Hydropower's Future in China for a Renewable Energy

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Abstract: Energy is an important factor of the social and economic development. But the energy consumption, especially burning fossil fuels is one of the main causes of climate change. The electric energy is one of the most popular energy forms. A way to reduce greenhouse gas emissions is applying renewable energy technology more actively in power production to reduce fossil fuel use. Hydropower with mature development technology is considered an environmental-friendly and low cost source of electricity. Taking into account the economy, technology and environment, most countries give priority to hydropower development. China has the world's most abundant hydropower resources. Though there is controversial about hydropower development. A hydro facility can be more than just an answer to energy demands. If developed well, it can help with water conservation, irrigation, and flood control. From the perspective of the comprehensive consideration, hydropower will play an active and irreplaceable role in China.

Keywords: energy; hydropower; renewable energy

1 Introduction

Energy is one of the most important commodities in modern society. It is an important factor of economic growth development. The importance of energy in economic development has been widely recognized. Production and consumption of the energy have close relations with other main social problems, including poverty, the deterioration of the environment and security issues. Generally, economic growth and electricity have very great relevance [1].

During the past decades, the reality of deterioration of the environment has already become more obvious. The growth of the environmental problem comes from the combination of several factors, such as the increase of world population, aggravation of industrial activities and energy consumption etc. Human activities impact on environment prominently [2].

One of the main reasons for causing climatic change is the combustion of fossil fuel. It produced massive greenhouse gas. To reduce the greenhouse gas emission, renewable energy must be promoted actively, especially reduce the proportion of using fossil fuel in electricity production[3].

Incombustible renewable energy source exists in many forms. Present renewable energy source, often refers to hydropower, wind energy, solar energy, or geothermal energy that is relevant to electricity. However, for electricity production, hydropower is the largest source of renewable energy with mature technology [4].

2 The characteristics of hydropower

Hydropower resources are distributed in all parts of the world. Potentiality exists in approximately 150 countries and about 70% of the economically feasible potential remains to be developed. It provides more than 97% of all electricity generated by renewable sources in the world [5]. It also provides a kind of choice to store energy and to optimize electricity generation.

Hydropower has superior peaking performance. For hydro-generator, output power from start-up to maximum power output only need 3~5 minutes. At the same time, according to the need to adjust the output power it only takes a few seconds. The performance of hydropower will be far better than other types of energy. Although other forms of energy have peak regulation capacity, for example, thermal generator has capacity of spinning reserve to meet the requirements of peak regulation, it costs much higher. The Table 1 is a simple comparison of re-starting time of different power equipment [6].

Table 1. Comparison of re-starting time of different power equipment.

Power type	Start-up time after stop 8 hours
Hydropower	3~5minutes
Coal-fired power plant	3 hours
Oil-fired power plant	3 hours
Liquefied Natural Gas	About 3 hours
Liquefied Natural Gas Compound Cycle	About 1hour
nuclear power	About 5 days

The above table reflect fine characteristic of hydropower in peak regulation and frequency modulation. These characteristics are very important for reliable operation of power grid. When the power grid presents the electric power demand beside the plan as well as the accident power cut, the hydropower equipment can start instantaneously and provide the power rapidly. Even in the course of operating generating equipment, output power can be adjusted within several seconds. So when

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electricity demand changes to a large extent in the daytime, hydropower can provide stable power supply.

In terms of effective use energy mostly, the hydropower is the best choice of undertaking task of peak regulation in power grid. As is known to all, electricity cannot be stored. The supply and demand balance must be maintained in the power grid all the time. There is a great change for electricity demand in a day. Hydropower equipments start conveniently and rapidly and at the same time they have strong adjustment ability, therefore, the most suitable role of hydropower in power grid is peak regulation undoubtedly.

3 The advantages and disadvantages of the hydropower

According to report of the International Hydropower Association (IHA), there are some of the supporting evidence summarized below [7].

Hydropower contributes to fresh water storage: hydropower reservoirs collect rainwater, which can then be used for drinking or irrigation. By storing water, they protect aquifers from depletion and reduce our vulnerability to floods and droughts.

