Biogas market potential

A Sino-German project makes good use of bioorganic municipal waste

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China is one of the largest producers of solid waste and greenhouse gas (GHG) in the world. Landfill gas emissions cannot be collected successfully; it is preferable that they be utilized for biogas production. Biogas from organic wastes could generate cumulative energy amounting to at least 6 GW_{tot} by 2020 and even up to 25 GW_{tot} by 2050. The total estimated potential from decentralized and centralized waste-biomass biogas plants, including urban, agriculture and agro-industrial waste, is at least 100 GW_{tot}. Increasing energy prices, carbon funds and GHG emission trading systems and the need of compost to overcome the depletion of arable land are essential drivers to select a new, sustainable focus on integrated waste management, renewable energy production and a circular economy.

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Introduction

China is one of the largest waste producers in the world. In 2005, 86 per cent of the 155 million tonnes of collected municipal solid waste (MSW) was land filled on the country's 580 official landfill sites. About half of the MSW is still not collected. The national policy on Renewable Energy Generation (2006) focuses, among others, on landfill gas (LFG) collection as an eligible biogas source. But due to the high content of fast biodegradable bio-organic matter (BMW), combined with low standards of landfill site operating practices, landfill gas collection and utilization cannot be applied successfully. It is estimated that only about 20 per cent of landfill gas can be collected, therefore LFG collection should be applied to existing landfills only as an emission prevention measure, but not for municipal waste yet to be disposed of.

With its growing energy consumption and resulting greenhouse gas (GHG) emissions, China will surpass the USA as the world's largest CO_2 producer in 2009, even though China's *per capita* CO_2 emissions will still be only three-fifths of the average of industrialized countries in 2030. Therefore China is going to have to take measures against GHG emissions. Biogas from bio-organic waste sources may contribute significantly to these measures as, on the one hand methane emissions from storage and landfilling will be avoided and, on the other hand biogas will replace fossil fuels and the resulting CO_2 emissions.

China's policies

Chinese resources and energy management policies are addressing this problem; and sustainable waste management could significantly contribute to achieving integrated waste treatment development targets.

A Sino-German project - *Resource Recovery of Bio-organic Municipal Waste* (RRU-BMW) - based on suggestions on how to integrate better waste treatment and renewable energy production via biogas generation, through a joint approach between urban and agricultural areas, recently announced elaborate forecasts. These show that as much as 6 GW_{tot} of BMW-derived biogas could be generated until 2020 and as much as 25 GW_{tot} until 2050.

The total estimated potential from all decentralized (56 million rural household digesters plus decentralized wastewater treatment systems or DEWATS) in 2020 and centralized waste-biomass sources, including MSW, agriculture and agro-industrial waste, as well as from municipal waste landfills, is about 100 GW_{tot}. Increasing energy prices, carbon funds, GHG emission trading systems and foreign investment might be essential economic drivers for development.

Within the Chinese political framework of a "Circular Economy" based on the Cleaner Production Promotion Law (2002) by NDRC and SEPA, the Renewable Energy Law (2006), the National Rural Biogas Construction Plan (BCP) by MOA (2003) and the pollution prevention targets from waste disposal in the 11th 5-Year Plan until 2010-1, China has to find more comprehensive solutions to develop an advanced sustainable solid waste management system that can cope with the demands of a modern emerging economy.

Waste management in China

China is one of the largest waste producers globally, but about half of its 155 million tpa of municipal waste from 666 cities,relating to 30 per cent of the Chinese population, is collected and disposed by land filling (86 per cent), incineration (8.6 per cent) and biotechnological treatment (5.4 per cent).[2, 3] The compost from mixed MSW does not match the quality requirements for utilization (which is the main reason why there was no progress in this direction for several years) and the low calorific value of the waste does not allow effective thermal utilization.[4]

The current (11th) 5-Year Plan targeted the 'treatment' of at least 60 per cent, starting from 53.5 per cent in 2005. If urbanization, changing consumer behaviour and extension of waste collection are considered in waste generation forecasts, an additional treatment capacity of about 40 million tpa, an effective increase of 50 per cent of the 2005 treatment capacities is required until 2010.[5]

Furthermore, the Renewable Energy Law by NDRC (2006), which stipulates the general conditions for renewable energy to become a more important energy source in China (10 per cent in 2010 and 16 per cent in 2020), is a driver to promote renewable energy from biomass, including energy utilization from wastes.[6]

Landfilling of biodegradable waste, and especially landfilling under less developed practical conditions, is subject to a phasing-out strategy in Europe (the EU Landfill Directive 1999 aims to reduce BMW landfilling by 65 per cent until 2016). Almost 15 years of experience with bio-organic waste management has taught Europe that source separation of BMW is the key to solving urban waste problems. In Germany, about 70 per cent of BMW had already been collected in 80 per cent of the communities by 2001, whilst the remaining waste was incinerated.

