Experience and Enlightenment of Japan's Emergency Power Supply Guarantee Mechanism

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Abstract. Japan is a country prone to natural disasters such as earthquakes, tsunamis, and typhoons. Electricity is the key material basis for production, life and emergency management, so the reliability and stability of its supply is an important content of Japan's disaster protection. In recent years, people have paid more and more attention to maintaining a normal and independent life even after the power and natural gas infrastructure has stopped. Therefore, the concept and practice of emergency power supply have been circulated and widely implemented in Japan for a long time. This paper summarizes the concepts, legal standards, development history, main methods, work of power grid companies, development trends, etc. of emergency power supply in Japan, and provides relevant experience and inspiration for the development of emergency power supply in China.

1. The concept of emergency power supply in Japan

Power system is the largest man-made system all over the world, which is fragile to natural disasters, and thus the quick load restoration of electricity is very important[1-2]. At present, Japan's emergency power supply mechanism is developed with the emergency power supply equipment deployed in each building as the core, and the main body of responsibility for emergency power supply is each building unit. The property rights of emergency power supply equipment belong to private individuals.

Japan stipulates that emergency power generation equipment is an emergency power supply especially used for disaster prevention. Legally speaking, the emergency power supply is to ensure the safety and stability of personal and fire protection in the event of a fire or other emergency situations[3].

There are two main types of emergency power generation equipment: "used for disaster prevention" and "used for safety", but the two are mostly used. When used for disaster prevention, the user is obliged to stick a fire certification ticket on the equipment[4]. The installation methods include indoor fixed type, outdoor fixed type, portable type and mobile power supply vehicle.

The so-called "for disaster prevention", the Building Standard Law and Fire Protection Law stipulate that it is obligated to install emergency power generation equipment according to the scale and purpose of the facility. In the event of a power outage caused by a fire, etc., emergency power generation equipment not only guarantees building emergency lighting and guide lights to evacuate the masses, but also needs to be able to provide indoor fire hydrants and sprinklers and other disaster prevention equipment for fire fighting activities with working hours above the legal regulations[5]. "Used for safety" refers to emergency power generation equipment that provides power to installed security equipment (general lighting, broadcasting equipment, medical equipment, etc.) voluntarily.
It should be noted that even for “safety” emergency power generation equipment, in addition to complying with the regulations of the Electric Business Law and the Fire Protection Law, there are also laws and regulations such as the Fire Prevention Regulations (Regulations of Local Governments). Therefore, even if the installation is voluntary, it is necessary not only to declare at the time of installation, but also to comply with laws and regulations on operation and maintenance.

2. Requirements of policies, regulations and technical standards

2.1. Responsible subject requirements
Japan currently does not require power supply companies to provide users with various emergency power supply guarantee services. Japan's various legal systems clearly require that all buildings be equipped with emergency power supply equipment, and the equipment should be regularly inspected and maintained. Units that fail to meet legal requirements will be fined. Therefore, the main body responsible for emergency power supply in Japan is the building, responsible for the investment, construction, operation and maintenance of emergency power supply equipment, not the power supply company. In addition, Japan's electric power laws do not specifically address the liability of power companies for interrupting or restricting power supply.

In addition, for independent residential houses, etc., Japan does not mandate the installation of related equipment. However, due to frequent daily disasters, ordinary Japanese people also attach great importance to emergency power supply under disasters. In order to ensure normal life after the disaster, many families have voluntarily installed emergency power generation facilities.

2.2. Specifications and setting requirements
Among various Japanese policies, regulations and technical standards, the main ones that have clear requirements for the specifications and settings of various emergency safety power sources are the Fire Protection Law, the Building Standards Law, and the Electrical Equipment Technical Standards. If you do not install and set up emergency power supply equipment in accordance with the regulations, you will be fined or even sentenced.

2.2.1. Emergency power supply regulated by Japan's "Fire Protection Law". This power supply refers to the "emergency power supply" used when cutting off the power supply of fire-fighting equipment, that is, equipment connected to and supplying power to fire hydrants, sprinklers, and fire-fighting flue gas discharge facilities, ensuring that the fire-fighting facilities can operate normally even if the power supply is lost. The "Fire Protection Law" stipulates that each fire-fighting facility must ensure continuous operation time, that is, under rated load, each facility should be able to operate continuously for 60 minutes or more, and the fuel oil of the emergency power supply should have a working time of 2 hours or more. Capacity reserve, and the supply voltage should be established within 40 seconds.

