Secondary Battery Utilization Technology

Background and Objective

The secondary battery energy storage (BES) technology is a key for electrification of household demands and transportation fields for low carbon society. One of the aims in this project is to propose utilization method of the heat pump (HP) type water heater and BES hybrid system installed in residential houses. And for electric vehicle (EV) and plug-in hybrid vehicle (PHV) diffusion, we study the optimization of the rapid charging infrastructure by traffic simulator and proposed a new effective charging method. We also investigate the transition of the diffusion policies and impact on the markets of EV and PHV.

Main results

1. Development of HP and BES hybrid system installed into residential houses

The energy consumption efficiency of the proto-type of HP hybrid BES system [Q08018] [R08026] was evaluated, in terms of overall energy-saving of a house. Operating HP during day-time by consuming BES energy charged during night-time improves energy efficiency, because HP water heater can utilize much heat of higher temperature atmosphere on day-time than at night with low operation cost. [Q10037].

2. Layout optimization of rapid charging infrastructures by traffic simulation

An integrated simulation system to optimize the layout of the rapid charging station (ST) has been developed based on the road traffic simulator. The traffic simulator can estimate the demand of recharging EV battery, which means the area where the EV runs out of electric power. This result is applied to optimize the layout of ST in the integrated simulation system (Fig. 2). It makes it possible to propose the optimum layout of STs to reduce the number of EV running out of electric power under the condition of the present household vehicle use [L10011].

3. Development of Bi-directional Inductive Power Transfer System

A charging method for EV batteries, which is convenient and safe in the night and rain, is investigated. A bi-directional inductive power transfer device was developed and demonstrated. The energy transfer efficiency was 90% at the operation power of 2kW (Fig. 3), which is equivalent to normal charging at home. This can be applied to various future systems such as V2H (power delivery from vehicle to house) [H10007].

4. Owner-drivers' attitudes toward EVs

Questionnaire survey results on EVs with about 6,000 owner-drivers show that more than 90% of drivers have knowledge that a) EVs are environmentally-friendly, b) can be charged at home, but c) deliver shorter mileage per charge compared to those of gasoline-powered vehicles. However, only 50% know the length of charging time and that driving in towns or the use of air-conditioner still shortens driving mileage. For facts with lower average levels of knowledge, their levels are likely to vary widely by owner's gender and age. For example, 30% to 70% of drivers know effects on driving mileage.

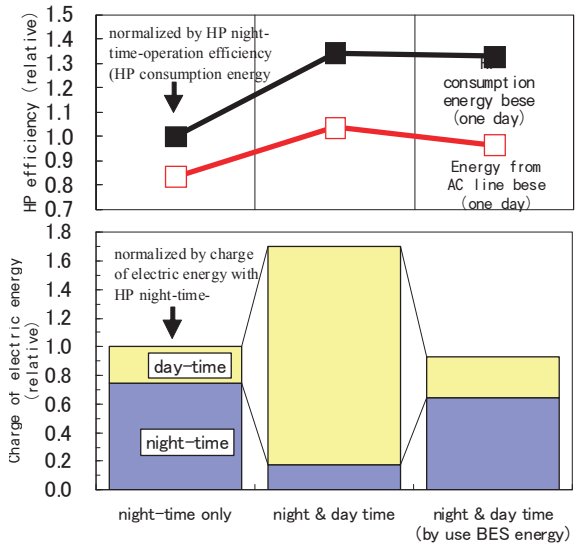

Fig. 1 Comparison of HP water heater operation efficiency (upper) and charge (bottom)

※Water heated up to the temperature, 70℃.
※Charge was calculated with assumption of 9.17 ￥kWh @night-time, 28.07 ￥kWh @day-time.
※Energy charge calculation includes HP operation energy, BES charge energy and consumption energy of power control unit of BES.

We operated HP under three conditions: the water heated during only night-time, during only day-time with AC power line and with supplement of BES.

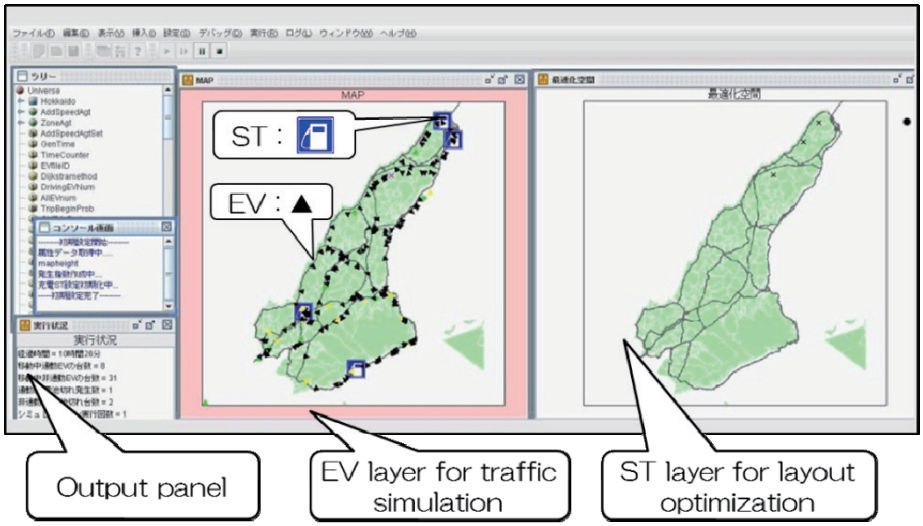

Fig. 2 An integrated simulation system for layout optimization of STs based on the road traffic simulator

The multi-layer system is applied to analyze the demand of recharging EV battery by traffic simulation in the EV layer and to optimize the layout of ST in the ST layer.

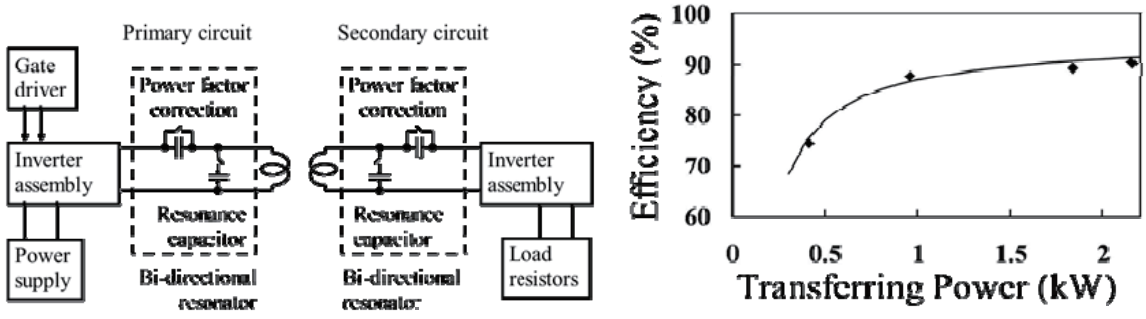

Fig. 3 Bi-directional inductive power transfer system

A bi-directional resonance circuit consists of power factor improvement capacitors and resonance capacitors. The power transfer efficiency is 90% with several centimeters coil distance.