

# **BUSINESS OPPORTUNITY OF MUNICIPAL SEWAGE SLUDGE TREATMENT IN CHINA**

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## ABSTRACT

This thesis focuses on the industry and market condition of municipal sewage sludge treatment in China. The main issues covered in the thesis are market status, industry competitiveness in Porter's five forces model, market attractiveness, and market segmentation analysis.

The purpose of this thesis is to illustrate and analyze the business opportunity of municipal sewage sludge treatment in China based on sufficient market information and analysis.

The research strategy of this thesis consists of 2 parts: data collection and business analysis. The collected data includes related technology, industry, and market information. The business analysis part includes industry competitive and market attractiveness and segmentation analysis.

Through this study, the segments of this business opportunity analysis are clear. The product segments focus on technology and equipment sales. The targets are wastewater treatment plants, government, sub-contractors. The geographic segments are megacities, eastern provinces, and developed coastal cities in China.

Key words: municipal sewage sludge treatment, China, business opportunity, industry competitive, market attractiveness, market segmentation, technology and equipment sales

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## 1. INTRODUCTION

### 1.1 Background

Virtually all municipalities in China are either constructing or planning to construct wastewater treatment facilities. Some of the larger projects being planned or built are in Beijing, Tianjin, Chongqing, Guangzhou, Shenzhen and Liuzhou. China also is experiencing problems in dealing with municipal waste water sludge, as most wastewater treatment plants developed over the last decade do not have facilities for sludge treatment and disposal. This has created a huge demand for water treatment technologies, sludge treatment and disposal equipment.

In this thesis, the author expands a full view of the business opportunity of municipal sewage sludge treatment in China. This thesis consists of abundant information and data for technology environment discussion, industry condition analysis and market segmentation analysis. In the end, a recommendation chapter based on the author's work experience is provided. In the meanwhile, a practical business opportunity is mapped out.

### 1.2 Research objective, questions, and limitation

With the rapid growth of urbanization and economy, the municipal sewage sludge treatment become to an increasing concern in China. The objective of this thesis is to illustrate and analysis the business opportunity of municipal sewage sludge treatment in China.

Research questions:

By answering the followed research questions, it will help to reach the research objective.

1. What is the market demand?
2. What is the market size for this business opportunity?
3. Who will be the customer?
4. How to enter the market?

Limitation:

As a business opportunity study, it is very important to collect and present sufficient information to the reader, in order to build up and support a systematic business opportunity analysis. But, for a detailed marketing strategy and plan analysis, it needs another study, which is not included in this thesis.

### 1.3 Research methodology

In 11<sup>th</sup> Five-year plan (2006 – 2010) of China, the China central government first time put municipal sewage sludge issue on the table as a national concern. With a constant attention in the new Five-year plan, the central government of China increased investment plan in wastewater treatment industry with municipal sludge treatment issue involved. To find out and extract the business opportunity in sludge treatment industry, it may have a significant meaning for stimulating the growth of this industry.

The research strategy of this thesis consists of 2 parts: data collection and business analysis. The collected data includes related technology, industry, and market information. The business analysis part includes industry competitive and market attractiveness and segmentation analysis.

The secondary data are mainly from books, journals, and the internet sources. The primary data collected in the field research includes photos, data through interview with stakeholders.

#### 1.4 Thesis structure

The first chapter is the introduction part of this thesis. It gives the background information about this thesis, such as the purpose of study and research method. This chapter likes a guide, which indicates the objective of the thesis and research questions.

The Chapter 2 is technology environment discussion part, which introduced the general technology background to the reader. Chapter 3 pictures a market size with potential of the business opportunity. The objective of these 2 chapters is that providing sufficient information for the reader to understand the business background.

The Chapter 4 is the industry condition analysis. It takes a close look to the inside of the industry, in order to understand the business environment. In this chapter, the reader will get to know the structure and industry and also the stakeholders.

The Chapter 5 gives a further analysis of the business. From there, it is clear about product, market, geographic segments of the business opportunity we talk about in this thesis.

The Chapter 6 – conclusion.

## 2. WHAT IS MSST?

MSST is the abbreviation of Municipal Sewage Sludge Treatment. To understand how MSST works, firstly, we should take a close look at “Where does Municipal Sewage Sludge (herein after referred to as the “MSS”) come from?” before we are getting to know “How to treat MSS?”

### 2.1 Where does MSS come from?

Sewage is the mix of water and whatever wastes from domestic and industrial life, and flushed into the sewer. Because of the wastes are inside of the sewage, to retrieve the water, the sewage must be treated or “cleaned” in wastewater treatment plant (herein after referred to as the “WWTP”) (sludgenews.org, 2011). In theory, WWTP suppose to take out all the “wastes”, which are inside of sewage. During the process, the “wastes” are removed from sewage by primary, secondary, or tertiary treatment and finally concentrated into the sludge.

In short, MSS is the residue that accumulates in urban WWTP.

### 2.2 The characteristics of MSS

Sludge originates from the process of treatment of waste water. Due to the mechanical, biological and chemical processes involved in the treatment, sewage sludge obtained as a byproduct reflects the chemical composition of the treated sewage. But, the composition of sewage itself is determined by the industrial wastewater inflow to the treatment catchment. Quantitative and qualitative composition of the sewage sludge is very complicated. It is rich in organic matter, nitrogen, phosphorus, calcium, magnesium, sulphur and other microelements necessary for plants and soil fauna to live. So it is characterized by the large manurial and soil-forming value. Except the indispensable elements to live, sludge can contain



toxic compounds (heavy metals, pesticides) and pathogenic organisms (bacteria, eggs of parasites) (P. Kosobucki, A. Chmarzyński, B. Buszewski\*, 2000. P1).

### Macro-nutrients and heat values

The sludge from municipal WWTPs contains macro-nutrients including organics, nitrogen, phosphorus, and potassium (P. J. He\*, F. Lü\*, H. Zhang\*, L. M. Shao\* and D. J. Lee, 2006, P4). As shown in Tables 1 and 2, sewage sludge contained more organics, nitrogen and phosphorus than manures, as the latter usually used as fertilizer for farming.

Table 1: Contents of macro-nutrients in sludge from 43 WWTPs in Jiangsu Province (Jiangsu Province Government, 2006)

Waste	pH	EC ( $10^2 \mu\text{S cm}^{-1}$ )	VSS (%)	Organics ( $\text{g kg}^{-1}$ )	TN ( $\text{g kg}^{-1}$ )	TP ( $\text{g kg}^{-1}$ )	TK ( $\text{g kg}^{-1}$ )	Water content (%)
Sludge	7.31±0.57	0.60±0.34	50.8±13.2	404±129	36.0±13.2	16.1±7.3	3.7±1.6	79.7±4.9
Pig manure	–	–	–	250	4.5	0.8	5.0	–
Cattle manure	–	–	–	203	3.4	0.7	3.3	–
Horse manure	–	–	–	254	5.8	1.2	4.4	–
Sheep manure	–	–	–	318	8.3	1.0	5.6	–
Organic fertilizer					0.4–1.0	1.5–3.0	0.9–1.7	

Table 2: Macro-nutrients and heat value of sludge from 8 WWTPs in Shanghai City (Shanghai City Government, 2006)

WWTP	Minhang	Songjiang	Caoyang	Beijiao	Tianshan	Shidongkou	Quyong	Bailonggang
Organics ( $\text{g kg}^{-1}$ )	702	653	765	660	729	616	774	564
TN ( $\text{g kg}^{-1}$ )	52.1	54.4	58.9	62.1	65.2	50.8	60.6	28.6
TP ( $\text{g kg}^{-1}$ )	16.9	31.1	19.9	27.1	22.5	28.9	21.5	25.5
TK ( $\text{g kg}^{-1}$ )	4.44	5.37	2.64	4.23	6.77	9.2	4.7	5.2
VSS (%)	59.8	50.6	64.2	52.6	59.0	49.3	61.6	47.6
C (%)	36.8	32.4	42.2	32.0	34.4	27.4	38.2	23.5
Cl (%)	3.55	2.23	2.77	1.55	3.03	2.60	0.34	0.07
S (%)	1.60	1.95	1.59	1.87	1.46	0.91	0.35	0.46
Water content (%)	87.3	81.4	79.0	86.9	84.8	77.3	84.0	73.0
High heat value ( $\text{kJ kg}^{-1}$ )	22000	18700	25200	17100	19400	13400	24100	11600
Low heat value ( $\text{kJ kg}^{-1}$ )	1380	2130	2740	1380	1810	2540	2260	2890

## Heavy metals

Tables 3 and 4 list heavy metal contents in sewage sludge collected in Jiangsu Province and Shanghai City. All heavy metals and As had the potential to surpass the limits for agricultural use. In summer, the concentrations of Pb, Cr, Ni, Cu and Zn were higher than those in winter except for Cd (data not shown). It could be attributed to better treatment efficiency in summer. The investigation shows that the WWTPs with higher heavy metals in sludge usually accept more industrial wastewater (P. J. He\*, F. Lü\*, H. Zhang\*, L. M. Shao\* and D. J. Lee, 2006, P5).

