Study Committee C5

Electricity markets and regulation

10726_2022

The Overview of The Rule Design and Studies for Non-firm access in Japan – Connect & Manage of Renewable Energy –

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Introduction

- Japan has declared its goal of achieving a carbon-neutral and decarbonized society by 2050. Toward this target, it is considered that nearly 40 % of the electricity supply in 2030 will be covered by renewable energy (RE), which is about double the actual amount in 2019. (Figure 1)
- Japanese Connect & Manage (C&M) has been introduced to make effective usage of the existing grid for further expansion of RE integration to achieve the environmental target in a cost-efficient manner.
- Japanese C&M consists of three components, namely, (1) Rationalization of power flow assumption, (2) N-1 generator shedding, and (3) Non-firm access. (Figure 2)
- "Non-firm access" is a unique scheme which grid connection is granted despite grid congestion is expected, provided that curtailment is accepted in such situation.
- Accepting applications of non-firm access started from Jan.2021 for bulk transmission system. Application amount has summed up to 40.7GW, and grid connection of 3GW has been already accepted (As of end of FY2021).
- This paper deals with various attempts to realize "Non-firm access" in Japan.

Rules and market design for Non-firm access in Japan

1. Congestion management to realize non-firm access

- "First-come, first-served" rule will be changed to "Non-firm access + Congestion management based on merit-order dispatch" (Figure 3)
- For a prompt implementation of congestion management, it was decided to introduce "TSO redispatch scheme" at the initial stage.
- A policy was presented to introduce market-driven congestion management, known as "implicit auction" as soon as possible, to incentivize grid connection to non-congested areas by utilizing price signals .

1.1 TSO-driven congestion management (TSO redispatch)

- In "TSO Redispatch scheme", after gate closure of the wholesale market, TSOs adjusts the generation of congested and non-congested areas by issuing redispatch orders to increase / decrease output to resolve congestion. (Figure 4)
- The redispatch order shall be based on merit-order, in which the curtailment of carbon-free renewable generation is usually minimized.
- Redispatch order to decrease output is issued to the generator whose marginal cost is the highest among those in the congested area, and vice-versa in the non-congested area. The generation control system to achieve this is explained in Section 2.2.

1.2 Market-driven congestion management (Nodal / Zonal pricing: Implicit Auction)

- In "Implicit auction" scheme, wholesale energy market will be divided by the grid elements where congestions are expected, and generators can send power via the congested element only when cleared in the market.
- The degree of subdivision of zones is under discussion by comparing pros and cons between dividing the existing zones to nodes (nodal pricing) or subzones (zonal pricing).
  - ✓ Impact of market structure change
  - ✓ Time required for implementation
  - ✓ Business predictability etc.

2. Establishing basic technology and required specifications

2.1 Online generation control for PV and wind (Figure 6)

- PV and wind power generation entities are now obligated to equip remote generation control system to respond to remote curtailment orders issued by TSOs.
- TSOs determine the required amount of generation curtailment based on demand forecast and PV/wind generation forecast, and issue orders through telecommunication network.

2.2 Development and field-testing of basic technology to realize non-firm access

- Generation control system to realize non-firm access is under development. This system determines the optimum combination of generation redispatch order to resolve both grid and balancing constraints, and issues orders to the generation entities online via telecommunication network. (Figure 7)
- Process-flow of supply-demand balance analysis including grid congestion management is shown in (Figure 8).

(1)Unit commitment considering grid constraints is derived by Security-constrained unit-commitment (SCUC)
(2) Optimum power flow and dispatch is evaluated using ACOPF, that analyses grid constraints including voltage.
(3) If violations of constraints are found, SCUC is adjusted to resolve such violation and optimum power flow and dispatch is evaluated by ACOPF again.

2.3 Implementation of Non-firm access to local transmission system

- Accepting applications to local transmission system is planned to start from end of FY2022, and demonstration using actual network is planned to start in FY2024.
- Measures to secure and control generation is under discussion, including the system mentioned in Section 2.2.
- Bundling multiple generation connection requests and policy-oriented grid expansion is considered to implement grid expansion and non-firm access in a well-balanced manner (Figure 9).

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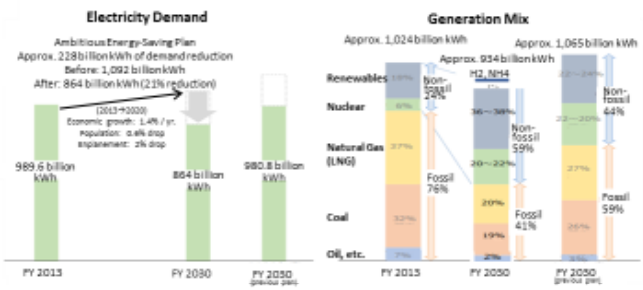

