

The development of MSW LFG in China

1、MSW Disposal

The amount of municipal solid waste (MSW) collected by local authorities in China has increased in parallel with rapid urbanization. Urbanization in this context means simply an increase in the number of cities and constructed urban areas. The average rate of increase in waste collected each year is about 6% .

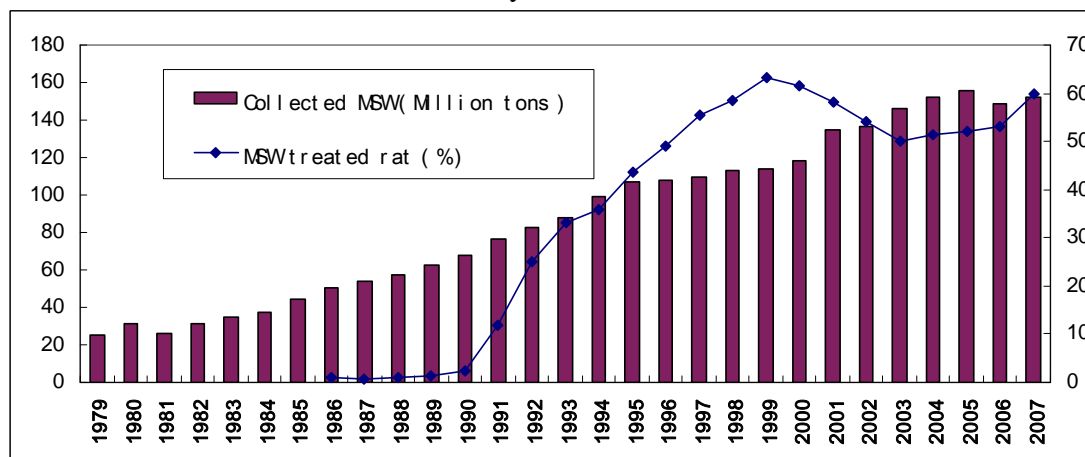


Figure 1: MSW collection and disposal in China: 1979 to 2007.

In 2007, six hundred and fifty five cities across China had generated approximately 152 million metric tonnes of MSW for disposal in 449 facilities. To be clear, this is the quantity of waste for disposal after recycling activities in 2007 alone.

2、MSW Landfill Disposal development

Over recent years, as part of the evolution of landfilling in China, and with financial support from state bonds, a number of landfills have been commissioned that use liner systems. More and more MSW are treated in sanitary landfill sites(see Table 1). The standard of liner design and construction in China is on par with international standards (see Table 2).

Table 1: The number of MSW landfill sites (2000 to 2007)

Year	2000	2001	2002	2003	2004	2005	2006	2007
Landfill sites	484	571	528	457	444	365	324	366
landfill quantity(million tons)	64.2	78.4	74.04	72.55	78.48	81.08	78.73	94.38

Table 2 – Basic requirements for bottom liners in MSW sanitary landfills

Liner System Requirements	Chinese Standard(CJJ 113-2007)
Leachate Drainage Layer	$K \geq 1 \times 10^{-3}$ m/s Thickness: 0.3m
Geomembrane liner	Thickness ≥ 1.5 mm HDPE
Compacted Clay Layer	$K \leq 1 \times 10^{-9}$ m/s Thickness: 75cm

3、Standards and regulations

In order to promote the construction and operation of municipal solid waste landfill, a number of Standards for MSW landfill are formulated or emended in recent years. (see Table 3).

Table 3 –Standards for MSW sanitary landfills in China

The name of Standards	Code
Standard for Pollution Control on the Landfill Site of Municipal Solid Waste	GB16889-2008
Technical specifications for operation and maintenance of municipal domestic refuse sanitary landfill	CJJ93-2003
Technical code for municipal solid waste sanitary landfill closure	CJJ112-2007
Technical code for liner system of municipal solid waste landfill	CJJ113-2007
Technical Code for Sanitary Landfill of Municipal Domestic Refuse	CJJ 17-2004
Technical Standard of Environmental Monitoring of Solid Waste Landfill Sites	CJJ/T3037-1995
technical requirements of Environmental Monitoring of Solid Waste Landfill Sites	GB/T 18772-2008
Standard of assessment on non-hazardous disposal of municipal solid waste landfill	CJJ/T107-2005
Geomembrane liner for municipal solid waste sanitary landfill	CJ/T234-2006
Disk tube reverse osmosis membrane facility for the leachate.	CJ/T 279-2008
The construction Standard of Environmental Monitoring of Solid Waste Landfill engineering	MOC/NCEC 2001