2.2.2. The backup power supply required by Japan's "Building Standards Law". This power supply refers to the "backup power supply" used for emergency lighting and smoke exhaust equipment, similar to the emergency power supply for fire fighting equipment. The backup power supply should ensure that even if the building loses power from the grid, the emergency lighting device will continue to work for a period of time. The "Building Standards Law" stipulates that the standby power supply should be able to supply power for more than 30 minutes and establish a working voltage within 40 seconds to ensure that emergency lighting and smoke exhaust equipment have the ability to work continuously for more than 30 minutes.

When a building is equipped with emergency power supply, the emergency power supply standard must meet at least one of the Fire Protection Law or the Building Standards Law.
2.2.3. The safe power supply specified in the "Technical Standards for Electrical Equipment". When the power supply from the power company is cut off, this power supply refers to the "safe power supply" or "commercial power supply" used to maintain the functions of the customer's electrical equipment. It is not a disaster prevention backup power supply used for evacuation or fire fighting, but a backup power supply used to maintain the continuity and safety of production and life.

Currently, there are two main types of emergency generators used as electrical equipment in buildings in Japan: diesel engines and gas turbines. Internal combustion generators have the advantages of quick start, high operational reliability, and easy maintenance and inspection, so they are widely used in emergency power generation. Japan's "Fire Protection Law" specifically stipulates that in order to ensure the reliability and stability of emergency power supply after a disaster, the starting performance of disaster prevention emergency generators is "diesel", "gas turbine" and above.

According to the Japanese Building Standard Law and the Fire Protection Law, the minimum time that various disaster prevention loads can continue to work after a disaster is shown in the following table.

| Disaster prevention loads                                      | Working time (min) |
|---------------------------------------------------------------|-------------------|
| Indoor fire hydrant                                            | 30                |
| Automatic sprinkler equipment                                  | 30                |
| Water spray fire extinguishing equipment                       | 30                |
| Foam fire extinguishing equipment                              | 30                |
| CO2 fire extinguishing equipment                               | 60                |
| Halide fire extinguishing equipment                            | 60                |
| Powder fire extinguishing equipment                            | 60                |
| Smoke exhaust equipment                                        | 30                |
| Emergency universal jack                                       | 30                |
| Wireless communication auxiliary equipment                      | 30                |
| Red signal light equipment entering the scene in case of emergency | 30                |
| Emergency lighting                                             | 30                |

2.3. Daily operation and maintenance requirements
In addition to installation and configuration requirements, Japanese policies and standards also put forward strict regulations on daily operation, maintenance and inspection to ensure the safety of the generator's daily operation, reduce fire hazards, and ensure the generator's operation in emergency situations.

The maintenance and inspection of emergency generators are regulated by the Building Standards Law, the Fire Protection Law and the Electric Power Business Law. The building owners of the equipment manufacturer shall carry out necessary inspections and repairs in accordance with these regulations.

The "Fire Protection Law" stipulates that generators should be inspected at least once every six months, and generators should be inspected at least once a year. Regular inspection reports must be issued and reported to relevant departments. The "Fire Protection Law" stipulates that a comprehensive inspection should be carried out under a test load of "30% or more of the actual load". If the test cannot be performed under the actual load connected to the generator, a simulated load can also be connected. If routine inspections are not performed, fines will be imposed in accordance with regulations.

The "Building Standards Law" requires qualified "architects" and "construction equipment inspectors" to conduct routine inspections on the emergency power supply facilities of buildings in a
period of 6 months to 1 year to confirm the appearance and performance of the equipment. Normal, and report the inspection results to the specific administrative office in time. If you violate the regular reporting rules, you will be fined.

The "Electric Power Business Law" stipulates that buildings where emergency generators are installed need to check the safety regulations established by their electrical engineers. Generally, in order to ensure the normal operation of related electrical equipment, daily inspections and regular and precise inspections must be carried out in accordance with the "Building Standards Law", "Fire Protection Law" or the provisions of the electrical equipment rules. If the relevant safety regulations are violated, the Ministry of Economy, Trade and Industry may impose a fine based on the technical standard compliance order.