Table 3: Heavy metals and As in sludge from 43 WWTPs in Jiangsu Province (Jiangsu Province Government, 2006)

Heavy metals, mg kg <sup>-1</sup>	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Min	0	0	29.8	105	0	19.7	39.3	356
Max	71.0	248	4130	13700	7.90	3420	740	8120
Median	2.25	5.09	74.9	288	2.68	63.8	91.3	1060
Average	5.86	10.9	302	1180	2.75	193	126	1370
Standard deviation	14.5	35.0	648	2440	1.75	530	134	1230
Standard value <sup>*</sup> Soil pH<6.5	75	5	600	800	5	100	300	2000
Standard value <sup>*</sup> Soil pH≥6.5	75	20	1000	1500	15	200	1000	3000

\* GB18918–2002

Table 4: Heavy metals and As in sludge from 11 WWTPs in Shanghai City in 2006 (Shanghai City Government, 2006)

Heavy metals, mg kg <sup>-1</sup>	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Quyong WWTP	5.68	0.85	15.8	350	1.22	34.8	9.95	<b>3740</b>
Wusong WWTP	2.32	0.10	3.74	226	1.12	65.2	7.27	149
Longhua WWTP	1.51	0.19	1.13	101	0.19	17.3	0.95	1370
Caoyang WWTP	15.0	<b>5.55</b>	70.0	146	<b>6.04</b>	42.9	129	147
Tianshan WWTP	22.0	1.49	46.6	426	<b>7.81</b>	42.6	116	1620
Minhang WWTP	7.10	1.67	53.4	119	2.16	32.2	76.0	1090
Beijiao WWTP	33.4	2.52	22.0	158	<b>9.25</b>	44.6	108	<b>2470</b>
Zhuyuan WWTP	14.9	3.00	74.8	341	2.28	51.0	67.3	1070
Bailonggang WWTP	12.9	2.36	265	497	2.80	70.5	46.5	<b>2360</b>
Songjiang WWTP	18.6	1.10	115	269	0.38	40.5	25.9	1610
Shidongkou WWTP	20.3	<b>7.00</b>	<b>2030</b>	569	0.24	65.0	109	<b>2160</b>

### Organic micro-pollutants

Organic micro-pollutant contents listed in Table 5 for sewage sludge should be considered preliminary. The organic content, nitrogen, phosphorus and potassium in sludge meet the requirements for agricultural use. However, heavy metals are still the matter of concern. By stringent pollution control of industrial wastewater, the risk introduced by heavy metals can be reduced. Organic micro-pollutants like endocrine disrupters are new emerging considerations. Case studies showed that the risk from micro-pollutants could be limited when less industrial wastewater was mixed into the municipal sewage. It is commonly agreed that the principal problem related to sludge characteristics is too high moisture content of dewatered sludge. (P. J. He\*, F. Lü\*, H. Zhang\*, L. M. Shao\* and D. J. Lee, 2006, P6)

Table 5: Micro-pollutants in sludge (mg kg<sup>-1</sup>) (Jiangsu Province Government, 2006)

Pollutants	Ether	Chlorobenzene	Nitrobenzene	Amine	Halo hydrocarbon	PAEs	PAHs	Benzo[a]pyrene
Value	1.66	0.77	4.49	0.227	0.222	23.4	15.7	0.024

### 2.3 MSS treatment and disposal

In accordance with above mentioned composition of sewage sludge, sludge is qualified as a waste material. It must be proper treated in a systematic way, which includes prevention of formation of waste material or minimize their quantities, removing the waste material from the formation place, and also utilizations or neutralization of waste material in such a way that assures the protection of life and health of people and protection of the environment (P. Kosobucki, A. Chmarzyński, B. Buszewski\*, 2000. P1). Figure 1 shows the overall treatment process of sewage sludge.

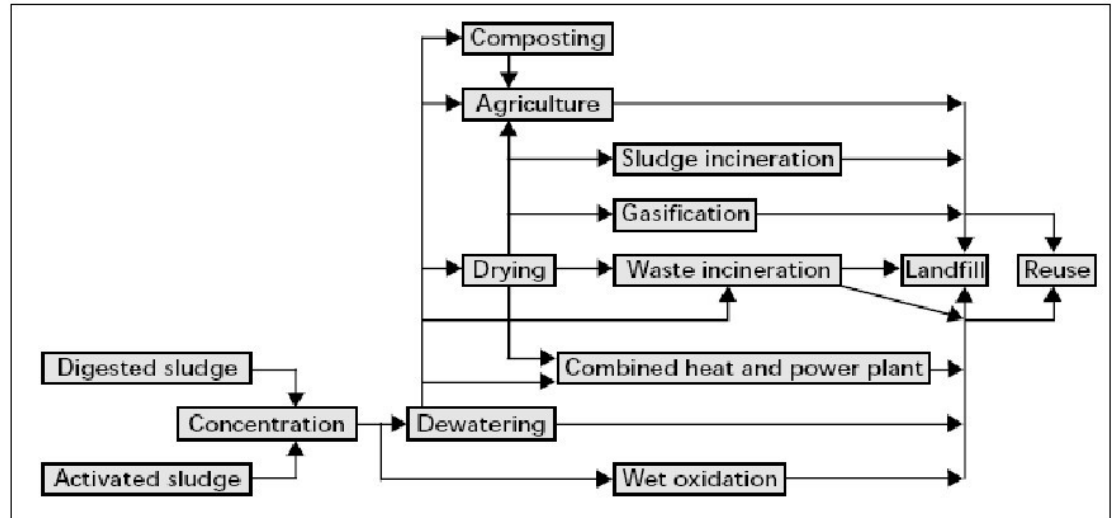


Figure 1: Major treatment process of sewage sludge (FECC, 2006, P42)

### 2.3.1 Selection of sludge treatment methods

The Figure 2 shows that composting and environmental utilization are two most preferred ways of sludge management and simultaneously these two groups of processes vary from the economical point of view. The composting is more expensive and environmental utilization is one of the cheapest methods of neutralization of sewage sludge (P. Kosobucki, A. Chmarzyński, B. Buszewski\*, 2000. P2).

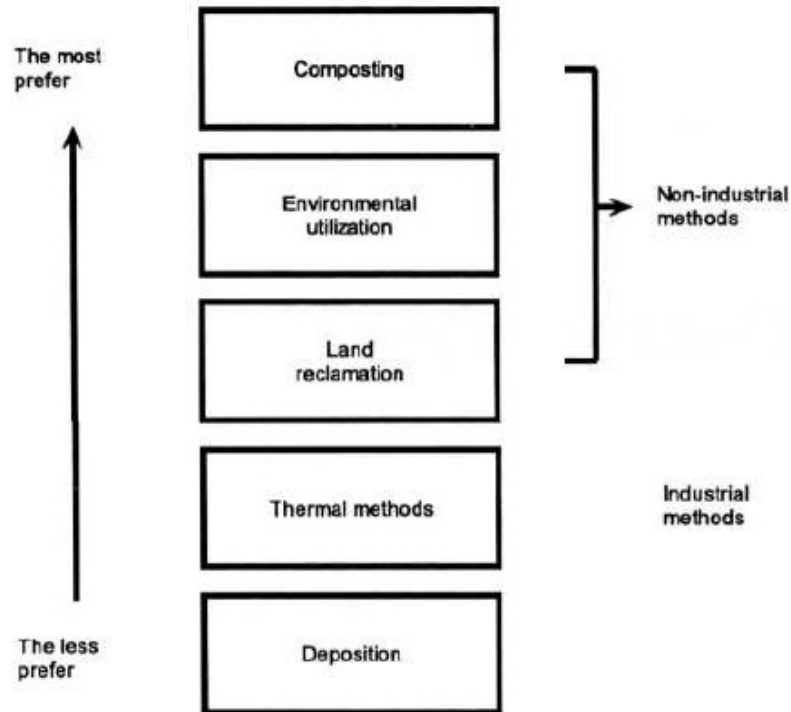


Figure 2: Management of Sewage Sludge

In the present, sewage sludge treatment methods are described, with special attention for non-industrial methods of neutralization of the sewage sludge.

### 2.3.2 MSST in China

In the early 1980s, the first sewage treatment plant, Tianjin Municipal Sewage Treatment Plant, was built and put into production. At that time the sludge was used for farming by farmers from the nearby countryside. Little attention was paid to the control or management of the physics/chemistry indices and odour. Pathogenic bacteria, heavy metals and toxic organic compounds were contained in the sludge from the beginning. The overall situation is now giving priority to the sludge applications structure and sludge will be used for agriculture in China. Figure 3

shows the proportion of several sludge treatment technologies in China (FECC, 2006, P41).

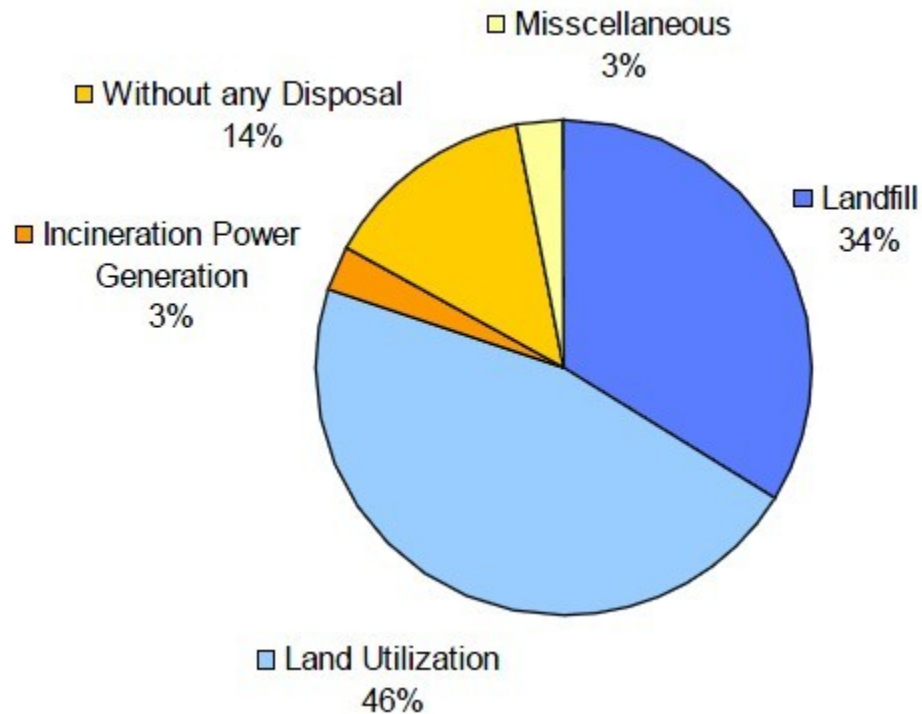


Figure 3: Sludge treatment technologies in China (FECC, 2006, P41).

