SUMMARY OF MASTER'S DISSERTATION

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Title

Comparison of EV and FCV Utilized in a Microgrid with Renewable Energy Sources

Abstract

Renewable energy sources (RES) have attracted attention from all over the world since global warming became a serious problem in 1970s. Especially, solar photovoltaic (PV) generation and wind generation have been increasing their market share, and are expected to replace conventional fossil fuels in the future. However, it will be growingly difficult to synchronize power demand and generation as the penetration of RES becomes high, due to the their intermittent nature.

A microgrid has been studied as one of the solutions to the problem. It is a small-scale energy grid which can be almost independent from the conventional grid by effectively integrating RES. Distributed power storage is used in order to balance energy demand and generation in a microgrid. Electric vehicles (EV) and fuel cell vehicles (FCV) also can function as power storage in a microgrid instead of stationary batteries, which can benefit both grid operators and consumers. Utilization of vehicles in electrical grids has been studied since 1990s, and many studies have been focusing on computing an optimal dispatch of charging and discharging of vehicles in recent years.

Which vehicle type will be dominant is an important question to consider from both economic and policy points of view. However, comparison of EV and FCV when utilized in a microgrid has not been done so far.

This paper proposes a novel optimization model which enables comparison of EV and FCV by the amount of a demand-generation gap in a microgrid with solar PV and wind generation. The constructed model also includes the psychological burden; range anxiety in the EV model and troublesomeness of going to a hydrogen station in the FCV model.

The simulation with the American statistical data shows the advantages and disadvantages of utilizing EV and FCV in a microgrid. EV can help the efficient energy operation in a microgrid even when the introduced capacity of RES is small because of the high system energy efficiency. However, the simulation results depend largely on the value of the psychological burden. Using FCV makes a demand-generation gap less sensitive to the value of the psychological burden, which leads to the easier operation of a microgrid. However, the low energy efficiency of the hydrogen system makes it difficult to satisfy the energy demand when there is smaller RES installed.

Key Word

Renewable Energy, Microgrid, Electric vehicle, Fuel cell vehicle, Psychological burden