Current Situation and Prospect of Tidal Energy and Geothermal Energy

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Abstract: In the case of increasing shortage of traditional fossil energy, tidal energy and dry hot rock geothermal resources have attracted much attention because of their huge development potential. However, the development of tidal and geothermal energy is still in its infancy, and the amount of resources that have been developed is small. In this paper, the development prospect, development technology and cost of tidal energy and geothermal energy are discussed in detail, and a comparative analysis is made. Studies have shown that the efficiency of current tidal energy applications is too low, there are technical barriers to intelligent control and installation maintenance, and the impact on biodiversity, fisheries and other fields. Improving renewable energy equipment technology and substituting advanced materials is the way to solve the dilemma of tidal energy development. Enhanced geothermal systems (EGS) technology of geothermal energy has some safety risks such as low development and application efficiency, easy to induce earthquake and so on. Changing reservoir reconstruction methods to reduce safety risks and using new hydraulic fracturing methods to establish horizontal fracture network to achieve high efficiency exchange of heat energy are the methods to improve EGS performance. In the future, it is necessary to continuously improve the development, reserve and application technology of tidal energy and geothermal energy. This study hopes to broaden.

1 INTRODUCTION

With the decreasing of the three traditional resources, the human thirst for new energy is getting stronger and stronger, and the development and utilization of renewable energy has become an important development direction. Tidal energy and geothermal energy have attracted worldwide attention because of their low carbon, high efficiency and renewable characteristics. The two kinds of energy have abundant reserves and broad prospects and have great research significance. Tidal energy refers to energy from the ocean and tidal movements, while geothermal energy refers to energy from deep heat sources on Earth.

In the early 20th century, some countries in Europe and the United States began to study tidal power generation, in 1913 Germany established the world's first tidal power station on the North Sea coast, France, the Soviet Union, and Canada have built tidal power stations. It has been more than 100 years since the establishment of the first tidal power station, and now the technology of tidal power stations is becoming more and more mature, and the power stations are also slowly turning to large-scale (Luo, 2015). Nowadays, most of the areas that use tidal energy widely are distributed in the coastal countries of Europe, Canada, Australia, South Korea, China and so on.

The specific distribution of geothermal dry hot rocks is known: the Gulf of Mexico of the United States, the Pacific coast countries of South America, the Korean Peninsula, Japan, northwest of China and other regions. In the 1970s, geothermal energy research began, initiated by the United States, then Britain, France, Japan and other countries joined the engineering research, to verify the feasibility of mining hot dry rock heat. Influenced by this achievement, the hot and dry rock research has started in the world. The United Kingdom and Japan have set

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up special studies on rock mechanics, respectively, and come to the conclusion that natural fractures are affected by the original ground stress, and thus affect the effect of artificial thermal energy extraction (He, 2021). These two kinds of energy have a wide range of application prospects in the world, and provide unlimited possibilities for human production and life. With proper planning and development, the use of tidal and geothermal energy will contribute to sustainable development worldwide.

The main purpose of this paper is to explore two new energy sources, tidal energy and geothermal energy, based on the world's demand for new clean energy. Firstly, the development status, development technology and advantages and disadvantages of tidal energy and geothermal energy are introduced, hoping that more people can understand tidal energy and geothermal energy. Then, the similarities and differences of the two new energy sources are compared from multiple angles. Finally, the paper puts forward suggestions for the future development direction of two new energy sources.

2 TIDAL ENERGY

2.1 Development Status

Tidal energy is a kind of renewable energy which uses the kinetic energy and potential energy generated by the periodic fluctuation of sea water to generate electricity. It has the advantages of green, renewable, stable and reliable. Currently, the total installed capacity of tidal power generation worldwide is small, only about 500 megawatts, but in recent years, as countries' demand for clean energy continues to increase, the development of tidal energy has received more and more attention. Europe, particularly the United Kingdom, France and Ireland, has made significant progress in tidal energy technology and construction, accounting for more than 86% of the world's installed tidal power capacity. In comparison, the installed capacity in the Asia-Pacific region is relatively small, but as China and South Korea speed up the development and construction of tidal power, the region of the tidal power market is expected to rapid growth in the coming years.

