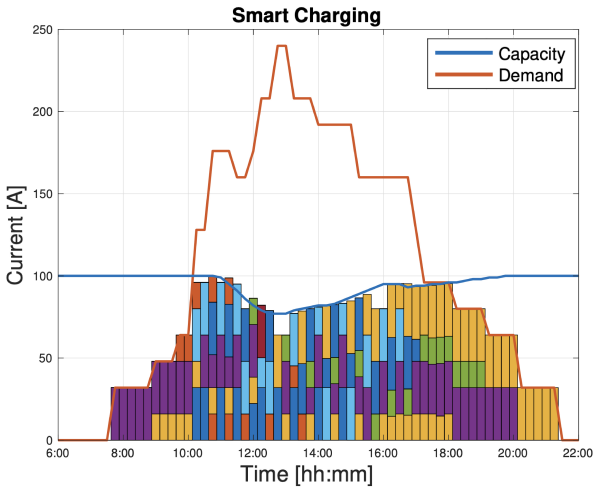
Master Project

Large Scale Control of Electric Vehicle Charging Stations for Aggregated Power Setpoint Tracking

Fères Hassan, Delft Center for Systems and Control, TU Delft
phassan@tudelft.nl

Peyman Mohajerin Esfahani, Delft Center for Systems and Control, TU Delft
P.MohajerinEsfahani@tudelft.nl

Context



High penetration of Electric Vehicles (EVs) will jeopardise the reliability and stability of the power grid. Rather than expanding the grid's capacity, i.e., investing in physical infrastructure, a consensus has been reached in literature that the focus should be on making the power system "smarter". Besides load shifting algorithms to protect the grid's circuit breakers, large scale energy consumers also have an economic incentive to implement smart charging. Energy is bought on the day-ahead market in the form of an energy profile. This profile then acts as an aggregated set-point for energy consumption. This set-point needs to be tracked as closely as possible to minimise fines given by the grid operator. Many control strategies have been developed in literature, but most, if not all, use data that isn't readily available during charging. The real challenge is to formalise control logic that considers these real-life limitations. This master thesis project aims to identify the most suitable control rules and design and validate an automated feedback controller. Considering the rapid growth of the EV sector, a focus will be on developing a controller for large-scale problems.

An interesting addition to the research is to analyse the opportunity to use the explicit demand-side flexibility of EVs to regulate energy markets. A topic becoming increasingly important, especially with the growing share of volatile renewable energy sources. The intermittency and uncertainty introduced by these energy sources present significant operational challenges for power systems, and power system flexibility becomes critical. This EV flexibility can be utilised through smart charging by an aggregator, e.g., an independent service provider or a supplier.

Project tasks

This master thesis project aims to develop an aggregated set-point tracking controller capable of large-scale implementation while acting on the imbalance energy markets. This MSc-thesis project will consist of the following:

1. A literature study concerning the following topics:
    - Introduction to smart charging and the EV charging domain
    - Breakdown on the energy market with a focus on the different roles
    - Unrealistic assumptions in literature and the impact of rejecting those assumptions
    - Overview of the modelling approaches for large scale optimisation
2. A formulation of the control goal of the controller, based on the results of the literature study
3. Modelling a simulation environment
4. Devise and develop a centralised controller to track a power set-point. Subsequently, explore how to extend this to (sub-optimal) large scale optimisation/control
5. A set of control rules to respond to the energy balancing market using available real-life data

This master thesis project is done in collaboration with Greenflux.