Sewage sludge is largely produced by municipal WWTP; little of it is generated by the wastewater treatment plants from industrial factories. See in the Figure 3, MSS disposal has serious problems. There is 14% of sludge still without disposal in any means. This will bring huge environmental pollution hazards.

In past years, many Chinese cities' master plans did not include sludge disposal sites even there were plans for new WWTPs. Only large-scale WWTPs in some mega-cities carry out sludge stability treatment, while most of the WWTPs have no sludge anaerobic digestion. Generally the sludge is being condensed and dewatered directly and then simply put into landfills.

### **Land/Agriculture Applications**

In a consideration of the economic conditions in China, for most of WWTPs, especially the small-scale plants, the use of sludge for farming is a relatively realistic disposal way. The nitrogen, phosphorus, kalium and microelements in the sludge are good for increasing the yield of crops, and the organic matter and humus in the sludge are good conditioners for the soil. (FECC, 2006, P28)

After being condensed and dewatered properly, the sludge is transported to the suburbs to be used as farm manure. This is the method adopted by many WWTP in China. However, the farmland is fertilized seasonally, so the sludge will create problems because there is a large amount when it is not needed and this will affect the normal operations of the WWTPs. Some plants will then pay farmers to move the sludge away without asking where the sludge will be transported, which may causes secondary pollution. (Mr. Sun Yanbin, 2011)

### **Landfill**

A large quantity of MSS needs to be disposed and dumped into the waste landfill plants as another option. Most dewatered sewage sludge is open dumped or landfilled with municipal solid waste. Many municipal sanitary landfills set special zones to landfill the MSS. But, in a consideration of the compositions of MSS, most of MSS are not safely applied in land. In case, due to high water content of dewatered sludge (normally as 80%–85%), the sludge has too poor strength to be accepted by landfills (Mr. Li Mingyu, 2011).

### **Dewatering and Drying**

The simple drying like to expose the sludge to the sunlight after simple dewatering in a mechanized way is widely applied in the most of WWTPs in China. Figure 4 shows the treated sludge under the “simple” treatment. However, the thermal stabilization technique is increasingly becoming an important treatment method for the MSS, especially in the eastern cities with developed economies.



Figure 4: Treated sludge in Laogang base Shanghai, July 2011

Shidongkou Municipal Wastewater Treatment Plant (Figure 5) in Shanghai has sludge incineration equipment in its sewage plant which was constructed in 2003. The design capacity is 0.4 million m<sup>3</sup>/d. The plant uses an integrated activated sludge process with dephosphorization and denitrogenation functions as the sewage treatment technology. It treats the MSS which contains a great deal of industrial wastewater with a large amount of chemical, medical and dyeing waste water. The sludge generated is 64 t/d of dry solids. The water content after dewatering is 70% and the sludge volume is 213 m<sup>3</sup>/d (dowater.com. 2011).





Figure 5: Shidongkou Municipal Wastewater Treatment Plant, 26<sup>th</sup> of July 2011

The drying and incineration joint treatment technology in this plant adopts the series of operations of low-temperature drying- high-temperature incineration. These two systems adopt foreign technology while being locally manufactured. The sludge drying and incineration equipment required a gross investment of CNY80 million and has now been put into operation. The sludge dewatering and drying technology can reduce water content from 70% to 10% (5% at the lowest) by adopting fluidized bed drying technology. Incineration refers to incineration of the dewatered sludge in the circulating fluidized bed incinerator and recycling the heat in the flue gas in the form of transfer oil (or steam), and the reclaimed heat is used for the drying system. (dowater.com. 2011)

### **Summary - MSST in China**

Nevertheless, the awareness of MSST management is rising up in China. The 11<sup>th</sup> five-year plan 2006 - 2010 put the MSST issue on the table for the very first time. National regulations are promulgating the construction of treatment plants for sludge,

including drying, composting, incineration, and brick manufacture as one way to utilize the treated sludge.

However, it is not realistic to search for a universal or master solution for MSST issue in China. Optimal solutions for local need require customized design and consideration. Different sludge management strategies with hierarchic structure should be evaluated, with regard to the economic level, climate, city planning, social concerns, and so forth.

### 3. CHINA MSST MARKET STATUS

Sewage sludge is an increasing concern in China, because of the extended sewerage control and advanced wastewater treatments resulting from urbanization and economic growth. Based on the evolution of municipal sewage generation and treatment technologies in the last decade, as well as the long-term national and local plans in China, the MSST business has a considerable market potential for global players.

#### 3.1 Market size

It is estimated that sludge volume (dry weight) discharged by Chinese urban WWTPS is about 1.3 million tons annually. With an annual growth rate of more than 10%, especially in those cities and regions with a higher level of urbanization, sludge discharge problems have already become very prominent. If all of the municipal sewage has been treated, it will generate 8.4 million tons of sludge (dry weight), accounting for 3.2% of total MSW in China. Figure 6 shows the annual waste water treatment volumes from 2000 to 2013. The figure also covers includes the discharge from industrial sector. (FECC, 2006, P35)

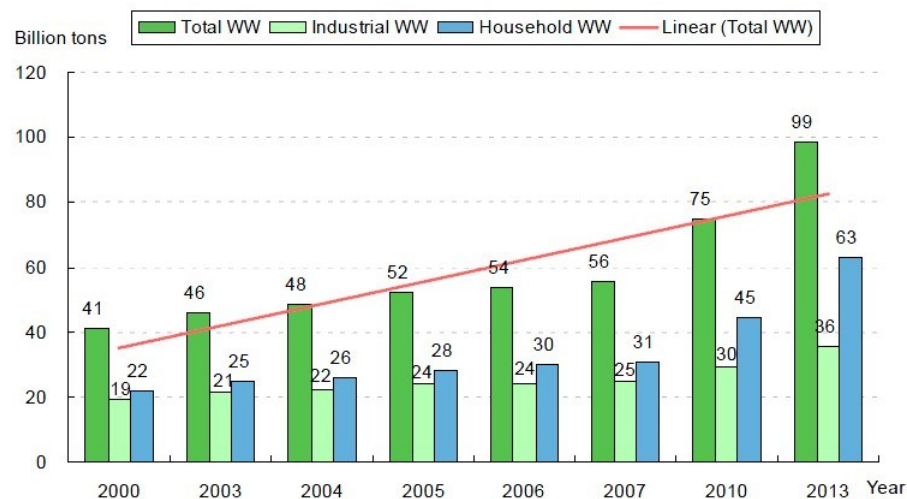


Figure 6: China wastewater discharge 2000 – 2013 (National Bureau of Statistics of China 2008)

According to the statistics, 1 000 tons of waste water will produce approximately 1 ton of sludge (water content 80%) (dowater.com, 2011) resulting in a total estimated sludge volume of 9.9 million tons (water content 80%) in 2013. But, under the current treatment condition, how to handle that amount of sludge is an increasing concern in China.

Sludge disposal has only been paid close attention in the past few years. The major popular treatment method is land application, which accounts for about 46% (see in Figure 3) comparing with other disposal methods, i.e. incineration, landfill. However, in China about 14% of sludge is still left without any treatment. Figure 7 shows field photo of sludge dump in China:



Figure 7: Sludge dump in Jiangsu Province, July 2011

In recent years, people have gradually realized the danger of municipal sewage sludge and begun to pay attention to the ultimate disposal problem. The use of land for sludge disposal still creates a secondary source of pollution to the environment and the country is still looking for an efficient and effective solution. The demand volume for sludge disposal is tremendous. The other emerging problem is land consumption for sludge landfill. Specially, in megacities and developed area, despite the high cost of land use the shortage of land is the real major prominent problem for every industry.

In recent years, sludge incineration plants have been built at an increasing rate in some well developed cities, which has created a new trend. Some big cities such as Beijing, Shenzhen, Chongqing and Shanghai have developed a specific sludge management plan. The demand for advanced technology and equipment of MSST is vast in China.

### 3.2 Market competition

As mentioned in the Chapter 2, China is basically adopting landfill and land utilization for their MSST. Apart from a few large-scale WWTPs that were built with anaerobic sludge digestion facilities, the others are basically without centralized collection and processing. Therefore, although MSST has a huge market potential, it is still in its infancy. The number of foreign enterprises entered this market are relatively the minority. The most of WWTPs are still controlled by local authorities and some water utilities groups with wastewater treatment business involved. These water utilities giants were originally formed and currently supported by the government. The industry structure is shaped and the competition in the industry so far is still at a stable and moderate level, but, it is changing.

Companies operating within this industry compete with each on technology levels, service range and quality, price, and government relationships.

**Technology levels**

Enterprises that possess core technologies for MSST will have significant competitive advantages over their competitors. This is because of some MSST solutions, like composting, incineration, land application etc. require advanced technology levels and equipments. At present, there are only no more than 25% of WWTPs in China have the proper sludge treatment process line.