In addition, Japan also regulates the smoke and smoke emission level, noise level, and environmental pollution level of emergency generators.

3. Development trend of emergency power supply in Japan

With the continuous development of smart grid technology, grid informatization level, and clean energy utilization level, intelligent control, information communication and digital technology have gradually been widely used in the field of emergency power supply, which has promoted the emergence of multiple types of new emergency power supply models and new business forms. Japan's emergency power supply equipment has shown a steady increase in output power, the safety, reliability, and continuity of output power have been continuously enhanced, and the continuous power supply time has been greatly extended, which has significantly improved the emergency power supply level for various users after disasters. At the same time, technological progress also drives the improvement and development of related mechanisms. Specifically, the development of emergency power supply in Japan mainly has the following trends.

3.1. Distributed generation and Microgrid are playing more and more important roles in power emergency recovery after disaster.

In the event of a large-scale power outage, a microgrid with distributed power sources can be operated in isolated mode, which can provide stable power supply for regional loads, especially important and critical loads, with sufficient fuel reserves, which greatly improves the power supply after disasters.

3.2. Energy storage will become an indispensable part of the emergency power supply equipment system.

With the continuous development of energy storage technology, the capacity and energy storage density of various energy storage devices have greatly increased, the volume of the equipment has been significantly reduced, and the continuity and stability of discharge have been greatly improved. The energy storage device can not only be used as an emergency power source alone, but also can be used in conjunction with various power generation equipment, especially distributed clean power sources, to avoid the volatility and instability of clean energy emergency power supply and improve overall power supply reliability.

3.3. The emergency power supply mechanism between power supply companies and buildings is continuously optimized.

With the continuous development of the digitalization and informatization of the power grid, the ability to accurately locate faults and quickly repair power systems has rapidly improved, which greatly shortens the time for faults. At the same time, relying on capital, technology, human resources and abundant customer resources, power grid companies are vigorously developing the emergency power supply market, constantly enriching related products and service systems, and improving their own operating standards while meeting customer needs.
4. Conclusion
(1) Japan has established a comprehensive system of laws, regulations and technical standards for emergency power supply guarantee. As early as nearly 50 years ago, Japan legislated to clarify that buildings rather than power supply companies are the main bodies responsible for emergency power supply, and continue to improve relevant regulations and standards in combination with technological development and practical issues. Japan has made clear requirements for the installation specifications, configuration standards, and operation and maintenance inspection mechanism of emergency power generation devices in various power outage scenarios, and has established a complete and strict supervision system to ensure the reliability of emergency power supply.

(2) Japanese society generally attaches importance to the important value of emergency power supply, and the emergency power supply market has a broad space. Japan's emergency power supply guarantee has a long history of development, mature equipment and technology, complete industrial system, and broad market space. In addition to specialized emergency power supply equipment vendors and service providers, large-scale power supply companies in Japan rely on their business strength and customer resource advantages to actively enter and expand relevant markets, forming a comprehensive service covering consulting services, planning and design, installation and commissioning, and operation and maintenance inspections. The all-round, multi-level, and differentiated product and service system has promoted the accelerated development of the emergency power supply market opened up new growth points for itself.

(3) Advanced intelligent control, information communication and digital technology have brought new development opportunities for Japan's emergency power supply. With the continuous improvement of smart grid technology, power informatization level, and clean energy utilization level, technologies such as microgrid, distributed clean power generation and energy storage are gradually applied to the field of emergency power supply, bringing new ideas and new developments to emergency power supply. Business format, new model. The coordinated use of new devices can further enhance the safety, reliability and continuity of emergency power supply.

(4) China should continue to enhance the society's awareness of emergency power supply, strengthen the construction of mechanisms and standards, and increase the popularity of emergency power supply equipment. In view of the weak awareness of emergency power supply caused by the few major blackouts in my country and the imperfect related policy mechanisms, we should vigorously promote the important value of emergency power supply, enhance the emergency power supply awareness of the whole society, improve relevant policies, regulations and technical standards, and clarify all aspects of emergency power supply. We will accelerate the popularization of emergency power supply equipment, vigorously develop the emergency power supply market, and improve the emergency power supply level of the whole society.

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