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## Technology, cost, a performance of waste-to-energy incineration industry in China



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### ABSTRACT

With the upgrading of urbanization and improvement of living standards, the volume of municipal solid waste (MSW) is increasing in China. The waste-to-energy (WTE) incineration industry promotes the harmless disposal and recycling of MSW. It is an important part of the energy conservation and emission reduction tasks of “12th Five-Year Plan” period (2011–2015). Based on the development status of WTE plants in China, this paper makes an analysis of the WTE incineration industry from two aspects. The one is the analysis of political, economic, social and technological factors that influence the external environment of this industry. The other one is the discussion of technologies, costs and performances of some WTE plants in China, including a detailed cost-benefit analysis. It proves that the external environment is conducive to the development of WTE incineration industry and this industry is faced with good market prospects. Also, the net profit margin and return on investment (ROI) of WTE plants is attractive, up to 25% and 18% respectively. The pay back period is 12.73 years and the internal rate of return (IRR) is 10.94%. Thus, WTE plant has good profitability and economic benefit. Besides, WTE incineration has significant environmental benefits.

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### Contents

1. Introduction . . . . .	116
2. Literature review . . . . .	116
3. The external environment analysis . . . . .	117
3.1. Political factors . . . . .	117
3.1.1. Incentive policies . . . . .	117
3.1.2. Regulations . . . . .	117
3.2. Economic factors . . . . .	118
3.2.1. Markets . . . . .	118
3.2.2. Capitals . . . . .	119
3.2.3. Financing modes . . . . .	119
3.3. Social factors . . . . .	119
3.3.1. Opportunities . . . . .	120
3.3.2. Barriers . . . . .	120
3.4. Technological factors . . . . .	121
3.4.1. Advantages . . . . .	121
3.4.2. Challenges . . . . .	121
4. Technologies, costs, and performances . . . . .	122
4.1. Technologies . . . . .	122
4.1.1. Technical details . . . . .	122
4.1.2. Problems and solutions . . . . .	123
4.2. Costs . . . . .	124
4.2.1. Investment costs . . . . .	124

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4.2.2. Operating costs .....	125
4.3. Performances .....	125
4.3.1. Economic benefits .....	125
4.3.2. Environmental benefits .....	126
4.4. Cost-benefit analysis .....	126
5. Conclusion and policy recommendations .....	128
5.1. 1. Conclusion .....	128
5.2. Policy recommendations .....	128
Acknowledgment .....	129
References .....	129

## 1. Introduction

The rapid development and urbanization of China have resulted in an increasing volume of municipal solid waste (MSW). The problem of MSW management has become a major social problem [1]. The delivering quantity of household waste averages 170 million tons in China, and the amount of untreated MSW over the years has reached 7 billion tons, with an annual increase of 8–10%. About one-third of cities in China have problems of MSW disposal, with direct economic losses amounting to \$ 1.467 billion<sup>1</sup>. The MSW causes damages to the environment and spreads diseases, having become a serious threat to the health of residents and an obstacle to the social development. Due to the lack of MSW disposal capacity, the backward infrastructure and operational skills of MSW treatment facilities, as well as the lack of supporting facilities, some cities are faced with the “garbage siege” problem.

The harmless disposal of MSW is important to build a resource-saving and environment-friendly society, reduce pollution, improve the living environment and level of ecological civilization, and achieve scientific urban development [2]. In response, Chinese government is seeking more effective ways of MSW disposal. Compared with other MSW treatment technologies, the waste incineration performs best [3], and it is a better waste management option [4]. The application of large-scale incineration technologies is inevitable as landfill areas would ultimately cease [5]. Thus, the waste-to-energy (WTE) incineration plant becomes a good choice in China, which uses incineration to convert MSW to electricity. It makes use of waste resources and transfers them to electricity to achieve waste reduction, recycling and harmlessness, which can meet the requirements of circular economy with significant economic and environmental benefits.

## 2. Literature review

WTE incineration also attracts the attention of some scholars. In technology, the advanced waste incineration technologies and solutions were discussed [6]. Poggio and Grieco [7] studied the influence of flue gas cleaning system on the energetic efficiency and the economic performance of an incineration plant. Their analysis shows that the few advantages of dry technologies can often be lost considering the costs of chemicals and the disposal of products. A review was made on air pollution control systems, among which the main technologies and devices are described and their basic principles, peculiarities, and applications are discussed [8]. Also, Barigozzi et al. [9,10] discussed the performance and optimization of WTE plant with combined wet and dry cooling system. Generally speaking, the technologies are matured and WTE plants should have a good development prospect in China

[11–13]. However, in the past few years, the development status was not satisfactory, with many problems such as high costs and potentially toxic emissions [14]. One reason is that the government takes a supportive attitude to this industry, though. There are many difficulties from other aspects, such as economic, social and technological constraints, etc. Another reason is the inherent characteristics of WTE plants, such as the high initial investments, difficulties in financing, etc.

Economic analysis is necessary and important in this field. A systematic literature review is made which applies economic analysis and theories to the issues [15]. Tooraj Jamasb et al. [16] made a social cost-benefit analysis of WTE in the UK, with the conclusion that meeting the waste management targets of the EU Directive are more cost-effective than the current practice. A performance evaluation was made with the conclusion that useful quantities of fresh water could be so produced by linking two processes with significant saving in fuel consumption, determining relevant economic benefits [17]. Also, techno-economic analyses had also been made to discuss the economic effects [18,19]. WTE plants are highly dependent on MSW treatment fees owing to its high installation, operation and maintenance costs.

Besides, WTE plants have huge environmental benefits and remarkable external benefits [20, 21], and they have great impacts on society and environment [22,23]. Bernadette Assamoi [24] evaluated the environmental performance and discounted costs of incineration and landfill of MSW accounting for waste diversion. He concluded that incorporated incineration performed better environmentally and contributed overall to a significant reduction in greenhouse gas emissions. Ting Tan et al. [25] evaluated the energy and carbon reduction potential for various WTE strategies for MSW based on a low carbon scenario in Malaysia. Their study provides valuable insights for policy decision in MSW management practices with cost effective, energy benefit, environmental protection. Cucchiella [26] believed the correct environmental management could increase the financial performance because waste investments would offer both environmental and economic benefits.

Although some previous studies have involved the analyses of costs and benefits in some countries, there are lacking studies focused on the cost-benefit analysis of China's WTE plants. Based on the latest industry status in China, this paper makes a discussion of this industry from two main aspects. The one is the analysis of external environment from political, economic, social and technological factors. The other one is the discussion of technologies, costs and performances, especially a detailed cost-benefit analysis of WTE plants in China to discuss the economic benefits. Finally, this paper puts forward some policy recommendations as reference for the government.

<sup>1</sup> According to the exchange rate on November 28, 2014.  
1 USD=6.139 CNY, that is, 1 CNY=0.163 USD

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