

## An overview of ocean renewable energy in China

Shujie Wang, Peng Yuan\*, Dong Li, Yuhe Jiao

College of Engineering, Ocean University of China, Qing Dao, Shandong province 266100, China

### ARTICLE INFO

#### Article history:

Received 20 August 2010

Accepted 15 September 2010

#### Keywords:

Ocean energy

Tidal energy

Wave energy

Marine current energy

Ocean thermal energy

Salinity gradient energy

China

### ABSTRACT

Facing great pressure of economic growth and energy crisis, China pays much attention to the renewable energy. An overview of policy and legislation of renewable energy as well as status of development of renewable energy in China was given in this article. By analysis, the authors believe that ocean energy is a necessary addition to existent renewable energy to meet the energy demand of the areas and islands where traditional forms of energy are not applicable and it is of great importance in adjusting energy structure of China. In the article, resources distribution and technology status of tidal energy, wave energy, marine current energy, ocean thermal energy and salinity gradient energy in China was reviewed, and assessment and advices were given for each category. Some suggestions for future development of ocean energy were also given.

© 2010 Elsevier Ltd. All rights reserved.

### Contents

1. Introduction	91
2. Current situation of renewable energy in China	92
2.1. Energy structure and development strategy of China	92
2.1.1. Sectors of renewable energy and situation of energy structure in China	92
2.1.2. Strategic planning of renewable energy's development in China	93
2.2. The development situation and prospect of renewable energy in China	94
2.3. Assessment of renewable energy development in China	94
2.4. Necessity for China to develop ocean energy	95
3. Ocean renewable energy in China	97
3.1. Reserves and distribution of ocean energy resources in China	97
3.2. Status of ocean energy development in China	97
3.2.1. Tidal energy in China	97
3.2.2. Marine current energy	100
3.2.3. Wave energy	104
3.2.4. Ocean thermal energy	107
3.2.5. Salinity gradient energy	108
4. Conclusions and perspectives	109
Acknowledgements	109
References	109

### 1. Introduction

China's economy has been rapidly growing for more than 30 years. Since entering the new millennium, the average growth rate of

China's GDP exceeds 10% [1]. Preliminary accounting, annual gross domestic product (GDP) of 33.5353 trillion CNY in 2009, annual GDP growth of 8.7% over the previous year [2]. Correspondingly, the energy requirements and consumptions in China have kept an annual growth since the year 2000. After 2001, economic growth continued apace, but energy demand growth surged to 13% a year. In 2001 China accounted for 10% of global energy demand but met 96% of those needs with domestic energy supplies; today China's share of

\* Corresponding author at: SongLing Road 238#, QingDao, Shandong, China, 266100. Tel.: +86 139 6969 3513; fax: +86 0532 85905 1020.

E-mail address: [yuanpeng50@hotmail.com](mailto:yuanpeng50@hotmail.com) (P. Yuan).

global energy use has swelled to over 15%. China is now the world's second-largest energy consumer [3]. According to preliminary estimation of 2009, the total energy consumption of China reached 3.10 billion tonnes of coal equivalent, with an increase of 6.3% from 2008 and 124% from 2000. And the total electricity consumption reached 3.697 trillion kWh, with an increase of 6.2% from 2008 [2]. According to estimation, before 2020, China's annual GDP will be continue to increasing at an average rate of 8% [5]. Predictably, China's energy requirement will be rising in near future with its economy development [4].

Coal has been predominated the primary energy consumption composition of China, [21] accounts for 68.7% and 76.2% in 2000 and 1990 respectively, and kept more than 68.7% in recent years, compared to the world average of 24% [10]. The coal consumption of 2008 reached 2.74 billion tons, making up 68.7% of total output and 3.02 billion in 2009, up to 9.2% [6,9]. And, China uses more coal than the total consumption of USA, EU and Japan [11]. Other fossil fuels consumption also increased. Crude oil consumption reached 0.38 billion tons and gas consumption 88.7 billion cubic meters, grow by 7.1% and 9.1% compared to the previous year respectively [2,6]. However, China is short of energy resources, of which reserves of fossil fuels are lower than the world's average. Proved coal reserves so far can only meet the needs for 80 years. Crude oil has been import dependency for a long period, with importing proportion more than 40% since 2004 and nearly 50% at one time [7,8,20]. It was estimated that in China the oil resources will be exhausted by 2040, natural gas by 2060 and coal by 2300 [12]. And even worse, China's energy efficiency is comparatively low. China's energy intensity (0.91 tonnes oil equivalent per thousand US\$ GDP at 2000 prices in 2005) was much higher than the world as a whole (0.32) [20]. Low energy efficiency further intensified China's energy consumption, made the situation even worse.

