

Unlocking flexible electric vehicle charging via new rate design

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To reduce CO₂, electric vehicles (EVs) are required to substitute Internal Combustion Engine (ICE) vehicles to achieve the decarbonisation goals established during international environmental summits. Between 150 and 230 million vehicles are expected to be on the world's roads by 2030, potentially causing future issues for power systems. EV charging should not drastically increase consumption in already existing peak periods neither create new ones which may exceed grid maximum capacity. To avoid costly grid reinforcements and to ensure proper guidance for EV charging, a solution allowing customers to access EV-only rates without installing a separate meter, which we refer to as submetering, is an attractive option for EV owners and grid operators

We develop a game-theoretic model is presented to capture the interaction between a national regulatory authority (NRA) designing EV-only tariffs and dwellings to address this question. The model consists of two levels, the lower level represents the dwellings and the upper level stands for the regulatory authority, both casted as an optimization problem and modelled as a mathematical program with equilibrium constraint.

Results show a fair energy cost reduction with an EV-only tariff for the adopter while keeping network charges fixed. However, by recovering grid costs via a three-part tariff that contains capacity charges, the increase in network costs offsets the gains brought by energy savings. With a pure volumetric tariff, fairness issues are nuanced, resulting in well-allocated network costs distribution in which consumers experience a higher decrease in their charges. In addition, we show that submetering can bring yearly gains varying from \$64 to \$125 with this type of tariff.

The integrated assessment of submetering exploring the variations in energy and network charge has shown that this solution can bring significant added value to EV charging. Policymakers would not need to deplete their political capital to implement complex TOU pricing and capacity-based tariffs across jurisdictions. To help deal with problems coming from ill-designed tariffs in an emerging technology context, submetering can be a straightforward solution with low transaction costs to be implemented.

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