M. Sc. Thesis: Learning Charging Control for Shared EV Parking Areas

A description of a project for a Master's Thesis at the Institute of Energy Systems, Energy Efficiency and Energy Economics (ie^3), TU Dortmund University.

Background and Motivation of the Thesis

Schemes of shared electric vehicles (EV) become more and more common in European urban areas. The batteries of EVs require relatively long charging times, which can be problematic. In order to minimize the impact of the EVs on low voltage (LV) distribution network (0.4 kV), many EVs cannot be charged (with full charging power) at the same time. On the other hand, the operator of the shared EVs should guarantee a sufficient availability of EVs to the customers. In other words, a user must be able use a car in any given moment.

In large parking and charging areas, a centralized control should make sure to guarantee that the EVs don't draw too much current from the LV network. The number of required fully charged EVs changes according to time (night/day, morning/evening,...), day of the week (working day/bank holiday), season (summer/winter) and of course is dependent on the location of the charging area.

Needless to say, the exact needs of the customers (how many fully charged EVs must ready in a given moment) cannot be forecasted with an accuracy of 100%, but certain patterns of demand can be recognized due to the daily routines of the people. One idea to improve the availability of EVs is to use learning algorithms that adapt to the needs of the specific charging area. The algorithm would allocate the available charging power between the EVs so that the customer satisfaction will be maximized.

Tentative Work Plan

The main objective of the thesis is to develop a universal and scalable learning and charging algorithm in order to

- minimize the impact of a shared EV charging and parking area on the power distribution network and
- maximize the availability of the shared EVs to the customers.

The steps of the work are as follows:

1) Establishing realistic restrictions for the algorithm.

2) Getting familiar with existing learning algorithms found in the scientific literature.

3) Creation of an algorithm. The algorithm can be self-created or adapted from other fields. The algorithm should be

    - scalable to be able to coordinate any (realistic) number of EVs,
    - simple and robust,
    - modular, so that new restrictions can be added.

4) Implementation of the algorithm on Matlab/Simulink. Creating a simulation in order to proof that it works.

Extra step (if there is time):

5) Implementation of the algorithm on dSPACE MicroLabBox (Simulink-based) as a hardware-in-the-loop simulation. Testing the algorithm with a real commercial charging station and EVs.

The Profile of the Student

The thesis is suitable for a motivated student with interest in smart grids and electric mobility. The focus of the thesis can be either more focused on the algorithms (Step 3) or practical (Step 5), depending on the wishes of the student. The thesis may be challenging, so self-imposed motivation is required. The thesis is encouraged (but not obligatorily) to be written in English.

Supervision

The work is supervised by Kalle Rauma. Co-supervisors may be included if considered necessary.

Further information

Please contact Kalle Rauma (kalle.rauma@tu-dortmund.de) for additional information.
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