

Research on Electric Energy Router Based on Limited Capacity Independent Power Supply System

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Abstract. At present in the frontier outpost, Sea Island and other area, which is not covered by the power grid, there are many disadvantages in the mode of power supply. Electronic energy router can provide multiple types of electric interfaces for new energy power generation device, storage device and load, and achieve energy bidirectional flow, at the same time, the AC and DC bus interface can be provided through the power electronic transformation technology. Take advantage of these features, an electric energy router based on a limited capacity independent power supply system is proposed. And the specific system structure and network structure are designed.

1. Introduction

Energy is the basis for the survival and development of the modern society, the gradual exhaustion of traditional fossil energy and the deterioration of environmental problems have put forward new requirements for the energy utilization situation. Therefore, in response to the energy crisis, all countries are actively studying new energy technologies and their utilization, especially renewable energy such as solar energy and wind energy. But these new energy power generation usually have the characteristics of intermittence, randomness and uncontrollability. This will give a greater impact on the power grid system and affect the quality of the power provided to the user. In order to improve the utilization of renewable energy, the energy storage system added to the power supply system can provide a buffer for the fluctuating energy flow [1, 4].

At present in the high altitude areas, remote mountain, sea island and other special geographical location, the public power grid cannot be covered because of the bad natural environment, the inconvenient traffic conditions, and the far away from the household. In these areas, the main power supply mode of military power supply system is diesel or gasoline generating set. Its operation is simple, stable and reliable, and mobile is convenient, but there are also some shortcomings that cannot be overcome: First, oil supply is difficult. Especially during wartime, oil supply is a big problem, especially in areas with inconvenient transportation, such as islands, highlands and deserts, which makes transportation more difficult and costly; the two is not easy to hide under the conditions of operation. The main reason is that the internal combustion generating units will generate heat and noise when working. The enemy may detect the area of weapons and equipment by using the far infrared detector and audio frequency detection device, and often cause serious safety problems [5, 6].



2. Electrical Energy Router based on Independent Power Supply System

Because of the shortcomings of diesel or gasoline generating set, combining new energy and energy storage technology, the development and utilization of new energy has become an important alternative or supplement for military power supply. Its outstanding feature is the combination of new energy power generation and traditional energy power generation, the use of solar energy or wind energy as the main energy source, battery and super capacitor as energy storage unit, and diesel generator together to form a hybrid power supply system of photovoltaic-diesel-storage. It can replace or supplement the traditional internal combustion engine generator set. It has the advantages of no pollution, low noise, fuel saving, reduced oil supply pressure and power supply safety [7, 8]. It has made a great improvement in the safety and reliability of the power supply system of the weapon equipment, thus making it more and more applied to the power supply of military equipment. The multi energy complementary power supply system can not only solve the dependence of military activities and weapons on large power grid, but also make full use of all kinds of clean and renewable energy to reduce the pressure of oil supply, which will become an important way for future military activities to ensure electric power [9, 10].

For the hybrid power supply system of photovoltaic-diesel-storage, different distributed generation and the same distributed generation have different power supply capability and power quality at different times. The intermittent, fluctuating and uncertain characteristics of distributed generation will affect the power supply quality of the system; The load side of the load on the power supply capacity and the power quality of the demand is not the same, and the load is also changed randomly; At the same time, the power supply system has the characteristics of power supply diversity and energy bidirectional flow, and the traditional power system equipment cannot meet these requirements. In order to solve the above problems, the electronic energy router based on power electronic transformation technology arises at the historic moment [11, 13]. In the limited capacity independent power supply system separated from large power grid (such as the hybrid power supply system of photovoltaic-diesel-storage), an electronic energy router based on power electronic transformation technology can provide multiple types of electric interfaces for new energy power generation device, storage device and load, and achieve energy bidirectional flow. If it is integrated with information technology, it can make the electronic energy router have communication and intelligent decision-making ability, and realize the active management of power network energy flow. [14].

3. System Structure

Based on the research of the hybrid power supply system of photovoltaic-diesel-storage and the electric energy router for the energy Internet, an electric energy router based on limited capacity independent power supply system is proposed in this paper. The intelligent electrical connection and power management control of the independent hybrid power supply system of photovoltaic-diesel-storage through the electric energy router, On the one hand, as the limited capacity of the system is controllable, can make rapid transmission and distribution control to fast response to load demand, on the other hand, the electric energy router can adjust the demand for power quality based on the load side, it also can provides more guarantee for the power supply of the important load, and realizes the reliable management of the distributed power and load. It can make the whole power supply system have the characteristics of green clean, safe and reliable, flexible operation and so on.

Based on the above analysis, the structure of the electric energy router system based on the limited capacity independent power supply system is shown in Figure 1.

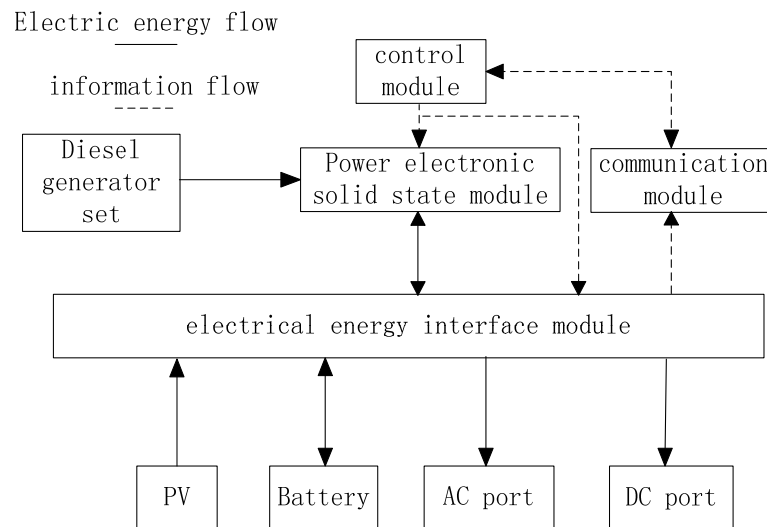


Figure 1. The structure of the electric energy router system based on the limited capacity independent power supply system

