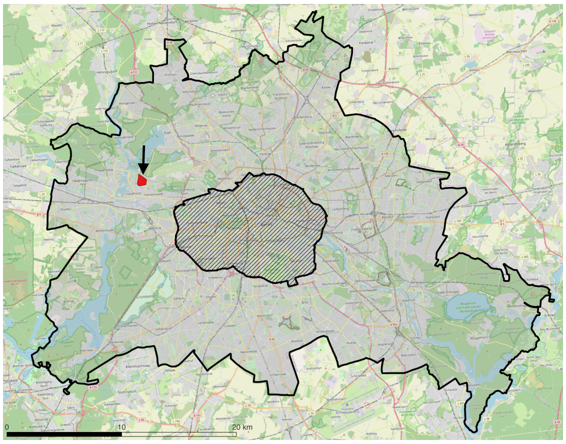

Fig. 1: Location of Das Neue Gartenfeld [DNG] (black arrow) compared to the inner city area within Berlin: *own illustration*

Based on the Open MATSim Berlin Scenario (Rakow et al., 2024), a comprehensive simulation model for the Berlin metropolitan region, the Open Berlin Scenario is expanded to include DNG for this study. The model includes a calibrated synthetic population, a detailed transport network and a basic demand configuration. In our simulation, DNG is manually implemented into the MATSim network, including synthetic population activities, new residential links, and additional infrastructure nodes[2]. The district is modelled with the expected EV ownership rate and the planned access via neighbourhood garages, where the charging infrastructure is situated[3].

[1] accessible via `https://github.com/matsim-org/matsim-libs/tree/master/contribs/ev`
[2] accessible via `https://github.com/matsim-scenarios/matsim-berlin/tree/gartenfeld`
[3] accessible via `https://github.com/matsim-scenarios/matsim-berlin/tree/evGartenfeld`

For this study, only EV users are retained in the simulation. Non-EV agents and all non-relevant replanning strategies -— such as route or departure time adaptation -— are disabled. This simplification reduces computational overhead while preserving high-resolution insight into charging demand. Travel times are held constant in 15-minute intervals, and the modal split is fixed throughout the day.

Open data. The spatial distribution of EV ownership is derived from postal code-level registration data provided by the Berlin Senate (SenStadt, 2025). Agents are linked to their residential postal zones, and in each zone, a number of car-using agents equal to the observed EV share is selected and assigned an electric vehicle. EV users are further characterized by State of Charge (SoC) and binary attributes indicating access to private chargers. Charging infrastructure is modeled using data from the same source, which includes information on charger location, power, plug type, and public accessibility (SenStadt, 2025). Semi-public infrastructure, such as chargers on commercial premises, is treated as publicly usable with time-window constraints. In DNG, additional chargers are defined synthetically to reflect the district's forward-looking infrastructure plans. It is intended that access to charging stations at home and at work will be allocated probabilistically on the basis of urban location, household structure and type of employment.

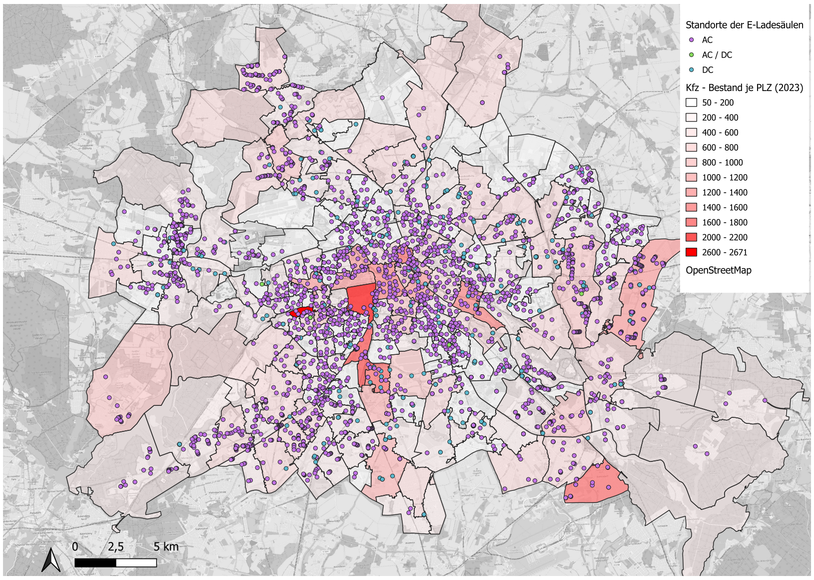

Fig. 2: Charging points and Number of EV distributed across districts in Berlin (SenStadt, 2025)

Price model. Given the simulation framework (Hörl et al., 2025), it is possible to implement a simplified but realistic tariff model as well. Stable, low prices apply to home charging; public AC chargers are subject to moderate time-of-day pricing; and DC fast chargers incur higher costs, especially during peak charging hours. Certain workplace charging stations are assumed to be free in order to simulate subsidy or employer support programmes. This setup supports the evaluation of user responses to different policy interventions and pricing models

Outlook. This study presents an integrated framework for the simulation of daily EV charging behaviour in MATSim that combines day-to-day decision making with long-term strategic behaviour. The application to Berlin and in particular to the planned district DNG shows how MATSim can be used to analyse the demand for electrical infrastructure in a dynamic, agent-based context. By modelling existing and planned infrastructure and incorporating real-world infrastructure data as well as EV user statistics, this approach supports scenario analysis for future energy demand, infrastructure expansion and behavioural response to policy measures. The central research question here will be answered as to how high the expected energy demand of EV in DNG is and how the local charging infrastructure will be dimensioned accordingly.

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