2.2 Advantages and Disadvantages of Tidal Energy

Tidal energy is a renewable energy source that persists in the ocean, does not cause energy shortages due to the exhaustion of renewable energy sources, does not produce carbon dioxide, nitrogen oxides, sulfides and other pollutants, and is less polluting to the environment. Tidal energy has a relatively long time period during tidal fluctuations, so it is more stable and reliable than solar and wind power, and the energy quality is higher. At the same time, there are many coastlines around the world, so tidal power generation is relatively flexible in terms of application, especially for those areas that are not suitable for solar and wind power generation, tidal power is a good alternative energy source. However, the technology of tidal power generation is costly and may also have an impact on the Marine ecological environment.

2.3 Development Technology of Tidal Energy

Traditional tidal energy development and utilization are mainly single-pool bidirectional, single-pool unidirectional, dual-pool unidirectional and dual-pool bidirectional. At present, the single reservoir mode is mainly used in the international operation of damming tidal power station (Liu et al, 2018). For example, the Lancs Tidal Power Station (240 MW), built in 1966 at the mouth of the St. Malo River in France, uses a single reservoir bidirectional operation mode, that is, it can generate electricity at high tide or low tide; Built in 1979, the Bell Island Tidal Power Station (2.7 MW) in Canada uses a single reservoir one-way operation mode, that is, electricity is generated only at high tide. In addition, both have only one reservoir. In addition to the traditional dam-type Tidal energy technology, research institutions in the United Kingdom, the Netherlands and other countries have also carried out research on open Tidal energy development and utilization technology, and proposed the Tidal Lagoon, Dynamic Tidal Power and other environmentally friendly new tidal energy technologies (Liu et al, 2018).

2.4 Existing Problems

At present, the energy conversion efficiency of tidal power generation equipment is relatively low. This is mainly because the movement characteristics of tidal waves are complex and it is difficult to fully convert them into electricity. In the course of the research, there are still technical difficulties in the replacement of advanced materials, the arrangement and arrangement of power generation equipment, predictive models and intelligent control. At the same time, the initial cost of tidal power generation projects is high, and the maintenance and operation cost of its

installations and equipment is also high, which limits the commercial application and promotion of tidal power generation.

In addition, the development and utilization of tidal energy will cause damage to Marine ecosystems, which will have an impact on biodiversity, fisheries and other fields. For example, the wastewater of the Swansea Bay Tidal power Station project in the United Kingdom was discharged into the local wetland area, resulting in the adverse impact on the ecosystem of the area, and the biodiversity of the wetland area was destroyed. During the construction of the Yukon River Tidal power Station project in the United States, the sound of the engine of the construction vessel disturbed the normal behavior of the surrounding Marine animals, resulting in whales and dolphins and other animals had to leave the construction site. Noise from the construction of a tidal energy project in Queensland, Australia, has damaged the local Marine ecosystem and disrupted the generation succession of fish and seabirds, which has had an impact on local fisheries and birdwatching.

2.5 Application Prospect

At present, there are few commercial tidal power stations built and put into operation, but tidal energy still has great development prospects because of its advantages of stability, reliability, clean and renewable. Many coastal countries and regions all have the requirement of building tidal power station. According to an EU study, there are 106 coasts and ports in Europe suitable for tidal power stations, and British offshore turbine research Institute expert Frank Peter has pointed out that many coasts in Japan, China, the Philippines and other countries have the conditions for the construction of tidal power stations (Yang et al, 2019).

In general, with the gradual attention paid to tidal power generation technology, more and more experts and scholars carry out research in this area, Tidal power station investment construction cost will become lower and lower, and the power station to provide power quality will become higher and higher, and Tidal power generation technology of large-scale commercial application will be implemented step by step. Tidal energy will become a part of the future energy structure and play a valuable role in energy.

3 GEOTHERMAL ENERGY

3.1 Introduction and Development Status

The Earth's interior is a huge heat source, with temperatures at its core reaching more than 7,000 degrees Celsius. Geothermal energy is the natural heat energy extracted by the Earth's crust. This energy comes from the lava inside the earth and exists in the form of heat. Geothermal energy is a new underground energy with wide spatial distribution, known abundant reserves and safe and reliable operation.

