# Proposal of Control Method for Compensating Communication Delay in Load Frequency Control Using Electric Vehicles


## Summary

Since the output of renewable power sources fluctuates depending on weather conditions, mass interconnection to the grid raises serious concerns about frequency stability in the grid power. This proposal*) puts forth a control method that directly controls electric vehicles (EVs) using real-time frequency deviation for the EV aggregator (EVA) to compensate for communication delays with the aim of improving the load adjustment capability of EVs, which is considered to be a promising solution in the area of frequency control [1]. As a result of evaluation by dynamic simulation, it was found that the proposed control method can improve the performance score of EVA and reduce the frequency fluctuation at the same time. It was suggested that load frequency control by EVA may be adopted after 2024, when the frequency regulation market is scheduled to be set up in Japan.


## Proposals for Policy Development

- Regarding the institutional design of the frequency regulation market, it is necessary to consider the balance for maintaining the stability of frequency control as well as to analyze the advantages and disadvantages of the systems such as PJM and CAISO in the preceding Western countries and to lower the entry barriers for EVA.
- The minimum bid for the Japanese frequency regulation market currently envisioned is 5 MW, which is larger than the 0.1 MW of the US PJM. Until the market matures, reducing the minimum bid to the level of PJM is considered to be an important measure for future EV's participation in the regulation market.

1. Simulation model
   The simulation model of the load frequency control system by EVA was examined based on the AGC30 model [2]. As the setting, it was applied that the system load is relatively light and that renewable power sources such as solar power generation and wind power generation are connected to the grid (Fig. 1).
2. Design of load frequency control method by EVA
   In the present proposed control method, the parameters are regulated based on the historical data of the received load frequency control (LFC) command and the historical data of the frequency deviation, and the EV frequency is controlled based on the real-time frequency deviation measured from the grid. The logic of the entire control method (Fig. 2) is simple, and it is considered possible to be incorporated into the charge/discharge control system of each EV.
3. Simulation results
   The room for improvement in performance of the proposed control method described in Section 2 was examined by simulation in a grid where the flat frequency control (FFC) method is used. In PJM, the performance score is calculated by evaluating the past result of how quickly each frequency regulation resource in the market can follow the LFC command [4], and the present proposal also calculated the performance score by a similar method as the PJM method (Fig. 3). It was found that in each delay time (horizontal axis), the performance was improved as compared with the case where no compensation was performed, regardless of the value of the calculation period $t_p$.

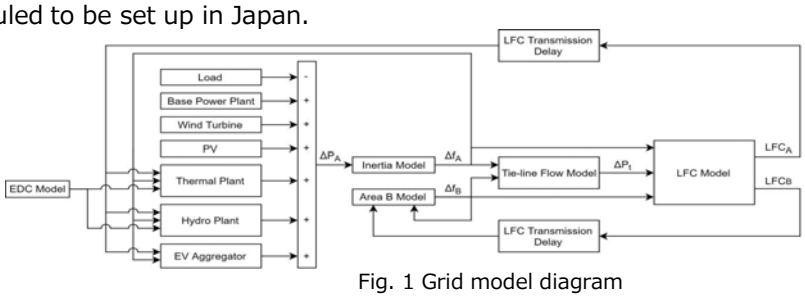


Fig. 1 Grid model diagram

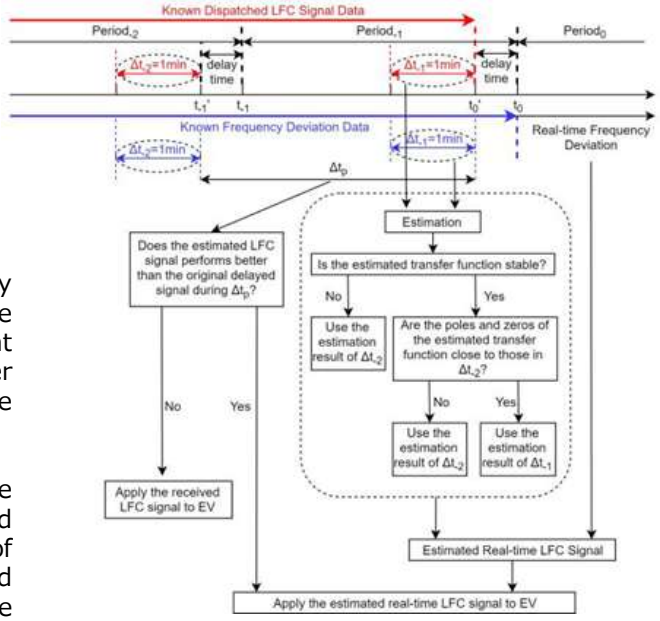


Fig. 2 Control structure in the proposed system

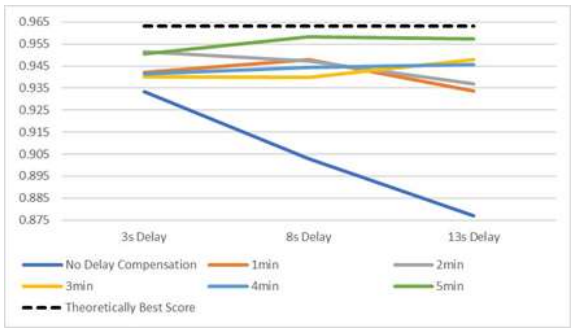


Fig. 3 Performance score (Numbers from 1 minute to 5 minutes are calculation period ($t_p$))

*) The present proposal is based on the content of the authors' paper in English [1] and is linked to policy implications and policy proposals that will lead to the realization of a low-carbon society.


[1] Sinan Cai and Ryuji Matsuhashi, "A Control Method for Compensating Communication Delays in Load Frequency Control with Electric Vehicle Aggregators", Journal of Society for Energy and Resources, Vol.41, No. 1, pp. 1-10, 2020, https://doi.org/10.24778/jjser.41.1_1.
[2] Investigating R&D Committee on recommended practice for simulation models for automatic generation control; Institute of Electrical Engineers of Japan Technical Report No. 1386, 2016
[3] Investigating R&D Committee on load frequency control in a normal time and an emergency in the power grid, "Load frequency control in a normal time and an emergency in the power grid", IEEJ Technical Report, No. 869 (2012), pp.1-147.
[4] PJM manual 12, "Balancing operations", Revisions:39, 2019.