Massively use of fossil fuels also brought about serious environmental problems. Burning coal is the principal agent responsible for air pollution, water shortages, polluted soil, ecosystem degradation, and widespread human illness [13]. The main problems caused by massive consumption of fossil fuels, especially coal, are emission of greenhouse gases (GHGs) and global warming. In 2005, coal accounted for 42% of global CO<sub>2</sub> emissions. In that year, coal combustion accounted for 82% of China's CO<sub>2</sub> emissions [14,15]. As the world's second-largest energy consumer, China is by far the biggest contributor to incremental emissions, overtaking the United States as the world's biggest emitter in 2006 [3,16,20]. Premier Wen Jiabao promised on behalf of Chinese government that China would cut CO<sub>2</sub> emissions intensity by 40–45% below 2005 levels by 2020 on the 2009 United Nations Climate Change Conference [17]. This promise fully embodies the positive attitude of Chinese government to the world and determination to change economic growth mode from high energy consumption and pollution to sustainable development.

High speed growth of economy, increasing demand for energy and requirement for reduction of GHGs emission has laid great pressure on China. In light of China's current energy conditions, to promote energy efficiency and to adjust energy structure, and to raise the proportion of renewable energy in overall energy mix are the only way to maintain sustaining economic development while keeping constant or even decreasing the pressure on environment and to achieve the goal of reduce GHGs emission by 40–45% from 2005 [18,19]. Although China has made great efforts in this aspect and great progress has been made on wind and solar power, the renewable energy's proportion in the whole energy mix is far below the world average [20]. On the basis of current situation, it is necessary for China to development various types of renewable energy to meet the growing demand for economy development while releasing the environmental pressure caused by usage of fossil fuels.

China boasts a mainland coastline of more than 18,000 km and a sea area of more than 3,400,000 km<sup>2</sup> with abundant ocean energy resources. Developing ocean energy bears enormous strategic significance for China's sustainable development [6]. As one class of renewable energy, although ocean energy currently shares a very small proportion in energy system, it has great potential for development. This article makes investigations and analysis about China's renewable energy, especially the research on ocean energy's utilization and situation in order to forecast and give advice on development of ocean energy in the future, help researchers learn current research status and explore research orientations and help decision making and investment for relevant groups.

The second part of this article will discuss significance and availability of exploiting China's ocean energy on the basis of an overview of the development of China's renewable energy and the strategic plan made by Chinese government. The third part will give an overview of China's ocean energy and research status of it in categories. The article will be ended with some conclusions and suggestions about the development of China's ocean energy.

## 2. Current situation of renewable energy in China

Chinese government has been committed to developing renewable energy for that it is of strategic significance to keep balance between energy demand and supply.

### 2.1. Energy structure and development strategy of China

#### 2.1.1. Sectors of renewable energy and situation of energy structure in China

In the *Middle and Long-Term Program of Renewable Energy Development*, the key areas of renewable energy's development from 2010 to 2020 are defined as hydro energy, bio-energy, wind energy, solar energy and other renewable energy (including geothermal energy and ocean energy) [22].

With the increase of the total energy production, the proportion of renewable energy in China's total energy mix is also on the rise. The proportion of renewable energy (including hydroelectric power, wind energy and nuclear power) in annual total energy consumption was 7.2% in 2006, compared with 7.3% in 2007 (as shown in Fig. 1) and 8.89% in 2008 [1,9]. According to this trend, although challenging, it is possible for China to achieve the goal set in *the*

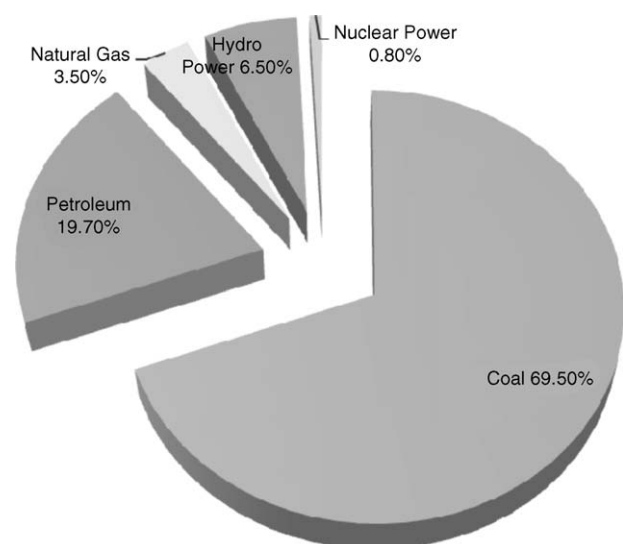


Fig. 1. Primary energy composition as percentage of primary energy production (%) (Coal equivalent calculation) in 2007 [9].

Download English Version:

<https://daneshyari.com/en/article/1751524>

Download Persian Version:

<https://daneshyari.com/article/1751524>

[Daneshyari.com](https://daneshyari.com)