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Review

Wave energy in China: Current status and perspectives

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ABSTRACT

The progress in wave energy technologies in China during the past decade is briefly reviewed. And the description is focused on the wave energy resource and the current status of wave energy in China. The difficulties facing wave energy developments in China are summarized. The national policy of wave energy developments is outlined and perspectives of wave energy in China are discussed.

1. Introduction

The world energy consumption is estimated to rise considerably over the next decades and in the same period the energy consumption in China will increase by almost a similar amount. Being constantly reminded that traditional methods of energy production are contributing to serious environmental problems the Chinese government has seen the urgent need for pollution-free power generation. The energy sector was forced through a renovating process, which sees its opening towards renewable energy. In the dynamic evolution of the renewable energy industry a wave energy industry is emerging. Wave energy is an abundant renewable resource in China, which is starting to be exploited by several domestic research institutions and universities. Considerable progress has been made over the past decade in this sector in China, resulting in some technologies being at, or near, commercialization; others still require further R&D [1,2].

In the present paper, the main subject of the next section is the analysis of the wave energy resources in China. Then follow, first, a section on current status of wave energy in China, and secondly, a section on the national policy of wave energy developments. Before the final section with concluding remarks, there is a main section, where perspectives of wave energy in China are discussed.

2. Wave energy resources in China

The wave energy is suited for countries with vast coast line and high waves approaching the shore. It is free from environmental pollution and continuous as waves are never going to cease. The potential market for wave energy is huge although wave energy resource is distributed unevenly to different regions in China. According to the estimation of State Oceanic Administration People's Republic of China, about 12.85×10^{10} W of wave energy is technologically available in the near shore in China, nearly half of the electricity production of China [3]. Taiwan, Zhejiang, Guangdong and Fujian are the top four provinces for wave energy resources. Fig. 1 shows top ten provinces where wave energy in each region is more than 100 MW. The majority of these wave energies are without any exploitation, few of them are being exploited but not being utilized efficiently.

It is observed that for most of the coast areas of China, the predominant wave period is more than 5 s. The calculation of mean significant wave power along the Chinese coast is estimated by dividing the coast into grids as mentioned in Table 1. Due to the complex topography and monsoon climate, the wave power varies remarkably from the region to the region. The National Marine Data and Information Service (NMDIS) manages the wave power data recorded from wave energy stations along the four typical coasts, which is shown respectively in Figs. 2–4 [3,4]. From where one can see that the wave power and stirring month in a year are remarkably different in the North coast and the South coast. Also, it can be observed that, in general, annual mean wave power in China is lower in the first half year when compared to that in the second half year.

According to the statistical estimation of NMDIS, the division of wave energy resources in the coastal area of China is showed in Table 2 [4]. Based on the wave energy flux density and the environment to be explored, the coast of Zhejiang and Fujian should be the priority area where to be developed, secondly, the eastern coast

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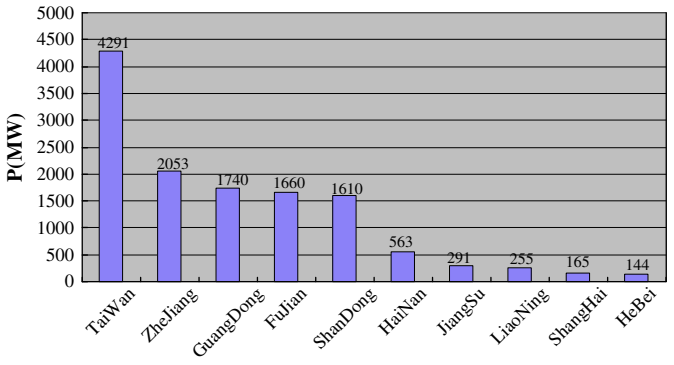

Fig. 1. The wave energy resource in some regions of China.

Table 1
Wave energy potential along Chinese coast.

Grid	Bohai Sea	Yellow Sea	East China Sea	South China Sea
Annual mean (kW/m)	7.73	6.29	6.36	5.32

of Guangdong, the estuary of Yangtse River and the southern byland of Shandong. The area with better condition, such as Chengshan island, Nanji island and Yun'ao, are provided with high energy density of energy, the small variations of season and the small difference of average tide, it's the good place for wave energy development, where also should be put into the priority.