In total about 800 composting plants, about the same number of anaerobic digestion plants (including agriculture waste, co-digestion and BMW digestion plants) and about 50 MBT plants have been established in Germany for processing biodegradable waste.[7] From 425 composting and 55 anaerobic digestion plants, using source-separated BMW as feedstock, the compost or digestion residues are labelled as quality products by the German Compost Quality Association.

Recycling of native organic waste is also part of the waste strategies in the USA and Japan.

Since Chinese MSW contains up to 78 per cent bio-organic matter, more than twice as much as in western countries, waste management must thoroughly consider the BMW fraction. The RRU-BMW project in Shenyang has conducted field and laboratory research to examine the feasibility of, and best practices for, BMW utilization in a Chinese metropolis in order to develop an Integrated Waste Management concept based on the specific composition of Chinese MSW.

The project, supported by the Liaoning Province Science and Technology Bureau, CIM/GTZ Germany and the Bauhaus Universität Weimar (BUW), is the first project that looks at BMW segregation in Chinese urban areas. The project, started in 2004, investigates the conditions for BMW collection based on the participation of citizens in source separation activities. Long-term field research and lab testing have provided information about the feasibility and application of a 3-way waste stream disposal system: (a) 'packaging' for merchandising on the informal but well functioning raw material market, (b) 'BMW' and (c) 'high calorific remaining waste' for thermal utilization.

The results from BMW collection and from laboratory measurements on biodegradability, biogas building potential and pollution level, together suggest that compulsory source separation for residential areas in China should be phased in to better meet the waste treatment and renewable energy targets.[5, 9]

It can be estimated that about 24 GW (6 GW_{tot} from MSW and BMW together) could realistically derive from waste biomass sources (building upon the existing capacities of the agricultural sector) till 2020, of which at least 25 per cent may come from BMW itself. But at present, the estimated municipal waste anaerobic mechanical biological treatment projects in China will only make use of 3 per cent of the MSW/BMW biogas potential.[6]

Figure 1: MSW collection, disposal and treatment ratio in China 1979-2005 [2, 11]