**Service range and quality**

In addition to the new sludge generated everyday in WWTPs, the volume of existing created sludge is also huge. The local authorities and WWTPs have capacity shortage to handle the remaining sludge. Enterprises that can provide a full package of services and solution from planning to implementation and outcome assessment are more likely to win tenders for MSST projects, which are usually funded by governments and WWTPs. Service quality is also very important, as it is closely related to reputation and brand image of the enterprises. To help local government and WWTP to solve the leftover problem may help the enterprise to win credits for the further cooperative projects.

**Price**

The price of sludge treatment is set by regional authorities. In one region, there is not much price competition on sludge treatment service among the WWTPs. But, to treat one ton of sludge under a proper way in China, the cost is about over 200 RMB (see in Table 8). Then, it is very obvious, with a fixed sludge treatment price set by the government the only way for WWTP to keep a good profit margin is to reduce the treatment quality. But, the improper treated sludge will catch the attention from the society and government, the corporate social responsibility issue is not WWTP want to confront about. Naturally, the “mercenary” who can solve the problem is need. In fact, there are such subcontracting firms to take care of the business with the lower offer from the WWTP.

Figure 8: Sewage and sludge treatment costs in China (State Key Lab of Urban Water Resource & Environment, 2009)

<b>Manner</b>	<b>Costs ① (RMB / t sludge)</b>	<b>Costs ② (RMB/t sewage)</b>	<b>Current situation</b>
<b>Discard</b>	<b>15</b>	<b>0.01</b>	<b>using</b>
<b>Landfill</b>	<b>40</b>	<b>0.03</b>	<b>Difficult</b>
<b>Simple compost</b>	<b>70</b>	<b>0.05</b>	<b>using</b>
<b>Mechanized compost</b>	<b>120</b>	<b>0.09</b>	<b>trying</b>
<b>Heat drying</b>	<b>220</b>	<b>0.17</b>	<b>few</b>
<b>Incineration</b>	<b>&gt;220</b>	<b>&gt;0.17</b>	<b>few</b>

In this case, it is very easy to understand that there is a very intense price competition among the sludge treatment sub-contractors and equipment suppliers. Unlike the decent WWTP has constant financial support and favorable policy from the government, most of the Chinese companies in sludge treatment industry have the similar technologies and at similar service quality level, owing to the lack of capital and human resource, which are the crucial elements for technology research and improvement. Thus low price is the only way to over perform the other competitors.

### **Government relationships**

Since most environmental projects and resources are dominated by the government, enterprises with stronger governmental background or with better government relationships usually have more chances to obtain contracts and increase revenue.

### 3.3 Major players in MSST industry

#### **Domestic sludge treatment companies**

China now suffers a severe lack of municipal sludge treatment facilities, and a majority of sewage treatment plants have no digestion facilities at all. In many cities, raw sludge is directly transported to landfill sites, causing operational difficulties in the landfills and incredible environmental pollution problem.

The sludge disposal projects have to face such problems as investment and operation costs. Taking the sludge drying and incineration as an example, the sludge treatment cost per ton is more than 200 RMB, which is a heavy burden for the less-developed regions.

In the sludge treatment sector, some companies have accessed China recently, and a certain degree of competition is just starting to take place. For the overseas companies, the current market opportunity is already reasonably mature.

#### **Foreign companies**

Basically, foreign companies in China's sludge treatment market carry out the business of sludge drying. The well-known companies of those are Vomm Impianti e Processi Srl and Andritz Fliessbett Systeme GmbH, Germany.

##### 1) Turbine sludge drying technology of Vomm Impianti e Processi Srl

Vomm Impianti e Processi SPA (VOMM) is an important supplier in terms of the world's sludge drying treatment equipment and has nearly 20 years of experience in sludge and wet waste treatment. Turbine drying equipment of VOMM Company has been running successfully for more than 10 years in dozens of sewage treatment plants in Italy, France, and Germany, Spain and the US and other countries. (vomm.it, 2011)

##### 2) Germany Andritz Fliessbett Systeme GmbH fluidized bed drying system

The fluidized bed sludge drying system of Germany's Ravensburg Company uses a direct sludge feed design, which features sending the sludge directly into the fluidized bed dryer, without any treatment. (andritz.com, 2011)



## Chinese research organizations and universities

Most of the Chinese research organizations are operating in the form of company. They are doing research and development of technology and products, and sell them as well. In the other way, they are also involved in national project with the budget from the government. There are Chinese universities owning schools and departments involved in research and develop (herein after referred to as the “R&D”) of wastewater technology. Some universities have their own R&D centers or key laboratory. Some universities cooperate with other companies and research organizations to set up a company to deal with R&D.

Table 6: Some Chinese major research organizations (Qin Zhou Road, 2009. P11)

Name	Location	Classification	Homepage	Brief Introduction
Development Center of Water Treatment Technology	Hangzhou, Zhejiang	City level	<a href="http://www.chinawatertech.com/english.shtml">http://www.chinawatertech.com/english.shtml</a>	<ul style="list-style-type: none"> <li>·The Development Center of National Liquid Membrane Separation Engineering &amp; Technology Research;</li> <li>·China production base of liquid separation membranes and modules.</li> <li>·The backing unit of Chinese Seawater Desalination and Water Reuse Society and Zhejiang Province Membrane Society;</li> <li>·State Equipping Center of Purifying Water Technology and Equipment;</li> <li>·State base for research &amp; development, fruit transfer and production of separation membrane, and academic exchange center both at home and abroad.</li> </ul>
Xuzhou Research Institute of Water Treatment	Xuzhou, Jiangsu	City level	<a href="http://www.xzwater.com/en/about.htm">http://www.xzwater.com/en/about.htm</a>	A professional company that specialized in researching and developing various kinds of water treatment technologies. It was founded at 1984, it had supplied about 1000 enterprises nationwide with various kinds of water treatment technical services. Product covers Ion Exchange Resin, Water Treatment Equipment, Water Treatment Medicament, Padding and Fittings of Water Treatment Equipment
China Industrial Water Treatment Research Center	Tianjin	State level	<a href="http://www.ciwt.cn">http://www.ciwt.cn</a> (no English version)	Established with the approval of the Ministry of Science and Technology, dealing with technology research of water treatment, chemical agent production with a capacity of 20000tons/year
Water Treatment and Water Environment Restoration Research Center of the Ministry of Education	Nanjing, Jiangsu	Provincial level	<a href="http://hjxy.nju.edu.cn/files/organization/xfzx.htm">http://hjxy.nju.edu.cn/files/organization/xfzx.htm</a> (No English Version)	Approved by the Ministry of Education, focuses on the technical innovation of wastewater treatment, water restoration and water efficiency.
Chengdu Jini Water Treatment Equipment Research Institute	Chengdu, Sichuan		<a href="http://www.chinagenii.com">http://www.chinagenii.com</a> (No English Version)	Belongs to Sichuan Yuyang Environment Engineering Co., Ltd., focuses on research and development of wastewater treatment engineering and equipment. Supplying reverse osmosis membrane water treatment equipment, buried sewage treatment equipment, water reclamation equipment and integrated service
Nanjing Water Treatment Engineering Technology Center	Nanjing, Jiangsu	City level	<a href="http://www.njust.edu.cn/site/huayuan/zhongxing5.htm">http://www.njust.edu.cn/site/huayuan/zhongxing5.htm</a>	Research fields: chlorine dioxide for sanitary water and wastewater treatment; corrosion and scale inhibitors and bactericidal algicide deal for recycle water; cationic polyquaternium for sanitary water, wastewater and sludge dewatering; dealing with waste water difficult to degrade, slightly polluted water

Table 7: Universities involved in wastewater treatment (Qin Zhou Road, 2009. P11)

Name	Location	Homepage	Brief Introduction
Department of Environmental Science and Engineering, Tsinghua University	Beijing	<a href="http://env.tsinghua.edu.cn/Eng/Research">http://env.tsinghua.edu.cn/Eng/Research</a>	Wastewater treatment and reclamation <ul style="list-style-type: none"> <li>• High efficient bioreactors and their principles</li> <li>• Membrane bioreactor and fouling control</li> <li>• Energy-saving N and P removal processes</li> <li>• Novel processes based on molecular biological theory</li> <li>• Eco-technologies and enhanced principles</li> </ul>
College of Environmental Science and Engineering, Tongji University	Shanghai	<a href="http://sese.tongji.edu.cn/College/english">http://sese.tongji.edu.cn/College/english</a>	Its Institute of Water Environment Rehabilitation s now focusing on the following research fields: the mathematical and physical modeling of surface water environment and ecological water treatment process; the ecological treatment engineering technologies of agricultural production and rural domestic pollution; regional environment planning, environmental standards and policies.
School of the Environment, Nanjing University	Nanjing, Jiangsu	<a href="http://hjxy.nju.edu.cn/en_wbe/eng">http://hjxy.nju.edu.cn/en_wbe/eng</a>	<ul style="list-style-type: none"> <li>• High-concentrated and Hard-degraded Toxic and Organic Waste Water Treatment</li> <li>• Clean Production Technology</li> <li>• Waste Water Treatment Project</li> <li>• Stratagem on Water Pollution Control</li> </ul>
Nanjing University of Science and Technology	Nanjing, Jiangsu	<a href="http://www.njust.edu.cn">www.njust.edu.cn</a>	Please refer to Nanjing Water Treatment Engineering Technology Center in Table 4, which is affiliated to NJUST
Wuhan University	Wuhan Hubei	<a href="http://sdsy.whu.edu.cn/sdxy">http://sdsy.whu.edu.cn/sdxy</a>	Owns 1 State Key Laboratory of Water Resources and Hydropower Engineering science and 4 provincial key laboratory
College of Environmental and Resource Sciences, Zhejiang University	Hangzhou, Zhejiang	<a href="http://www.cers.zju.edu.cn/">http://www.cers.zju.edu.cn/</a>	The school owns the Key Lab of Ministry of Education (Laboratory of Remediation of Polluted Environment and Ecological Health), and the Research Center of Environmental Technology. Research Center of Membrane and Water Treatment is affiliated to Zhejiang University, please refer to Table 4

#### 4. CHINA MSST INDUSTRY CONDITION

In a consideration of the subordination of wastewater treatment to MSS, the China MSST industry condition discussion in this chapter is somehow involved in a study in wastewater treatment industry.