In 2006, China's Ministry of Construction (now it is changed to Ministry of Housing and Urban-Rural Construction) initiated an inspection exercise on the status of landfill operations, and the classification of landfills according to the Standard of assessment on non-hazardous disposal of municipal solid waste landfill(CJJ/T107-2005). there are a evaluation formula to calculate the score of the landfill, the result of the score are more than ≥ 85 , the landfill is classified as Class I, the result of the score are more than 70 and less than 85, the landfill is classified as Class II. Based on the inspection and assessment, at the end of 2005, there were 190 landfill-sites were classified as Class II, or Class I. the second evaluation programme will be finished by the Ministry of Housing and Urban-Rural Construction in the end 2008, and there are about 300 landfill-sites that reached Class II, or Class I in the nationwide.

Renewable Energy Law of People's Republic of China is implemented from Jan. 1 2006. according to the development program of renewable energy, hydropower, wind,

solar, landfill gas, biomass energy use are promote, by the year 2010, renewable energy consumption accounted for the proportion of primary energy consumption will reach 10 percent. The price of the electricity from LFG will be priority to electronic net and will get 0.25 Yuan RMB/kW more than the price of the electricity from coal.

According to the Standard for Pollution Control on the Landfill Site of Municipal Solid Waste(GB16889-2008), the LFG recovery facilities and flare should be installed when the landfill design capacity are more than 2.5 millions ton and the landfill body depth are more than 20 metres ,and for small scale landfill the flare or measures to reduce methane emissions should be also used.

4、 LFG recovery

In China, landfill gas-to-electricity projects are underway in Hangzhou, Guangzhou, Nanjing, Xian, Beijing, Changsha, Wuxi and Jinan. By the end of 2008, 28 LFG utilization projects had been completed and commissioned throughout mainland China. 18 of these contain facilities for electrical power generation using landfill gas, with a total capacity of 40MW. (see Table 4).

Table 4 –LFG recovery and incineration in China

Number	Province /City	Project Name	Generator (kW)	Other	Start up year
1	Zhejiang	Tianziling Landfill-Site Hangzhou City	1940		1998
2	Guangdong	Datianshan Landfill-Site Gaungzhou	3000		1999
3	Jiangsu	Shuige Landfill-Site Nanjing City	2520		2002
4	Shandong	Xiaojianxi Landfill-site Qingdao City	500 m ³ /h	Only Flare	2003
5	Shanxi	Jiangcungou Landfill-Site Xian City	3900		2003
6	Anhui	Maanshan City Landfill Site	200 m ³ /h	Flare And To Incinerate Hospital Waste	2004
7	Jiangsu	Taohuashan Landfill-Site Wuxi City	1940		2004
8	Beijing	Ashuwei Landfill-Site	2700	Flare Only In 2004	2004/2007
9	Beijing	Beishengshu Landfill-Site	1000		2004

10	Guangdong	Xingfeng Landfill-Site Guangzhou City	2000		2004
11	Hunan	Qiaoyi Landfill Changsha City	2100		2005
12	Hubei	Erfeishan Landfill-Site	1200		2005
13	Beijing	Anding Landfill	750 m ³ /h	To Evaporate Leachate	2005
14	Jiangsu	Tianjinwa Landfill-Site Nanjing City	1030		2005
15	Shandong	Weihai City Landfill-Site	800 m ³ /h	Only Flare	
16	Shandong	Jinan Landfill-Site Jinan City	1400		2006
17	Liaoning	Yangeryue Landfill-Site Anshan City	500 m ³ /h	To Truck Fuel	2007
18	Guangdong	Shenzhen Xiaping Landfill-Site Shenzhen City	3500	Also to Truck Fuel	2007
19	Anhui	Liuan City Landfill-Site	200 m ³ /h	Only Flare	2007
20	Jiangsu	Huaian City Landfill-Site	200 m ³ /h	Only Flare	2007
21	Beijing	Liulitun Landfill-Site	800 m ³ /h	Only Flare	2007
22	Beijing	Gaoantun Landfill-site	1500 m ³ /h	Flare	2007
23	Zhejiang	Ningbo Landfill-Site	200 m ³ /h	Only Flare	2007
24	Jiangxi	Maiyuan Landfill-Site Nanchang City	4500		2008
25	Fujian	Hongmiaoling Landfill Fuzhou City	2000		2008
26	Tianjin	Shuangkou Landfill-site Tianjin City	1380		2008
27	Liaoning	Laohuchong Shenyang City	2000		2008
28	Shanghai	Laogang Landfill-Cite	2500		2008