3. The current status of wave energy in China

The research and development of wave energy in China started in the late 1970s, which is performed mainly at the Guangzhou Institute of Energy Conversion (GIEC) under the sponsorship of

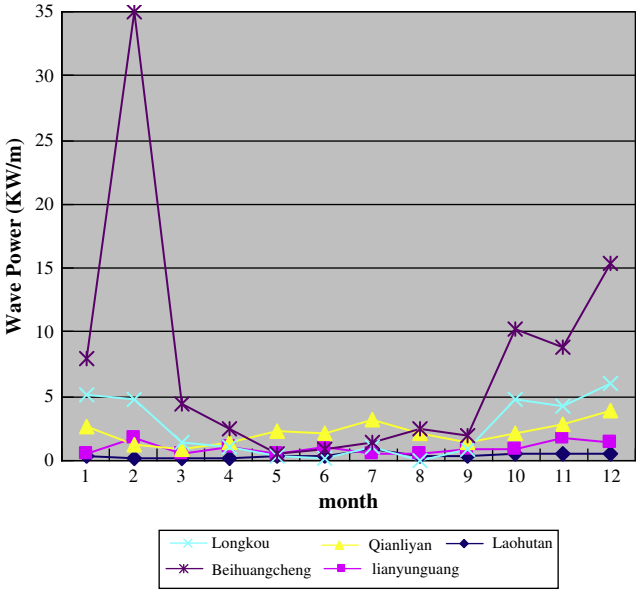

Fig. 2. Wave power along Bohai Sea and Yellow Sea.

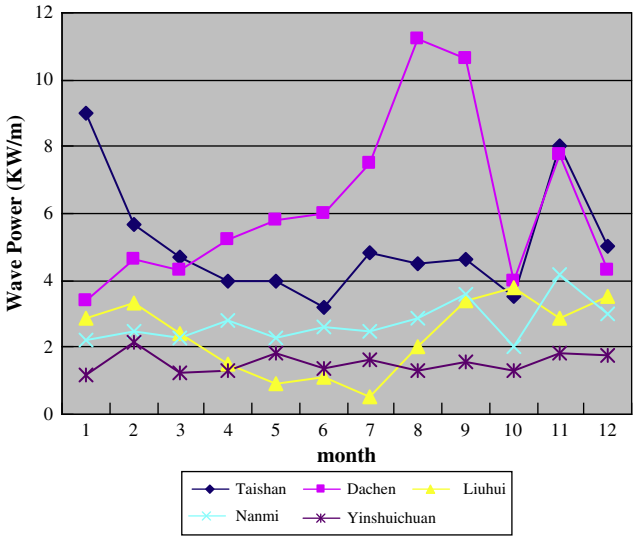

Fig. 3. Wave power along East China Sea.

Chinese government, in co-operation with other national and international research institutions. Up to now, the main types of wave energy converters in China are shoreline Oscillating Water Column (OWC) wave power plants, floating OWC buoys and pendulous wave power plants [5]. All those OWC wave energy devices are developed by GIEC, among which the Central-Duct OWC navigation buoys (CDB, Fig. 5) are well developed. The CDB is a point absorber, which usually provides a heave motion that is converted by mechanical and/or hydraulic system in linear or rotational motion for driving electrical generator. More than 700 CDBs of 10 W have been put in use for port and harbor facilities and for unmanned lighthouses since the first full scale sea trial in Qiongzhou Strait between 1990 and 1992 [6]. In the same period, the sea trial of the Backward-Bent-Duct Buoy (BBDB, Fig. 6) of 5 kW in the estuary of Pearl River has proved that it has a relatively higher conversion efficiency, but a limitation to be used in shallow water for its poor reliability [7]. Several years later, two pendulous wave plants of 8 kW and 30 kW have been developed and constructed at Jimo of Shandong Province.

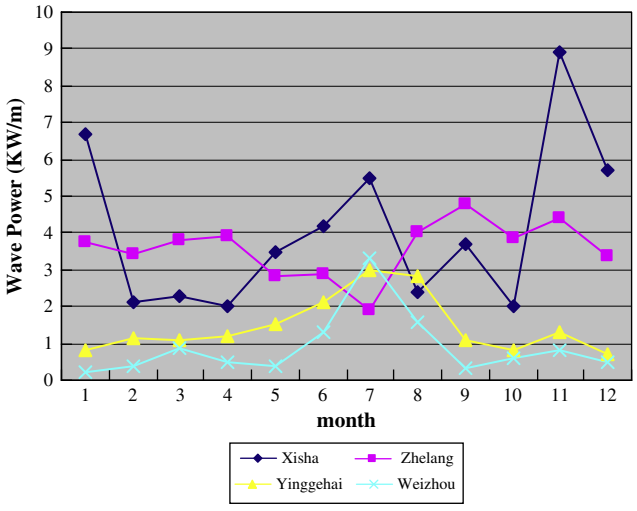

Fig. 4. Wave power along South China Sea.