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Overview of Superconducting Power Applications in Japan

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Abstract—In Japan, during the period of high economic growth since the 1960s, the power system including power plants has been strengthened. Based on the expectation that it would be difficult to increase the power system by conventional technology from the 1980s onward, the development of technologies such as superconducting large-capacity generators, superconducting power cable transmission, and SMES technology was actively promoted mainly by national projects. After that, Japan's energy demand peaked around 2000, and the growth in electricity demand stagnated accordingly. In particular, since the Great East Japan Earthquake in March 2011, energy conservation has been thoroughly implemented, and electricity demand has remained flat or slightly declining to this day.

On the other hand, in order to stop global warming, efforts are being made to reduce carbon dioxide emissions per unit of production in electricity supply by the introduction of the FIT system. At the end of 2024, solar power generation has been introduced by about 73 GW, and wind power generation has been introduced by about 5.6 GW. As for wind power generation, it is expected that the introduction of offshore wind power generation will continue in the future, and the FIT certified capacity is 13.9 GW. Already, mainly in spring and autumn, the amount of power generated including solar power generation exceeds the demand of electricity, and it is becoming normal to suppress output. For this reason, the characteristics required of electric power equipment are also changing. There is a growing need for the ability to adjust ΔkW to match power supply and demand, and the ability to supply inertial and synchronization forces when the proportion of inverter power sources that do not have inertial power is the majority. Superconducting power devices can exhibit various characteristics that are difficult to realize with conventional power equipment, and research and development to maximize these characteristics is beginning.

In addition, Japan is considering importing hydrogen produced using renewable energy overseas in order to pursue a low-carbon energy supply. Liquid hydrogen is considered to be one of the most likely transportation mediums in this case, and consideration of a specific import base has begun. In the vicinity of the import base or the satellite base where hydrogen is supplied in liquid form, liquid hydrogen can be used as a refrigerant or a low-temperature heat source for cooling superconducting equipment. Studies on superconducting power devices that utilize the cold heat of such liquid hydrogen have already begun.

In this presentation, I will give an overview of the history of superconducting power equipment development in Japan and introduce the recent state of research and development.

***Keywords (Index Terms)*—liquid hydrogen; power devices**

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