Integrating Solar Photovoltaics and EVs to Decarbonize Singapore

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SOLAR PHOTOVOLTAICS, ELECTRIC VEHICLE, DUCK CURVE

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BACKGROUND

- The increasing adoption of EVs adds stress to power grids.
- The massive deployment of solar PV could introduce grid stability challenges, e.g., "duck curve".
- These obstacles can hinder the advancement of EV adoption and PV deployment.

RESEARCH GAP

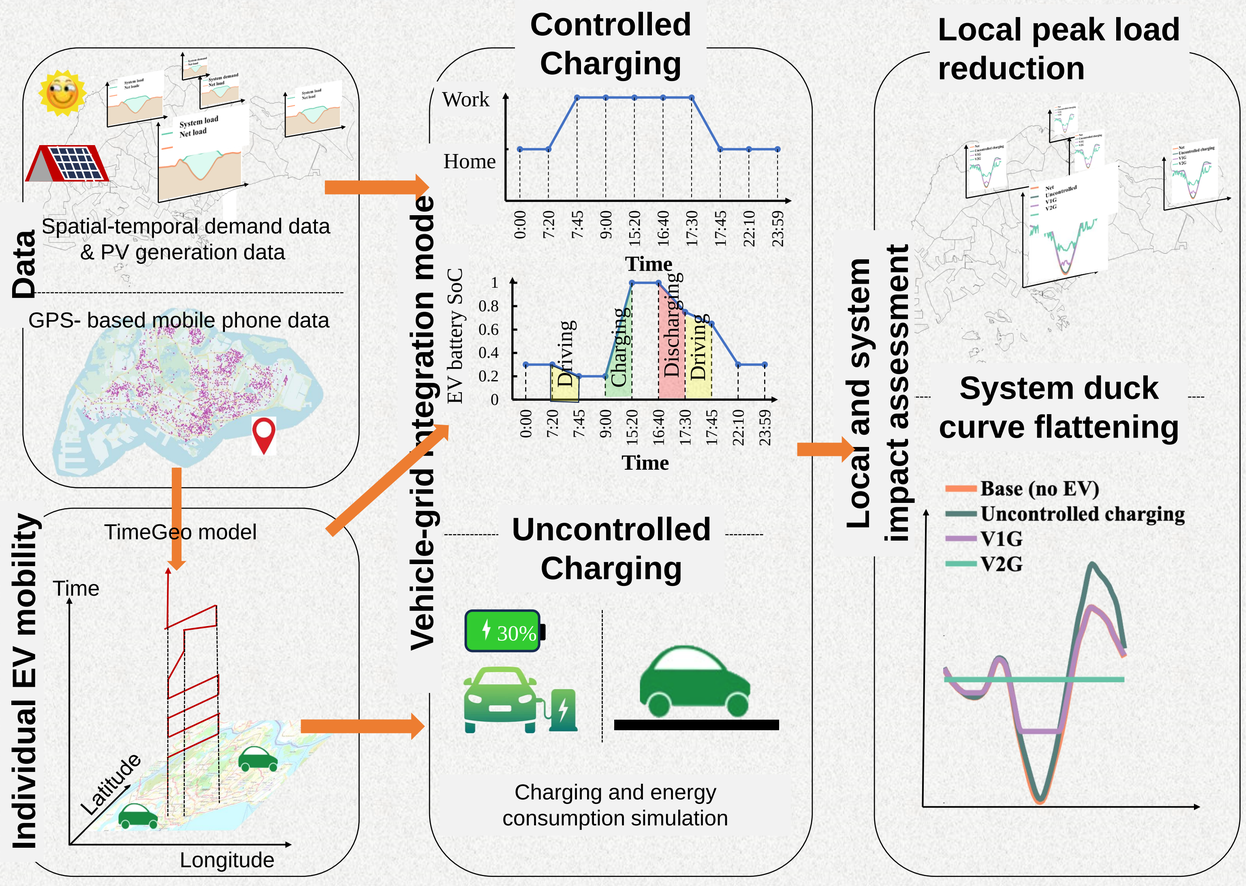
- Insufficient incorporation of individual mobility needs into EV charging modelling.
- Exclusive focus on EV charging loads, overlooking the contributions of non-EV loads.

AIM

This study explores the potential of using EVs to assist the deployment of PVs and support the power grid operation in the Singapore context, using mobile phone mobility data.

METHODS

Framework



FINDINGS

- **Uncontrolled charging:** increase the peak by approximately 10% (system load) and up to 50% (local load).
- **Optimized unidirectional charging (V1G):** can completely prevent any increase in peak load
- **Optimized bidirectional charging (V2G):** not only flattens the load profile but also achieves a 5% reduction in peak load.

