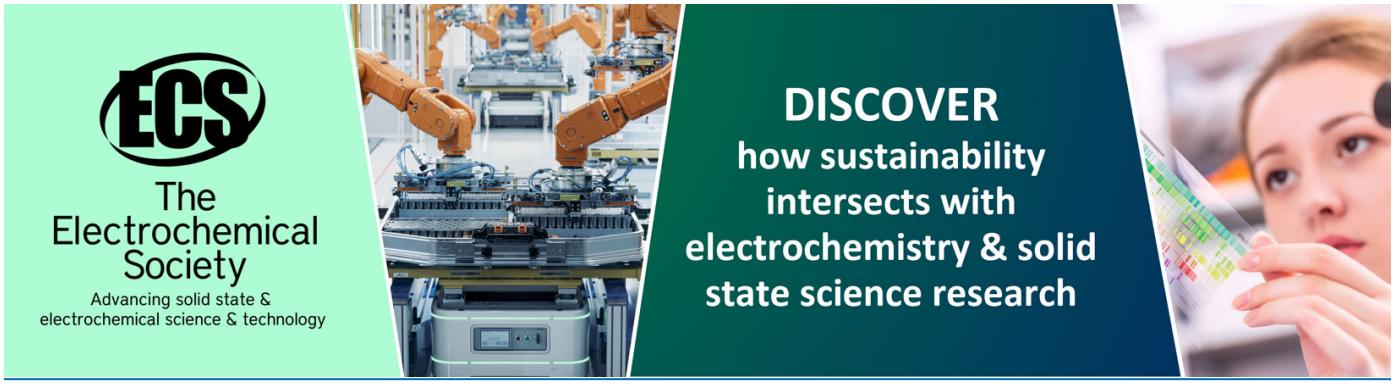
Multiple Load Characteristic Analysis for Interacted and Interconnected Micro Grid on Pelagic Clustering Islands



Multiple Load Characteristic Analysis for Interacted and Interconnected Micro Grid on Pelagic Clustering Islands

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Abstract. With the gradual emphasis on the development and utilization of islands, the energy supply problem of islands far away from land-based has become increasingly prominent. Based on the traditional single energy acquisition method, this paper establishes an island independent energy cycle system with high reliability power exchange ship as the main part, tidal energy and photovoltaic power generation as the auxiliary. It has opened up an effective way to meet the needs of military life and production on the island.

1. Introduction

Combined with the island's environmental conditions, new energy such as wind power generation, tidal current energy and photovoltaic energy can be used to provide basic power [1-2]. However, these new energy sources are affected by factors such as season, climate and geographical location. Each power source has intermittent characteristics. However, the characteristics of these three new energy sources can be comprehensively analyzed to adapt measures to local conditions and make complementary use of them, so as to give full play to their respective roles and provide relative stability power output [3-4].

The climate conditions of islands are often bad. Even if a variety of new energy complementary utilization methods are used to achieve relatively stable power output, it can not guarantee that such power output is all-weather in a year. In case of extreme bad weather, the power generation device is likely to be in the shutdown state. At this time, the power supply is interrupted, and the production and life on the island will be greatly affected. Therefore, it is necessary to establish energy storage system, refer to the principle of multiple energy complementary, make full use of various energy storage devices to achieve complementarity, maximize the energy storage efficiency and reduce the risk of energy interruption [5-7].

In addition, due to the geographical constraints of the island, freshwater resources are scarce, and freshwater is an indispensable resource for island survival and production. Therefore, sustainable desalination capacity is also an important part of the energy system. The energy consumption of seawater desalination is high. Only by providing sufficient and stable power output in the way of multiple energy and multiple storage complementary utilization, can the demand of island seawater desalination be met. Based on the above situation, it is necessary to establish a systematic living

energy system integrating power exchange ship, basic power supply, energy storage and seawater desalination, so as to effectively develop and utilize the island.

