Study on cooperative technology system of global energy internet

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Abstract. This topic focuses on the shape of the global energy Internet. The global energy Internet will be based on UHV AC and DC. With reference to the interconnection model between domestic and developed countries, this paper analyzes and proposes technical and business adaptation plans.

1. Introduction

Global energy interconnection will promote the efficient use of energy and the use of low-carbon clean energy. It is an important solution to accelerate energy transformation, achieve clean development, and cope with climate change. It is the only way to achieve sustainable human development. Global energy interconnection will become the trend of energy development.

The global energy interconnection puts new demands on the interconnection of information and communication. The global energy Internet communication network needs to provide reliable communication means for large-scale new energy development in complex environments such as polar, desert, and ocean. It needs to provide real-time information transmission for large-scale and highly dynamic distributed energy, and support energy. Information interconnection and interaction require functions such as wide-area communication and data distribution, ultra-long-distance measurement and control, and information acquisition across regions and industries, and place high demands on the coverage, flexibility, and reliability of power communication.

2. Status of domestic and international technology research

2.1. Status of Global Energy Internet Research

The Global Energy Internet is a strong smart grid with a UHV grid as the backbone grid (channel), which is driven by clean energy and is globally interconnected. The global energy Internet will be composed of a cross-border backbone network and a national ubiquitous smart grid covering various voltage-level grids (transmission grids, distribution networks) in various countries, connecting “one pole together” and large energy bases in various continents to adapt to various distributions. The power supply needs to be able to transport renewable energy such as wind, solar and ocean energy to various users. It is a global energy allocation platform with wide service scope, strong configuration capability, high safety and reliability, and green and low carbon.

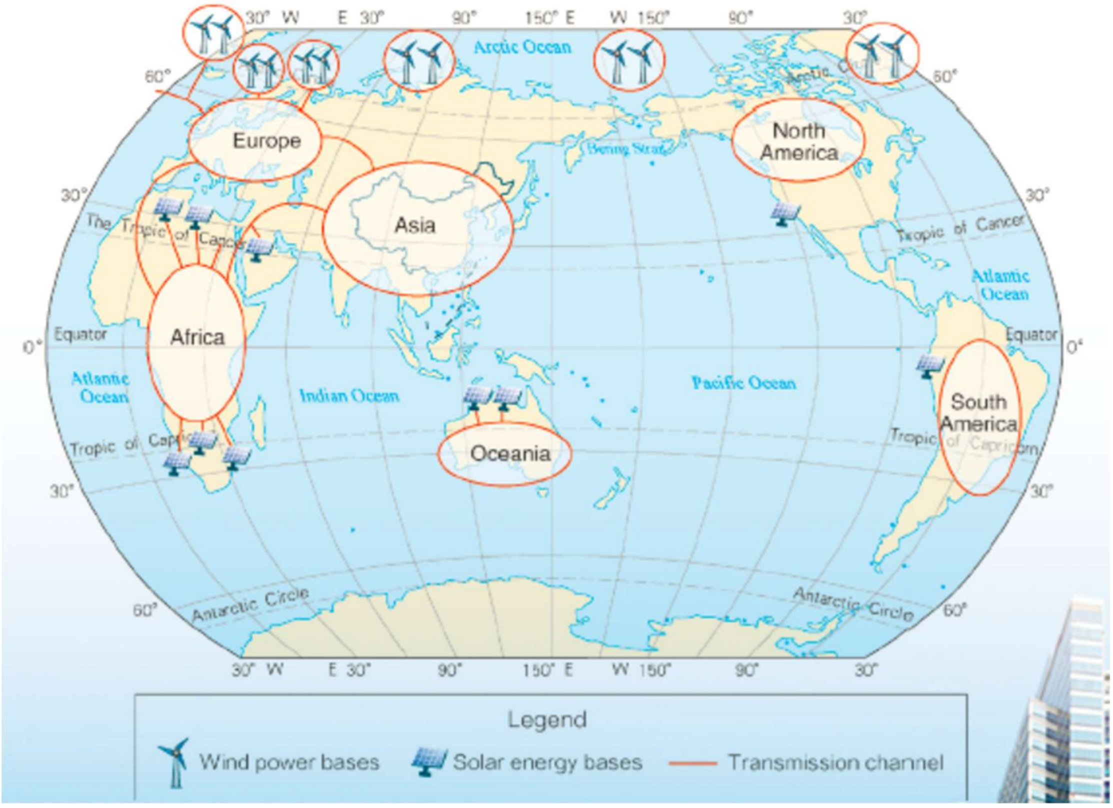

Figure 1. The global energy Internet

2.2. *Status of Energy Internet Information Communication Research*

At present, there are not many researches on energy Internet information communication in the world, and domestic research on energy Internet information communication has been carried out. The focus of the research is on the form of energy Internet, the key technologies of information and communication supporting the energy Internet, and the standardization of energy Internet information communication. The basis of these studies is the understanding of the form of energy Internet. The key technology of information communication is SDN, which is forward-looking from a technical perspective. The large-scale application of power electronic devices brought by large-scale and direct introduction of new energy, the integration of primary and secondary components will bring about changes in the characteristics of the power grid, but the safety requirements of large power grids such as the speed, reliability and the cut of faults will not have some fundamental changes. Energy Internet information and communication research must be based on the study of the form of energy Internet and the premise of ensuring safe production of power grids. These studies are not sufficient.

