Modeling

On the Characterization and Evaluation of Residential On-Site E-Carsharing

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Motivation

Electric vehicles are an essential alternative to conventional cars to meet the global and national targets set in the 2016 Paris Agreement, taking also into account the fact that the concentration of traffic in urban centers still results in an increase in the atmospheric pollution and poor air quality. Electric cars are becoming more popular and this is mitigating these negative effects, but there are many obstacles hindering their rapid expansion, starting from the acquisition costs, which are higher than the costs for an automobile with an internal combustion engine. The potential of the e-carsharing concept can be a promising solution to face this challenge, since the ownership costs can be spread among many users instead of only one owner. Many studies have proven the positive impact of different e-carsharing approaches on urban sustainability (Roblek, Meško, & Podbregar, 2021). When it comes to residential buildings, the added value of shared mobility gets visible as parking space can be reduced while maintaining the mobility offer. This work is part of the Car2Flex project and investigates the feasibility and economic benefits of residential on-site e-carsharing.

Methods

This work proposes a simple and complete method to describe residential energy management systems' optimal operation with different technologies and set-ups. Figure 1 shows two of the investigated set-ups: The Individual scenario and the Fully Integrated Carsharing Company scenario.

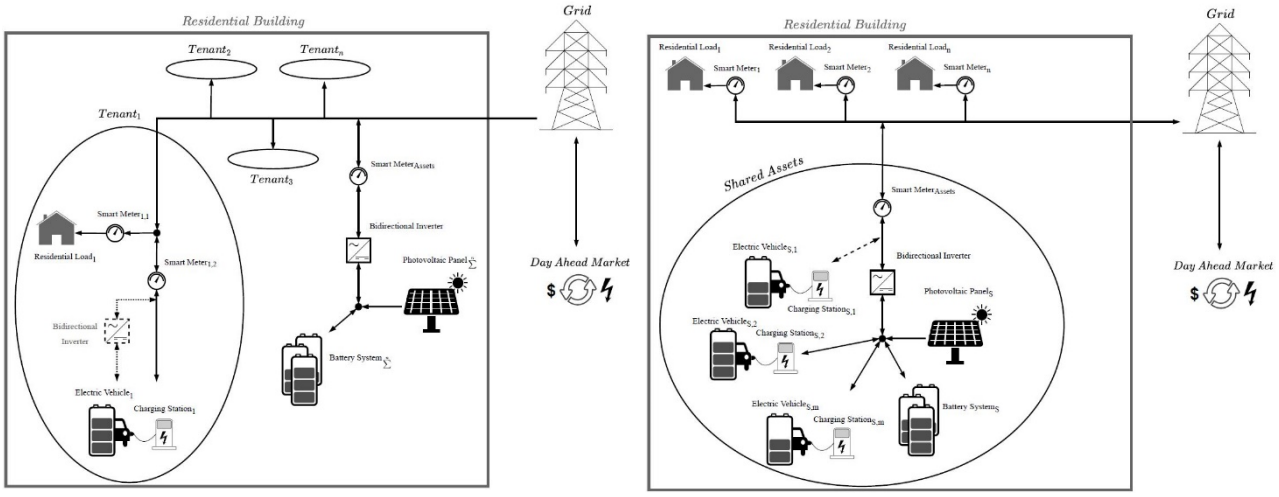

Figure 1: Individual (left) and Fully Integrated Carsharing Company (right) scenarios of one residential building

A mathematical optimization problem is defined to determine the optimal investment of each tenant of a residential building in the various set-ups in multiple technologies, such as photovoltaic panels, electric cars, charging stations (unidirectional and bidirectional ones) and stationary batteries. The carsharing optimization framework allows determining the optimal number and types of the electric vehicles under the consideration of the tenants mobility needs. Furthermore, considering the grid costs, the trading on the Day-Ahead spot market is optimized to minimize the overall costs. Moreover, in this work, the case of a joint investment of the residential building tenants is investigated and different methods are explored to share the costs and the resulting earnings among the participants.

Results

This work presents a comprehensive overview of modelling residential energy management systems and evaluating optimal investments in different set-ups and multiple technologies. Furthermore, the potential of residential on-site e-carsharing for a real-life use case with measured data is investigated. Comparing the considered technologies in different set-ups, we identify various diversities and potentialities. Figure 2 shows the comparison of the overall annual total costs of the tenants of the residential building.

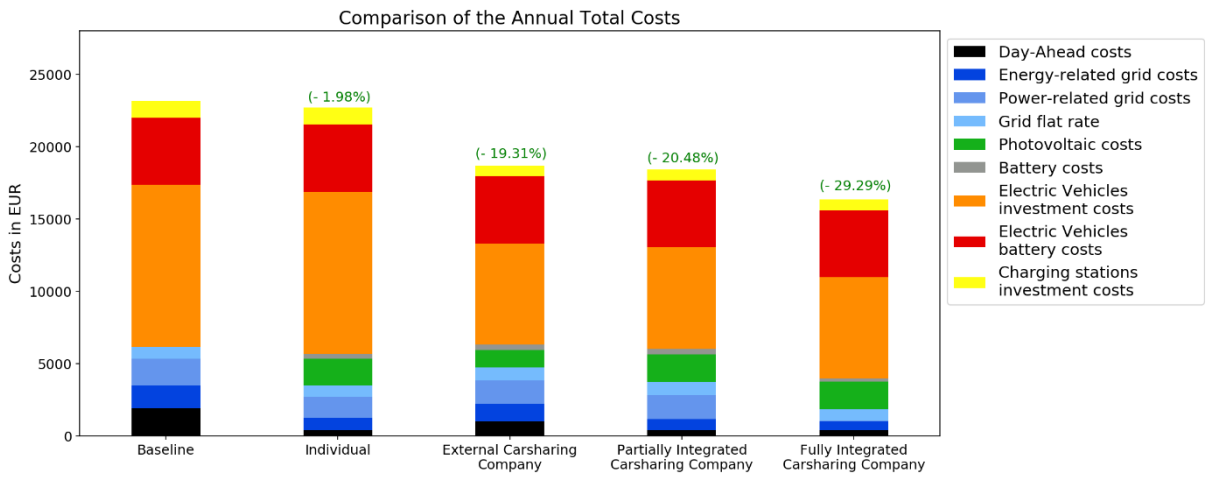

Figure 2 Comparison of the overall annual total costs of the tenants.

Applying the e-carsharing approach, we observe how the number of the required number of electrical vehicles decreases while charging stations with higher nominal power are needed. Moreover, it is shown how the joint investments in photovoltaics, batteries and electric vehicles can make the operation of these technologies more profitable for all the stakeholders involved.

References

Roblek, V., Meško, M., & Podbregar, I. (2021, January 18). Impact of Car Sharing on Urban Sustainability. *Energies*.

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