2. Key technologies interacted and interconnected micro grid on islands

The key technologies of integrated energy supply system includes renewable energy generation and technology, demand response technology and submarine cable transmission, and furthermore the design and manufacturing technology of energy storage vessel, the theory about calculation and simulation on power flow, the optimization strategy of pelagic island power grid, the multiple forms of energy transformation and consumption strategy.

2.1. Renewable energy generation, energy storage and demand response technology

Along with development of pelagic islands, the power demand including residential load, seafood processing industry load and shipping load, and resource demand including fresh water and hydrogen require a stable and reliable integrated energy supply system, and could not by fully satisfied by the long-term and long-distance gasoline supply. Hence, the renewable energy generation technology, energy storage technology and demand response technology are needed to guarantee the energy supply for pelagic islands.

The demand response technology can achieve peak load shifting by changing the load according to the response of users to electricity price or other reasons, which can help the island power grid maintain stability for small load island. The demand response technology needs the technical support of communication network, intelligent terminal, hydrogen and fresh water production and other controllable loads, as well as the corresponding incentive strategies.

2.2. Multiple rate hybrid power supply technology

The traditional energy supply relies on long-distance energy supply from the mainland can not fulfill the need of pelagic clustering islands. Therefore, the interconnection and support among pelagic clustering islands are important for the transport and consumption of renewable energy. The multiple rate hybrid power supply technology includes the traditional power flow of power system and the logistic with the energy storage vessel, and can switch different operation modes. The key technologies to realize the multiple rate hybrid power supply are about the submarine cable and energy storage vessel.

To realize the multiple rate hybrid power supply among pelagic islands, it is necessary to study the planning and design technology of marine cable connection and energy storage vessel according to the energy distribution of pelagic clustering islands, the constraints (distance, depth, route, cost) of laying marine cables, the constraints of power dispatch, transportation, storage volume and the sea traffic.

2.3. Optimal planning of pelagic island power grid with power flow and logistics

In the integrated energy system of pelagic clustering island, the differences on the geographical conditions of the island lead to the different power utilization and power demand. The micro grid planning nowadays does not consider the island climate, the fluctuation of renewable energy generation, the characteristics of energy storage vessel transportation and the diversity of island load. To design the planning of the multiple rate hybrid power transmission network that includes power flow and logistics, the characteristics of both island hybrid power transmission network and transportation for the energy storage vessel are needed to be considered, and the technologies involved are shown in Figure 1.

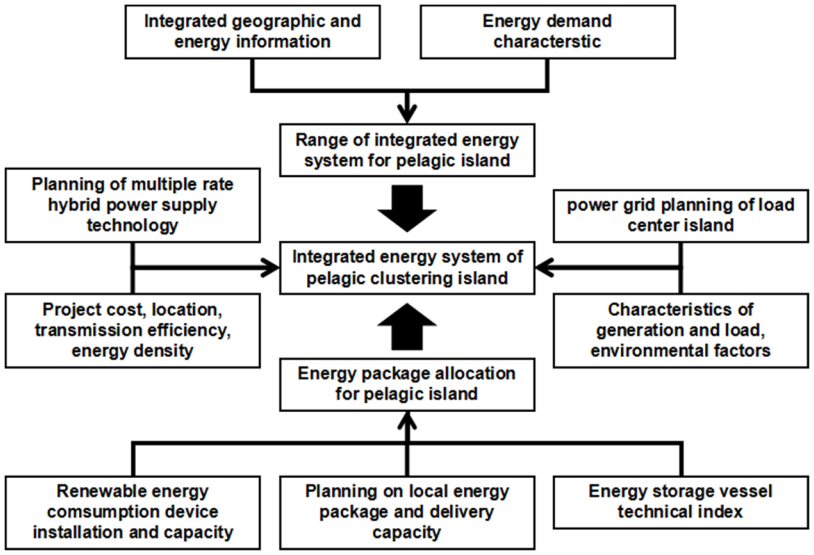

Figure 1. Optimal planning of power supply system with both power flow and logistics.

