Towards harmonized power system control based on PV power prediction

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This paper presents the outline of the research project ''System Theory for Harmonized Power System Control Based on Photovoltaic Power Prediction (HARPS)," (PI: Jun-ichi Imura), supported by the EMS CREST research program of JST, which has started in April, 2015 for five years. According to “Long-term Energy Supply and Demand Outlook” proposed in July 2015 by METI, a roadmap to photovoltaic (PV) generation dissemination, 7% of the total electric energy and about 30% of the total electric power in Japan, which equals to 64GW of PV power generation, will be covered by a large penetration of PV in 2030. This makes an approach to install a large amount of PV generation to reduce CO2 emission gaining momentum. Therefore, developing a new structure of control technologies to achieve a stable electric power supply using PV generation forecasts is urgent. In addition, there are needs to fundamentally review frameworks of the entire system to achieve the supply and demand balance. Electric power supply systems will be renewed after the separation of electrical power production from power distribution and transmission, and the deregulation of electricity. Developments of new mechanisms, such as demand response, from advancements in information infrastructures and home battery technologies also cause the necessity to review the frameworks. The goal of this research project is to develop a system theory for the more advanced generation electric power system control by fully exploiting demand/PV predictions and focusing on properties and functions of a middle layer. The middle layer is expected to take many different forms such as demand-side energy management systems (BEMS, CEMS, etc.), cooperative power conditioners, demand response aggregators, and balancing groups of suppliers. In particular, as a basic theory and technology to be the core of harmonized electric power systems control to enable PV introduction of 102GW, and further towards PV introduction of 330GW, we aim to develop the following fundamental theories and technologies: (i) Electric Power System Design: a system design theory composed of supply layer, middle layer, and consumer layer, (ii) Prediction Technology: a PV generation prediction technology adapted to power system control techniques that achieves a stable power supply, (iii) Control Technology: a power system control theory and technology to realize a harmonized stable power supply from the perspectives of fairness and comfort as well as the economics and environmental friendliness, by fully exploiting PV generation predictions. This research is performed from the following five viewpoints: PV power prediction, supply and demand control, consumer-side control, control of power transmission and distribution systems, and basic systems theory. The number of researchers including students is 112 (36 students). This research is performed from the following five viewpoints: PV power prediction, supply and demand control, consumer-side control, control of power transmission and distribution systems, and basic systems theory. See http://www.cyb.mei.titech.ac.jp/crest/ for the details on this project.

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