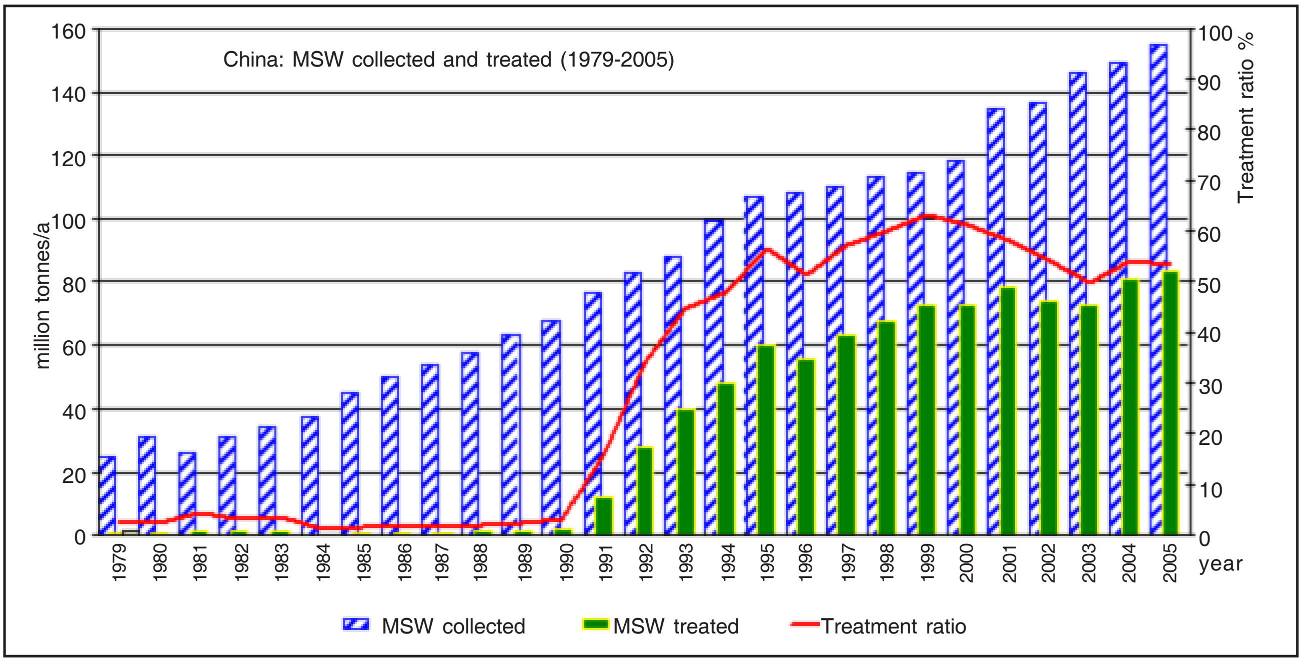


Table 1: Solid waste treatment in China in 2005[11]

Type of treatment	Number	Capacity (mln tpa)	Capacity (%)
Landfill	580	72.7	86.1
Incineration	63	7.4	8.6
Composting	61	4.5	5.3
Total	**704**	**84.6**	**100**

MSW collection and disposal

About 155 million mt of MSW derived from 30 per cent of the population were collected in Chinese cities in 2005.[11] Of this, 53.5 per cent is 'treated' primarily at 580 landfilling sites, of which about two dozen are currently in the pipeline for LFG collection under CDM funding. The total number of landfills suitable for active LFG collection is estimated to be 100.[15]

About 8.6 per cent of the waste is incinerated, or better co-incinerated with coal (40 per cent coal and 60 per cent MSW) and 5.3 per cent is treated in mixed waste composting plants to a low quality end product (Table 1). Due to unexpected problems, such as insufficiently performing waste treatment plants, the ratio of waste treatment even in China has been decreasing from 2000 through 2005 (Figure 1).

It was one of the main targets of the RRU-BMW project to assess the requirements and design criteria for waste treatment suitable for the forecasted situation in China. The ongoing urbanization process (expected urban population 40 per cent in 2010 and 70 per cent in 2050), changing consumer behaviour, and the quantities of municipal wastes collected have maintained rapid MSW growth since 1979. It is predicted that MSW will amount to 480 million mt in 2050, which is related to an increase of MSW by 2.5 times compared to 2005.[12, 21]

Monthly MSW analyses in four different residential areas in Shenyang in 2005-6, and results from 38 waste analyses carried out since 1998 (MOC 1997, Gu Run Nan Tshinghai Environment 2001; Wu De Li, Urban Environment & Urban Ecology 2002; Gao Guang 2000, Biological Treatment Technology 2003)[9] have shown that, the MSW in 27 cities all over China contains on average 66 per cent (32.5-92.6 per cent) of bio-organic matter. Shenyang municipal waste contains on an average (n=48) 78 per cent bio-organic matter (including 3 per cent fine fractions <10 mm, mainly bioorganic matter, in non coal-burning areas), which is about twice as much as in industrialized countries.[10]

Public participation

Waste quantities after source separation

Through a comprehensive communication strategy,[9] the RRU-BMW project approached the citizens of two blocks in each of four residential pilot areas in Shenyang city to participate in BMW separation. In three pilot areas, primary source separation (PSS) or biowaste bin was applied directly at the source, that is, in the kitchen; and in one pilot area, the BMW was separated from MSW by secondary source separation (SSS), that is, in the courtyard by community workers, as proposed by the municipal government.

The amounts of waste collected during the one-year test period are shown in Table 2. It can be seen that on average 70 kg of BMW per person per year (70 kg/c/a), corresponding to 84 per cent (m/m wm) of the total waste

Table 2: Specific per capita annual amounts of BMW, RMW and BMW ballast matter content, collected in PSS and SSS residential pilot areas Shenyang, China, RRU-BMW 2005/2006[9]

03/05 - 03/06 (365 days)	Persons (n)	BMW (kg/c/a)	BMW (% m/m)	BMW ballast matter (% m/m)	RMW (% m/m)
Primary source separation - PSS					
Beifang Yiyuan	155	81		3.4	
Van Ke	143	65		4.7	
Quan Yuan	207	66		4.1	
Total PSS	**505**	**70**	**84**	**4.0**	**16**
Secondary source separation - SSS					
Dong You	180	64		2.3	
Total SSS	**180**	**64**	**71**	**2.3**	**29**
Grand total	***685***	***68.6***	***81.5***	***3.6***	***19.5***

amount provided by the participants, was collected by PSS in the three pilot areas. The ballast matter (non-BMW materials) content was 4 per cent on average. This is low compared to BMW collection in Europe in similar housing structures (Hamburg- Harburg, 1996), where the ballast matter content amounts to 7 per cent. The remaining waste (RMW) amounted to 16 per cent, and mainly contained small packaging materials and fine waste, which could not be classified and therefore could not be allocated to the informal packaging material collection system.

