Economic and Technological Evaluation for Zero Carbon Electric Power System Considering System Stability (Vol.1):

Technological Development Issues for Reliable and Affordable Zero Carbon Power Supply

A multifaceted evaluation of zero carbon (ZC) electric power systems to provide direction for the technological development necessary to realize Japan's ZC power system by 2050 was performed. Analyzed systems had a demand for electric power of 800 to 3,000 TWh a year, with the analysis being based on LCS quantitative technological scenarios. Under the assumptions of potential expansions in solar power generation, introductions of offshore wind power including floating wind turbines, and enhancements to the power grid, estimations were made regarding the economic impact of introducing new pumped-storage power [1] and hot dry rock geothermal power (HDR). For these estimations, the power generation ratio of synchronous generators (hereafter called “inertia constraint”) was set at 50%, 25%, and 10% to act as a system stability index.

- The introduction of new pumped-storage and HDR power enabled ZC power system under the annual demands of 2,000 TWh and 2,600 TWh, with inertia constraints of 50% and 25%, respectively.
- Affordable ZC power system will be realized with the expanded potential of renewable energy as well as cost reductions in renewable energy technologies and energy storage systems, and enhancements to the power grid (Figure 1).
- Cost reductions in renewable energy systems and technology developments of potential expansions would lead to reductions in power generation cost of 1 to 10 trillion JPY per year. Improvements in system stability technologies would produce reductions in power generation cost of 1 to 20 trillion JPY per year.

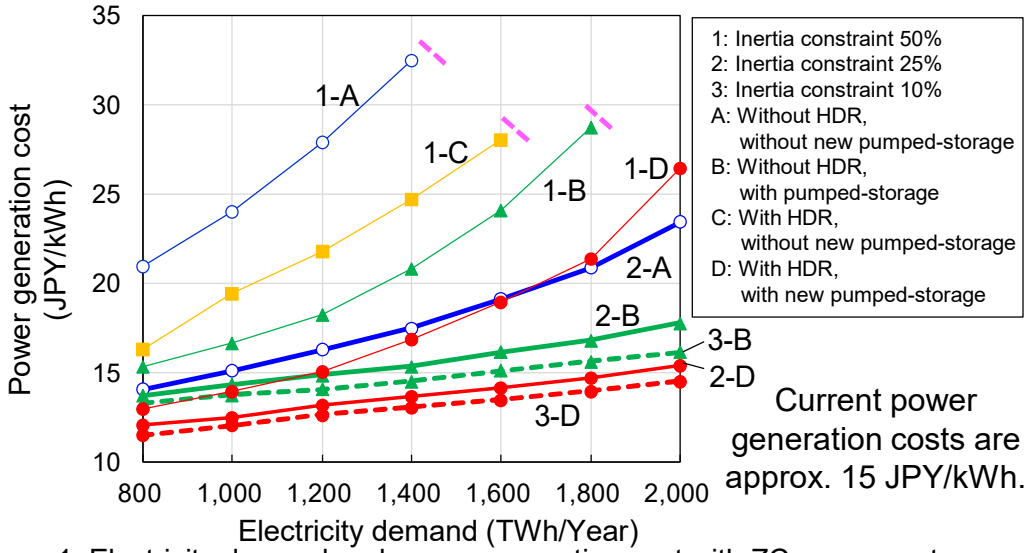

Figure 1: Electricity demand and power generation cost with ZC power systems

Proposals for Policy Development

1) Promote the development of system stabilization technologies which enable ZC power system with low rate of inertia constraints.
2) Support the development and introduction of new pumped-storage and HDR power as low carbon power supply systems that contribute to inertial force supplies.
3) Improve the efficiency of solar power generation, foster the solar power industry, and promote technologies to reduce the costs of offshore wind power.
4) Provide large scale transmission planning for ZC power systems and long-term technical and economic assessments of the grid system.

[1] LCS Proposal Paper for Innovation Policy Development "Potential Capacity and Cost of Pumped-Storage Power in Japan (Vol. 2)", Feb. 2020.
https://www.jst.go.jp/lcs/pdf/fy2019-pp-21.pdf