INTERNATIONAL TRANSACTIONS ON ELECTRICAL ENERGY SYSTEMS
Int. Trans. Electr. Energ. Syst. (2014)
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/etep.1840

Multi-agent management system for electric vehicle charging

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SUMMARY

This paper proposes an implementation, based on a multi-agent system, of a management system for automated negotiation of electricity allocation for charging electric vehicles (EVs) and simulates its performance. The widespread existence of charging infrastructures capable of autonomous operation is recognised as a major driver towards the mass adoption of EVs by mobility consumers. Eventually, conflicting requirements from both power grid and EV owners require automated middleman aggregator agents to intermediate all operations, for example, bidding and negotiation, between these parts. Multi-agent systems are designed to provide distributed, modular, coordinated and collaborative management systems; therefore, they seem suitable to address the management of such complex charging infrastructures. Our solution consists in the implementation of virtual agents to be integrated into the management software of a charging infrastructure. We start by modelling the multi-agent architecture using a federated, hierarchical layers setup and as well as the agents' behaviours and interactions. Each of these layers comprises several components, for example, data bases, decision-making and auction mechanisms. The implementation of multi-agent platform and auctions rules, and of models for battery dynamics, is also addressed. Four scenarios were predefined to assess the management system performance under real usage conditions, considering different types of profiles for EVs owners', different infrastructure configurations and usage and different loads on the utility grid (where real data from the concession holder of the Portuguese electricity transmission grid is used). Simulations carried with the four scenarios validate the performance of the modelled system while complying with all the requirements. Although all of these have been performed for one charging station alone, a multi-agent design may in the future be used for the higher level problem of distributing energy among charging stations.

KEY WORDS: simulation techniques; tools and environments; modelling the dynamics of MAS; negotiation; auction and mechanism design; electric vehicles; aggregation agent