Because of the low content of wet BMW (12-month average 28.9 per cent +/- 0.27 per cent), the RMW contained an average calorific value of 16,446 kJ/kg FM, about 4.5 times higher than the heat value of the original MSW. RMW was therefore suitable for industrial co-incineration.

About 85 per cent of the MSW from the participating households could be collected by the project. The recyclables (REC) separated as PSS materials and directly merchandized by door-to-door merchants amounted to 46 kg/c/a. The waste quantity rationale, the *per capita* quantities and the specific quantities generated in a catchment area and the landfill quantities are given in Table 3.

The annual *per capita* quantities based on the actual number of households actively participating at that time in the collection of BMW and RMW amounted to 112.8 kg/c/a and 26.5 kg/c/a. The quantity of recycled packaging, including waste paper (REC) material was 46.1 kg/c/a.

Therefore the amount of household MSW, following international terminology, is about 210 kg/c/a. Including the non-household MSW from business, offices, public institutions, street cleaning and similar activities (not industrial waste), the total is about 285 kg/c/a (Table 3). The total specific MSW generation is estimated to be 430 kg/c/a, which is below the average per capita MSW collected in EU 25 in 2003 of 534 kg.[22]

For practical reasons, the average gross specific annual generation related to an entire catchment area is important, because this will be the real amount which can be collected. In the three PSS pilot areas in the course of one year, 70.2 kg/c/a BMW and 13.1 kg/c/a RMW were collected.

The remaining MSW is estimated to be 80.6 kg/c/a. Based on these figures we can say that the waste collection ratio is about 66 per cent in Shenyang (about 5,500 tpd), which is better than the average in Chinese cities in 2005 with 53.5 per cent. Looking at the annual waste quantity distribution, an increase of waste generation during the summer period was found, but the annual fluctuation of about ± 25 per cent is relatively low. One reason for that is, that holiday seasons in China do not strongly influence waste generation, except at obvious tourist destinations.

Waste recovery rate

The bio-organic waste recovery rate is calculated to be 69 per cent in the PSS and 58 per cent in the SSS areas and therefore better than results gained in multistoreyed buildings in Berlin 1994 (Figure 2).[13]

Public participation in source separation

The positive attitude of the participants towards source separation of BMW was shown by a survey, by practical active participation in separating the biowaste continuously over one year, by the achieved quantities (bio-organic recovery rate) and by the low ballast matter content. All these are relevant indicators demonstrating people's willingness to accept BMW source separation.

The survey before and after the first year of the biowaste bin in households shows that the participants are even better motivated after one year than before, and 97 per cent want to continue to participate in source separation if the materials are thoroughly used afterwards (Figure 3). As many as 51 per cent of the participants are willing to pay a waste fee, 43 per cent will pay if there is a legal obligation and only 5.4 per cent say they would not pay a waste fee at all.

According to survey response, initially 95 per cent of the households in the selected pilot areas (84 per cent in high income areas and up to 100 per cent in standard living areas) have agreed to join source separation. According to waste collection data, 85 per cent have finally delivered their waste during the first months. The average participation rate then stabilized in the

Table 3: Specific annual per capita generation and gross-generation in a residential area of BMW, RMW and MSW in the average of the 3 PSS pilot areas (household), and REC materials from HH and non-household (NH) and the specific total amount of MSW as delivered to the landfill, Shenyang, China 2005/2006 (kg/c/a wm), (*estimate)

Waste fraction	Specific generation	Generation at catchment area	Remarks
BMW (HH)	112.8	70.2	Potential for BMW treatment
RMW (HH)	26.5	13.0	Potential for thermal treatment
MSW (HH)	24.5	80.6	Not separated MSW 15%/c
REC (HH)	(46.1)		Secondary raw material recovery
Total MSW (HH)	**210**		According to international MSW definition
MSW (NH)	> 122		Commercial activities, public space
REC (NH)	(> 40)		Secondary raw material recovery*
Total MSW collected	**285**		To the landfill, REC quantity neglectable, about 66% MSW collection rate
Total MSW	**430**		(See Table 4)

Figure 2: Bioorganic matter recovery rates by means of BMW source separation in PSS and SSS pilot areas Shenyang (2005/06) compared to different living structures Berlin 1994 (% m/m wm)

