Renewable Energy 35 (2010) 1283–1291

Contents lists available at ScienceDirect

Renewable Energy

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

Critical success factors for BOT electric power projects in China: Thermal power versus wind power

Zhen-Yu Zhao [a,*], Jian Zuo [b], George Zillante [b], Xin-Wei Wang [c]

[a] School of Business Administration, North China Electric Power University, Beijing 102206, China
[b] School of Natural and Built Environments, University of South Australia, Adelaide 5001, Australia
[c] Shandong Nuclear Power Equipment Manufacturing Co. Ltd, Haiyang, Shandong 265118, China

ARTICLE INFO

Article history:
Received 5 August 2009
Accepted 18 September 2009
Available online 25 October 2009

Keywords:
BOT
Critical success factors
China
Thermal power project
Wind power project

ABSTRACT

Chinese electric power industry has adopted Build–Operate–Transfer (BOT) approach in a number of projects to alleviate the pressure of sole state-owned investment. The Chinese government has taken enormous efforts to create an environment to facilitate the application of BOT approach in electric power projects. Moreover, the growing attention on the sustainability issues puts the traditional major source of electricity – thermal power project under more strict scrutiny. As a result, various renewable energy projects, particularly the wind power projects have involved private sector funds. Both thermal power and wind power projects via BOT approach have met with a varying degree of success. Therefore, it is imperative to understand the factors contributing towards the success of both types of BOT power projects. Using an extensive literature survey, this paper identifies 31 success factors under 5 categories for Chinese BOT electric power projects. This is followed by a questionnaire survey to exam relative significance of these factors. The results reveal the different levels of significance of success factors for BOT thermal power projects versus wind power projects. Finally, survey results were analyzed to explore the underlying construction and distributions among the identified success factors. This study provides a valuable reference for all involved parties that are interested in developing BOT electric power projects in China.

1. Introduction

In order to meet the requirements of the rapid economic growth, China demands massive energy, particularly electricity. It is critical to secure affordable and environmentally sustainable energy for its 1.3 billion people. As a result an increasing number of power plants will be built in order to meet the increasing electricity demand. However, high capital requirements of power plants present a big issue, especially for developing countries. The World Bank has estimated that China will spend an estimated total of US $132 billion per annum over the period of 2006–2010, while the Chinese electricity sector has the largest share (44%) of total annual expenditure in infrastructure in East Asia [1]. Being short of capital is one of constraints factors for the development of electricity in China. Build–Operate–Transfer (BOT) is one of project finance mode to overcome the financial problem in the development and operation of infrastructure [2].

In China, BOT approach has been adopted in various industries such as the development of power plants, transportation and water facilities [3]. A number of power plants have been built via BOT approach since then. The earlier experiences of BOT projects brought in needed capital and investment to develop China's electric power industry. But it also illustrated many problems. One example is the Changsha Power Plant Project where the financial arrangement could not be closed because of the temporary decreased demand and policy adjustment in the energy industry [4].

Although there are a number of publications on BOT in China, none of these studies focus on this approach in China's electric power sector specifically. The focus of this study is placed on the identification and prioritization of factors contributing towards the success of two types of BOT electric power projects, i.e. thermal power plant and wind power plant. Considering the growing emphasis on the renewable energy development from the Chinese government and the international community, this study provides a valuable reference to understand the current situation of the

* Corresponding author. Tel.: +86 10 80798644; fax: +86 10 80796904.
E-mail addresses: zhaozhenyuxm@263.net (Z.-Y. Zhao), jian.zuo@unisa.edu.au (J. Zuo), george.zillante@unisa.edu.au (G. Zillante), wxw8355@126.com (X.-W. Wang).

0960-1481/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.renene.2009.09.016

involvement of the private sector and foreign investors in the electric power industry.

2. Chinese electric power landscape

The Chinese energy market is featured with coal as the primary energy source and an overall development of crude oil, natural gas and renewable resources such as hydropower, nuclear power and wind power (see Fig. 1).

In 2007, China consumed approximately 1.8×10^9 tons of standard coal, which accounts for 67.8% of total energy consumption [5]. Exploitation of renewable energy sources is taking an increasingly prominent position in Chinese energy supply. The Chinese government sets up a target that the production of renewable energy covered 10% of gross energy consumption in 2010 and 15% in 2020 compared to 4% in 1980 [6].