As there are a bundle of incentive plan and updated regulations given for wastewater treatment from the central government of China in these years, this industry condition discussion have a significant meaning for the companies have interested in MSST business to set up their business strategy in China.

##### 4.1 Porter's five forces analysis

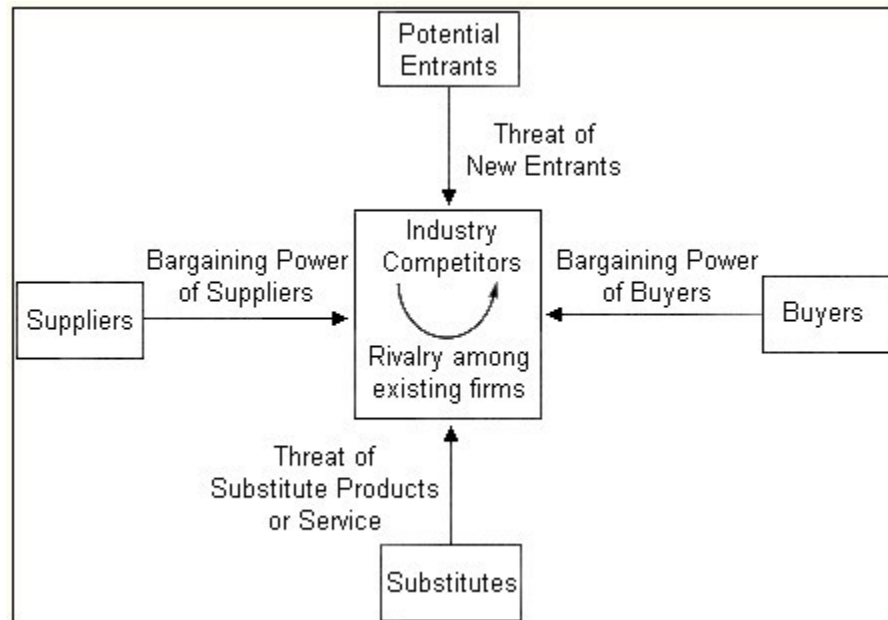


Figure 9: Michael Porter's five competitive forces model (12management.com, 2011)

The Five Forces model of Porter is an Outside-in business unit strategy tool that is used to make an analysis of the attractiveness (value) of an industry structure. (12management.com, 2011)

### **Threat of new entrants – Very limited**

Figure 8 shows there are 57 WWTPs under construction in China 11<sup>th</sup> Five-year plan. The total amount of WWTPs planned to be built up in 2 Five year plans are 135 plants. With the government favorable policies for wastewater treatment industry, this huge amount of WWTP construction is attracting many companies to take part in the China wastewater treatment business.

Table 8: Construction plans for WWTPs

Year	Budget (\$ billion)	Number of Plants	Capacity (million m <sup>3</sup> /day)
2001–2008	1.17	78	3.785
2009–2013	0.77	57	2.905
Total	1.94	135	6.690

(PRC, State Environmental Protection Administration, December 27, 2002)

However, as mentioned, due to the feature of wastewater treatment industry, the competition pattern has shaped. Most of the new players entered this industry through joint venture and merge & acquisition with capital strength or advanced technologies as the only way to join this business. The most of resources are still controlled by the WWTPs.

### **Threats of substitute of products or service - None**

The products of wastewater treatment are cleaned water and well processed sewage sludge. So far, there is no substitute could replace the function of WWTP in wastewater and sewage sludge treatment sector.

Moreover, the level of wastewater treatment industry volatility is low. As long as our society is still producing sewage, the wastewater treatment industry will exist. Actually, with the urbanization and economic growth, the municipal wastewater treatment industry has a considerable potential for further development.

### **Bargaining power of suppliers - Strong**

Most of WWTPs in China are lacking of proper technology and facility to against the increasing demand of municipal wastewater treatment.

For the MSST sector, the supplier of advanced technology and equipment for sludge incineration, stabilization and dewatering has a strong bargaining power.

### **Bargaining power of buyer - Weak**

The buyer of wastewater treatment is private and corporation user. But, the price of sewage and sludge treatment is set up by the government and local authorities.

In a consideration of people's need, the pricing of sewage treatment for private user is under a restrict monitor and control undertook by government or local authority. Thus, the bargaining power of private user of sewage treatment in China is fair.

But, for corporate user, the government has a complicated system to assess the formation and amount of the sewage they produced. According to the assessment, the cost of sewage treatment will be charged. The bargaining power of corporate user of sewage treatment in China is weak.

### **Intensity of rivalry – Increasing**

The main players in wastewater treatment industry are those water utility groups who have business involved in wastewater treatment. In a comparison with these water utility group giants, the companies only focus on wastewater treatment are rather small. They are mainly small or medium sized companies. Due to the regional feature of wastewater treatment industry, the competition among existing players is at a moderated level.

But, with the urbanization and economic growth, the municipal wastewater treatment has become to an increasingly concern. There is a huge demand of advanced technology and equipment on the market. The wastewater treatment industry has entered a capital and brand competition era. The small and medium sized companies

with the concentration in the wastewater treatment also have the opportunity to build up the reputation in the industry. The old competition pattern is collapsing.

## 4.2 Taxation

### **Corporate Income Tax**

Corporate Income Tax Law of the People's Republic of China was implemented from January 1, 2008. It unified the previous various income tax policies for foreign and domestic enterprises. Within the new system, income taxes are levied on both domestic and foreign enterprises at a rate of 25%, with favorable tax rates applicable to high-technology enterprises (15%) and small-sized domestic enterprises (20%). Enterprises engaged in infrastructure construction, public transportation, energy generation and environmental protection projects are exempt from income tax for three years after establishment, and only have to pay half of the taxable amount in the following three years. (chinalawblog.com, 2011)

The new system exempts enterprises investment in research and development activities by calculating the taxable income. The aim is to enhance the general R&D level of all enterprises in China. The system also provides a five-year transition period for foreign enterprises to adjust. This is to maintain FDI (Foreign Direct Investment) in China. (chinalawblog.com, 2011)

More important is that, the implementation of this new income tax system might help to create an environment for fair competition, promote industrial restructuring and improve the overall quality of foreign investment in China. It will also encourage investment in environmental protection and R&D.

### 4.3 Rules and regulations

Table 9: Regulations related to sludge management in China (Global Atlas of Excreta, P266)

<b>Code</b>	<b>Title</b>	<b>Level</b>	<b>Category</b>
GB18918-2002	Pollutants Discharge Standard of Municipal Wastewater Treatment Plant in China	National	Discharge control Dewatering
CJ247-2007	Sludge Characteristics of Municipal Wastewater Treatment Plant	Ministerial	Discharge control Dewatering Stabilization
CJ/T239-2007	Classification of the Technologies for Sludge Disposal	Ministerial	Classification of disposal options
<b>Code</b>	<b>Title</b>	<b>Level</b>	<b>Category</b>
GB4284-84	Pollutants Control Standard of Sludge for Agricultural Application	National	Land application
CJ248-2007	Sludge Characteristics of Gardening from Municipal Wastewater Treatment Plant	Ministerial	Land application
CJ/T249-2007	Sludge Characteristics of Landfill with Municipal Solid Waste from Municipal Wastewater Treatment Plant Disposal	Ministerial	Landfill
GB16889-2008	Standard for Pollution Control on the Landfill Site for Domestic Waste	National	Landfill
-	In preparation	-	Construction materials
-	In preparation	-	Incineration
-	In preparation	-	Drying

The quality of sludge before being discharged out of WWTPs was regulated in the “Wastewater and Sludge Disposal Standard for Municipal Wastewater Treatment Plants” (Ministerial Standard No. CJ3025-93), which was replaced by the “Pollutants Discharge Standard of Municipal Wastewater Treatment Plant in China” (National Standard No. GB18918-2002). GB18918-2002 formulated that the sludge had to be dewatered to a moisture content of less than 80% and stabilized. On Jan 29, 2007, a new regulation “Sludge Characteristics of Municipal Wastewater Treatment Plant” (Ministerial Standard No. CJ247-2007) was issued and formulates the pollutants limits of sewage sludge discharged out of wastewater treatment plants.

