Study on the Energy Mix in Future Smart Electricity Systems in Japan

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1. Overview

This study focuses on the future smart electricity system to 2030 in Japan from both supply and demand sides in light of the Fukushima Accident happened in March 2011. Three electricity supply scenarios in 2030 are proposed according to different future nuclear power development strategies: (1) negative nuclear power; (2) conservative nuclear power; and (3) active pursuit of nuclear power. Renewable energy is used under their physical potentials [1]. In demand side, all electrification will be realized in residential and commercial sectors. , and new electric devices such as battery, electric vehicle and heat pump etc will also penetrate into the system under their smart control strategies. Apart from nuclear safety issue, Japan faces very serious energy security and climate change pressure. The future developments of nuclear, renewable and fossil energy need to be considered together in Japan to realize a safe and clean future electricity system after the Fukushima Nuclear Accident under continuing policies of CO_2 emission reduction. On the other hand, one of the most crucial elements of future electricity systems will be the capability for “smart” controls on both supply and demand sides to perform under real-time dynamics [2]. Therefore, the purpose of the study is to propose energy mix in smart electricity systems and penetration of electric devices under their smart control strategies from reliability, economy, security and environment aspects.

2. Method

Therefore, an analysis model is proposed shown in Fig.1. [3] It is organized in an “Input-Output” framework and realized by hour-by-hour demand-supply balance simulation. The arrows in real line and dotted line in the figure show the data flow and integration respectively. The basic inputs are divided into two classes, one is basic physical data the other is predefined operation rules. Main input data are historical traditional electricity load, solar irradiation, wind speed, fuel supply, installed capacity, CO2 emissions factor and basic cost information, etc. A number of alternative

regulation strategies are classed into technological, economic and environmental perspectives, with emphasis on control strategies of new devices, blackout permission (whether blackouts occur is allowed or not in the electricity system), generation priority of various technologies, upper limitation of excess electricity, range of capacity factor, cost and CO2 emission constraints respectively. New electricity devices (battery, EV, HP, etc,) and their combinations are optional, and their control strategies are also defined as optional rules. Outputs are mainly energy balances and the resulting annual electricity production, fuel consumption, total/average cost, total/average CO2 emission, operation patterns of the new devices under their defined control strategies, etc.

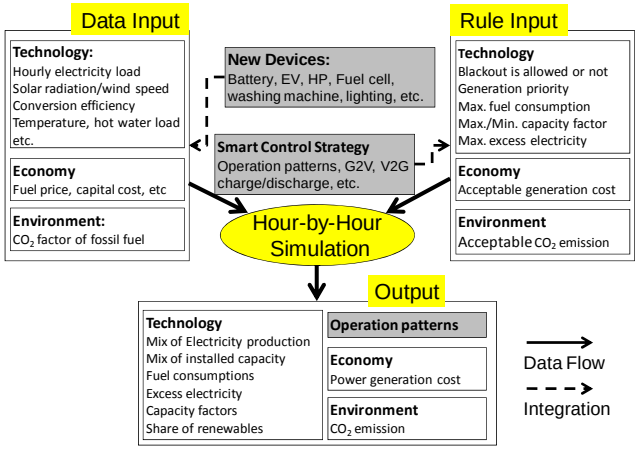

Fig.1 Input-output analysis model for future smart electricity systems

3. Expected Result

As results, in future smart electricity systems in Japan, different mix of renewable, nuclear and fossil energy in supply side and different penetration levels of electric devices under their smart control strategies in demand side are expected to be obtained. And the performance of the systems in reliability, economy, security and environment aspects are expected to be uncovered.

4. Reference

1. ME (Ministry of Environment of Japan), study of Potential for the Introduction of Renewable Energy, 2011. [in Japanese]
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3. Q. Zhang, T. Tezuka, B. Mclellan and K. N. Ishihara, Scenario Analysis of Low-Carbon Smart Electricity Systems in Japan in 2030, Zero-Carbon 2011, Spring, 2011