Biogas from Landfills or Anaerobic Digestion Plants in China
– Comparison for Biomass Wastes in China –

Bernhard Raninger and Hongjun Zhou

1. Biomass wastes in China

China is currently facing the most rapid urbanization in the global history but environmental protection, national energy security, renewable energy and climate change issues have to be tackled in order to ensure a sustainable socioeconomic development. China faces a rapid development in MSW generation. The overall waste generation is increasing accordingly (Table 1). Even though it's specific per capita amount of waste is still half of the one in Germany (Table 2), China is, due to its size and large population, since 2004 the globally largest waste producer [1]. The application of biogas from various biomass sources for the generation of energy and organic compounds from biomethane (bio-refinery) are going to play an important role in China's attempts to achieve ecological and economic stability.

Biomass wastes of agricultural and municipal origin, and in the future, to certain extend energy crops, will represent the main feedstock for biogas production. The potential annual biogas yield for middle and large scale biogas plants (not including small scale household biogas digesters, amounting to 40 million in 2011), will be from agriculture 29.1 billion nm^3, from municipal solid waste (MSW) and municipal waste water sludge 12.3 billion nm^3, 215 billion nm^3 from crop residues (straw) and 33.4 billion nm^3 from animal manure. About 290 billion nm^3 biogas could be generated annual in total, which could cover 6.9 % of the total energy demand in China in 2010 and 5 % of the overall energy demand of 190,000 PJ, in 2050 if some energy crops from marginal land is included [2, 3].

In total MSW of 340 million t/yr, with 60 m/m% to up to 80 m/m% bioorganic matter, was estimated to be generated in 2010, from which 190 millions are coming from the urban areas, the collected part amounts only to 160 million tons [1, 4, 5]. This MSW quantity will, mainly due to the migration of more 300 million people into cities until 2025 reach 510 million t/yr [1].

Table 1: Type and quantity of available biomass wastes for biogas production in middle and large scale biogas plants (MLBP) in China

Biomass waste and residues	Available 2010*	Potential 2030**
	million t/yr	
Straw (crop residues)	340	744
Agroindustry waste	400	
Livestock waste	4,000	5,907
MSW/BMW (household kitchen waste)	360/120	510
Restaurant kitchen waste	14	
Organic industrial waste water	30,000	
Municipal sewage sludge***	22 – 30	133

Sources:

* Li Shaohua: China Biogas Policy Frame during 12th Five-Year. In: Sino – German Biogas Cooperation Strategy Workshop in Beijing. Beijing, 2011

** Brauner, C.; Raninger, B.; Villa, R.; Dong, R. (2011): Biogas Potential of Middle- and Large-Scale Biogas Plants and Its Estimated Contribution to Climate Change Mitigation in China. In: Biogas Engineering and Application, Volume 2, pp. 57-87, 2012

*** Green tech Report on Sludge Treatment and Disposal Market in China, 2012

Table 2: MSW Generation in China, Germany and US, current data and projections for 2025

Country	In 2011 available data			2025			
	Urban population	MSW generation	Total MSW generation	Total population	Urban population	MSW generation	Total MSW generation
	million n	kg/c.d	million t/yr	million n	million n	kg/c.d	million t/yr
China	512	1.02	190	1,445	822	1.7	510
Germany	61	2.11	47	80	62	2.05	46
USA	242	2.58	228	355	305	2.3	256

Source: World Bank: What a Waste: A Global Review of Solid Waste Management, 2012

As a response to the quantitative pressure, and learning from waste treatment projects in the past considerations within the 12-FYP (till 2015) are made to treat 80 % of the collected MSW in Chinese cities. Therefore the investment in MSW treatment will be doubled compared to the 11-FYP, reaching CNY800 billion. MSW incineration shall be increased from about 98 plants in 2009 by another 600 plants till 2020 (in total 88 million t/yr), additionally the flue gas emission standards shall be set to European levels in 2012 [4]. So far waste incineration plants in China suffer from the low calorific value of the feedstock of only 3,500 kJ/kg and the low emission standards. Composting is due the difficulty to treat the easy decayable bioorganic matter and finally due to the low quality of the end product no subject of development [6] and simple *aerobic mechanical – biological treatment* for waste stabilization prior land filling is, as it *only* aims at green house gas (GHG) emission reduction not seen meaningful in China, which does not apply for *an-aerobic mechanical – biological treatment*, where biogas production is the driver.

In respect of the high bio-organic content in the waste stream, within the 12-FYP, for the first time, bioorganic waste separation in the residential areas was considered. Pilot areas for source separation of the bioorganic fraction are established in major cities like Beijing, Shanghai, Guangzhou, etc. and 1009 residential communities have been established introducing biowaste source separation by the end of 2011. To treat this waste the construction of 50 biogas plants in 33 cities with a daily capacity of in total 8,000 to 10,000 ton per day for restaurant- and municipal organic kitchen waste is planned till 2015 [4]. Some of these projects receive the support of the World Bank [9] and other donors.

To support the electricity generation from landfill gas, potentially required at 1,600 landfills till 2050, is another target of the 12-FYP, but its effectiveness will be discussed below.