On Jan 29, 2007, the Chinese Ministry of Construction released a new standard of “Classification of the Technologies for Sludge Disposal” (Ministerial Standard No. CJ/T239-2007). The major disposal manners for sludge in the new standard are classified into four types: land application, landfill, production of usable materials and incineration. (Global Atlas of Excreta, P265)

The land application of sludge was divided into gardening, land reclamation and agriculture application. The rules and regulations related to the land application are “Pollutants Control Standard of Sludge for Agricultural Application” (National Standard No. GB4284-84), “Pollutants Discharge Standard of Municipal Wastewater Treatment Plant in China” (National Standard No. GB18918-2002) and “Sludge Characteristics of Gardening from Municipal Wastewater Treatment Plant” (Ministerial Standard No. CJ248-2007). The standard of “Control Standards for Pollutants in Sludges for Agricultural Use”(GB4284-84) was released in 1984. In this standard, the maximum permissible concentrations of some metals (such as Cu and Zn) are need to be re-formulated. Meanwhile, there is an absence of pathogens in this standard. The aim of “Pollutants Discharge Standard of Municipal Wastewater Treatment Plant in China” (GB18918 2002) is a comprehensive pollutant discharge standard. It therefore lacks specific instructions on land application of sludge. The new standard “Sludge Characteristics of Gardening from Municipal Wastewater Treatment Plant” (CJ248-2007) was released on Jan 29, 2007, and came into effect on Oct 1, 2007 on. It regulates in more detail the characteristics, sampling and monitoring techniques for sludge applied to gardening. The characteristics include sludge appearance, smell, stabilization, nutrition, pathogens, heavy metals, etc. The regulation related to sludge landfill is “Sludge Characteristics of Landfill with Municipal Solid Waste from Municipal Wastewater Treatment Plant Disposal” (Ministerial Standard No. CJ/T249-2007). It regulates the sludge characteristics, sampling and monitoring requirement of landfill operation and landfill covering soil. The detailed requirements are listed in Table 5 and Table 6. When sludge is disposed in MSW landfill site, it should also meet the MSW landfill standard GB16889-2008 (Table 9), which says the moisture content of sludge must be less than 60%. However, at present, in most sewage plants it is above 70%. (Global Atlas



of Excreta, P267) If the above requirements were complied with strictly, the sludge of most of the sewage plants would not be allowed to enter the MSW landfill plants. In some regions, the sludge is still transported into the sanitary landfill plants for landfilling.

#### 4.4 Industry assistance

The Chinese governmental 4 trillion stimulus package has since its issue been a grand investment banquet attracting wide attention. The State Development and Reform Commission announced the investment fields and distribution of the 4 trillion from the 4th quarter of 2008 to 2010 wherein 210 billion were invested in energy saving and emission reduction projects, and ecological projects. Stimulated by governmental investment, more social investment is also focusing on environmental protection fields including water treatment. (The 11th Five-Year Plan of Construction of Urban Wastewater Treatment Facilities and Recycle Facilities)

The investment demand for sludge treatment is 32.3 billion RMB according to the 11<sup>th</sup> five-year plan. In the following 2-3 years the government will allocate 50 billion RMB to support sludge treatment and to build demonstration projects of sludge treatment in the major cities. The market scale of sludge treatment is anticipated to be 3-9 trillion RMB. (China Statistical Yearbook, 2007, China National Bureau of Statistics,)

#### 4.5 Economics

Proportion of annual cost (operational and finance charges) of sewage treatment and disposal attributable to sludge treatment and disposal for a typical works of 100,000 p.e.:

About 30%-50% of the total cost of a WWTP on investment and operation. This value is for a typical works of 100,000 m<sup>3</sup>/d, because the WWTPs of this scale are common in Chinese cities. (Global Atlas of Excreta, P266)

#### Basic data for calculation

- The cost of sewage treatment is 0.40 RMB per m<sup>3</sup>-wastewater (including operation and investment charge).
- The cost of sludge dewatering is 8-12 RMB per m<sup>3</sup>-thickened sludge. (The moisture content decreases from 97% to 80%).
- The cost of sludge disposal in MSW landfill is 40 - 90RMB per ton-wet sludge (moisture content < 80%).

(Jiangsu Province Government (2006). Strategy study on the treatment technologies for sludge from municipal wastewater treatment plant.)

#### Charge to customers for treating 1 cubic meter of sewage:

- The charge for 1 cubic meter of sewage ranges from 0.15 to 1.20 RMB, taking an average of 0.56±0.23 RMB in January 2008 in China.

(China Price Information Network, [www.chinaprice.gov.cn](http://www.chinaprice.gov.cn))

#### Cost of 1,000 liters of diesel fuel

- The cost of 1,000 liters of diesel No. 0 was 5950~6150 RMB in February 2008 in China.

(National Development and Reform Commission of China

<http://www.sdpc.gov.cn/nyjt/>)

#### Cost of one kilowatt hour of electricity

The price of 1 kWh electricity for residential use ranges from 0.38 to 0.76 RMB, taking an average of 0.52±0.06 RMB in January 2008 in China. The electricity used in WWTPs counts as to industrial use, which costs 1.2 to 1.5 times that for residential use. (China Price Information Network, [www.chinaprice.gov.cn](http://www.chinaprice.gov.cn)) For example, the price of 1 kWh electricity for residential use in Shanghai in January 2011 was 0.61RMB from 6:00 to 22:00 and 0.30 RMB from 22:00 to 6:00. The electricity price

for industrial use was 0.666 RMB. (Shanghai Price Information Service Network, [www.wj.sh.cn](http://www.wj.sh.cn))

#### 4.6 Capital and labor intensity

The labor to capital ratio represents the level of labor used for each unit of capital. It indicates the extent of labor usage compared to capital. According to the study conducted by ACMR-IBISWorld, they use total wages of the wastewater treatment industry as a proxy for labor, and depreciation of the current year as a proxy for capital. With a labor to capital ratio of about 2.8:1 in 2010, this industry is subject to a high capital intensity level.

The wastewater treatment industry uses extensive levels of high-technology equipment and facilities. The equipment often is required to be frequently upgraded due to chemical corrosion and long-term wear during the heavy duty operation. Also, companies constantly introduce new equipment and technologies to improve their competitiveness. Therefore, the industry has a high depreciation level.

This industry also employs a large number of well-educated technicians. They are highly paid compared with employees in many other service industries of China. However, their average wages level is still low compared with developed countries, at an expected \$300 per month in 2010. This is due to the relatively abundant human resources in China.

So to say, the wastewater treatment industry with MSST involved has a high level of capital and labor intensity.

#### 4.7 Technology change

The level of technology change is high.

In China, the sludge treatment in WWTPs has been overlooked. The simple thickening and dewatering are basically the only treatments applied in plants. Most of the dewatered sewage sludge from the plants is open dumped or landfilled with municipal solid waste. Because of lacking of advanced facility for dewatering, the water content of the dewatered sludge is too high (80% - 85%). This makes the sludge has too poor strength to be accepted by landfills.

However, with the increasing concern of MSST in China, a deep change is undergoing now. In recent years, the central government of China initiated a Five-year Plan for wastewater and sludge treatment along with updated rules and regulations. For MSS treatment and disposal, there is a huge demand for upgrading of advanced technologies and equipment in regard of sludge incineration, stabilization, and dewatering.

#### 4.8 Globalization

The level of Globalization is low

The trend of Globalization is increasing

This MSST industry is dominated by domestic enterprises, especially private firms and state-owned enterprises. There are only few percent of enterprises in this industry were subject to foreign ownership (ie, wholly foreign-owned enterprises or joint ventures, including investment from Hong Kong, Macau and Taiwan). They are mainly involved within some big scale of technology BOT (Build – Operate – transfer) project in wastewater treatment sector.

Up to the current industry condition, in a long run, domestic companies will continue to dominate the industry. Meanwhile, in a consideration of the domestic companies, which have a vast demand for technology and equipment, more foreign players are expected to enter the Chinese market, bringing advanced technologies and equipments.

#### 4.9 MSST industry stakeholder analysis

Table 10: China MSST industry stakeholder analysis

<b>Stakeholder</b>	<b>Description</b>	<b>Influence</b>	<b>Impact level</b>	<b>Management strategy</b>
Local authorities	Regional government and communities	Supervision and MSST quality control	High	Keep satisfied
National authorities	Ministries and environmental agencies	Rules and price maker	High	Keep satisfied
Wastewater treatment industry	WWTPs, water utility group	MSST operation	High	Manage closely
Facility supplier	Technology and equipment provider for MSST	MSST capacity improvement	Medium	Manage closely
Service payers	Private & corporate user	Main income for MSST	Low	Keep informed

Sub-contractor	Handling MSST project	Supplement for MSST capacity shortage	Low	Keep informed
Organizations	Institution, Nature protection organization, NGO etc.	MSST research and giving advice	Low	Keep informed
Finance sector	Bank and other financing service companies	Provide financing service for wastewater treatment companies	Medium	Keep informed
Agriculture industry	Sludge Land application	Sludge disposal	Medium	Manage closely
Municipal solid waste management industry	Sludge Co-landfill with MSW	Sludge disposal	Medium	Manage closely

## 5. MARKET ANALYSIS

### 5.1 Export market attractiveness

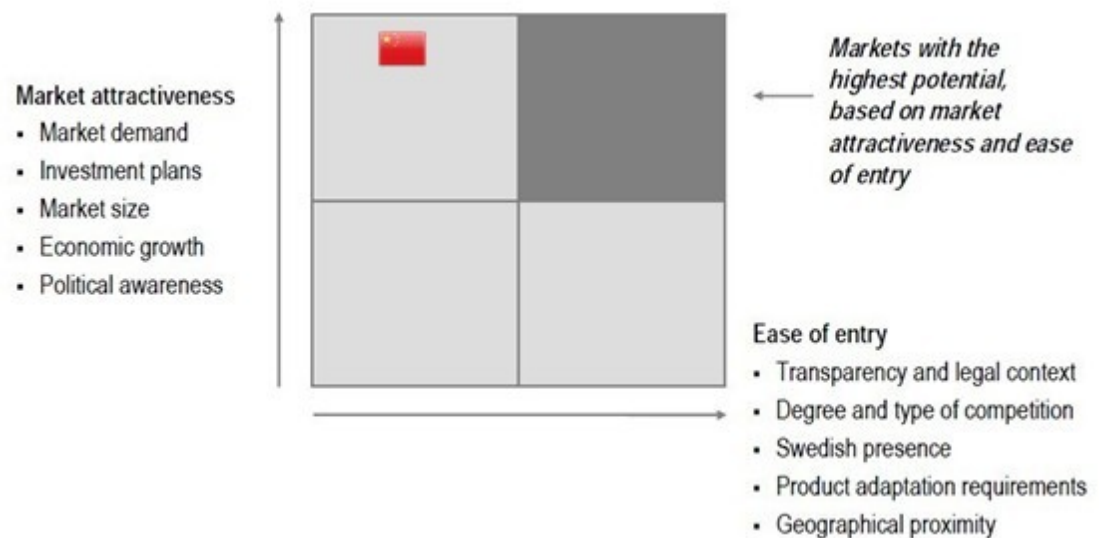


Figure 10: Export market attractiveness of China in MSST industry

Figure 10 shows the market attractiveness of China in MSST industry. It is clear to see, the Chinese market has the substantial demand and opportunities in MSST industry, but, the high barrier to entry is also very obvious.