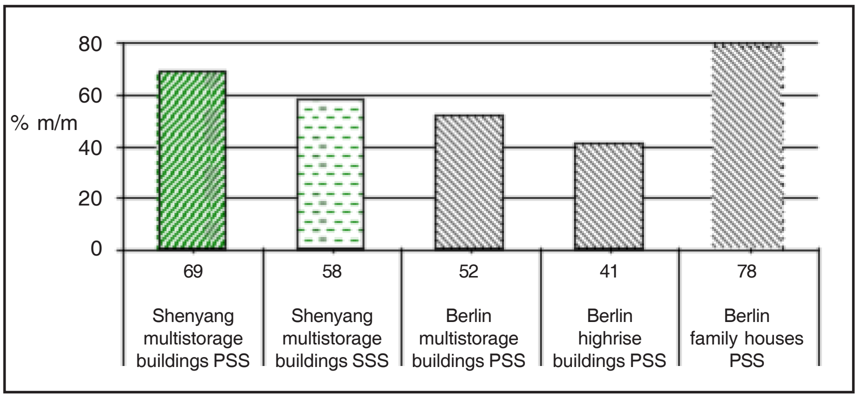
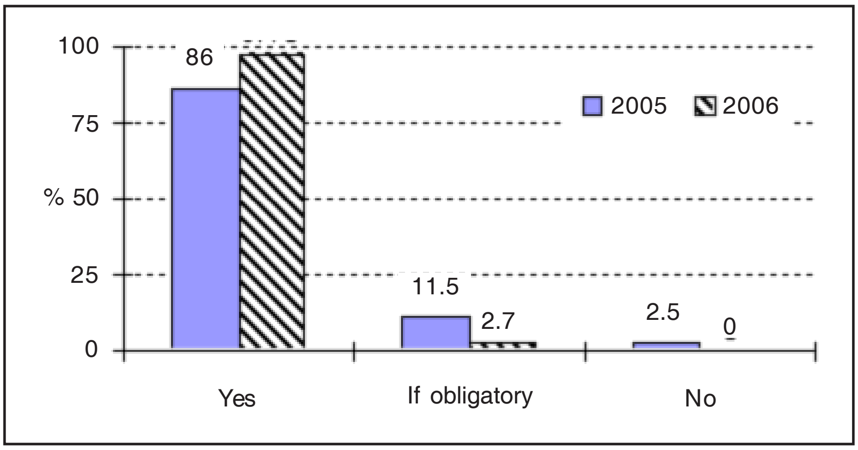


Figure 3: RRU-BMW participants' opinions before and after the BMW pilot collection. [Research question Q7/2005 Q3/2006: "Do you like to carry out, or continue biowaste collection if utilization of the biowaste is ensured?"[9]]



course of the first year at about 70 per cent, giving an annual average of 73 per cent (Figure 4).

China's potential

Biogas from municipal wastes

Biogas can be derived from both mixed MSW and BMW from source separation. In order to comply better with 'Circular Economy' principles and to close the loops by providing organic fertilizer instead of landfill material, the RRU-BMW research project in Shenyang focused on source separations of BMW.

On the basis of the results of actual collections from residential area results, a conservative forecast of biogas-energy production was made for China.[9, 13] If 40 per cent BMW potential is gathered under the above conditions, 28 million tpa BMW would be available as feedstock for biogas plants. The specific gas yield[9] is 100-120 m^3/t and about 2.8 bn m^3/a biogas will be produced, equivalent to 1.8 GW_{tot} (Table 4).[6]

The calculation of power generated from MSW/BMW biogas till 2050 in Table 5 takes into account an increase of urban population (urbanization of 70 per cent in 2050); an annual increase in specific MSW production of 0.8 per cent (packaging recycling is not seen as MSW for disposal and therefore is not included (Table 3); an increase of MSW collection rate in the cities from 53.5 per cent (2005) to 60 per cent in 2010 (11th 5-Year Plan) and to 75 per cent in 2050; a decrease of organic matter content in MSW from average 66 per cent (actual content in 2005) to 45 per cent by assuming that the consumer behaviour of the Chinese (more instant food and single households) will change the waste quality; a slight increase of organic content by further reduction of coal ash from decentralized cooking and heating in the 'non-gas' or centrally heated areas (although these are already widely phased out); a participation rate in BMW separation from 70 per cent to 80 per cent in 2050; and an increase of BMW/MSW residential catchment areas from 40 per cent to 75 per cent.

MSW/BMW biogas plants in China

So far within the 5.3 per cent biotechnological treatment (Table 1), anaerobic MSW/BMW treatment does not exist in China, but at present some 20 MSW, food waste and manure co-fermentation anaerobic digestion (AD) projects are under implementation, as listed in Table 5.

