Electric Vehicles Smart Charging: Representative Load Profiles Based on Residential Time-Varying Electricity Tariffs and Household Characteristics

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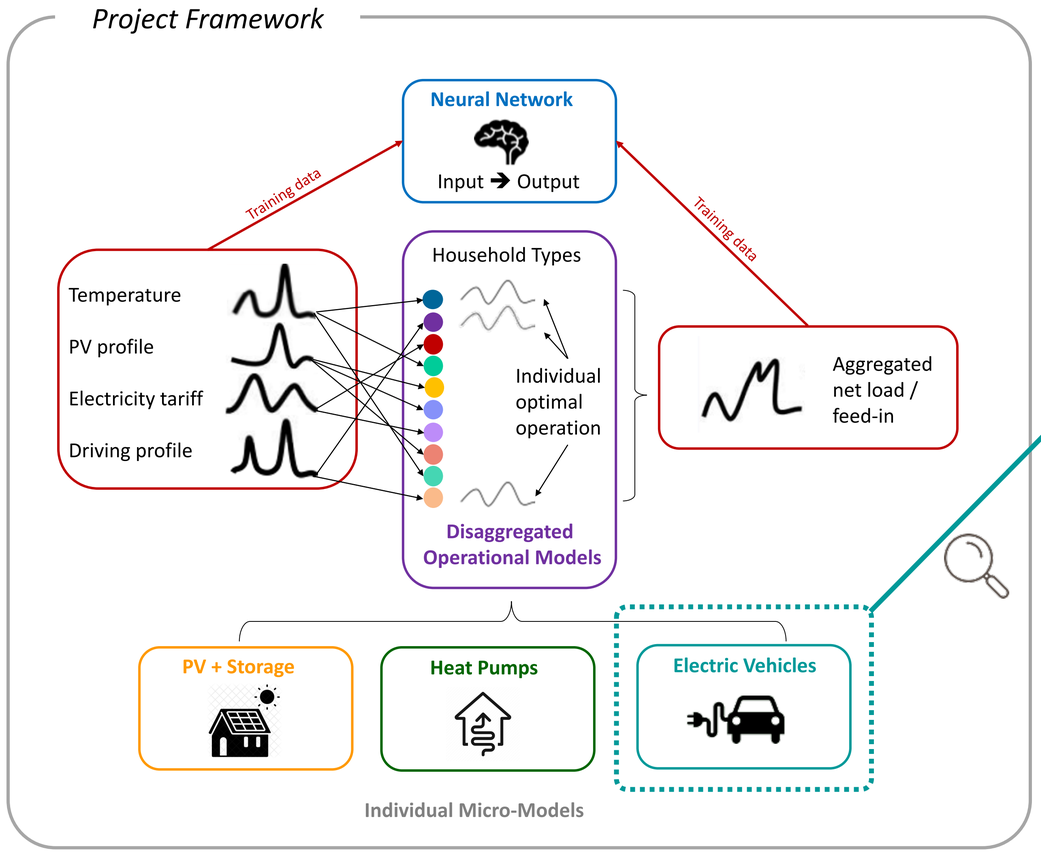
Motivation

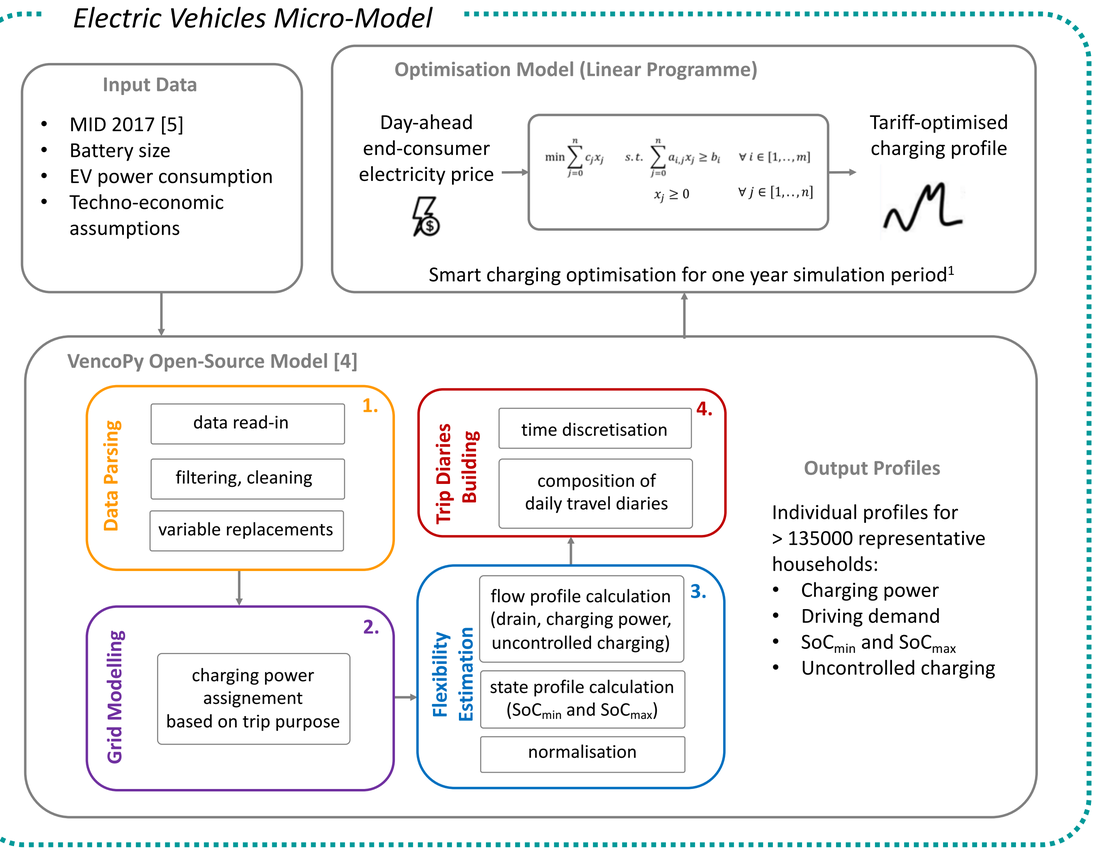
- Operating decisions of **private actors** are having an ever increasing influence on the energy system [1, 2].
- The individual consideration of **household specific load patterns from EVs** allows to consider this **heterogenic behaviour** in decentralised energy systems in greater detail, e.g. for electrotechnical considerations or local market interactions.
- **Individual charging decisions of EV owners** influence the load shifting potential of future EV fleet batteries [3] but are seldomly explicitly taken into account in power system modelling.
- Overall research goals:
  a) **Integration of decisions** on the operational behaviour of flexibility options into electricity market models
  b) **Modelling** of the **interaction** of these decisions with other (central) energy actors
  c) Research the framework conditions for a sustainable development of the energy system, taking into account **decisions in an uncertain environment**