#### **Market status:**

- The resource and project are still going to be conducted by domestic players, especially the giants of water utilities groups. For new wastewater treatment projects, the opportunity for foreign companies is about BOT (build-operate-transfer) and joint venture with local player to take part in this industry. It is still a niche market for foreign players. But, according to the new policy in taxation, the trend is to open the market for global players in a proper model.

- China is an emerging market for MSST. There was not much investment in wastewater treatment previously. But, with the fast growth of urbanization and economic, the volume of sewage and sludge is increasing dramatically. Many of WWTPs is under construction. The demand for advanced technology and equipment for MSST is prominent.
- In regard of huge regional differences, the further market segmentation and mapping is meaningful.

**Demand:**

- As the increasing concern, MSST is emphasized in the central governmental Five-year investment plan, which is included in environmental programs.
- Currently, the domestic sludge treatment technologies and equipment are basically dependent on imports. As long as the technologies show good results in reducing the waste quantity, implementing safe treatment and effectively utilizing the waste resources, then they will have a promising market in China.

**Challenges:**

- China has a large geographical area. The geographical distance between regional markets will bring the operating and management difficulties.
- Low transparency with economical and political uncertainty. Local players are preferred and also protected by local authorities.
- With the huge demand in MSST, the market is attracting many international players, but the purpose is to absorb the needed technology and investment. How to get the share of profit through the cooperation with the existing players is the biggest question for new comers.

**Potential for:**

- Companies with financial strength in regard of long-term and complex market entry.
- Advanced technology and equipment suppliers.



- Products in mid/low price segment of fast pay-off time

## 5.2 Market segmentation

### 5.2.1 Products segmentation

Increasing sludge volumes are forcing municipalities and industries to seek advanced sludge treatment options. Maintenance and construction of sludge treatment facilities are strong drivers for the growth of the Chinese sludge treatment and disposal market.

Under a consideration of the industry condition, entry to the MSST market is truly difficult in China. It requires great strength on finance, technology and government relationship. Therefore, market segmentation in the sludge treatment and disposal market is done based on the types of sludge treatment technology and equipment are needed in the wastewater treatment facilities. The three main types of sludge treatment technology and equipment include:

- Sludge stabilization unit (anaerobic or aerobic digestion/composting) + incineration system
- Sludge dewatering and drying equipment
- Technique of utilization of treated sludge

#### **Sludge stabilization unit:**

So far, sludge treatment was not considered at the time of design for many of the WWTPs. In China, only 25% of existing plants have sludge stabilization unit.

Therefore, the tremendous amount of sludge becomes the headache for plant owners nowadays. For a typical wastewater treatment plant with 100,000 tons/day treatment capacity, the daily sludge generation can be 70 to 80 tons (P. J. He\*, F. Lü\*, H. Zhang\*, L. M. Shao\* and D. J. Lee, 2006, p6)

But, along with the planning for the current Five-year plan (the 12<sup>th</sup> Five-year plan) from the central government of China, sludge treatment and disposal issue is expected to attract tremendous amount of investment from internal and external parties. For newly built wastewater treatment plants, the sludge treatment facilities have been made mandatory. For the old existing WWTPs without sludge treatment facilities, there is a trend that sludge treatment will be eventually coupled with wastewater treatment plants. This is will be a great market opportunity for the sludge stabilization unit and incineration system. Thus, the sludge stabilization unit and incineration system is also expected to become a key target segment over the next five years.

**Sludge dewatering and drying equipment:**

At present, most of dewatered sewage sludge is open dumped or landfilled with municipal solid waste. "The Disposal of Sludge from Municipal Wastewater Treatment Plant—Sludge Quality for Co-landfilling" specifies that the waste content of sludge in the landfill plant shall be less than 60%, but at present, in most sewage plants it is above 70%. The sludge has too poor strength to be accepted by landfills. If the above requirements were complied with strictly, the sludge of most of the sewage plants would not be allowed to enter the municipal solid waste landfill plants. In this case, the tremendous amount of sludge will have no place for disposal. As the consequence of this situation, before the sludge stabilization unit will be widely armed in WWTPs, advanced sludge dewatering and drying technology and equipment have an urgent need in China.

**Technique of utilization of treated sludge:**

Downstream application of treated sludge is also another potential market for technology suppliers to add value to the downstream industrial participants for profit and at the same time, complete the sustainable cycle of sludge generation and utilization.

The technologies in terms of sludge digestion pre-treatment, sludge dehydration, toxic gas removal and useful gas collection and utilization, waste-to energy and treated sludge applications will have a very promising market in China.

### 5.2.2 Major market segments

Table 11: MSST market segments analysis

Market Segments (with share from High to Low)	Description
WWTPs	<ul style="list-style-type: none"> <li>• The main sludge “producer”</li> <li>• No substitute for WWTP in MSST in a near future</li> </ul>
Government	The local government needs to be responsible for the municipal sludge generated from other than WWTP, for example lake, river, untreated sludge in landfill and harbor, also the reformation of old WWTP etc.
Sub-contractors	Sub-contractor for MSS handling, as a supplement for capacity shortage of government and WWTP.
Others	include NGOs and institutions for research purpose etc.

### 5.2.3 Geographic segmentation

The eastern provinces and megacities, i.e. Jiangsu, Shandong, Zhejiang, Shanghai and Beijing, show very strong market volume in the wastewater treatment industry. The total annual treatment capacity is significantly higher than the national average. In terms of treatment capacity per unit, Guangdong, Beijing and Shanghai have the greatest advantage.

Thus, the eastern provinces, megacities and some developed coastal cities in China are the major geographic segments for MSST business. Figure 11 and 12 shows the top provinces and cities have the most number of WWTPs and sewage treatment capacity in China.

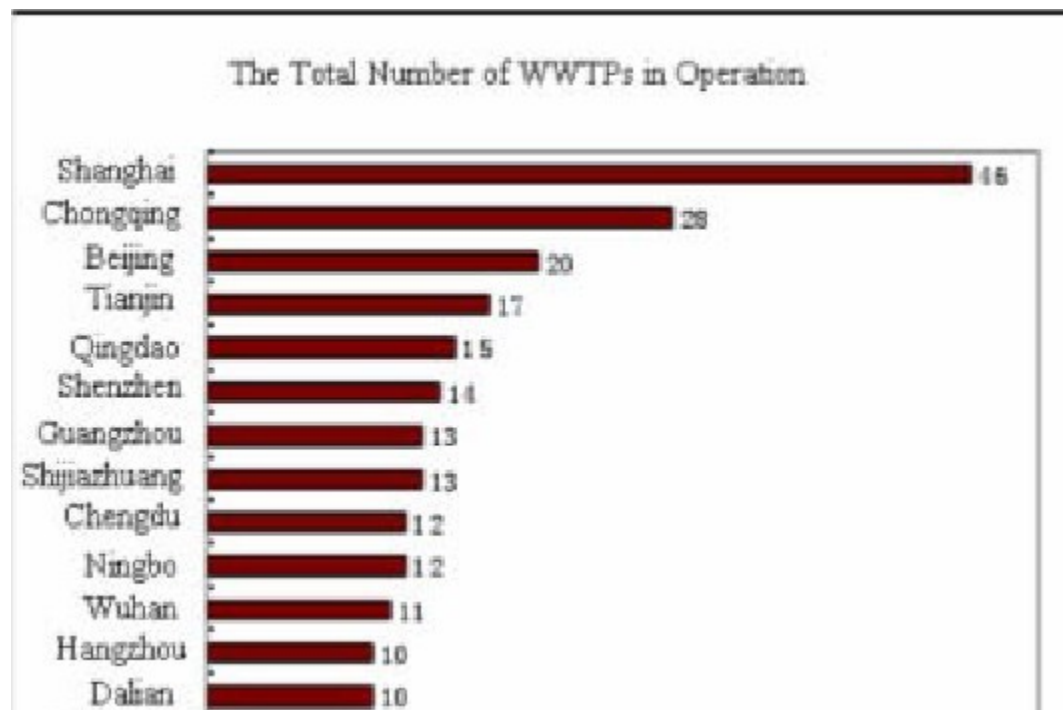


Figure 11: Provinces and cities have more than 10 WWTPs in operation in China (Uwe Gyßer, 2007, P14)

