IMPACT OF ELECTRIC VEHICLE INTEGRATION ON DISTRICT ENERGY SYSTEMS

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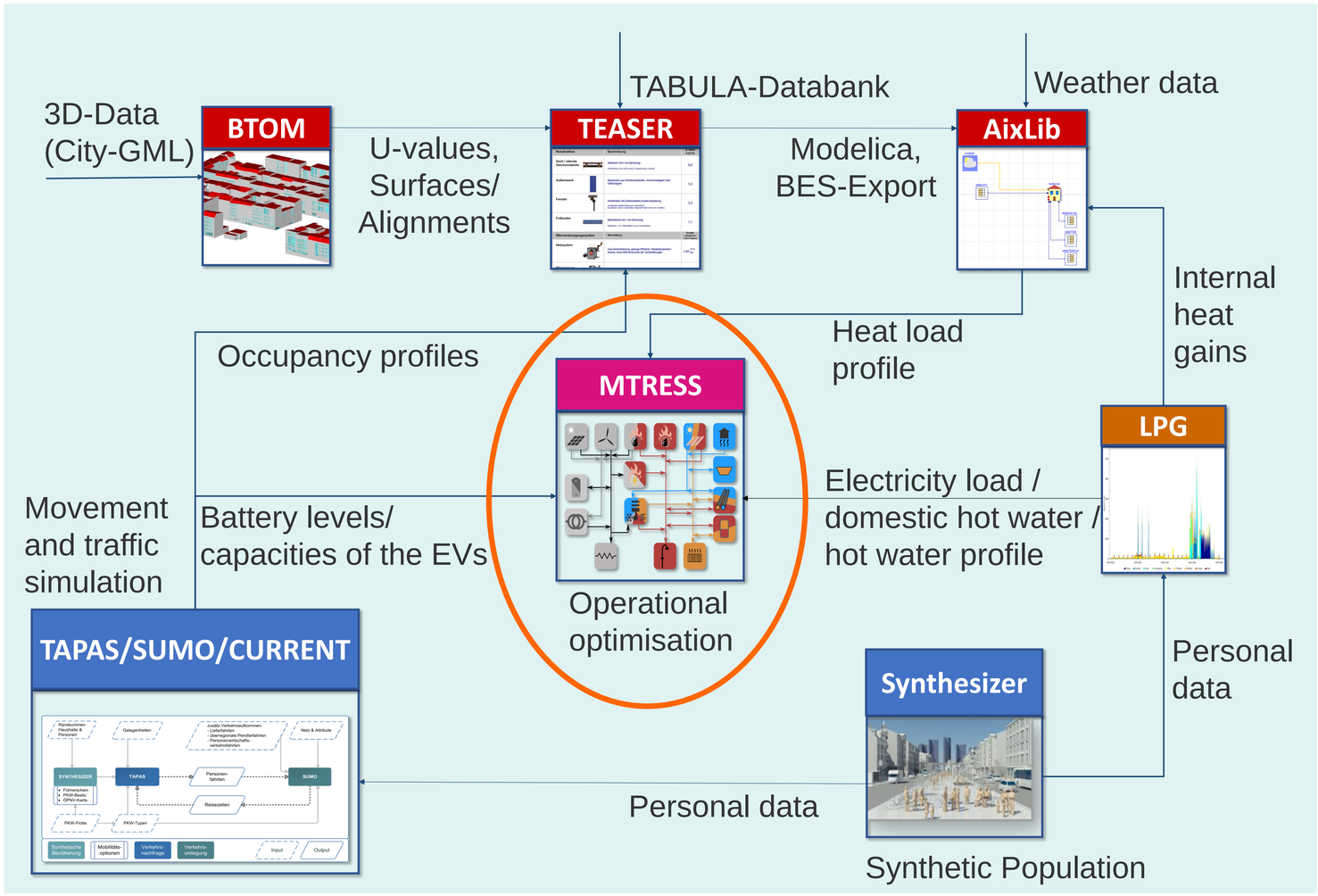
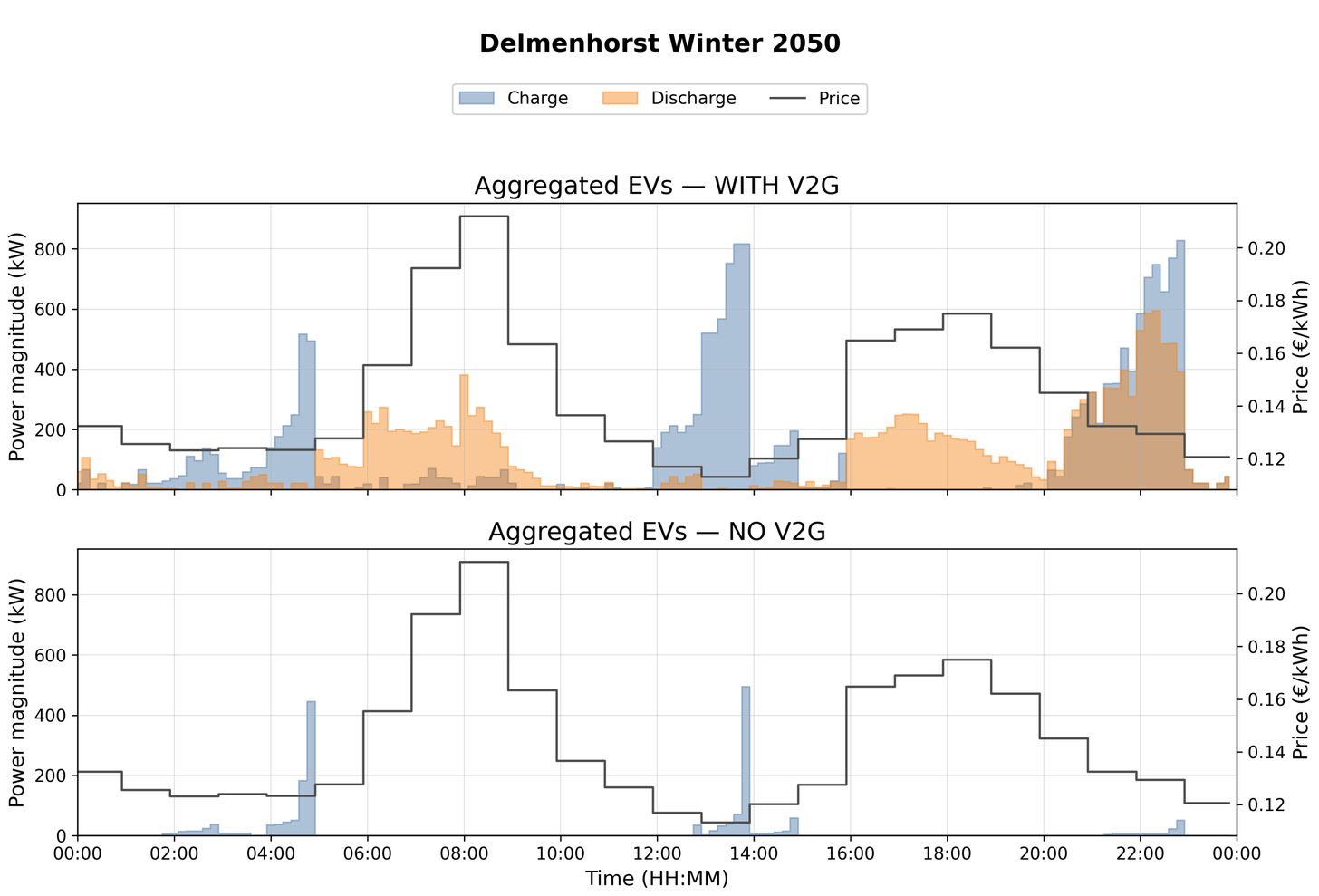