Many landfill-sites owner are active to the applications linked with the Clean Development Mechanism (CDM). As of Nov 11, 2008, 29 MSW landfill projects have been approved by the National Development and Reform Commission (NDRC , <http://www.ndrc.gov.cn/>).(see Table 3).

Table 5 –LFG Projects Approved By NDRC of China
(Total: 29, Up to Nov 11, 2008)

No.	Project Name	Project Owner	CER Buyer	Estimated Ave. GHG Reduction (tCO ₂ e/y)

29	Huizhou Landfill Gas Recovery and Utilization Project	Shenzhen PhasCon Technologies Co.,Ltd	The Netherlands represented by its Ministry of Housing, Spatial Planning and the Environment acting through in its Capacity as a Trustee of the IFC-Netherlands Carbon Facility (INCaF)	136,250
28	Huangshi Landfill Gas Recovery for Power Generation Project	Shenzhen PhasCon Technologies Co.,Ltd.	Vitol S.A.(Switzerland)	93,365
27	Dalian Maoyingzi Landfill Gas Recovery for Power Generation Project	Dalian PhasCon Technologies Co.,Ltd	The Netherlands represented by its Ministry of Housing, Spatial Planning and the Environment acting through in its Capacity as a Trustee of the IFC-Netherlands Carbon Facility (INCaF)	287,433
26	Hefei Longquanshan Landfill Gas Power Generation Project	Hefei Xinguan Energy Development Co.,Ltd	OneCarbon International BV.(The Netherlands)	130,881
25	Shanxi Taiyuan Xingou Landfill Gas Recovery and Utilization Project	Taiyuan Kaitian Renewable Energy & Environment Co.,Ltd	Asja Environment International B.V. (Switzerland)	46,648
24	Liaoning Landfill Gas Recovery and Utilization Project	Liaoning Kaitian Renewable Energy & Environment Co.,Ltd	Cantor Fitzgerald Europe (UK)	69,961
23	Shanxi Taiyuan Shanzhuangtou Landfill Gas Recovery and Utilization Project	Taiyuan Kaitian Renewable Energy & Environment Co.,Ltd	Asja Environment International B.V. (Switzerland)	41,653
22	Xiamen Dongfu Landfill Gas-to-Energy Project	Xiamen Perfect New Energy Co.,Ltd	Marubeni Corporation (Japan)	94,084
21	Changchun City Landfill Gas Power Generation Project	Jilin Province Shijie Renewable Energy Co.,Ltd	EcoSecurities Group PLC (UK)	150,330
20	Nanyang Landfill Site LFG Recovery to Electricity Project	Shanghai BCCY NewPower Industry Co.,Ltd	Renaissance Carbon Investment Ltd (UK)	57,167
19	Luoyang Landfill Site LFG Recovery to Electricity Project	Shanghai BCCY NewPower Industry Co.,Ltd	Renaissance Carbon Investment Ltd (UK)	86,770
18	Shenyang Laohuchong LFG Power Generation Project	Shenyang Laohuchong Municipal Solid Waste Management Co.,Ltd	Asja Ambiente Italia S.p.A (Italy)	126,179