Hydropower improves electric grid stability and reliability: the management of electricity grids depends upon fast, flexible generation sources to meet peak power demands, maintain level system voltages and quickly restore service after a blackout. Electricity generated from hydropower can be placed on the grid faster than any other energy source.

Hydropower's ability to go from zero power to maximum output rapidly and predictably makes it exceptionally good at meeting changing loads and providing ancillary electrical services that maintain the balance between electricity supply and demand.

Hydropower helps fight climate change: the life-cycle of hydropower produces very small amounts of greenhouse gases (GHGs). By offsetting GHG emissions from gas, coal and oil fired power plants; hydropower can help slow global warming. Although only 33% of potential hydro resources have been developed, hydropower currently avoids burning 4.4 million barrels of oil equivalent daily, worldwide.

Hydropower means clean, affordable power for today and tomorrow. They can easily be upgraded to incorporate the latest technologies and have very low operation and maintenance costs.

However, there is also controversial about hydropower development. Current, the public concerns for environmental issues, security issues and social problems mainly. Critics say large-scale hydroelectric facilities have deteriorated the living conditions of aquatic species, damaged vegetation over, affected the local climate, and are vulnerable to military targets. It is risky for the projects that locate in problematic geology. For the immigrants, forced displacement could lead them to poverty and vulnerable social groups, rather than improving their standard of living.

Critics of hydropower frequently cite the lessons learned from other countries, while proponents tend to advocate cautious planning rather than the abandonment of hydropower development. In reality, many countries around the world have prioritized water-based energy. The rate of hydropower exploitation in the United States is 82 percent, Japan 84 percent, France more than 80 percent, Germany 73 percent and China only 27 percent below Asia average level 34 percent [8].

4. Energy and electricity situation in China

In 2007 China's energy consumption structure is that coal accounts for 76.6%, petroleum accounts for 11.3%, natural gas accounts for 3.9%, nuclear power, hydropower and wind power account for 8.2%. By comparison the world energy consumption structure is that coal accounts for 28.5%, petroleum accounts for 35.5%, natural gas accounts for 23.7%, nuclear power, hydropower and wind power account for 12.4%. Oil and gas are low proportion in the China's energy consumption. Coal is important basic energy in China and the electricity industry is the biggest user of the Chinese coal (Figure 1)[8].

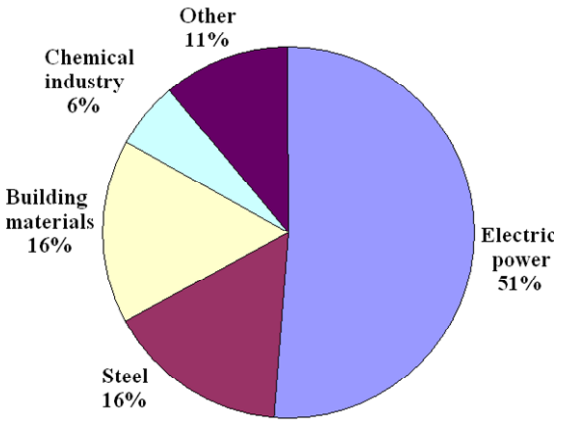

Figure 1. Structure of coal consumption in China, 2007

In recent years, China's power industry experienced high growth. The total installed capacity increased from 380 GW to 793 GW [9], more than doubled from 2003 to 2008. In 2006, addition generating capacity was 102GW[10].

In 2007 the electricity generation of world was 19771 TWh. Among them 41.5% come from coal, 20.9 from natural gas, 13.8% from nuclear, 15.6% from hydro, 5.6% from oil and 2.6% from geothermal, solar, wind and other renewable energy sources (Figure 2). But in China electricity generation thermal power proportion has occupied above 70% since 1949[11]. In 2008, among

the China gross generation, the thermal power probably accounted for 80% and the coal occupied dominant position absolutely in thermal power. The installed capacity of hydropower accounted for only 24% of the installed gross capacity. The hydroelectric generation was less than 20% of the total generation [8].

