Evaluation and Optimization of the Charging Strategies for Electric Vehicles Based on Dynamic Electricity Prices

Master‘s Thesis of Alexander Heiß

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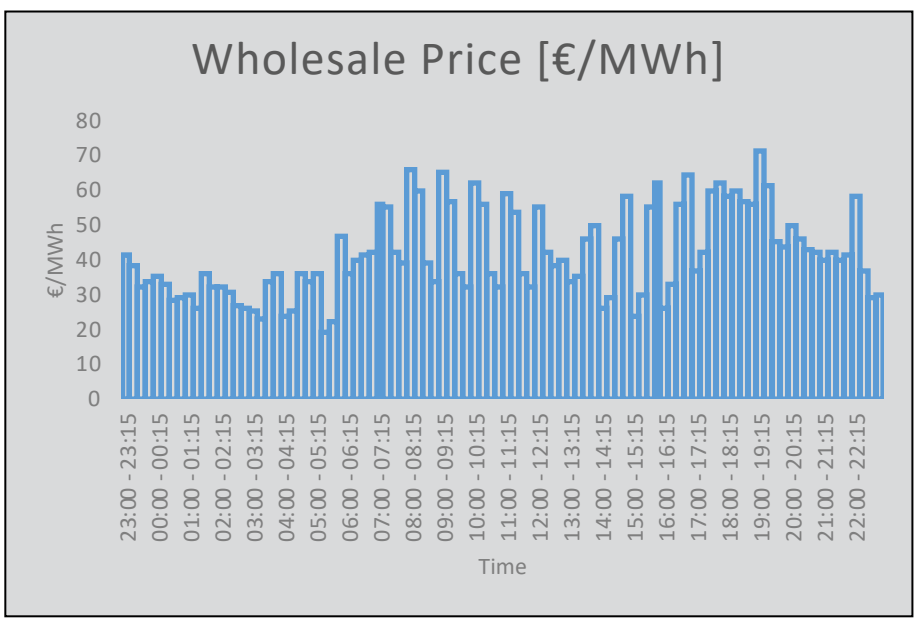


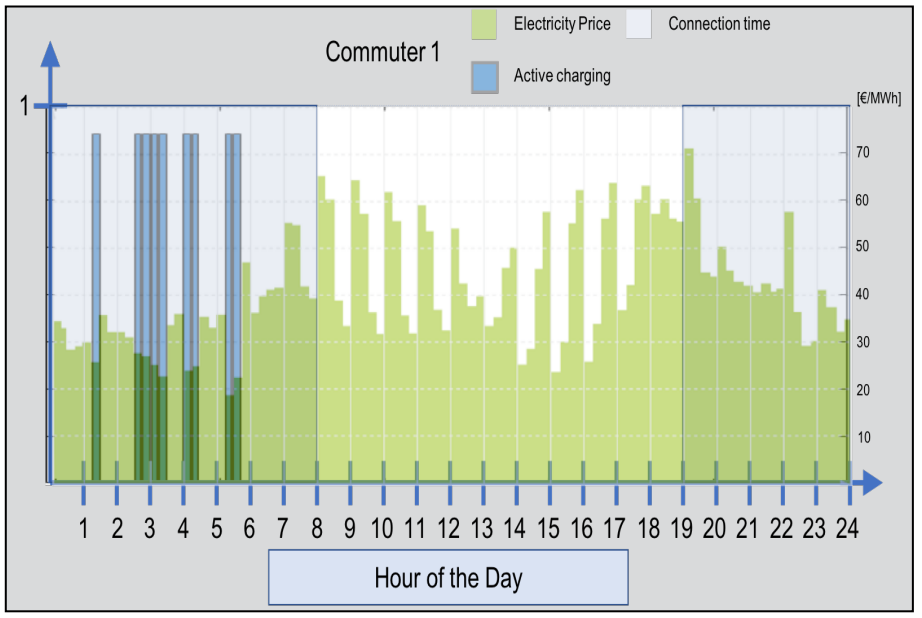
As the production of renewable energies like photovoltaic and wind continues to rise in the course of the energy revolution and will progress in the foreseeable future, it will become increasingly necessary to regulate the electricity grid. The need for regulation arises from the impossibility of controlling those volatile renewable energies. Like on any other market, the electricity price is regulated by supply and demand.

