Group Optimization for Conserving In-Vehicle Batteries Shared in Apartment Buildings

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Utilized In-Vehicle Batteries: Vehicle-to-X (V2X)

Energy Management Systems (EMSs)
- Control and balance demand and supply of energy.
- EMSs are important component in Smart Grid.

Power Storages
- Work as buffers for balancing of energy. e.g. stationary batteries for electricity

In-vehicle batteries installed in EVs and PHEVs
- Reduce the number of stationary batteries and its installation cost.
- Add value to EVs and PHEVs providing services (e.g. ancillary services).
- Be available as movable electricity resources at the time of disaster.

Huge and Expensive!

Utilization!

Overview of Smart Grid with V2X

Model Predictive Energy Management System

Model Predictive Home EMS with V2H using Mathematical Programming
- Optimize the charging/discharging schedule of in-vehicle batteries considering the vehicle use.
- Minimize the electricity fee for 24 hours in a house.

The model predictive HEMS with V2H can reduce electricity cost in its house.

Actual Services and Business Model in Japan
- Started aggregator services of Mansion* Energy Management System and supported from 2013.
- Make a basic profit from the reduction of electricity price by the collective power receiving service.
- Manage totally electricity of common and individual spaces with PV, batteries and others.

Example of Computational Experiment
- 40 households (10 households for each setting)
- An EV for each household Capacity: 24 kWh
- Collective power receiving service
- All quantity buyback program for PV energy with Feed-in-Tariff Scheme (32 JPY/KWh)
- Two patterns of electricity demand:
  1. High consumption
  2. Low consumption
- Two patterns of vehicle use:
  1. commuting
  2. shopping, picking up and dropping off

The EMS for apartment buildings can make a profit by electricity interchange.

[JPY/day]

Extension of the Home EMS for Apartment Buildings Sharing In-Vehicle Batteries
- Reverse power flow is permitted only for discharging power of in-vehicle batteries as electricity interchange in the building.
- Even if an EV is away from the building, the other EVs are able to charge/dischage for apartments and the building.
- All the charge/dischage schedules of in-vehicle batteries are optimized every 30 min. simultaneously in group optimization.

V2G: Vehicle to Grid
V2H: Vehicle to Home

Electricity trade between the three agent layers

An EMS for Apartment Buildings