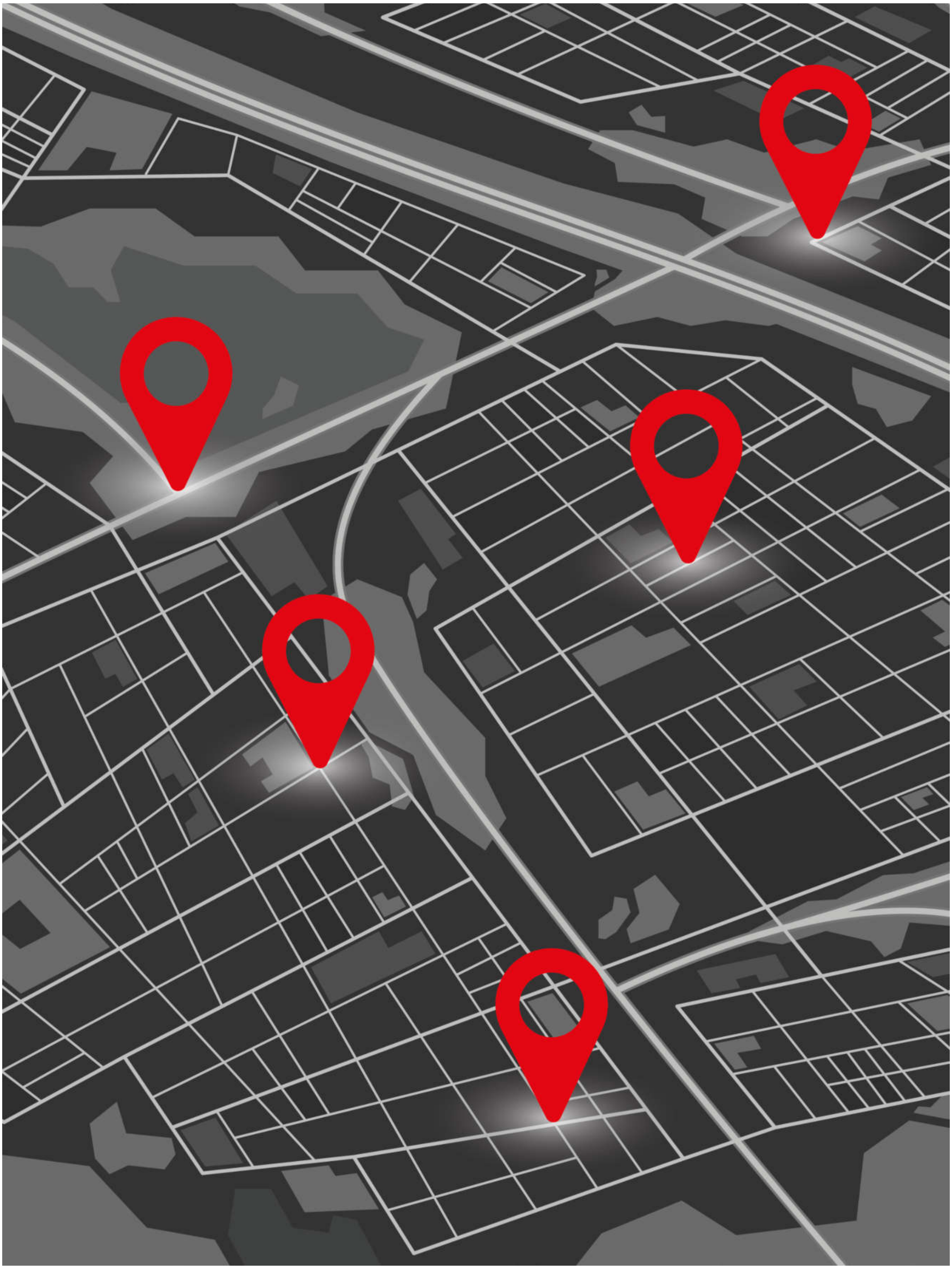
STUDENT AWARDS 2014 - 2025



Quality in parking

SHARED EVS AND V2G SERVICES

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Relocation strategies for shared electric vehicles to transport energy and provide vehicle-to-grid

Decarbonising transport is an important climate goal as transport accounts for approximately 25% of global CO_2 emissions. Cars and vans are responsible for about 48% of these emissions. Furthermore, transport demand is expected to grow.

The main strategies for decarbonising car transport are:
- electric vehicles (EV)
- vehicle sharing systems (VSS)
- electric vehicle sharing systems (EVSS).

Another challenge facing Car Sharing Operators (CSOs) is ensuring efficient vehicle distribution. Vehicles tend to be picked up in high-demand areas (hot zones) and returned in low-demand areas (cold zones). This results in lower fleet utilisation, thus decreasing efficiency and profitability.

Shared EVs need to be kept charged and ready for use throughout the day to avoid missing rentals due to range anxiety. Other challenges include:
- charging at the right time and place;
- keeping enough EVs charged to meet demand;
- managing charging without overloading the charging infrastructure.

Bidirectional charging grid (source: ev-lectron.com)

Research goal

In general, cars are parked and idle for 95% of the time. EVs have large batteries (40-100 kWh) which can provide sufficient power for an average household for up to 3 days, thus acting as a mobile energy buffer.

EVs can potentially help alleviate grid congestion by supplying energy during periods of high demand and absorbing energy during periods of excess energy supply.

This research explores the financial implications of enabling shared EVs to participate in energy markets.

Research model

The mathematical model developed for this study explores how a Car Sharing Operator (CSO) can maximise profit.

In the model, a CSO manages five charging stations with 24 EVs. The key factors considered include:
- consumers driving the EVs;
- relocating the vehicles to match rental demand;

- charging and discharging EVs using vehicle-to-grid (V2G) technology, which enables bidirectional power flow between EVs and the grid.

The model explores scenarios with and without V2G, accounting for electricity prices varying according to time and location. The model also includes considerations for summer and winter conditions as well as the impact of peak-reducing measures.

Results

The results demonstrate that V2G technology boosts overall profit by allowing energy to be sold back to the grid during periods of low driving demand and high electricity prices, particularly when electricity prices vary across different charging locations.

In addition, peak-reducing measures effectively reduce peak load demand without substantially compromising overall profit. However, integrating V2G increases the complexity of vehicle relocation, which can lead to higher relocation costs. This highlights the importance of developing optimised vehicle management strategies to balance the trade-offs between V2G implementation and operational efficiency.

Conclusion

Combining V2G with EVSS has potential and supports decarbonising car transport.

Integrating V2G with EVSS is a novel approach. The results show that:

- V2G can improve profitability by enabling EVs to participate in energy markets;
- Location-dependent electricity prices boost V2G potential;
- Peak load demand can be reduced without substantially impacting overall car sharing system profits.

The findings have significant implications for designing EVSS and related policies, particularly where dynamic electricity pricing and incentives for grid participation are involved.

However, in the scenarios where electricity prices did not vary, the increase in profit was minimal. In such circumstances, operators should consider whether V2G participation is worth the extra battery degradation caused by frequent battery cycling.

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