336

Interplay between tariff schemes and the electricity market: a case study of electric vehicles

Menna Elsobki, Marius Tillmanns, Aaron Praktiknjo
RWTH Aachen - Chair for Energy System Economics, Aachen, Germany

Extended Abstract

Download file

Abstract Summary

This study analyses how alternative electricity tariff schemes for battery electric vehicles (BEVs) affect both user-level charging costs and wholesale electricity market outcomes in Germany. Against the backdrop of ambitious decarbonisation targets, growing deployment of sector coupling technologies and the legal requirement to offer energy-efficient tariffs from 2025 onwards, variable electricity tariffs are examined as a key instrument to activate demand-side flexibility from BEVs.

We develop a soft coupling framework that links optimisation based models of individual BEV charging decisions with the German electricity spot market. In a first step, an optimisation model generates BEV charging profiles for different tariff designs, including a flat tariff, time-of-use tariffs, load-dependent tariffs and load management tariffs, some of which enable vehicle-to-grid (V2G) operation. The model uses mobility profiles from the open-source tool emobpy and solves a linear program to minimise user electricity procurement costs subject to vehicle usage, battery constraints, user preferences and assumptions on charging infrastructure. A rolling optimisation accounts for day-ahead prices and trips.

In a second step, the aggregated optimised charging profiles are integrated into the JERICHO electricity market model through an iterative soft coupling that endogenises the interaction between EV demand and spot prices and is run to convergence.

Preliminary results indicate that load management tariffs with participation in balancing markets yield the lowest average electricity procurement costs, while dynamic tariffs also provide substantial savings. V2G-enabled tariffs markedly reshape aggregated EV load profiles and exert a significant influence on spot market prices, thereby increasing the system value of EV flexibility.

Presenting Author Biography

Menna Elsobki studied Business Administration and Engineering: Electrical Engineering at RWTH Aachen University and during a semester abroad at CentraleSupélec with a focus on electrical energy engineering and operations research and management. In 2018 she earned her bachelor's degree (B.Sc. RWTH) and in 2021 the master's degree (M.Sc. RWTH). During her studies, she worked as a student assistant at the Institute for High Voltage Technology (IFHT). In June 2021 Menna Elsobki has started to work as a research associate at the Chair for Energy System Economics (FCN-ESE).