This development has started to solve the problem of an environmentally and hygienically sound utilization of the large amount of restaurant waste in Beijing and Shanghai (1200 tpd). The currently planned anaerobic biotechnological municipal waste projects (MBTs) for biowaste and food waste (so far no BMW), may cover a capacity of 4 million MSW tpa and therefore only make use of about 3 per cent of the available biogas potential from MSW/BMW in 2010. These plants will contribute only an additional 1.5 per cent MSW treatment (see 11th 5-Year Plan target). In Europe in 2005 about 30 per cent of MBT plants (80 MBTs in total, 50 of them in Germany) were using AD to produce biogas.

Biogas production and potential

Decentralized, small-scale, household bio-digesters and DEWATS, as well as centralized middle and large-scale AD plants in the agricultural, industrial and municipal sectors contribute to biogas-energy production in China. The 2006 figures, the estimated or targeted biogas quantities in 2010 and 2020 and the overall production potential are listed in Table 6.[15]

Figure 4: RRU-BMW project, average participation rate of households during one-year field test in 3 primary source separation (PSS) pilot areas in Shenyang city, China, (%)[9]

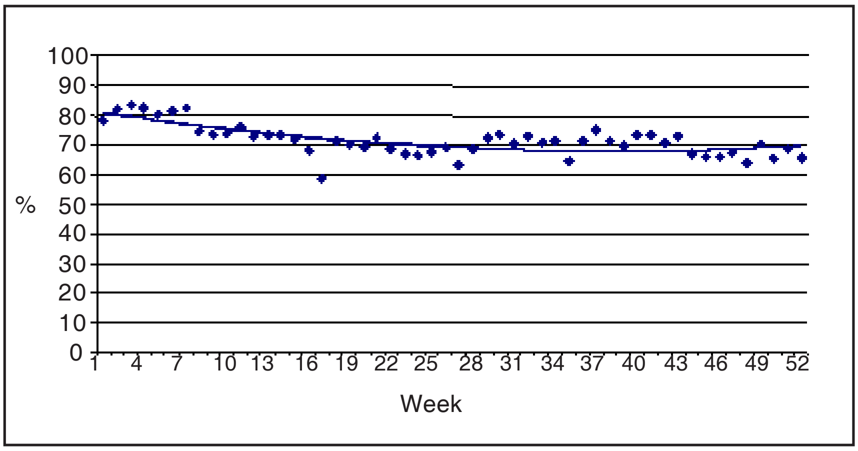


Table 4: Estimates of biogas building potential from MSW/BMW in China until 2050[6]

Description	2005	2010	2020	2050
Urbanization rate in China (%)	28	36	51	70
Citizens (million)	360	470	650	940
MSW HH&NH (t/c/a) / (kg/c/d)	0.43 / 1.12	0.51	0.58	0.76 / 2.0
MSW collection rate (%)	53.5	60	65	75
MSW from cities (mln tpa)	155	240	380	700
MSW organic matter (% FM)	66	62	55	45
Organic matter in MSW (tpa)	102	150	210	315
Citizens participation * (%)	70 *		80	
BMW overall potential (m tpa)	71	105	147	252
BMW collection area (%)	40	45	55	75
BMW net-potential (m tpa) *	> 28	> 47	> 80	> 189
Biogas potential (bln m^3/a)	> 2.8	> 4.7	> 8.0	> 19
Biogas energy potential (GW)	> 1.8	> 2.9	> 5.0	> 11.8

* According to RRU-BMW field test results, participation rate 70% and net-BMW 70kg/c.a (2005/2006)

Besides about 25 billion nm^3 of biogas from MSW, derived from municipal wastewater (sewage sludge), agricultural residues and livestock waste, can produce 70 billion m^3 of biogas (MOA). In total, there are about 1.5-2.0 billion tpa of biomass available, and the existing landfill sites that may produce at least 155 billion m^3 biogas per year, or about 96 GW. It is estimated that one-third (43 billion nm^3) might be produced till 2020. The forecast figures are seen in Table 6 and Figure 5.[14]

With urbanization, more suitable biogas sources are likely to appear in the city; while, with the industrialization of agriculture, more middle and large-scale plants will be installed in the rural areas. According to Table 6 there will be need to use urban waste sources to comply with national renewable energy targets. The benefit of using BMW from source separation is that this can be done immediately and no

Table 5: MSW/BMW and food waste biogas plants currently under consideration in China[14]

