ME Analytics, an efficient simulation tool to select the appropriate charging equipment of a parking

Ibtissem Chouba[1], Ilyass Haddout[1], Salim El-Houat[1], Maxime Roy[1]
[1] Mob Energy, 66 Bd Niels Bohr, 69100 Villeurbanne
ibtissem.chouba@mob-energy.com

Abstract

The implementation of charging infrastructure for the electric vehicles (EV) can be costly and often complex to set up, moreover, the solutions are numerous and varied. We propose in this paper a discrete-event simulation software: ME Analytics, a techno-economic tool using discrete-event simulation (DES) to test and validate different charging solution strategies, make the most suitable investment and ensure the best quality of charging service. An efficient DES model is created to model the complex logistic flow. The model is illustrated by simulating a real case study. Once the current situation is understood, what-if scenarios can be used to establish ways of making decisions that result in charging stations performance improvement. The simulation results allow to answer the customer questions: First, what type of charging stations (CS) should be installed for the first CS (first wave of equipment to reach the quota targeted by the regulation in 2025, e.g., 5%)? Second, when will these first CS be insufficient, and what strategy to put in place to overcome this situation of saturation?

***Keywords**: Electric vehicles- Discrete event simulation- sizing*

1 Introduction

EV sales have surged. In this regard, the deployment of a charging infrastructure network is crucial. Technological developments, government guidelines and power usage all influence the installation of EV charging infrastructure. In order to ensure the efficiency of EV charging systems and to increase their energy performance with acceptable costs, the modeling and sizing of these systems are essential. Simulation has been used in few studies to treat the problems related to EV CS [1,2]. In this paper, we present ME Analytics, a decision support system dealing with the sizing of EV CS. Many factors are taken into consideration such as charging demand, user behavior patterns, costs of charging station construction and operation, charging costs and other factors. Also, forecasts of electricity demand from EV charging are taken into account in this model.

2 Methods

An efficient DES model is created with ARENA simulation tool to model the complex logistic flow. A usage characteristic was identified in this case study: some users (30%) return home for lunch while the others (70%) stay parked all day. This phenomenon plays a key role in the subject of recharging: these round trips naturally create an opportunity for rotations (freeing up an electrified spot allowing a new vehicle to be recharged over the day). Hence, users' arrival is assumed to be non-homogenous during the hours of the day and the days of the week. EV and their charging technologies, market data related to these vehicles, the technical and financial characteristics of different recharging solutions are all parameters that are regularly updated and integrated into the simulations. Based on the simulation results and the current situation, we have presented different scenarios that could improve CS performances. These scenarios can be classified into two categories. The first category aims to specify the most interesting solution(s) to be installed for 2025 and comply with the law. The second category aims to identify the situation of saturation, e.g when the first CS installation becomes insufficient, and to specify the strategy to put in place to overcome this situation of saturation. All in all, thanks to these premises, the model became a new approach in order to reflect the reality as much as possible and also a helpful and critical tool for the decision maker to reach the best decision. Figure 1 shows the simulation based-optimization approach.

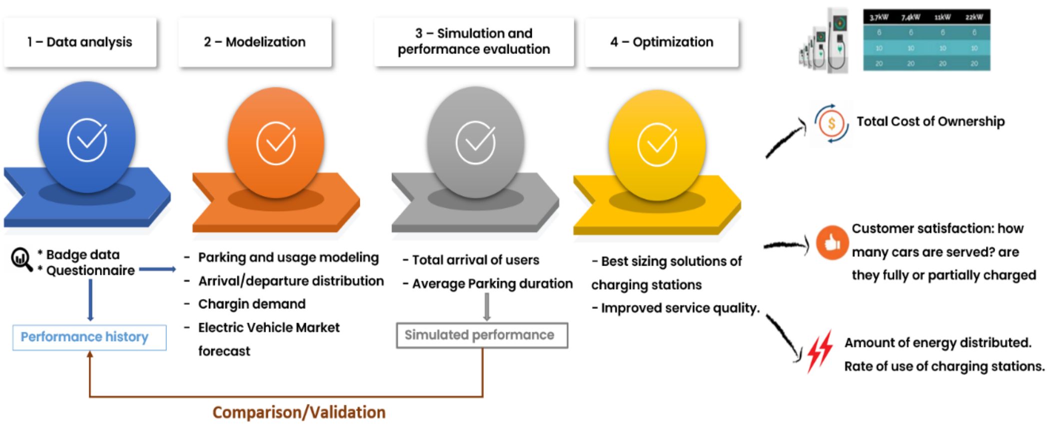

Figure 1: Simulation-based optimization approach

3 Results and Conclusion

In order to ensure the model reliability and accuracy, the verification and the validation steps were achieved throughout all the conceptualization and the development phases of the simulation model. The comparison between the real and the simulated performances shows a gap of less than 8%. This deemed the model validated and apt to support experiments. 22 scenarios of pre and post saturation were simulated. These scenarios are about installing CS with different charging power. Forecast data on the possible evolution of EVs are implemented in the model over an 8-year horizon. To analyze these scenarios, we consider various keys' performances indicators such as: number of total and partial recharges requests, number of rejected charging requests, usage rate of charging stations per hour of the day, total cost of ownership. The calculation results show that there are several variables that can be correctly determined to avoid prohibitive costs in the deployment of charging stations.

References

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