Area 8: PV Systems Including BOS Components

DAY-AHEAD ALLOCATION OF PLANNED POWER FLOW TO THE RESIDENTIAL HOUSES WITH PV AND BATTERY FOR MAXIMUM USE OF DISTRIBUTED BATTERIES

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Beginning in 2012, Feed-in Tariff law is well-known in Japan, and promotes practical use of renewable energy such as solar power. However, it is difficult to make the highly-efficient operation plan of conventional generators in advance and make sure the stable supply-demand balance because of the uncertainty of PV power generation. In this research, we proposed intermediate layer between the market and the demand-side, so-called balancing group (BG), which could adjust demand and supply balance within the group. BG possesses generators of a certain capacity for adjustment and aggregators bundling up a certain number of consumers such as residential houses. We chose one aggregator who manages 540 residential houses in the designated area and supposed each house has the PV generator with battery storage system. One of the main role of the aggregator is gathering the individual PV output and electricity load so that the fluctuation and uncertainty of power flow would be leveled, which helps making the plan of operation. The BG will make the optimal plan to use own generators efficiently and ensure the maximum output of PV generators. Aggregators will receive the hourly Aggregator Request (AGR) from BG in the operation planning phase a day before, and attempt to allocate it to each house reasonably. Then, in the phase of real time operation, each house determines their battery operation based on the past data to try to satisfy the allocated request. The steps of AGR distribution are as follows.

Step1: evenly distribute hourly AGR to each house

In this step, the houses who were charging and the houses who were discharging would exist simultaneously and this situation was not desired because it is wasted operation from the aggregator point of view. Therefore, we were going to remove the reversed operation, which is, the battery operation of house, charging or discharging, opposite to the centralized operation assuming aggregator has a large scale single battery. The houses who were operating reversely would be allocated the same value of original net power flow as the request first. The remaining houses, whose battery operation were the same to the centralized operation assuming aggregator has a large scale single battery, would share the total charging or discharging amount of the whole group. As a result, total of charging or discharging amount were less than before removing the reversed operation so that avoid the waste.

Step2: confirm the battery capacity and inverter output/input if they are within limits

It surely happened the situation of shortage of battery capacity or over the inverter output/input capacity. The shortage parts of charging or discharging from the battery limits would be shared by the houses with extra capacity.

Step3: unify the end of SOC of the each house

In order to maximize the use of charging or discharging of battery in the next day, the AGR was calculated in the condition of 50% of SOC at the end of the day treating the total batteries of each house as a large scale single battery. After the battery operation of each house in the second step, the end of the SOC of the each house were totally different and were off from 50%. If the end of SOC was larger than 50%, it should more discharge in the discharging time or less charge in the charging time. So we divided the shortage of discharge into two parts, increasing discharge amount and decreasing charge amount. Vice versa. The hourly total request would deviate from the hourly AGR if we unified the end of SOC. Therefore we had to adjust the deviated parts to each house in every hour. Then we repeated the work of unifying SOC and the work of satisfy the hourly AGR successively until two results of work would achieve target values at the same time.

Step4: real time operation based on the hourly demand distribution of past data

We assumed the hourly demand distribution of past data will be a normal distribution, and each house will refer it to realize and predict their own position and then adjudge operation at real time. In order to avoiding waste of charging or discharging, the houses at the edge of the distribution stipulated by certain threshold are going to skip operation, and others will perform as planned.

According to the above steps, AGR will be distributed with some degree of fairness and the useless operation will be reduced, as well as the batteries were able to be made the most of the use because we made effort to return to 50% of the end of SOC. In future we will propose the request compromised between useless operation and the end of SOC. Also we will try to focus on how to solve the gap between AGR and current flow at real time due to the prediction error of PV generation and electricity load.

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