Location	Start	Feedstock	Technology developer	Capacity mln tpa	•	Remarks
Beijing Dong Cun, Taihu County	2007	restaurant & MSW, manure	Linde Valorga	0.2	Inv. 18 m Fee 13.5pmt	feasibility 05 CDM
Beijing	till 2010	restaurant & MSW,..	Not defined			9 plants anticipated
Shanghai Jinshan	2008	MSW, BMW		0.22	Inv. 32 m	public tender
Shanghai Putuo, Shanghai	2007	municipal wet waste	Valorga	0.18 to 0.29	Inv. 30 m Fee 17pmt	feasibility 05 CDM PDD1/06
Guangzhou Likeng (Guandong)	2007	municipal wet waste	Valorga	0.36	Inv. 32 m	preparation
Changsha Huiming (Hunan)	2005	MSW		0.73	Inv. 11 m	biogas power plant
Mianyang (Sichuan)	2002	MSW	tunnel type	0.25 AD: 3,600 tpa		AD as pilot project
Yingkou (Liaoning)	2007	MSW, SS	Tsinghua Tongfang	0.27	Inv. 20 m	
Shenyang (Liaoning)	2010	BMW (source separation)	wet AD recom mended[16]	0.12 to 0.20	Inv. 12 m Fee >6 pmt	prefeasibility study

Table 6: Biogas production in 2006, forecast for 2010 and 2020 and overall production potential, (bn nm³/a)[14]
Estimates in italics

	Source	2006	2010	2020	Potential
Decentral	Household small-scale bio digesters	6.5	11.0	19 - 22	25 **
	Wastewater DEWATS (<100 m³/d)	0.05	0.12	1.0	15
				20	
Central	Urban MSW/BMW	0.0	0.16	6.0?	25 - 30 *
	Agriculture and agro industry, med/large (wet waste, manure)	0.34	3.8	5.6	70 - 80
	Landfills (old and new MSW)	0.36	1.4	4.4	< 2 - 5 ***
	Sewage sludge (WWTP)	0.05	0.5?	6.0?	25 *
Biomass based biogas production target (State Grid Company)				24	
Production/production target, potential		7.3	19	44	> 155

* Potential for 2050, consideration of urbanization and infrastructure development
** 50 per cent realization
*** Estimate for 2010 China 290 mln tpa MSW. If 70 per cent is disposed of in landfills with methane collection, the LFG recovered could be equivalent to 40-280 bln m³ (UNEP, Intergovernmental Panel of Climate Change). World Bank estimates are much more realistic with 10 bln m³/a.[17]

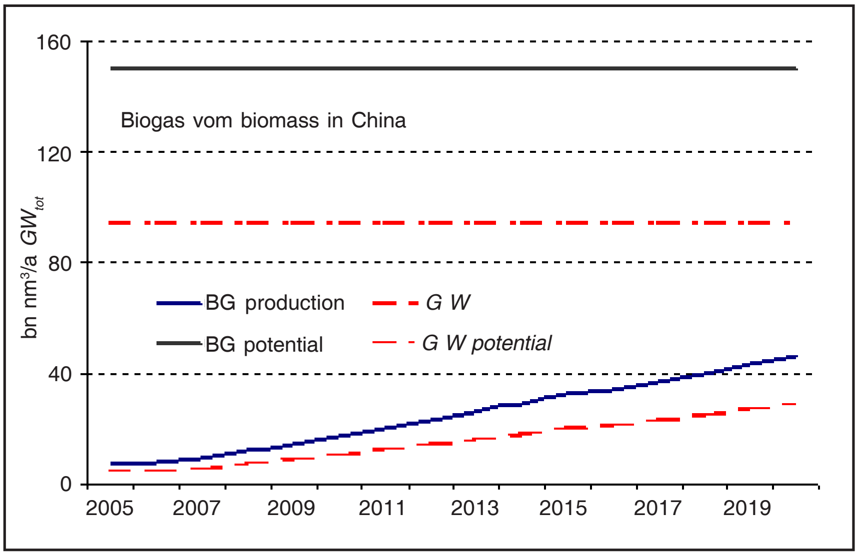
landfill fraction will be produced. In the case of urban wastewater sludge digestion, the by-product has to be disposed of again by landfilling or incineration, and it may take long lasting efforts (10 years of indirect discharger controls in the 1990s in Munich, Germany) to achieve a decontamination level of sewage sludge acceptable to make land application acceptable.[4]

BMW treatment - a business opportunity

Besides for commercial service providers and waste treatment enterprises, a new income opportunity for the rural population, as part of the 'Construction of New Socialist Countryside' policy in China 2006, could be developed. Farmers may act in the suburbs of cities and at county level as BMW collectors and AD plant operators.