3. Global Energy Internet Morphology Research

3.1. *Global energy distribution*

With the gradual exhaustion of fossil energy, clean energy will become the dominant energy source in the future, mainly converted into electrical energy. The global clean energy resources are very rich, only 5 per cent of the development can meet the global energy demand, but the global clean energy distribution is uneven, wind energy resources are mainly concentrated in the Arctic Kara Sea, Barents Sea, Bering Strait and Greenland Western China and Central Asia in Asia, North Sea in Europe, Northeastern Africa, Central North America, South America, and the Midwest of Australia. Solar energy resources are mainly concentrated in West Asia, Central Asia and western China in Asia, North Africa and East Africa in Africa, Southwestern North America, Midwestern South America and Northern Australia. Most of these resource-rich areas are far from the power load center, and need to be converted into electricity and long-distance transmission on the spot, and deployed on a global scale. Wind power and photovoltaic power generation have intermittent and volatility. They can only be integrated into the global interconnected power grid and build a global energy Internet. Only in this way can clean energy be deployed globally and efficiently.

3.2. Global energy transmission

According to the planning study, the global power flow in 2035 is dominated by transnational power exchanges on all continents, and intercontinental power is in its infancy. In 2050, the clean energy base entered a large-scale development stage, forming a globally optimized configuration of clean energy, multi-energy complementarity, and cross-time zone mutual aid. The inter-regional power flow in the continent mainly includes Russian hydropower, wind power, and Central Asian clean energy power generation to China, South Korea, Japan and other countries, West Asia Solar to send electricity to South Asia; Arctic wind power base to China, South Korea, Japan and other countries; Central and Eastern Africa hydropower sent electricity to western and southern Africa; Peru and Bolivia hydropower sent electricity to Brazil. Intercontinental power flow mainly includes: North Africa solar energy base send electricity to Europe, Central Asia Kazakhstan, Russia Siberia clean energy send electricity to Europe, West Asia solar base send electricity to Europe.

The global energy Internet backbone grid is supported by advanced technologies such as special/ultra-high voltage transmission, flexible direct current transmission and submarine cable, connecting large clean energy bases and major power consumption centers. The world has formed 18 grids of synchronous grids, nine horizontal and nine verticals in China, Southeast Asia, Northeast Asia, Europe, and Northern Europe.

It can be seen that the energy Internet form is characterized by the concentrated development of new energy sources such as wind power and photovoltaics, and the use of UHV AC and DC transmission from the energy base to the load center.

4. Research on key communication technologies for global energy Internet

The global energy interconnection puts higher requirements on communication technology, mainly in the following aspects:

(1) It has the ability to transmit over long distances.

(2) Adapt to extreme climatic conditions and support the requirements of unmanned maintenance and less maintenance.

(3) Support communication requirements for large-scale, ultra-long-distance, and sparsely populated.

(4) For the large-scale access of distributed energy, there is a communication technology that adapts to flexible access and meets the requirements of reliability and security.

The choice of global energy Internet communication technology should match the business needs to meet the real-time, reliability and security requirements of the business.

At present, the technologies that are applied or are developing in power systems mainly include: optical communication technology, satellite communication technology, microwave communication technology, power line carrier communication technology, mobile communication and Internet of Things communication technology, and communication technology based on high-altitude platforms. The following are analysis options for various communication technologies.

(1) Optical fiber communication technology has the advantages of small delay, high performance, good security and reliability. Fiber optic cable technology, SDH, OTN optical transmission technology, and ultra-long-haul optical transmission technology can basically meet the requirements of energy Internet ultra-long-distance transmission. Submarine cable and submarine optoelectronic composite cable technology can be applied to the intercontinental interconnection of energy interconnection through submarine cables.

(2) Satellite communication technology can support narrowband services such as voice communication and low-speed data transmission in large-scale, ultra-long-distance, sparsely populated areas. The geostationary orbit satellite has a large delay, and the call delay in the single-hop range is still within the acceptable range, but the experience is relatively poor. The medium-low orbit satellite communication has a small delay. The geostationary orbit broadband satellite communication can support data network services in remote areas, and the number of low- and medium-orbit satellites cannot meet global data network services.

(3) Communication based on high-altitude platforms can be used as a temporary and emergency communication method, but its technology is not mature, and it does not have the conditions for application in engineering.

(4) Microwave communication has strong ability to resist natural disasters, has small transmission delay, and has better performance than satellite communication technology, which is inferior to optical communication technology. Limited by single-hop relay distance, it can only be used as a supplement to optical communication and be used locally.

(5) Mobile communication and Internet of Things communication are suitable for ubiquitous user access and can be applied on the load side.

(6) Power line carrier technology is a communication technology unique to power systems. It has many years of operating experience in high-voltage AC power grids and is widely used to carry relay protection services. In the medium and low voltage AC grid, the power line carrier technology can be used to carry distribution automation information, power consumption information.

5. Conclusion

This paper analyzes that the global energy Internet will be based on UHV AC and DC. The global energy interconnection puts forward higher requirements for communication, and analyzes optical communication technology, satellite communication technology, stratospheric communication technology, microwave communication technology, power carrier communication technology, and mobile, referring to the interconnection mode between domestic and developed countries. Communication and IoT communication technologies have proposed technology and service adaptation solutions.

With the accelerated construction of the global energy Internet, people's progress in the fields of UHV transmission, ultra-long-haul fiber transmission, broadband communication, etc., the global energy interconnection communication business will be more diverse, and the application of communication technology will be more advanced.

It is foreseeable that with the construction of the global energy Internet as an opportunity, the high integration of energy information systems and energy physics systems will greatly change the way human beings use and use energy, and the global mutual economic flow of energy accompanying information will become a reality.

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