A data-driven approach for optimal distribution network operation with rapid charging infrastructure and large-scale battery storage

Dr. Chun Sing Lai and Professor Gareth Taylor, Brunel Interdisciplinary Power Systems Research Centre, Brunel University London

Project Description and Methodology

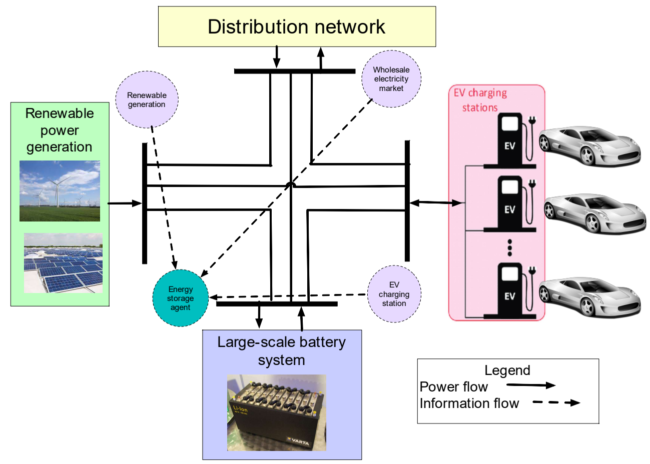

Fig. 1. System context.

This project develops an innovative toolkit to enable the active management of distribution networks to maximise the large-scale battery profit and to maintain distribution networks' voltage limits. The toolkit will support energy storage investments in distribution networks. The power dispatch strategy for large-scale batteries aims to enhance the performance of distribution networks and considers EVs charging demand, photovoltaic power generation and electricity arbitrage. The Twin Delayed Deep Deterministic Policy Gradient (TD3), a reinforcement learning method which works in environments with continuous action space, is used to perform the power dispatch of large-scale battery.

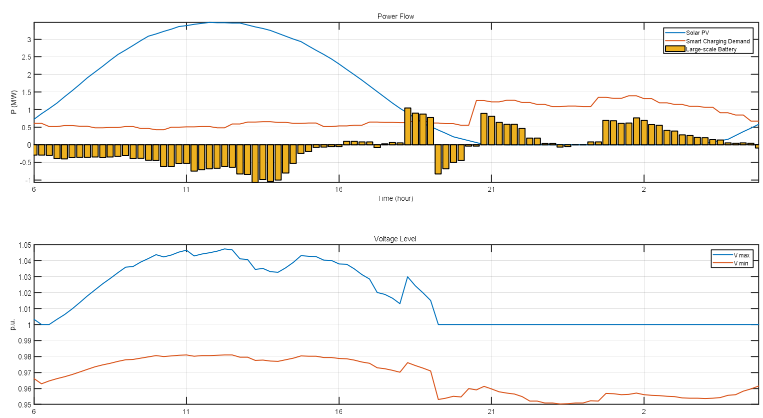

Fig. 2. Power flow and voltage level of the distribution

Fig. 1 presents the basic components of a distribution network with EV charging stations, renewable power generation including solar, and large-scale batteries. The project employs the following methodology: consider that the distribution network operator has access to large-scale batteries owned by a third-party company, the objective for the energy management system is to maximise the profit of the large-scale battery. The voltage constraints are considered and to maintain a healthy voltage level of the distribution network.

Preliminary Results and Collaboration

This project utilises smart EV charging (SMC) data from **UK Power Network's** recent project, Project Shift and photovoltaic data of Great Britain for case studies. After TD3 is trained with

Fig. 3. Levelized Cost of Storage analysis.

the forecast data, the dispatch strategy can work effectively with real-time data or environment as shown in Fig. 2. The distribution network can charge the large-scale batteries during off-peak hours and provide electricity to charging stations during high and rapid charging demand. Local renewable power generation such as solar can be used to meet the local charging demand, to be stored in battery storage, or to export to the grid. Fig. 3 presents the Levelized Cost of Storage (LCOS) results which provides the economic comparisons between different types of energy storage operating methods and consideration of charging demand. As the LCOS is lower than the average retail electricity price when below 10% Weighted Average Cost of Capital (WACC), the use of large-scale battery can be a viable option. The ongoing research includes a detailed financial analysis of the large-scale battery investment. A journal article is under preparation to report the novel power dispatch methodology. International collaboration has been formed with **Guangdong University of Technology, China** and one conference article has been published. The work has paved ideas for developing a research proposal with the DTE consortium members on wireless charging technology.

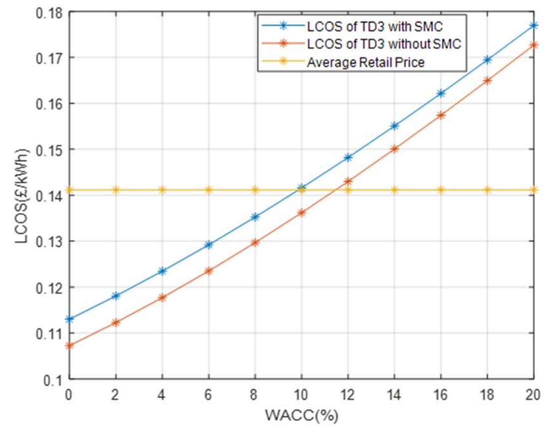

Fig. 3. Levelized Cost of Storage analysis.