2. Landfill disposal

Till today landfill disposal of MSW is still the most widely used type of MSW disposal in China, accounting for 89 m/m% of the MSW collected (8.8 m/m% incinerated and 2.2 m/m% composted) in 2009 [4]. There are 447 official engineered large scale landfills in operation, which should all be potential *landfill-/biogas* sources, reaching a cogeneration of heat and power (CHP) capacity 80 – 90 MW_{el} plus biomethane upgrading [7]. But as a matter of fact, at sanitary landfills in China only a low quantity of landfillgas (LFG) can usually been captured (see certified emission reduction of Clean Development Mechanism – CDM projects, UNFCCC) [8].

China should obviously have a great potential for landfill gas projects. During the last decade many international CDM developers and certified emission reduction (CER) buyers were focusing on landfill gas projects. As of 03/2011, 56 projects have been approved by the National Development and reform commission (NDRC). But only about 20 CDM projects were registered by UNFCCC and only half of these projects could provide monitoring reports with an issuance success rate of in the average of 13 % (not included landfills which didn't submit monitoring reports at all). The landfill gas collection rates are far below the estimated quantity of CER and the expected revenues from carbon emission reduction.

Considering these facts, landfill simulation research was conducted at the biotechnological laboratory at the Institute for Clean Energy and Environmental Engineering (ICEEE), Aerospace University in Shenyang to analyze the landfill behavior of Chinese MSW in comparison to *western* MSW. It was seen that the traditionally used biogas calculation models of the US EPA [10, 11] did not reflect the given MSW composition and its easy decay ability in China. The key is the differentiation between the bio-decay ability of the various bio-organic waste fractions. The landfill gas collection technology and operation practice may play a relatively unimportant role, since landfills operated by international waste service companies could not perform better.

3. MSW Composition and characterization of the bioorganic fraction

A significantly different Chinese MSW composition with a high bio-organic content (Figure 1, Table 3, 4) leads to a landfill behavior of the remaining MSW disposed at landfills,

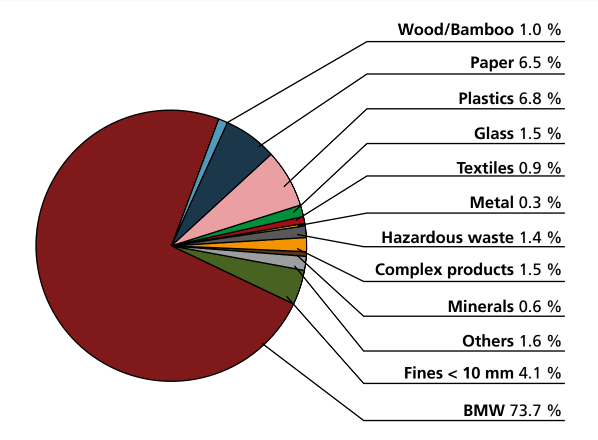

Figure 1:

MSW analysis Shenyang, Sino-German Resource Recovery and Utilization of biological municipal waste (RRUBMW) project, monthly analysis 3/2005 – 10/2007, n = 692 (in m/m% FM)

Source: Raninger, B.; Li, R.; Chen, X.; Xu, H.: Biomass Wastes-to-Energy in China. Biogas from Landfills or Anaerobic Digestion?, Depotech, ISBN 987-3-200-02018-4, pp 105-111, Austria, 2010

Table 3: Characterization of MSW in Ningbo City 2010, amount 2,300 t/d, random sampling, China

Area		Paper	Plastic	Bamboo and wood	Textiles	Kitchen waste	Peel	Metal	Glass	Stone ballast	Coal ash	Hazard Materials	Others	Low Calorific Value	Moisture content	West-Density
		m/m% FM												kJ/kg	m/m% FM	kg/m^3
Residential community	Jindu Jiayuan	6.3	18.4	0.6	15.6	53.8	3.7	–	0.3	0.9	0.4	–	–	4,960	60.63	145
	Ningxing community	8.8	15.5	–	3.8	59.8	4.8	–	3.5	2.6	–	–	1.2	4,740	57.98	124
	Average	7.6	17.0	0.3	9.7	56.8	4.3	–	1.9	1.7	0.2	–	0.6	4,850	59	135
School and enterprise		16.5	16.5	1.1	–	61.2	2.5	0.5	0.9	0.9	–	–	–	5,760	56.25	127
Baoshan grocery market		1.6	9.3	–	–	86.3	–	–	–	–	2.7	–	–	1,590	77.48	263
Transfer station		11.9	17.7	–	1.2	64.5	2.6	0.6	1.4	0.2	–	–	–	3,400	63.59	263

Source: World Bank: Feasibility Study Demonstration Project of Collection and Recycling of Household Waste in Ningbo Urban Area, (Draft), 2012

Table 4: Characterization of Chinese MSW as used in Project design documents (PDDs) and the result of four years monthly MSW analysis in Shenyang (RRU-BMW project)