17	Mianyang Landfill Gas Utilization Project	Mianyang Taidu Environment Energy Technical Development Company Ltd	Sindicatum Carbon Capital Ltd (UK)	103,204
16	Shenyang Daxin Landfill Gas to Electricity Project	Shenyang Xinxin Tomorrow Renewable Co.,Ltd	Danish Ministry of Foreign Affairs(Denmark)	195,436
15	Nanchang Maiyuan Landfill Gas Recovery and Utilization Project	Nanchang Xinguan Energy Development Co.,Ltd	One Carbon B.V. (Netherlands)	150,599
14	Kunming Dongjiao Baishuitang LFG Treatment and Power Generation Project	Kunming Huan Ye Project Development Co.,Ltd.	Asja Ambiente Italia S.P.A(Italy)	64,302
13	Tianjin Shuangkou Landfill Gas Recovery and Electricity Generation Project	Tianjin Clean Energy and Environmental Engineering Co.,Ltd	International Bank for Reconstruction and Development (Spain)	155,823
12	Fuzhou Hongmiaoling Landfill Gas to Electricity Project	Fujian Tianyi Renewable Energy Technology & Utilization Co.,Ltd	Eco Bank Ltd(Japan)	181,234
11	Hunan Changsha Qiaoyi Landfill Gas Recovery and Electricity Generation Project	Changsha Huiming Environment Energy Co.,Ltd	Trading Emissions PLC(UK)	238,319
10	Kunming Wuhua Landfill Gas to Energy Project in Yunnan Province	Kunming Huan Ye Environmental Protection Engineering Development Co., Ltd	Biogas Technology Ltd (UK)	201,586
9	Nanning Landfill Gas to Energy Project	Guangxi Gettop Science & Technology Co.,Ltd	Biogas Technology Ltd.(UK)	195,208
8	Shandong Jinan Landfill Gas to Energy Project	Shandong Shifang New Energy Ltd	EcoSecurities Group Ltd	150,158
7	Guangzhou Xingfeng Langfill Gas Recovery and Electricity Generation Project	Guangzhou Huijing Environment Protection Technology Co., Ltd.	ICECAP Ltd.	626,834
6	Wuxi Taohuashan Landfill Gas to Electricity Project	Wuxi Tianshun Environmental Technology Co.,Ltd	Toyota Tsusho Corporation	75,316
5	Jiaozishan Landfill Gas Recovery and Utilisation Project	Nanjing Yunsheng New Energy Development Co.Ltd	CAMCO International Limited (UK)	147,880
4	Shenzhen Xiaping landfill Gas Collection and Utilization Project	Shenzhen Lisai Development Co. Ltd	Climate Change Capital Carbon Fund s.a.r.l	749,186
3	Meizhou Landfills Gas Recovery and Utilization as Energy Project	Shenzhen PhasCon Technologies Co., Ltd.	Austrian JI/CDM Programme, Kommunalkredit Public Consulting Gmbh	278,000
2	Nanjing Tianjinwa Landfill Gas to Electricity Project	Nanjing Green Waste Recovery Engineering Co., Ltd.	EcoSecurities Ltd (UK)	265,032
1	Anding Landfill Gas Recovery and Utilization Project	Beijing Erqing Environment Engineering Group	Energy Systems International B.V. (ESI)	90,000

5、 Trend and challenge

More small-scale sanitary landfills will be built for counties

Small-scale sanitary landfills (landfills with waste intake capacity of below 200 tonnes/day, representing most landfills on a county level) will increase rapidly in 5 to 10 years. Now there are about 1635 counties and there were about 131 landfill sites for counties in 2007 , and it is estimated that The number of MSW landfill sites will be reached to more than 200 for county level by the end of 2008 (see Table 6,the

date is from o the China Urban Construction Statistical Yearbook, 2006 and 2007),

Table 6: The number of MSW landfill sites for county

Year	2006	2007
Landfill sites	109	131
landfill quantity(million tons)	3.62	4.53

LFG collection rate is low

There are obstacles linked with the nature of China's MSW stream. A relatively high proportion of China's MSW is food waste, while the proportion of fibre, wood and other slowly biodegradable organics is relatively low. Food waste exhibits the fastest biological decomposition among all waste types, which leads to rapid gas generation and hence limiting its collection efficiency. The recovery and utilization rate of landfill gas is generally less than 60% in developed countries; whereas achieving a 20% gas recovery in China appears to be difficult. ²

How can things be improved?

It is needed that more support from financial and technical aspect, management and train for local landfill-sires. More and more landfill sites will be installed LFG recovery system. Methane to market is a good mechanism to promote the LFG recovery. Now more than 50 LFG generator projects are under construction or in prepare stage ,it is estimated that some of these projects with total 40Kw will be in use by the end of 2010 .

Now the invest cost of a landfill is mainly come from landfill liner system and the operating cost of a landfill is mainly come from landfill leachate treatment. The aerobic bioreactor landfill technology may be a solution to develop sustainable landfill especial for Small-scale sanitary landfills.

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