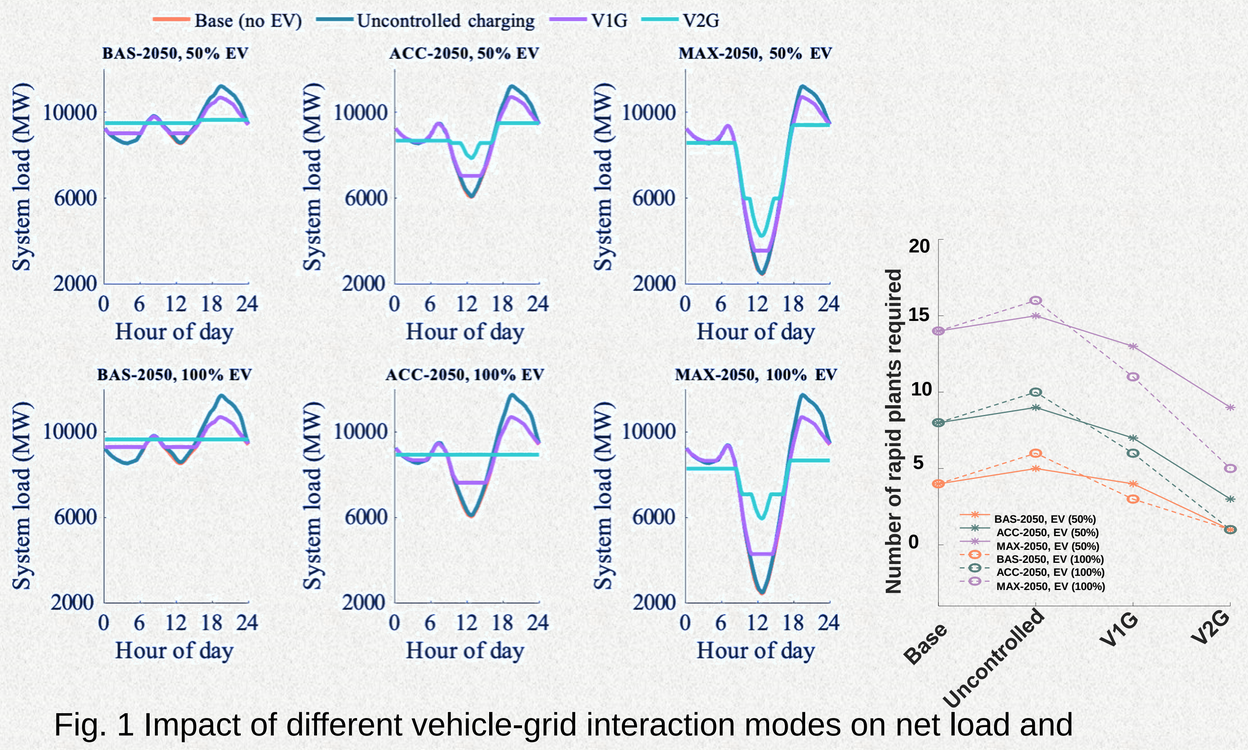
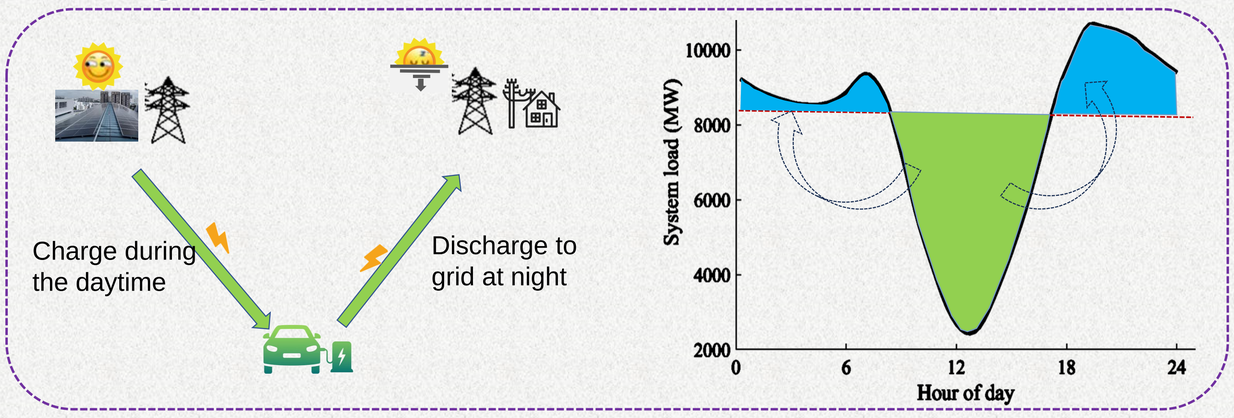


Fig. 1 Impact of different vehicle-grid interaction modes on net load and reduction of natural gas plants

Scenario	Description	Year	PV capacity (GW)	Scenario	Description	Year	PV capacity (GW)
BAS-2030	the base scenario	2030	1	ACC-2030	accelerated scenario	2030	2.5
BAS-2050	the basic scenario	2050	2.5	ACC-2050	accelerated scenario	2050	5
MAX-2050	maximum potential	2050	8.6		_		

Table 1 Summary of the PV deployment scenarios

Controlled bi-directional charging (V2G)



KEY DISCUSSION POINTS

- Coordinated planning of PV and EV is necessary to make use of renewable energy and minimize the influence on power systems.

CONCLUSIONS

- We evaluate the impacts of large-scale PV and EV deployment on the generation system and local grid, respectively.
- We address the challenges, namely, the duck curve and the increased peak load, brought by PV and EV deployment, simply by the controlled EV charging.

FUTURE DIRECTIONS

- Incentive policies and business models for vehicle charging

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