2.4. Multiple temporal-spatial scale coordinated power dispatch technology

In the power generation dispatch of the integrated energy system for pelagic clustering island, there are significant differences between the annual, quarterly, monthly medium and long-term power dispatch and the day-ahead and intra-day power dispatch. At the same time, the fluctuating power load including fresh water and hydrogen production of resource island need to coordinate with the power dispatch. To solve the multiple temporal-spatial scale coordinated dispatch, the research about adjustment of the energy storage vessel route adjustment, the multiple temporal-spatial scale coordinated dispatch, the optimization of island power generation and load dispatch, the medium and long term power dispatch, and the day-ahead as well as intra-day rolling coordination are needed, which are shown in Figure 2.

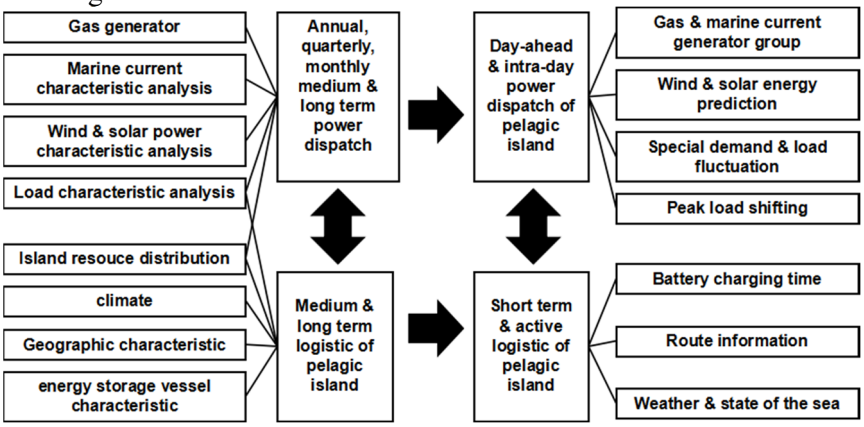

Figure 2. Generation-network-load multiple temporal-spatial scale coordinated dispatching of supply system powered with multi-rate energies.

2.5. Relationship between key technologies and energy supply system

To guarantee the energy and resource supply of the pelagic clustering islands, the key technologies to operate an independent and stable integrated energy system is proposed in this paper, and the key technologies and integrated energy system is shown in Figure 3.

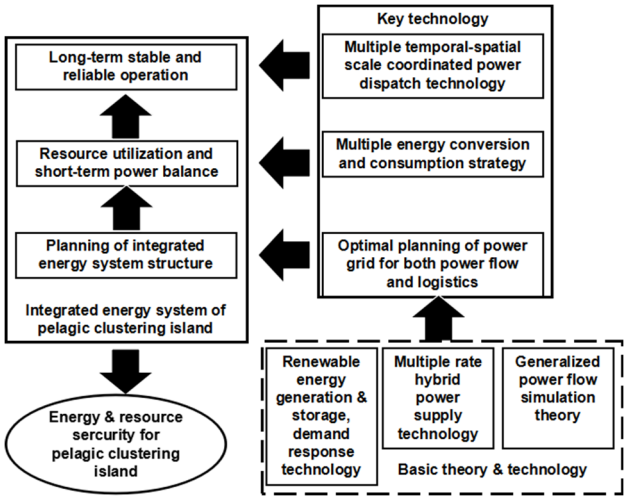

Figure 3. Relationship diagram between key technologies and integrated energy system.

3. Conclusions

Various new energy power generation and energy storage technologies have developed rapidly in recent years, accumulating a lot of product experience and practical operation experience, which has laid the foundation for the construction of island smart energy system.

Based on the power exchange ship, this paper studies the comprehensive utilization and complementary key technologies of various clean energy sources, and establishes an island energy cycle survival system with power exchange ship as the main part, tidal energy and photovoltaic as the auxiliary, and integrates power generation, energy storage and seawater desalination as one. The hardware coupling of each power generation system is studied, which establishes the foundation for the intelligent direction of the integrated system.

Acknowledgments

This research was supported in part by the State Grid Hubei Electric Power Company Science and Technology Project (52153820000J).

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