The Outline of the 11th Five-Year Plan for National Economic and Social Development of China projects that the per-unit GDP energy consumption by 2010 will decrease by 20% compared to 2005, and the total amount of major pollutants discharged will reduce by 10%. The Outline stipulates that the electric sector will be optimized to satisfy the demands of national economic and social development. The reform of the electric sector will take various factors, e.g. resources, technology, environmental protection and market into consideration. These measures include: (1) investing in clean coal technologies; (2) building large scale, highly efficient and environmental friendly thermal power plants; (3) closing down small scale thermal power plants; (4) developing nuclear power, hydropower and natural gas power with a consideration of the local conditions; (5) building regional power grids and power transmission and distribution networks; (6) expanding the scope of the power transmission from western to eastern China [7].

In order to meet the demands of the economic and social development, a number of electric power projects are under construction or being planned. The Chinese government has recognized the importance of the investment from the private sector, particularly the foreign participation into the electric power development due to the shortage of capital. Over the past decades, China's electric power industry has undergone marked reform. For instance, the monopoly of exclusive investment in power generation is terminated; the power generation market is gradually opened [8,9]. Using the economic method of Differences-in-Differences, Du et al. (2009) discovered that the regulatory reform of the Chinese electricity industry led to the efficiency in labour input and gains in nonfuel materials. A series of preferential policies and laws have been issued to regulate the industry [10]. This facilitates the adoption of BOT approach into more and more electric power projects. A list of examples of electric power projects via BOT approach is described in Table 1.

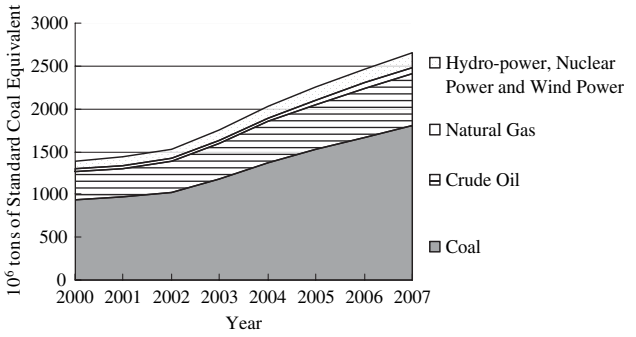

Fig. 1. Composition of energy consumption in China 2000-2007.

In China, the legal system applicable to BOT projects has been gradually improved. The political and social environment is stable and the investment environment continues to improve. All these factors gain the confidence of foreign investors to invest in China. According to the statistics provided by the China Electrical Council, the structure of the Chinese electric power industry has been a fundamental change. The traditional major electricity source, thermal power obtained a negative growth rate (−10.08%) in 2007, 8.26% down since year before. In contrast, wind power achieved a 173.94% growth rate in the same period [11].

3. Research methodology

In order to develop a nominated critical success factors for China's BOT electric power projects, an extensive literature review was conducted. The resources, e.g. academic journals, professional body reports, case study reports and government reports were reviewed. The results of literature survey are presented as shown in Table 3.

A questionnaire was developed based on the above literature survey results. The questionnaire consists of three sections. The first section aims to collect the basic information of the respondents, e.g. the type of the organization, working experience, and the type of projects. The second section investigates the relative importance of each success factor to different types of electricity power projects (P1: Thermal power plant projects, and P2: Wind power plant projects). A comment box is given in the third section to allow participants to: (1) make further comments related to items included in the questionnaire; (2) make comments related to BOT electric power projects in China that may not be covered in the questionnaire.

A questionnaire survey was conducted with the practitioners involved in the Chinese electric power industry. A sample of 105 industry practitioners received the questionnaire and 73 valid questionnaires were returned for analysis with a response rate of 70%. These respondents are selected from five cities in China: Beijing, Shanghai, Shenzhen, Jinan and Changsha. All interviewees have more than 15 years experience on the electric power industry and have BOT related experience. This makes them as reliable and credible sources of information which is crucial to satisfy the research goal. The distribution of respondents is shown in Table 2.

The Likert scale was selected to obtain weights for the 31 success factors to BOT electric power projects in China that are identified in the literature review. A 5-point Likert scale was adopted, where 1 represented "not significant", 2 "less significant", 3 "significant", 4 "more significant", and 5 "most significant". The ranking of each success factor W_{jv}^K is calculated via formula (1):

$$W_{ij} = \sum_{j=1}^{31} W_{ij}^{Kv}/73 \tag{1}$$

The questionnaire survey results are shown in Tables 4 and 5.

The procedure, findings, and relevant discussion of the analyses are detailed in the following sections.

4. Nominated success factors and analysis

The conducted extensive literature review identified 31 factors that are critical to the success of BOT electric power projects in China and these factors can be grouped into 5 categories as Table 3.