3.2 Advantages and Disadvantages of Global Geothermal Energy

At present, hydrothermal shallow geothermal resources have been partially utilized, but dry thermal lithologic deep geothermal resources are still in the exploration stage。 The whole life cycle of geothermal energy of hot dry rock is basically divided into the construction period of underground part, the construction period of above-ground part, the operation period and the retirement period. In the underground part of the construction period, the main method is to increase the injection pressure (hydraulic fracturing, hydraulic shear) and reduce the rock fracture strength (chemical stimulation, thermal stimulation). The former has low cost of working medium, but the risk of inducing earthquake is greater. Although the latter injection pressure is low, but there is environmental pollution, wellbore damage (chemical stimulation), time and economic costs are high (thermal stimulation) and other problems. Geothermal energy is not affected by environmental weather, can be exploited at any time, and maintain-stability is its advantage different from other energy sources (Qi & Zhang, 2019).

3.3 Geothermal Energy Development Technology

Enhanced geothermal systems (EGS) are the main way to obtain underground heat of hot dry rocks, EGS technology uses "hydraulic stimulation" to enhance and create the heat available in hot dry rock. The main principle of the system is: in the dry hot rock, drill a straight well or injection well, use fracturing fluid and other large displacement fracturing, high-temperature rock cold crack. In the case of continuous high pressure, the fracture continues to extend and increase

with the continuous injection of low temperature water, forming the artificial thermal storage disturbance rock. At the same time, production Wells are constructed near injection Wells to extract high-temperature water and high-temperature water vapor (He, 2021). The high-temperature water and water vapor are finally generated by direct steam method, expansion method and intermediate medium method, so as to form a cycle. Because the direct steam method requires the extraction of high-temperature steam from the well and is less efficient, it is rarely used. In the expansion method, hot water in the production well is first transported to the expansion vessel, and the steam generated by the decompression and expansion drives the turbine to generate electricity. The most widely used is the intermediate medium cycle, such as the organic Rankine cycle and Carina cycle. In the whole cycle process of geothermal energy application, no exhaust gas, waste liquid and waste are emitted, so the impact on the environment is very small, and the whole life cycle sustainable development and utilization is achieved.

3.4 Existing Problems

EGS technology is still immature, and field tests in several countries and regions have demonstrated the microseismic risk of hydraulic fracturing methods. For example, the hot dry rock development in Basel, Switzerland, triggered four earthquakes of magnitude 3 or greater during the water injection, causing damage to buildings, forcing the project to be terminated, leading to a huge investment failure and numerous legal disputes. In 2017, a hot dry rock development project in Pohang, South Korea, triggered a MW5.4 earthquake on a nearby fault and caused severe economic damage, forcing the South Korean government to suspend the project's operation (Yin et al, 2019). The main factor restricting the development of deep geothermal energy in China, especially hot dry rock geothermal energy, is the exploitation technology, especially in the reservoir transformation and heat transfer, there are still many scientific and technical problems to be overcome. In addition to technological immaturity, geothermal energy development also faces the problem of time and economic costs. Due to the different geothermal energy reserves in different places, a lot of exploration and preliminary preparation are needed to determine the development field, which greatly increases the development cost.

3.5 Application Prospect

China is rich in geothermal resources, which are equivalent to hundreds of billions of tons of coal in the country's sedimentary basins. It has a broad development prospect and is widely distributed. Ground source heat pump is one of the main forces for future energy structure adjustment and clean energy development. Geothermal energy is not only abundant in reserves, but also widely used in various fields. The ground source heat pump can draw heat from the underground soil to heat the room through its own air conditioning system in winter and recharge heat to cool the room in summer. The ground source heat pump can realize the transfer of energy from low temperature heat source to high temperature heat source by input a small amount of high grade energy (electric energy). In the Yangtze River Basin of China, heating in winter and cooling in summer can be achieved by relying on ground source heat pumps, which remove heat from the soil in winter and input heat into the soil in summer. At the same time, geothermal energy also has biological, medical, agricultural and other fields of value. Although the investment cost of geothermal energy development and application is high in the early stage, the income from geothermal energy is characterized by sustainable stability and can be suitable for long-term investment and development.

