

論 文 の 要 旨

題目 Development of Short-term Photovoltaic Forecasting and Application to Energy Management System
(太陽光発電の短期発電量予測法の開発と電力需給制御への適用)

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Renewable energy resources (RESs) have attracted significant attention due to their reduced environmental impacts. In particular, active installation of photovoltaic (PV) power generation is being strongly promoted in Japan. However, the PV output is generally uncertain due to the spatially and time-varying changing solar radiation. Therefore, it is necessary to achieve a stable power supply by using controllable generator groups, which correspond to existing thermal power and/or diesel generators, based on a well-suited generation planning, operation and control policies. On the other hand, if one can predict the amount of solar radiation accurately, it will then be possible to make efficient operational plans for electric power storages as well as for existing thermal and hydraulic generators. In addition, the proper reserve margins are kept in order to maintain the security of power systems by analyzing the prediction error and its statistical distribution. Thus, development of an accurate prediction technique and the application to advanced energy management technology are generally regarded as an important task in recent power system.

The main objective of this work is to develop a simple and reliable PV forecasting method that can be applied to energy management system (EMS). First, a new day-ahead PV forecasting method is proposed by using only weather report data that are provided by the Japan meteorological agency (JMA) and are available to the public. Secondly, a novel approach based on the correlation analysis is developed to realize the high accuracy prediction for the real-time PV forecasting. In above two approaches for PV forecasting, the multiple neural networks (NNs) based on a weather clustering technique are used to obtain the predictions and the confidence intervals (CIs). Finally, these forecasting methods are applied to the EMS controller, where the prediction and CIs are effectively provided to maintain the robust power system security. These demonstrations for supply and demand management are presented to confirm the effectiveness and robustness of the proposed PV forecasting approaches.

The contents of the thesis are summarized as follows:

- Chapter 1 presents the background of this study, including the characteristics of the PVs.
- Chapter 2 describes the conventional PV forecasting methods and techniques.
- Chapter 3 provides a new approach to predict the day-ahead PV outputs only using a public data. The multiple NNs are constructed and evaluated using testing data. Then, the prediction and CIs are obtained and applied to day-ahead planning manager of EMS controller.
- Chapter 4 provides a novel method to estimate the real-time PV outputs by the correlation analysis.
- Chapter 5 performs the application to the EMS controller by using the propose PV forecasting. The day-ahead and real-time PV forecasting are applied to the unit commitment and the dynamic economic load dispatch, respectively.
- Chapter 6 presents the resume of the major achievements. Furthermore, the future research works are provided to continue this research.