In this thesis, an optimized charging strategy is developed, which is based on dynamic electricity prices. Therefore, controlled charging processes at times of favorable electricity prices smooth the load curve on the one hand, and the vehicle owner can achieve a more favorable charging price, on the other hand. Therefore, different user types are examined on their potential to save charging costs. This question is of great interest as it increases user acceptance for controlled charging. Nevertheless, in the literature mainly the technical side of the network is considered and the benefits for users are largely neglected.

First, a detailed analysis of the electricity market is carried out to explain how volatile electricity prices arise. The last traded electricity price on the continuous intraday market is used as basis for the optimized charging strategy.

In order to be able to estimate the potential savings, the charging behavior must be investigated. It turns out that the charging behavior depends on several components and will also change over time. Since the charging behavior is subject to complex processes, abstractions are made. Consequently, the amount of energy consumed between two charging sessions and the times at which frequent charging sessions take place are considered.

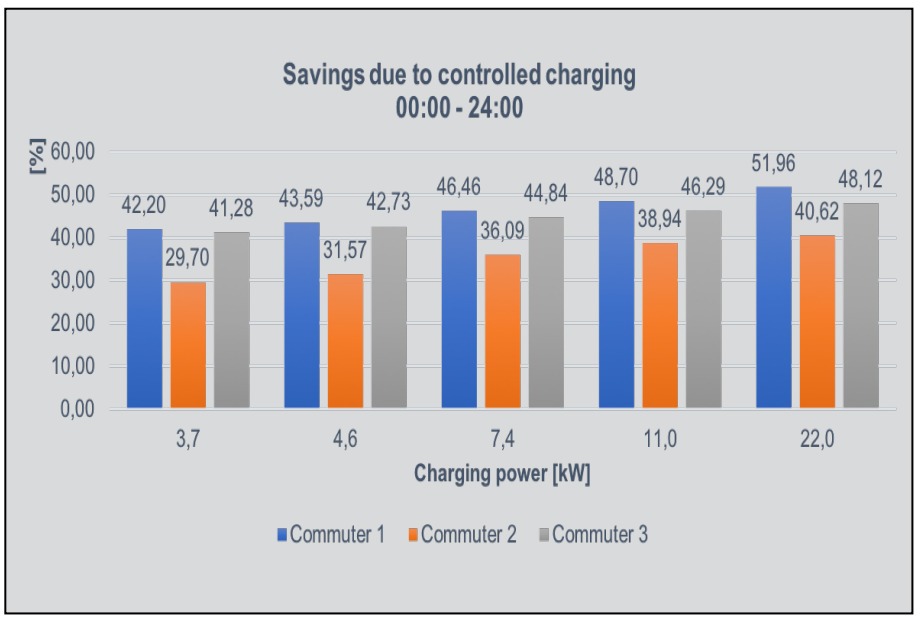
For the development of an optimized charging strategy, the charging process is investigated. The different charging powers for conductive charging are determined. It turns out that the state of charge (SOC) should swing between 20% and 90% and that in this range the charging power can be regarded as constant.



To develop the charging strategy, a MATLAB program is implemented, which is used to calculate the potential savings afterwards. The figure in the middle shows the principle of optimization using the example of a commuter vehicle.

The potential savings are calculated for four different user groups: These are commuters, taxis, delivery vehicles and car-sharing vehicles. As can be seen in the figure on the left, considerable savings can be achieved for commuter vehicles.

In general, it can be said that the best savings can be achieved in the early morning hours. Charging in the evening should be avoided, as otherwise existing peak loads in the household sector would be further intensified.



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