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(54) Title: POWER SYSTEMS INTERCONNECTION METHOD

(57) Abstract: The invention relates to electric power industry, in particular, to power systems with electrical alternating current networks, more specifically, to the methods of power systems interconnection. The basis of the present invention is the task to interconnect power systems with the help of the method that will allow to improve the reliability and quality of their functioning, as well as to minimize the financial costs associated with its implementation. The method of interconnection of power systems with AC networks, each of which is characterized by its technical characteristics of electricity through the use of at least one energy storage device (ES), which contains the equipment providing energy storage and its usage. According to the invention the equipment (3), providing energy storage and consuming electricity, is connected to one power system networks, and equipment (4) participating in the usage of stored energy and generating electricity is connected to the other power system networks, thus, ensuring possibility to change the position of these power systems.



Description

Title of Invention: POWER SYSTEMS INTERCONNECTION METHOD

Technical Field

- [1] The invention relates to electric power industry, in particular, to power systems with electrical alternating current (AC) networks, more specifically, to the methods of their interconnection.

Background Art

- [2] In the countries of modern world there are a lot of power systems with electrical alternating current networks, each of which is characterized by its technical characteristics of electricity, i.e., period, amplitude, frequency and voltage of alternating electric current.
- [3] In order to optimize the electric power sector operation it is necessary to integrate the abovementioned power systems into a single power grid.
- [4] In the electric power industry there are several ways known for interconnection of individual power systems into a power grid:
- [5] - full synchronous interconnection of both networks, which envisages a direct-connection of one system alternating current network end to the beginning of the other system alternating current network. In this case, it is necessary for the power systems to be interconnected to meet the requirements of unified norms which integrate the process of production, transformation, transmission, distribution, power consumption, and creation of a single control center.
- [6] The disadvantages of this method of power systems interconnection are related to large capital costs for implementation of the abovementioned measures and long-term implementation;
- [7] - non-synchronous interconnection through DC substations (back-to-back links) located at the ends of existing AC interconnection lines. DC back-to-back link (BBL) is a converter substation designed for conversion of AC into DC, and subsequent conversion of DC into AC with initial or other frequency. (GOST 24291-90 'Electrical Power Plants and Electrical Networks. Terms and Definitions'). The disadvantages of BBL include manufacturing of complex and expensive power equipment, execution of a large volume of civil and erection works with a long payback period, substantial financial costs, and less reliability of high-voltage power semiconductor plants in comparison with the main equipment of power systems limits their widespread use;
- [8] - dedicated work of power stations on the basis of radial scheme or supply of dedicated units ('islands') through AC and/or DC power transmission. The implemen-

tation of this method also requires quite substantial costs.

[9] - hybrid interconnection combining the elements of the above-mentioned methods (with the same problems which are characteristic of each individual method).

[10] In the patent literature there are documents that basically describe how power systems with AC networks are interconnected with application of DC back-to-back links. For example, in the following patents: RU2354024, RU2010103504, RU2260233, UA52793, RU44891, RU50726, RU50726, RU2354023, UA12730, JP11410302, JP1123378, JP1123379, JP11410301, US5055702.

[11] However, these documents provide solutions which are expensive for implementation, complex in technical terms, and principally differ from the method suggested in the invention that is presented below in the description.

Disclosure of Invention

Technical Problem

[12]

Solution to Problem

Technical Solution

[13] The present invention is aimed at power system interconnection problem solution with the help of such method that will allow for higher reliability and quality, as well as for minimization of financial costs associated with its implementation.

[14] The solution of the task set provides the suggested method for interconnection of power systems with AC networks, each of which is characterized by its technical characteristics of electricity through the use of, at least, one energy storage (ES) containing equipment that ensures energy storage and its usage. This is performed due to the fact that the equipment providing energy storage and electric power consumption is connected to networks of one system, and equipment involved in the usage of stored energy and generating electricity is connected to networks of the other system, and in this case the position of these power systems can be rearranged.

[15] The following results are achieved with application of the present invention:

[16] - compliance with the requirement of uniform technical characteristics of electricity, i.e., period, amplitude, frequency and voltage refers only to energy storage system equipment, generating electricity and the power system to which it is connected;

[17] - possibility of electric power export and import from one power system into the other.

[18] The essence of the invention is illustrated by the following description and drawing (Fig. 1), where block diagram of the power system interconnection method is presented.

Advantageous Effects of Invention

Advantageous Effects

[19]

Brief Description of Drawings

Description of Drawings

[20] (Fig. 1, A): equipment (3) of energy storage (ES), accumulating power is connected to power system (1), while equipment (4) of energy storage (ES), generating electricity, is connected to the system (2) .

[21] (Fig. 1, B): equipment (3) of energy storage (ES), accumulating power is connected to power system (2), while equipment (4) of energy storage (ES), generating electricity, is connected to the system (1).

