Renewable and Sustainable Energy Reviews 44 (2015) 657–668

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Development mode for renewable energy power in China: Electricity pool and distributed generation units

Ou Zhang, Shunkun Yu, Pingkuo Liu*

School of Economics and Management, North China Electric Power University, Beijing 102206, China

ARTICLE INFO

Article history:
Received 14 July 2014
Received in revised form
15 November 2014
Accepted 4 January 2015
Available online 22 January 2015

Keywords:
Renewable energy
Electricity pool
Distributed generation units

ABSTRACT

Distributed generation (DG) units can provide approaches and methodologies for the utilization and development of renewable energy. Meanwhile, electricity pool (EP), as a mode which can adapt to China's energy and power market, can effectively promote the market competition. After analyzing China's energy and power market, this paper, combining characteristics of distributed generation units with electricity pool, proposes Base–Market–Assist (BMA) in the pool mode. BMA mode not only makes a rational division according to China energy resources' endowment, but also utilizes agent operators to conduct operation management of distributed generation units, providing new methods for China renewable energy development in aspects of technology, market and policy.

Contents

* Corresponding author. Tel.: +86 10 51963118; Mobile: +86 130 1116 8395.
E-mail address: pingoforever@sina.com (P. Liu).

http://dx.doi.org/10.1016/j.rser.2015.01.020
1364-0321/

1. Introduction

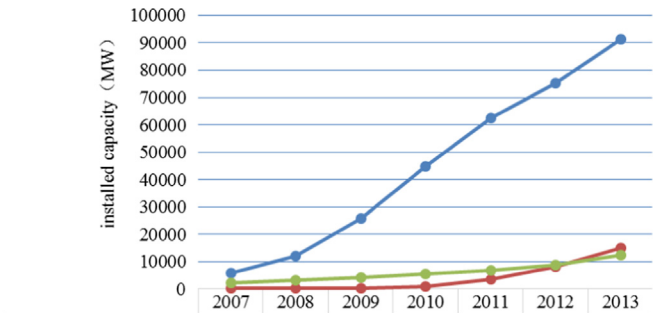
China's renewable energy develops in a period with both opportunities and challenges. On one hand, under the support of government policies, China's renewable energy industry has developed rapidly. On the other hand, China's renewable energy industry still has a lot of problems to be solved at current crucial stage of development. Only to overcome these obstacles can China's renewable energy industry have a sustainable development.

1.1. Present situation of China's renewable energy

In the last three years, the government of China increased efforts in support for renewable energy, the renewable energy industry support are more abundant than ever before [1]. As of 2012, China's installed capacity of grid-connected wind power has reached to 75,324 MW; the new installed capacity has reached to more than 12,000 MW. The electric energy production of wind power has exceeded 100 billion kilowatts, which accounts for more than 2% of the total, and wind power has become the third main power supply after the thermal power and hydropower. The new installed capacity of photovoltaic power is more than 4500 MW, the cumulative installed capacity is more than 8020 MW kilowatts [2]. In 2013, China's new energy power industry is developing more rapidly. The installed capacity of wind power, solar power and hydroelectric has respectively reached to 91,413 MW, 91,413 MW, 15,100 MW and 12,226 MW, respectively, until the end of 2013 (Fig. 1).

1.2. Development opportunity of China's renewable energy

On the other hand, China's *Twelfth Five-Year Plan* (2011–2015) explicitly put forward the strategic plan for the development of new energy to promote multiple clean development of energy, strengthen the construction of grid-connected matching projects and effectively develop wind power, actively develop new energy such as solar power, biomass energy, geothermal energy etc., popularize the application of distributed energy resources system and take new energy construction as the focus of the transformation of energy production and energy utilization [3]. Apparently new energy construction has become a key task for China's transformation and upgrading and improvement of industry's core competitiveness. China's *White Paper of Energy Policy 2012* proposed to vigorously develop renewable energy. At the end of the *Twelfth Five-Year Plan*, the proportion of non-fossil energy consumption over primary energy consumption would reach to 11.4%, while the proportion of installed capacity of non-fossil energy would reach to 30% [4]. In August 2012, China officially launched the "Twelfth Five-Year Plan for Renewable Energy Development" and released four thematic plans including hydropower, wind power, solar energy and biomass energy, putting forward clearly the guiding ideology, basic principles, development goals, key tasks, industrial layout, safeguard measures and implementation mechanisms of China's renewable energy development, which had made a new developing stage of China's renewable energy.



	2007	2008	2009	2010	2011	2012	2013
wind power	5848	12002	25805	44734	62364	75324	91413
photovoltaic power	100	140	300	820	3520	8020	15100
biomass power	2200	3150	4300	5500	6850	8781	12226

Fig. 1. Domestic installed capacity of wind power, solar power, biomass power in past years.

In January 2014, renewable energy was put in a very important position in China's national energy working conference, in which the Ten Key Work was proposed. Three attempts out of the Ten Key Work are to vigorously develop renewable energy and promote energy green development. The conference put forward clearly to adhere to both centralized and distributed, combine centralized supply and consumption on the spot, steadily promote the development of hydropower, wind energy, solar energy, biomass energy, geothermal energy and other renewable energy development. In 2014, the newly approved installed capacity of hydropower is 20,000 MW; the newly approved installed capacity of wind power is 18,000 MW; the newly approved installed capacity of photovoltaic power is 14,000 MW (including distributed generation accounted for 60%); the newly approved installed capacity of nuclear power is 8640 MW [5]. All the above show that China's renewable energy development will usher in opportunities.

1.3. Development obstacles

China has currently reached a considerable scale in the renewable energy industry [6]. However, compared with developed countries, there is still a wide gap in such respects as resource assessment, technological level, cost control and market mechanism. Bottlenecks still exist in the development process of renewable energy (Fig. 2).

1.3.1. Resources exploitation obstacles

Because of wide varieties and broad scope, energy resources in China have a high requirement in exploitation and evaluation of resources. In addition, the evaluation work of China's renewable