Methodological Framework

Project Framework



Electric Vehicles Micro-Model

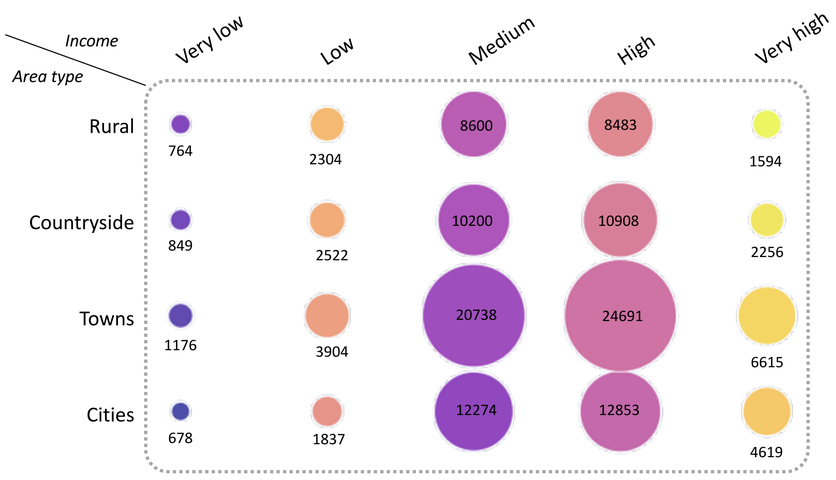


[1]The charging profile optimisation is carried out for one year for each household cluster for different electricity price scenarios.

Results

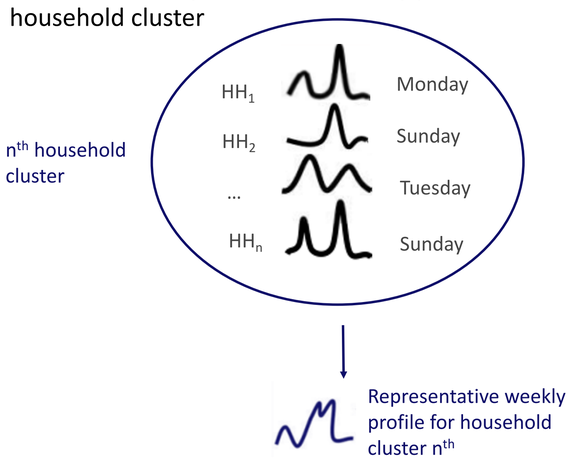
Household Clusters[2]

The clustering algorithm was carried out on >135000 vehicle usage profiles from the German National Travel Survey (MiD 2017) dataset [5], which represents the overall German population.



Ongoing

Challenge:
Generation of representative weekly profiles for each household cluster



Approach:
Timeseries clustering for each household cluster to generate a representative weekly profile using k-means and dynamic time warping distance metric

[2] The results are preliminary and might change during further analysis.

Summary

- The proposed approach ensures that the individual battery constraints of every vehicle and mobility profile combination are met for all evaluated charging strategies, leading to a more realistic flexibility assessment.
- By employing an optimisation routine, different EV charging profiles are obtained for different household types and electricity prices.
- For all combinations of households types and weekdays, effective load profile curves are calculated with the individual micro-models, taking into account the residential electricity tariffs and the optimal operation of HPs, EVs and PV-storage systems. These are then used as training dataset for the neural network to include the interplay of decisions made by private and commercial energy actors under uncertainty.

Sources

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[4] Wulff et al. (2021), Vehicle Energy Consumption in Python (VencoPy): Presenting and Demonstrating an Open Source Tool to Calculate Electric Vehicle Charging Flexibility. Energies, MDPI. 2021; 14(14):4349. https://doi.org/10.3390/en14144349
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