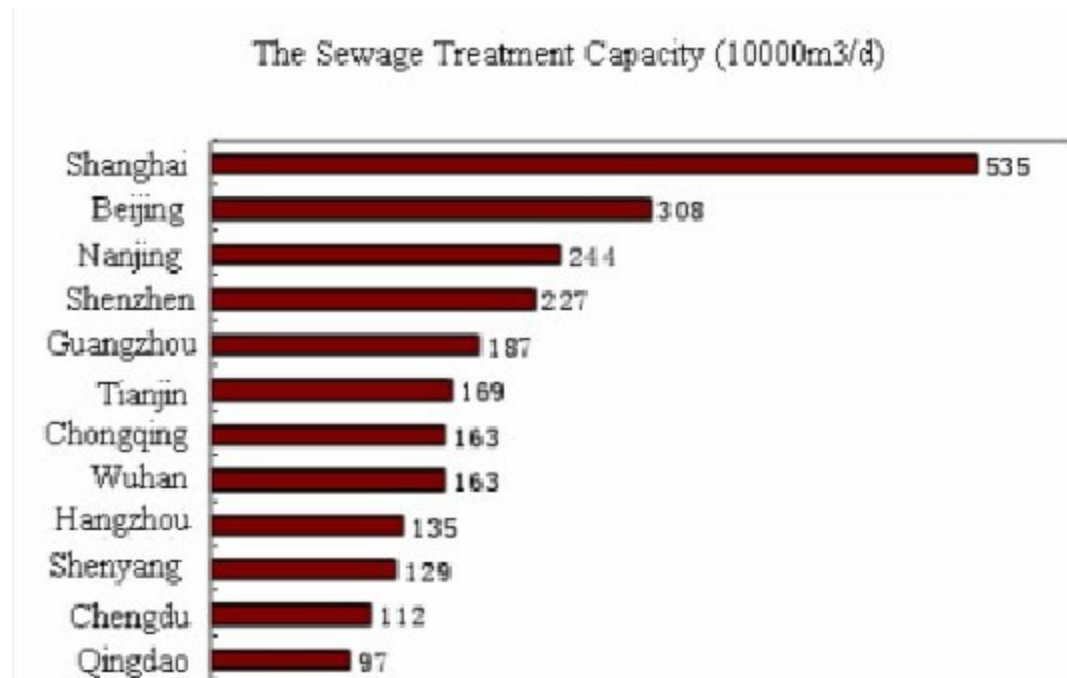


Figure 12: Top provinces and cities with the most of sewage treatment capacity in China (Uwe Gyßer, 2007, P14)

## 6. RECOMMENDATIONS

### 6.1 Entry mode – technology and equipment sales

- 1) **Technology and Equipment Export:** This is the most readily acceptable and accessible investment strategy for foreign companies to undertake. There is a low long-term risk in the export of technology and equipment.

But, in case of any kind of halt during the transaction, the company will be barely has any react as you do not know what really happened in another side. The company could be a very passive situation in that case. In the meanwhile, the costs of sales will be considerable higher. Frequent long distant travel, expensive employee travel allowances plus salary, inefficient communication etc.all may cause a big costs for the directly export sales. This is not a company's long term strategy for Chinese market.

- 2) **Local Agents/distributor:** This is highly recommended as first step into the market. Beijing, Shanghai and Guangzhou could be chosen as basic entry points given their geographic position and significant roles in China's economic development.

In this mode, the challenge starts with distributor selection. In a new market, what are the qualifications your local dealer should have? Basically, the dealer should have his own channel to distribute the product. But, how to ensure the dealer will also understand and follow with your marketing strategy or plan? Should you just point one exclusive dealer in one market or build up the deal network in the divided territory in one market? By using this model, the company will see that distributor management is more important and difficult

than sales. Because, you must make sure without the dealer you will not face a horrible customer and market lose.

- 3) **Representative Office:** Representative offices are the easiest type of offices for foreign firms to set up in China but these offices can only perform limited tasks such as "liaison" activities according to Chinese law and cannot sign sales contracts or directly bill customers or supply parts and after-sales services for a fee. Establishing a representative office gives a company increased control over their sales and permits greater utilization of its specialized technical expertise.

Basically, by choosing this entry mode, the head of the office must have a very strong skill in public relationship management, especially in an industry needs intensive contact with local authorities.

- 4) **Establishing a Chinese Subsidiary:** A locally incorporated equity or cooperative joint venture with one or more Chinese partners, or a wholly foreign-owned enterprise, may be the next step in developing markets for a company's products. Local production can avoid import restrictions including tariffs and provides firms with greater control over both intellectual property and marketing. The transaction will have less financial influence from global market. In case, the subsidiary in China may offset company's loss in other market.

## 6.2 Marketing mix recommendation

### **Product:**

For China MSST equipment market, the product is not just the item produced in your backyard and shipped to China. The successful product in China must be:

- Solution: You are offering an effective solution other than a container of metal. To build up the feeling to the customer, you are helping them to solve their problem. Do not lose in your technical specification explanation or fancy product presentation. A cost analysis for the payback time will give you product a big plus.
- The “Chinese model”: this means you have to forget your successful story in other market, and start over the study in China. One customized model for China are always more welcome than the standard model. The different is that do not push the best you have to the customer, only give them what they want.
- The service: Remember the service include the warranty is part of the product you offer. One 24/7 service line will bring you better promotion effect than any other promotion activities.

**Price:**

- China is a very price sensitive country. If you think that you have made the best offer to your Chinese customer, make sure you will not let them feel there is any possibility to have even a little bit price compromise. But, in the end of negotiation, the Chinese customer may symbolic ask for a favorable offer basically for saving their “face”(mianzi in Chinese), your compromise will be very positive gesture of a goodwill. But, remember, do not agree with the customer too fast.
- Purchase price rather than life-cycle price is a main consideration for the Chinese customers. There is not a high premium on high-technology and reliability. So, do not try to convince the customer for the purchase price with your argument of big saving in the operation cost.
- Flexible pricing: Different configurations with different prices. This is also a learning session for the customer to understand the advantages of each option.
- It is very popular in China, the equipment supplier is also offering buyer with financing or financial leasing service. In some cases, a local partner for finding financial service for your buyer is necessary.



**Place:**

- For the equipment business, keep the spare parts stock in China is one of the best ways to upgrade your service level.
- The successful story as the product reference built up in megacities will always have a demonstration effect in whole China.

**Promotion:**

- For the product from foreign country, to find a chance to build up a success reference in the market is the most effective promotion. The priority is in Chinese megacities with governmental/national project.
- The government might not be the best customer. The Chinese government has a rich image in western countries with a considerable foreign exchange reserves. But, in reality, due to the different and complex politic system, the payment form the local authority may not run as contracted. But, the biggest advantage for doing business with government in China is, you may have other favorable in other project with rare competition, and increase your public presence.

## 7. CONCLUSION

The Chinese sludge treatment market is at its high growth stage with a strong market potential but characterized with a few bottlenecks. The Chinese government has realized the ever serious situation of the unregulated sludge market and put forward several significant guidelines, policies and standards to help organize and guide the overall market. Due to the rapid increasing of sludge generation, there are thousands of wastewater treatment plants planned for construction across the country. The central government has specific guidelines in its 12th five-year plan to regulate the sludge market in terms of funding opportunities, government subsidies and support, encouragement of different financing models, technical innovation, as well as encourage industry chain integration.

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Company	Person	Title	Date	Reason	Location
Allu Finland Oy	Mr. Liu Yong	Sales Manager	9.heinä	Information gathering	Yangzhou
Allu Finland Oy	Mr. Baojian Wang	Country Manager	11.heinä	Interview	Shanghai
BioMintec Environment Ltd.	Mr. Chang Haipeng	Vice GM	13.heinä	Interview	Wuhu
Shanghai Laogang solid waste treatment center Ltd. Co.	Mr. Huang Renhua	Vice GM	14.heinä	Information gathering	Shanghai
Shanghai Laogang solid waste treatment center Ltd. Co.	Mr. Sun	Department Manager of equipment purchase	27.heinä	Information gathering	Shanghai
Shanghai Hitach Machinery Dealer	Ms. Shao Xuefang	Entrepreneu	28.heinä	Interview	Shanghai
Shanghai solid waste research institution	Mr. Ouyang Hai	PhD	29.heinä	Information gathering	Shanghai
Shanghai City Construction Design Institution	Mr. Zhang Jian	Chief Engineer	30.heinä	Information gathering	Shanghai
Shanghai Environmental Protection Agency	Mr. Wang Jianjun	Head of water control department	30.heinä	Information gathering	Shanghai
BioMintec Environment Ltd.	Mr. Yuan Yang	Sales Manager	2.elo	Information gathering	Hefei
BioMintec Environment Ltd.	Mr. Fu Yanlei	Engineer	4.elo	Information gathering	Hefei
Shanghai Guhua Sludge Treatment Company	Mr. Zhang Shujiu	Managing Director & Owner	5.elo	Interview	Shanghai
Shangahi Shenhua Sludge Treatment company	Mr. Sun Yanbin	Managing Director	7.elo	Interview	Shanghai
Shanghai Laogang solid waste treatment center Ltd. Co.	Mr. Li Mingyu	Managing Director	8.elo	Information gathering	Shanghai
Suzhou River Improvement Research Institution	Mr. Tian	Project Manager	10.elo	Information gathering	Suzhou
Shanghai Runrong International Trade company	Mr. Tang Wenzhong	Vice GM	12.elo	Interview	Shanghai
Beijing Greenuse Ltd.	Ms. Li Nan	Project Manager	15.elo	Interview	Beijing

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