The electric energy router consists of five modules:

(1) Power electronic solid state module

The module is composed of multi-stage power electronic conversion unit, and is the main body of power control. It mainly includes cascaded H bridge rectifier, high frequency transformer, filter and related interface. It can realize the AC and DC voltage level transformation and electrical isolation, which is the main part of the flexible control of electric energy.

(2) power interface module

The power interface module comprises a DC bus, DC/AC inverter and a few of DC/DC converters, According to different needs, different interfaces and converters are used to achieve plug and play electrical interface function, so as to achieve the bidirectional flow of successful rate flow and controllable AC and DC output functions.

(3) Communication module

The communication module is responsible for detecting the information of voltage and current of each module unit, and timely feedback the working state of the device and the information communication between the control modules.

(4) Control module

Receiving information from the feedback from the communication module. At the same time, according to the state of each module and equipment, the control instructions are issued according to the coordination and optimization goals of the electric energy router's whole system, so as to achieve the energy balance of the electric energy router.

(5) The external port module

The external port module includes diesel generator set, battery, and photovoltaic and AC/DC load port. These devices can be connected to the electric energy router by plug and play electrical interface, and can also be removed immediately when a fault occurs.

The specific schematic diagram of the network structure is shown in Figure 2.

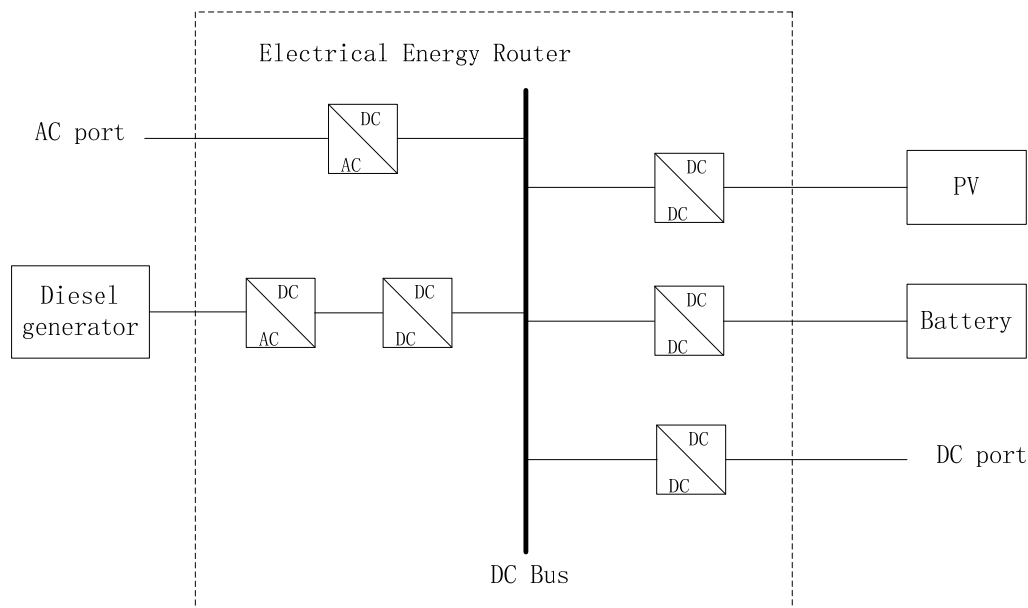


Figure 2. Schematic diagram of network structure of electric energy router

The input end of the power supply system consists of photovoltaic power generation system, energy storage system and diesel generator set, the photovoltaic power generation system is the main energy generating unit of life, through its own control, complete the production and output of electric energy; When there is a high power load in the barracks in need of power supply, such as weapons, etc, photovoltaic power generation system and energy storage system cannot provide enough energy, at this time, the diesel generator set needs to be started as the main energy generating unit of the system at this time; The energy storage system can adjust the power quality by charge and discharge control, improve the instability of the photovoltaic power generation, quickly adjust the supply and demand balance of the system, and improve the reliability of the power supply.

The output end is composed of a DC output interface and an AC output interface. The DC bus can output different DC power for different DC load power supply through the DC/DC converter. The DC bus voltage is converted to 220V and 50Hz AC power to AC equipment by DC/AC converter.

4. Conclusion

The shortcomings of the main mode of power supply for special geographical location are analyzed, combined with the advantages of electric energy router, the distributed generation, energy storage device and diesel generator set are combined to form a hybrid power supply system of photovoltaic-diesel-storage, so as to improve the safety and reliability of power supply. The intelligent electrical connection and power management control of the independent hybrid power supply system of photovoltaic-diesel-storage through the electric energy router, On the one hand, as the limited capacity of the system is controllable, can make rapid transmission and distribution control to fast response to load demand, on the other hand, the electric energy router can adjust the demand for power quality based on the load side, it also can provides more guarantee for the power supply of the important load, and realizes the reliable management of the distributed power and load. It can make the whole power supply system have the characteristics of green clean, safe and reliable, flexible operation and so on.

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