Vehicle-to-Grid Application

This practice is based on our publication listed in the end of this document.

In the practice, you will learn how to develop an optimal V2G model to reduce the peak demand and/or the variance of the load profile meanwhile obtain monetary benefit.

You are provided as follows:

- *As3_data.mat*: Real time price (RTP) and load profile on October 27, 2019 [3]. The sampling time of the data is 5 minutes. The time span is 24 hours; therefore, there are 288 data points in each file.
- *sample_code*

You need to develop an optimal V2G model to minimize the variance of the load profile with EV penetration.

The EVs can be charged/discharged at home with level-1 charging stations (1.7 kW) and at workplace with level-2 charging stations (7.7 kW).

The following figure shows the important times, where blue areas show plug-in time while green areas show driving periods. t_1 is the home leaving time and t_2 is the work arrival time. t_3 is the work leaving time and t_4 is the home arrival time. To ensure the EV has sufficient energy for driving at t_1 and t_3, the $soc = 50\%$ at t_1 and t_3.

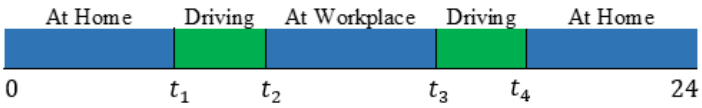

FIGURE 1. Important times

We assume that the driving time is 45 minutes and power consumption of driving EVs is 8 kW. The EV battery capacity is assumed as 60 kWh.

Solve the proposed model using CVX with MATLAB or Python.

Conduct simulation in the following scenarios:

1. Scenario #1: Consider one EV, with $t_1 = 7{:}00$ and $t_4 = 17{:}00$.
2. Scenario #2: Consider 100 EVs and are stochastic variables with normal distribution having the following parameters.

t_1: Normal distribution with $\mu = 7{:}00$ and $\sigma =$ 1 hour
t_4: Normal distribution with $\mu = 17{:}00$ and $\sigma =$ 2 hours

References:

[1] K. Ginigeme and Z. Wang, "Distributed Optimal Vehicle-To-Grid Approaches with Consideration of Battery Degradation Cost under Real-Time Pricing", *IEEE Access*, vol. 8, pp. 5225 - 5235, 2020.

[2] Z. Wang and R. Paranjape, "Optimal residential demand response for multiple heterogeneous homes with real-time price prediction in a multiagent framework," *IEEE Trans. Smart Grid*, vol. 8, pp. 1173 - 1184, 2017.

[3] PJM. Accessed on: Oct. 3, 2019. *Data Miner*. Available: https://www.pjm.com/markets-and-operations/etools/data-miner-2.aspx