Berliner Hochschule für Technik

Project work on

Geo-based Analysis of Demand for EV Charging Stations in Berlin

Instructor: Professor Dr. Harald Stein

Team No: 04

Team members:

Mohammad Sakhawat Hossain, Sharmin Islam, Farzana Zaman Prome, Nigel William-Quartey

Project App: https://berlin-ev-heatmap-sakhawat.streamlit.app/

GitHub Repository: https://github.com/msakhawath/berlin-ev-heatmap

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1. Objective

This project visualizes how Berlin's population (residents) compares to the availability of electric vehicle (EV) charging stations across different postal-code (PLZ) areas.

Demand in a PLZ is assumed to rise with population and fall where many charging stations already exist. Housing type is excluded due to lack of reliable data. So, we combine population and station locations to create interactive heatmaps of estimated demand.

Using several geospatial datasets, the program creates two interactive heatmaps in Streamlit:

1. Residents Heatmap : shows population density
2. Charging Stations Heatmap : shows how many EV charging stations exist per postal area

The goal is to quickly spot areas where population demand is high but charging infrastructure is lacking, helping support data-driven planning and expansion of EV charging stations.

2. Data

This project uses three main datasets:

1. Electric charging stations
2. Population per postal code (PLZ)
3. Geographical shapes for each PLZ

Each dataset plays a different role in building the heatmaps.

2.1 Charging Stations (Ladesäulenregister)

Source: Bundesnetzagentur , official German charging-station registry

File: Ladesaeulenregister.csv

This file contains all publicly known EV charging points in Germany.

- PLZ : postal code of the charging point
- Bundesland : used to filter entries for Berlin
- Breitengrad, Längengrad : coordinates of charging infrastructure
- KW : nominal power of the charging unit (Nennleistung Ladeeinrichtung [kW])

We clean and filter this data so only Berlin charging stations remain.

2.2 Population per Postal Code (Einwohner)

Source: Berlin population statistics converted to PLZ level

File: plz_einwohner.csv

After cleaning the dataset, the important columns are:

- PLZ – postal code
- Einwohner – total number of residents in that PLZ

This dataset is used to create the Residents heatmap.

2.3 Geodata (Postal Code Shapes / Polygons)

File: geodata_berlin_plz.csv

It includes:

- PLZ – postal code
- PLZ_GEO – polygon geometry (in WKT format) used for map visualization.

This is what allows the heatmaps to draw the borders of Berlin's PLZ areas on the map.

3. Program Structure

The project is organized into a main script, a configuration file, a core module with helper functions, and a datasets folder and the datasets directory contains the Berlin PLZ geodata, optional district data, population figures, and the charging-station register.

3.1 main.py

This is the central script that runs the application. It loads all input files, calls the preprocessing functions from the *core* module, and prepares two key GeoDataFrames:

- **gdf_lst3**: PLZ-level counts of charging stations
- **gdf_residents2**: population data merged with PLZ boundaries

After processing, the script launches the Streamlit interface and displays the final interactive heatmaps.

3.2 core/methods.py

This module contains the main data-processing logic. It cleans and standardizes the charging-station file, aggregates station counts by PLZ, aligns population data with Berlin's postal-code geometry, and finally generates the Folium map that Streamlit embeds.

This file contains most of the logic for transforming and preparing the data:

- **preprop_lstat():** Cleans the charging station dataset, fixes postal codes, removes unnecessary columns, etc.
- **count_plz_occurrences():** Counts how many charging stations exist in each postal-code region.
- **preprop_resid():** Merges the resident population data with the geospatial boundaries of Berlin.
- **make_streamlit_electric_charging_resid():** Builds the interactive Folium map shown inside Streamlit.

3.3 core/HelperTools.py

Provides small utility functions that support the workflow—tools for cleaning DataFrames, renaming fields, handling errors, and ensuring PLZ formats are consistent.

3.4 datasets

Holds all raw input files used by the program, including:

- Berlin PLZ geometry
- Population per PLZ
- The national charging-station register

3.5 config.py

Acts as the project's settings file. It stores paths to all datasets along with column names and map settings. Contains the configuration dictionary pdict, which defines:

- File names for datasets (e.g. file_lstations, file_residents, file_geodat_plz).
- Column names for joining (e.g. geocode = "PLZ").
- Visualization parameters (map center, colors, radius, etc.).

4. Interpretation of results

4.1 Conceptual method

For each PLZ we conceptually consider: A simple demand index:

$$D_i = \frac{\text{Einwohner}_i}{\text{NumberStations}_i + \varepsilon},$$

where $\varepsilon$is a small constant to avoid division by zero.

Einwohner_i: population in PLZ i.

NumberStations_i: number of charging points in PLZ i.

A high D_i signals more demand per station, a low D_i shows good coverage, and the heatmaps help identify PLZs with many residents but few charging stations.

4.2 Qualitative findings

4.2.1 Residents Heatmap: What It Shows

- Highest population densities occur in central districts: Mitte, Friedrichshain, Neukölln
- Medium density around: Charlottenburg, Tempelhof
- Lowest density in outer districts Köpenick, Spandau (west), Lichterfelde

4.2.3 Charging Stations Heatmap: What It Shows

- Strong clusters in parts of east Berlin
- Moderate availability in the city center
- Very low coverage in several outer zones such as:
  Southeast (Köpenick, Müggelheim), Southwest (Zehlendorf, Dahlem), West outskirts (near Spandau)

4.2.4 Comparison — Where More Charging Stations Are Needed

URGENT PRIORITY AREAS

- Köpenick (SE)
- Zehlendorf (SW)
- Spandau outskirts (W)
- Reinickendorf border (NW)

MODERATE PRIORITY

- Neukölln
- Wedding
- Friedrichshain

LOW PRIORITY

- Forest/outskirts with very few residents

Comparing both heatmaps, it becomes clear that some PLZ areas have a strong population footprint but only a small number of charging points. These locations combine high demand with limited supply and therefore stand out as good candidates for expanding the charging network.

4.3 Decision-theoretic view

In simple decision-theoretical terms, each PLZ corresponds to a possible action. In a simple decision framework, each PLZ can be seen as a potential investment option, where areas with many residents and few stations score highest.With limited budget, prioritizing PLZs with the largest demand index is most effective, and the heatmaps make this ranking easy to understand for all audiences.

5. Conclusion

This project shows how demographic and geospatial information can be brought together to create meaningful insights for urban planning. By processing several Berlin datasets and merging population data, charging-station records, and PLZ geometries, it builds interactive heatmaps that reveal patterns in demand and coverage. These visualizations make it easy to spot areas with infrastructure gaps and provide useful guidance for planners and EV service providers. Ultimately, the results offer a clear picture of where additional charging stations would have the greatest impact.

6. References

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