Best Mode for Carrying out the Invention

Best Mode

[22] The method of power system interconnection implies that the equipment (3) of energy storage (EC), providing energy storage, is connected to power system (1), which has one characteristics of electric power , while equipment (4) of energy storage (ES), generating electricity, is connected to the system (2) , which has other characteristics of electricity (Fig.1, A). (Fig.1, A).

[23] The equipment (4) of energy storage (ES) which generates electricity should correspond to the technical characteristics of electric power system (2), while the equipment (3) of energy storage (ES), providing energy storage, should match the specifications of electric power system (1).

[24] This method allows for changing positions of power systems (Fig. 1, B). While changing the positions of power system (1) and power system (2), the equipment (4) of energy storage (ES) , generating electricity , should correspond to the technical characteristics of electric power system (1), and the equipment (3) of energy storage (ES) , providing energy storage, should conform to specifications of power system (2).

[25] Let us consider the suggested method of power system interconnection with the help of the example of the most widely used energy storages.

[26] **Air (gas) energy storage .**

[27] Various capacities are used as air (gas) energy storages including cavities in the earth's crust , mine workings which are used in air-storage gas turbine plants (ASGTP). ASGTPs include also gas turbine unit, several motor driven compressors, and air-turbines with generators .

[28] As applied to air-storage gas turbine plant the sequence of power system interconnection should be as follows: compressors, whose engines are connected to the electric networks of power system (1) , inject air (gas) into capacity . Then air turbines use the energy of compressed air of power storage, and generators of air turbines

connected to power system electric networks (2), generate electricity into it. Thus, interconnection of power systems is performed.

[29] **Hydraulic power storage.**

[30] Upper reservoir of pumped-storage plant (PSP) can be used as hydraulic energy storage .

[31] The invention can be implemented under all schemes of pumped-storage plants and for any layout of PSP hydropower equipment which includes motor driven pumps, turbines with electric generators, reversible pumping units. The procedure of power system interconnection is similar to that in the example with air (gas) energy storage. Pump electric motors are connected to power system (1) , and hydroturbine generators - to system (2).

[32] **Mechanical energy storage**

[33] Flywheels and super flywheels are used as mechanical energy storage .

[34] Electric motor rotates the flywheel. In this case, the flywheel stores energy that is subsequently converted into electrical energy in the electric generator. It is possible to use reversible motors - generators .

[35] Interconnection of power systems is performed in this case in the following way. Electric motor which rotates the flywheel storing the energy is connected to power grid (1) networks. The energy of rotating flywheel is converted into electrical energy in electric generator, connected to power grid (2) networks.

[36] The method of power system interconnection suggested in the invention allows :

[37] 1. - to perform power system interconnection by means only of functional, operational staff actions that do not require substantial financial costs and design changes;

[38] - to perform export - import of electrical energy from one power system into the other .

Mode for the Invention

Mode for Invention

[39]

Industrial Applicability

[40]

Sequence Listing Free Text

Sequence List Text

[41]

Claims

[Claim 1]

1. The method of interconnection of power systems with AC networks, each of which is characterized by its technical characteristics of electricity (ES), by using at least one energy storage device that contains the equipment that provides energy storage and its usage, **characterized** in that the equipment (3) providing energy storage and consuming electricity, is connected to networks of one power system, and the equipment (4) participating in the usage of stored energy and generating electricity is connected to the other power system networks, where power systems can change their positions.

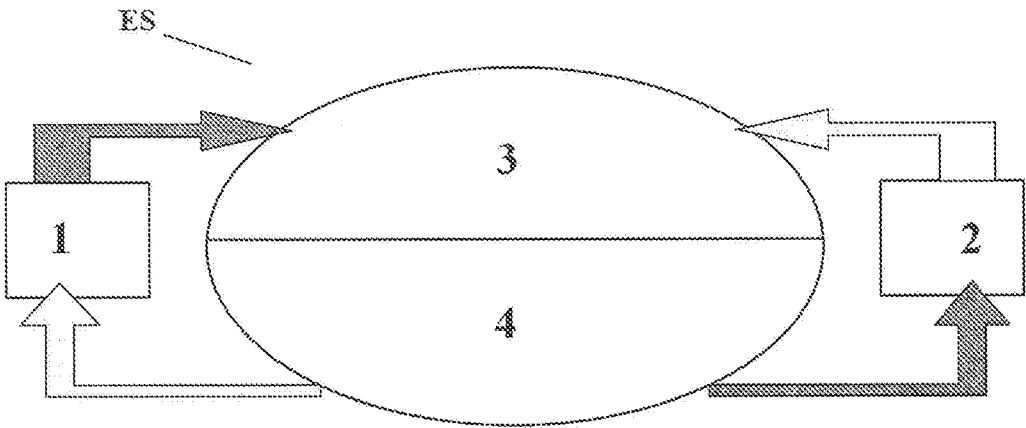


Fig. 1

→ -A
⇒ -B