Situation and Research Question

Considering the increasing numbers of electric vehicles (EVs), there is a significant potential to use the combined energy storage of their batteries. **What is the potential benefits of integrating EVs into our district energy systems?** We examine system flexibility, self sufficiency (SSR) and lower system costs.



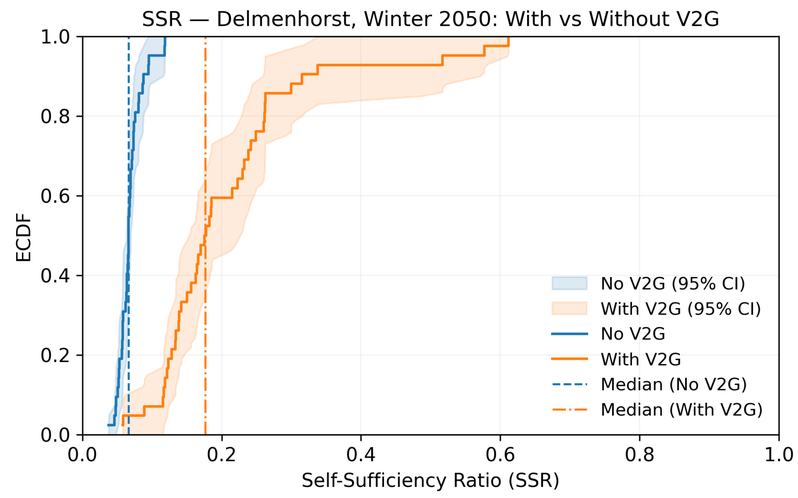
Methodology

District energy systems are simulated and optimised using MTRESS and oemof.solph. Data for the mobility and buildings are generated in an integrated manner, with the occupancy data being informed by the trip data. The optimisation minimises costs across a base case and a time-shifted mobility case. The effect of V2G is examined through analysis of the district energy systems with scenario combinations of:

- Season: summer / winter
- Year: 2025 / 2050
- Location: Moabit (urban) / Delmenhorst (rural)
- V2G: with / without

Results

- V2G integration may also **increase the SSR of buildings** in the energy system. The histogram below shows the SSR distributions for Delmenhorst winter 2050. The EV batteries can store excess energy during the day which can then offset the demand later in the day, improving SSR.



- Charging and discharging behaviour of the EVs can be seen in the top left figure, showing the aggregated power flows to and from the EVs. **The electricity price has a strong influence on the charging behaviour,** with V2G discharging and charging clustered around the local price maxima and minima respectively. Correspondingly, specified pricing could be used to influence grid behaviour, for example, to achieve peak shaving.
- The use of V2G reduced the total district energy system costs across all 2025 scenarios:

Location	Season	Change in cost (%)
Delmenhorst	Summer	-3.28
Delmenhorst	Winter	-0.07
Moabit	Summer	-3.23
Moabit	Winter	-0.43

- Smaller savings in the winter scenario are due to the minimal excess energy that can be sold to the grid. The slight savings are a result of the small number of vehicles in comparison to buildings. Preliminary investigation shows a larger savings in 2050 with more EVs.

Highlights of V2G Integration:

- Self-sufficiency: winter increase through reusage of excess energy
- Charging behaviour: charging and discharging strongly follow electricity prices
- Costs: ~3% savings in summer, small savings in winter

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Reference

Reininghaus, Nies, et al. "SekQuaSens3: sector integration heat, electricity and mobility demand in a district." IET Conference Proceedings CP890. Vol. 2024. No. 15. Stevenage, UK: The Institution of Engineering and Technology, 2024.