4 COMPARISON OF TIDAL ENERGY AND GEOTHERMAL ENERGY WITH OTHER ENERGY SOURCES

4.1 Comparison of Tidal Energy and Geothermal Energy

Both tidal and geothermal energy rely on the Earth's internal energy sources, and both are clean, reliable, and stable sources of non-fossil energy, and both of them have technical defects and problems of time and economic cost, which can not be commercialized on a large scale. In terms of power generation efficiency, tidal energy is comparable to geothermal energy in terms of power generation efficiency usually around 20%. However, due to the regularity and stability of ocean tides, the actual efficiency may be higher. Geothermal power generation is usually divided into three types: direct steam method, expansion method, indirect medium method. Power generation steam is divided into dry steam generation and flash steam

power generation. Overall, geothermal power is between 10 and 30 percent efficient. In terms of operating cost, the operating cost of tidal energy is slightly higher than that of geothermal energy, mainly including equipment maintenance, manual inspection, and the impact of Marine environment on equipment. The operating cost of geothermal power generation equipment is lower than that of tidal energy, because the fuel source of geothermal energy is the heat energy inside the earth, and the emission of pollutants is less, and there is no need to carry out fuel purchase and pollution treatment costs.

4.2 Comparison with Other Energy Sources

4.2.1 Comparison of Tidal Energy with Other Energy Sources

Tidal power generation has a more environmentally friendly and sustainable life cycle than fossil fuels. Tidal power produces no greenhouse gases such as carbon dioxide and is less polluting than conventional fossil fuels. Compared with renewable energy sources such as solar and wind, the practical application of tidal power generation is subject to some limitations, such as site selection and technology, so more preparation and investment are required. Among the subsequent operating costs, the operating cost of tidal energy is slightly higher than that of other clean energy sources, mainly including equipment maintenance, manual inspection, and the impact of Marine environment on equipment. Energy density: The energy density of tidal energy is about 0.8Wh/kg, which is lower than fossil fuels (248,000 Wh/kg) and nuclear energy (109,000 Wh/kg). For power generation efficiency, Tidal power is on par with wind power and slightly less efficient than solar power, usually around 20 percent. In terms of commercialization prospects, compared with traditional energy, tidal energy has a unique advantage, because of its strong stability and high reliability characteristics, tidal energy is regarded as one of the most promising new energy in the future. Although the current tidal energy technology is not very mature, commercialization is also facing various challenges, but its basic research and technology research and development has been carried out, and there is also a huge potential of tidal resources, so the commercial prospect of tidal energy is still very broad (Malcolm & Gorlov, 2019, Tsai et al, 2014, Kim et al, 2012) .

4.2.2 Comparison Between Geothermal Energy and Other Energy Sources

For life cycle, compared with fossil fuels, geothermal energy is cleaner and more reliable, and can achieve zero or low carbon emissions throughout the life cycle. For commercial prospects, because of its reliability and stability, although the early development and application of geothermal energy investment cost is high, but geothermal energy income has the characteristics of sustainable stability, can be suitable for long-term investment and development. At present, the commonly used geothermal power generation technologies include dry steam power generation and flash evaporation power. The efficiency of dry steam power generation is generally between 10% and 23%, while the efficiency of flash evaporation electricity can reach 20% to 30%. Compared with clean energy such as solar energy and wind energy, geothermal energy is not affected by environmental weather, can be exploited at any time, and remains stable (Qi & Zhang, 2019). Compared with fossil energy, geothermal energy has the advantages of pollution-free and clean emission.

5 CONCLUSION

Coal, oil and natural gas are the traditional energy sources for human daily survival. With the increasing shortage of traditional energy sources, tidal energy and geothermal energy, as clean and efficient new energy sources, can help alleviate the current energy pressure and contribute to the goal of carbon peak and carbon neutrality. The tidal power generation technology has some defects, such as low collection efficiency, immature equipment maintenance technology, high initial construction cost and easy impact on ecological environment. However, EGS technology has some problems, such as immature geothermal reservoir reconstruction technology, imperfect heat transfer system, low life of technical tools in extreme environment and easy to cause earthquake disasters during construction. However, tidal energy and geothermal energy have the advantages of continuous resource reserves, low carbon and efficient renewable and stable operating mechanism, so there is still a large development space and commercial prospects. In the future, we should continue to increase scientific research, improve production technology and reduce production costs with the support of the government and the people, so

as to achieve the large-scale and safe application of the two.

AUTHORS CONTRIBUTIONS

All the authors contributed equally and their names were listed in alphabetical order.

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