Figure 1 Outlook for demand and supply of electricity of Japan in 2030

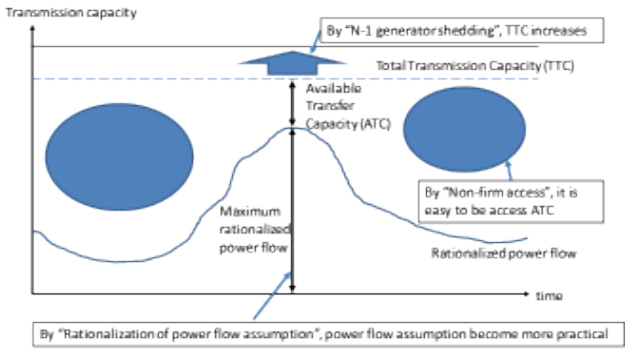

Figure 2 Image of Japanese Connect and Manage scheme

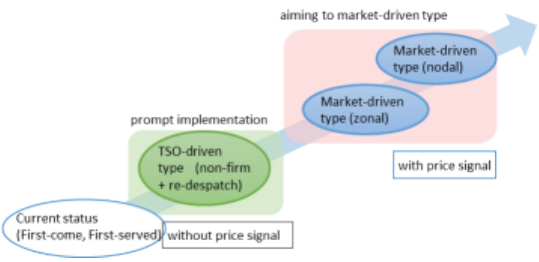

Figure 3 Congestion management considering Non-firm access

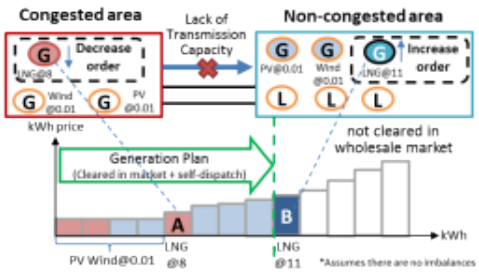

Figure 4 Congestion management flow (TSO redispatch)

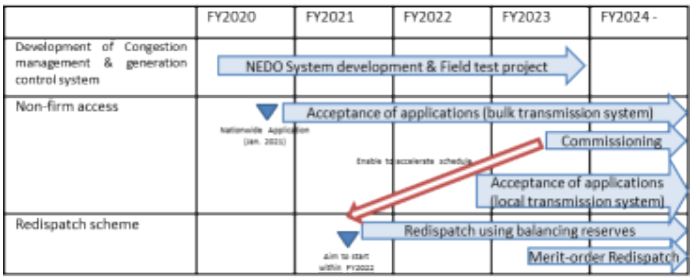

Figure 5 Schedule of implementation of Non-firm access scheme

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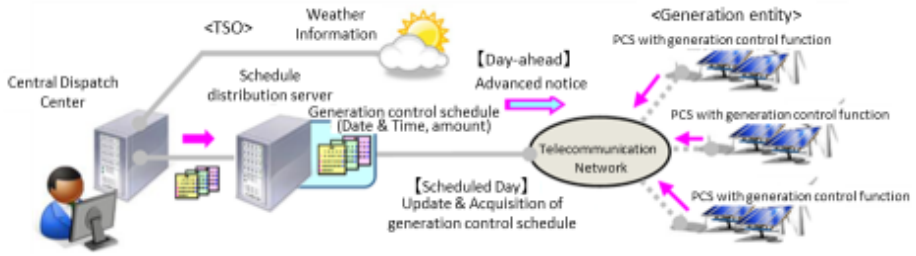

Figure 6 Overview of online generation control system for photovoltaic and wind

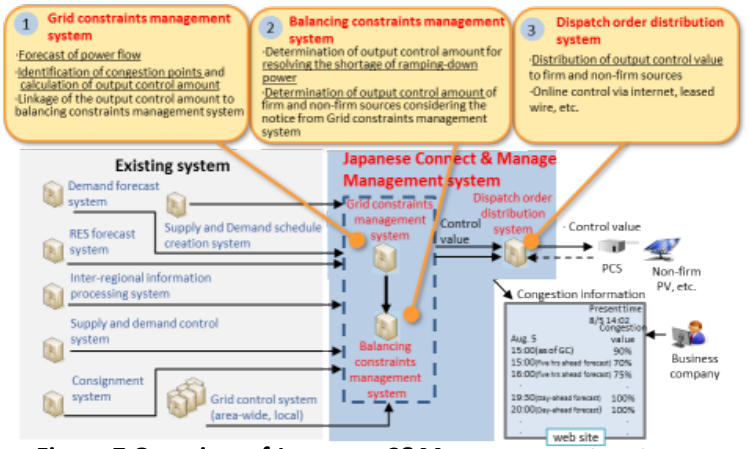

Figure 7 Overview of Japanese C&M management system

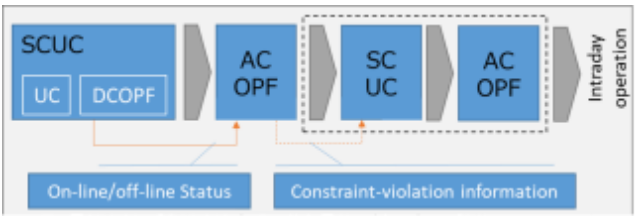

Figure 8 Process-flow of supply-demand balance analysis model including grid congestion management

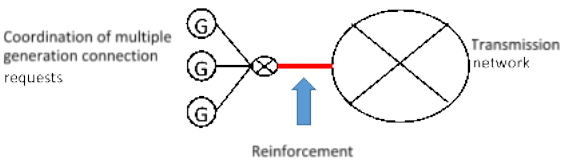

Figure 9 Cost-benefit analysis based on coordination of multiple generation connection requests