HAL
open science

Parking duration optimization for electric vehicles in a loss queueing system

Alix Dupont, Yezekael Hayel, Tania Jimenez, Jean-Baptiste Breal, Cheng Wan, Olivier Beaude, Raphaël Payen

To cite this version:

Alix Dupont, Yezekael Hayel, Tania Jimenez, Jean-Baptiste Breal, Cheng Wan, et al.. Parking duration optimization for electric vehicles in a loss queueing system. PGMO days 2022, PGMO; EDF (Electricité de France), Nov 2022, Palaiseau, France. hal-04434890

HAL Id: hal-04434890

https://hal.science/hal-04434890

Submitted on 2 Feb 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Parking duration optimization for electric vehicles in a loss queueing system

Alix Dupont[1,2] Yezekael Hayel[1] Tania Jiménez[1] Jean-Baptiste Breal[2]
Cheng Wan[2] Olivier Beaude[2] Raphael Payen[2]

[1] Avignon University, LIA, France,
[2] EDF, R&D Paris-Saclay, France.

Keywords: Electric vehicles, charging station, stochastic model

With the rise of Electric Vehicles (EVs), the demand for parking spots equipped with plugging devices in the charging stations (CSs) is tremendously increasing. To face this demand, a charging point operator responsible for one CS deals with limited resources, both in terms of the number of parking spaces equipped with a Charging Point (CP) as well as the available power. This motivates us to study how to improve the quality of charging service at a given CS. Each CP within the CS can deliver a maximum power, independently of the time. Moreover, there is a total limited maximum power available at the CS level, also independently of the time. Therefore, at each instant, the current charging EVs have to share the total power available at the CS according to a modified processor sharing rule, i.e EVs charge at the maximum power per CP when the number of charging EVs (CPs in use) is sufficiently low, otherwise the total power is uniformly shared. In our model, the stochastic nature of arrivals and departures at the CS is modeled by a queueing system [1]. EV users arrive at the CS according to a Poisson process and with a random amount of energy needed to fully charge their battery. An EV can occupy a CP without consuming power: each EV has a random parking duration and leaves the parking spot only when its parking time expires. The total number of EVs and the number of charging EVs at the CS at each instant follows a two-dimensional Markov process. In our work, and based on a study of the Markov process [1], a closed form approximation of the optimal average parking duration in terms of the expected energy received per EV is provided. The model is numerically simulated using a Python discrete-event simulation framework *Simpy*. The theoretical approximation is then compared with the optimal average parking duration obtained from the simulations.

References

[1] A. Aveklouris, M. Vlasiou, and B. Zwart, *Bounds and limit theorems for a layered queueing model in electric vehicle charging*, Queueing Systems, 93:83–137, 2019.