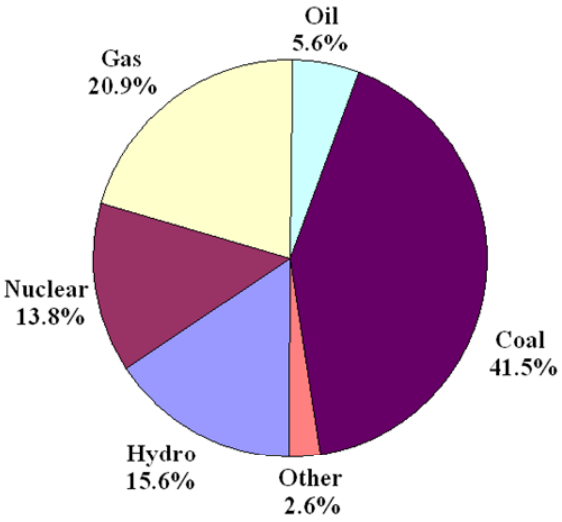

Figure 2. Structure of electricity generation in the world, 2007

Producing per KWh electricity, coal has the highest level of carbon dioxide emissions and other pollutants. However, due to its low cost and high availability, it will continue to dominate the market, but also will challenge the principle of sustainable development[12].

Coal consumption is not only the main reason of smoke pollution in China but also the major source of greenhouse gases. More and more environmental and ecological pressure is caused by coal consumption. Because of excessive consumption of coal, almost one-third of the Chinese territory has suffered acid rain [8]. In 2006, the carbon dioxide from the burning coal accounts for 82% of total emission in China. China has been world's number two emitter of carbon dioxide [8].

5. Hydropower developments in China

China is country that is currently experiencing tremendous economic boost, its ever-increasing demand for energy requires constant development of energy sources and China is looking for other energy sources, besides dominant coal. This trend is not only the result of increased energy demand, but also because of serious environmental problems.

China has promised to make renewable resources supply 15 percent of its total energy consumption by 2020, in a bid to reduce greenhouse gas emissions and promote sustainable economic growth [8].

To keep the promise, the alternative looks to be hydropower. Because China hydropower resources are rich and the developable resources are 540 GW. Water resources are mainly concentrated in the central and western regions of medium and large rivers. The developable capacity of main streams of these rivers accounts for about 60% of gross capacity. In comparison with nuclear, wind and solar power, hydropower is lower-cost. Accelerating the development of hydropower will lighten the reliance on coal effectively [13].

China already has half of the world's largest dams, including the largest one Three Gorges dam, which is the world's biggest hydroelectric station with estimated total capacity of around 22,500 MW once being completely functional. The installed gross capacity, annual power generation and new power capacity of China's hydropower rank the top in world now. According to the development planning of Chinese energy, China will raise the installed capacity of its hydropower to more than 300 GW by 2020 from 190 GW at the end of 2009 [13].

On the other hand according to the statistics of China Dam Association, the total amount of reservoirs in China ranks number one in the world. The total reservoir capacity of China is 634.5 billion m^3 in 2007. But per capita water resource saving ability is low-ranking. The capacity adjusted by dams and reservoirs is less than 300 billion m3. Per capita capacity is less than 500 m^3 which is far less per capita storage level of developed countries, about 2000 m3. According to China's reserves of hydropower resources and population, China also needs to develop hydropower greatly.

6. Conclusions

The hydropower has great impact on ecological environment and it is worthy of paying close attention. Hydropower development must be based on the protection of the ecological environment. Before construction and management of hydropower station, environmental analysis and evaluation and input-output analysis should be made systematically in response to the appropriate place of renewable alternative energy [3].

So environment impact assessments (EIA) are now considered a must for any project. They should be undertaken in the early stages and at the strategic level, taking into account the entire ecosystem of the related region. In the planning stage, attention must be paid to such issues as biodiversity and vegetative cover, and during construction, care should be taken in waste disposal, the unearthing of cultural relics, and disease control. The government should intensify monitoring and supervision of hydro projects.

Hydropower will play a more important role in China's energy safety strategy in the future. Hydropower will never be the complete answer to emissions-free energy production, but a strong case can be made that it can be a

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useful part of the answer.

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