The basis would be Built-Own-Transfer (BOT) or Built-Own-Operate

Figure 5: Estimate of trends - Biogas and energy production from biomass (bn nm³/a) in China and biomass biogas and energy production (GW_{tot}) potential[14]



(BOO) contracts with municipalities and this management model would follow the example of some middle European countries, where farmers took over biowaste collection and treatment services in smaller cities or in the suburbs of large cities.

Farmers collect the quality of waste they can use, within legally permitted quality requirements (according to soil and food safety) treat or co-treat BMW with their own agricultural waste at their own composting or biogas plants, the whole process supervised by independent bodies. For example, about 20 per cent of the bio-organic waste in Austria is treated in this way. Farmers there earn about • 30-50 per mt for collection and • 40-60 per mt for treatment, and also obtain the benefits of biogas/electricity sales. In Lower Austria, 60 per cent of the plants are operated by farmers in plants with a capacity up to 5,000 tpa.[18]

It is suggested that China applies a similar model, thus providing new jobs for the farmers and supporting recycling of organic matter to prevent soil depletion. About 10-20 per cent of BMW from the cities could be left to these "new entrepreneurs" from the rural areas around the cities.

The size of the BMW or co-treatment plants could be small and middle-scale, say 20-100 tpd. The required number of decentralized AD plants might be a few thousands while the demand for large-scale plants will be about 200 until 2020.[19]

Summary

Given the global requirements on solid waste management to phase out bio-organic materials from landfilling, source separation and recycling of BMW, it is essential to further develop multidisciplinary, sustainable, integrated waste management systems in China. This will contribute to the development of waste treatment, the development of the countryside, the reduction of GHG emissions, the better enforcement of the "recycling economy" by closing material loops, and support to 'renewable energy production'. The effectiveness of source separation of bioorganic waste in a mega city has been demonstrated to be feasible in China.

Chinese biogas potential from MSW is still underestimated. Chinese authorities have to realize the given BMW biogas energy potential. About one third, or 8 billion nm³, of the targeted feed-in-grid biogas production in 2020 could derive from municipal waste biogas plants. Biogas from 300 million tpa BMW in China till 2050 could replace another Three Gorges Hydropower Project with 18 GW_{el}.

Therefore biogas power from wastes is to be seen as an important factor in line with the other non-fossil energy production targets in China: 20 GW_{el} wind power and 40 GW atomic power till 2020. The estimation is, that about 24 GW (6 GW_{tot} from MSW/BMW) could be produced from waste biomass sources till 2020. Current municipal waste biogas projects (anaerobic MBT projects) in China will only make use of 3 per cent of this MSW/BMW potential.

LFG collection should only be applied for existing landfills and mainly for waste that is already disposed of there; while, in the sense of the "Circular Economy" and Climate Protection, more emphasis should be put on MSW/BMW biogas plants prior to landfilling. Farmers may operate middle-size biowaste and co-treatment biogas plants and benefit from biogas utilization and compost application. The recently established private sector partnership (PSP) model of Shanghai can motivate other municipalities to outsource public waste services.

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Asia-Pacific Regional Biogas Research and Training Center

The Asia-Pacific Regional Biogas Research and Training Center (BRTC) is a scientific institute engaged in the study of anaerobic digestion technology in China. BRTC is the only one international biogas research and training centre in China. BRTC’s functions include the study of fundamental theory and applied fundamental theory of anaerobic digestion of industrial organic wastewater, urban domestic sewage as well as agricultural residues; the study and design of anaerobic digestion processed systems and the counter-part equipment; conducting biogas technology training domestically and internationally; information study in biogas technology in China and foreign countries; developing and marketing the products of rural energy technology; being responsible for the quality monitoring and inspection for both biogas technology and rural energy technology; consulting for decision-making of the development of rural energy technology in China.

The institute also offers many technical services such as:

- Wastewater treatment - e.g. the treatment of wastewater from the production processes of alcohol, molasses, slaughtering, tanning, bio-chemical pharmacy, printing and dyeing;
- Design and construction of a complete set of technology for recovery and utilization of resources from the above wastewater treatment;
- Design for industrial and civil construction;
- Systematic project design and construction for poultry wastes and domestic sewage treatment;
- Design and construction for small-sized and high-efficiency rural household biogas digesters which are manufactured commercially;
- Systematic design and construction of biogas purification, storage and supply; and
- Talented personnel training, technical consultation, quality-monitoring of technical products for the trade industries of biogas development and rural energy development, etc.

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