MSW composition	UNFCCC-PDD	Shenyang 2004-2009 RRU-BMW
	m/m% FM	
Paper, Textiles	30	8.5
Garden and park waste (non-food organic putrescibles)	28	0.0
Biowaste from households (kitchen)	25	73.7
Wood	8	1.7
Others (not bioorganic matter, plastic, inerts, metals, glass)	9	16.1
Total	**100**	**100**

Sources:

Raninger, B.; Li, R.; Chen, X.; Xu, H.: Biomass Wastes-to-Energy in China, Biogas from Landfills or Anaerobic Digestion? Depotech, pp. 105-111, Austria, 2010

Raninger, B.; Bidlingmaier, W.; Li, R.; Lei, F.: Bioorganic Municipal Waste Management to deploy a sustainable Solid Waste Disposal Practice in China. The Chinese Journal of Process Engineering, Vol. 6 No. 2, Apr., pp. 255-260, China, 2006

UNFCCC PDD, Ref 1906, Shenyang Laochuchong LFG Power Generation Project, Version 03, 2009

which is quite different from that of residual-waste at landfills in the EU or in other *western* industrialized countries. In typical Chinese MSW, as it is collected by the municipalities, 88m/m% of the organic matter is easy and moderate biodegradable with a low lignocelluloses content (Table 5).

4. Landfill gas capture efficiency of Landfills in China

At landfills in western industrialized countries (Canada, Germany,) it was reported that after 30 years disposed telephone books and wasted newspapers still can be read. In Chinese landfills this may not happen because of:

- paper and other lignocelluloses fibers materials are valuable material subject of recycling and will not end up at the landfill (this results in a low amount of celluloses, hemi-and lignocelluloses in the landfilled MSW) and
- due to high amount of easy decayable bioorganic matter, the high water content, large surfaces disposal practice, and under the given temperatures and the impact of penetration, the conditions in the landfills are favorable for a fast hydrolysis, acidification but not for a methane production, as to the low pH. This leads to huge amounts of highly TOC (chemical oxygen demand, COD) loaded leachate which is drained from the landfills and the remaining bioorganic matter in the landfill is decomposed very fast by a combination of aerobic and anaerobic processes [14].

Chinese landfills, even managed by international organizations, cannot generate the calculated and expected amount of biogas. The landfill Laochuchong in Shenyang, Liaoning, operated by the Italian CDM project developer Asja, is generating under best condition during summer time only half of the anticipated CERs (PDD 2008: based on the CDM methodology ASM0001 Version 6, a calculated amount of 355,875 tons CO_2 eq/yr, resp. 1,365,700 tons CO_2 eq/yr for a ten years crediting period) [15], (see Figure 2 and 3).

Figure 2: Three of six cogeneration of CHP units of Shenyang Laochuchong Landfill 3,000 tons/day, grid connection operated as CDM project by Asja, Italy

Source: Chen, X.; Raninger, B.; Feng, L.; Li, R.: Why Chinese MSW Landfills do not generate the expected amount of Certified Emission Reduction (CERs). ORBIT China, 2009

5. Landfill simulation

A comparison of the characterizations of Chinese and European MSW organic matter under consideration of its biodegradability is shown in Table 4 with the result that in the Chinese remaining MSW 78 m/m% are rapidly and moderately degrading, but only 12 m/m% in the western MSW (Austrian MSW composition of the 1990th was considered, at a time when BMW separation was still not introduced) [16].

Various calculation models were developed for quantifying emissions from the decomposition of waste in MSW landfills, which provide different approaches to estimate landfill gas emission. The most widely used LFG calculation models in China are the US-Environmental Protection Agency (EPA) landfill gas emissions model (Land GEM) [10] and the IPCC Guidelines for National Greenhouse Gas Inventories, Tier 1 method (2006) [18]. Most of the LFG CDM projects are using the methodology AM0025, and the Central American LFG model [11]. All these models are depending on variables such as kf factors and L0, which are difficult to choose, as long as waste classification in rapidly-, moderately- and slowly degrading substances is not sufficiently considered (Table 5).

Table 5: Comparison of Chinese and European MSW organic matter and its biodegradability (Sino-German RRU-BMW project, 2008)

MSW characterization		China		EU*	
		m/m%			
Rapidly and moderately degrading	Bioorganic municipal waste BMW (food- and kitchen waste, green garden waste)	78	∑ 88	12	∑ 59
Slowly degrading	Organic matter with a higher semi- and ligno-celluloses content (wood, yard waste, paper, textiles, composite material,)	10		47	
Non degrading	Inert organic and inorganic matter (plastic, metal, glass, ash,)	12		41	
Total		**100**		**100**	

* Average EU countries (Germany, Austria, EU) 1993-1996 (no BMW separation at that time) in Raninger, B.: Deponiebetrieb in der Praxis. Kongressbericht Depotech, Montanuniversität Leoben, in Deponietechnik, Entsorgungsbergbau und Altlastensanierung, Rotterdam/Brookfield: Verlag A. A. Balkema, pp 135-143, 94, Austria, 1994

Source: Raninger, B.; Li, R.: Municipal Waste degradation at engineered landfills and its impact on the generation of greenhouse gas emission reduction in China. ORBIT e.V., Germany, 2008

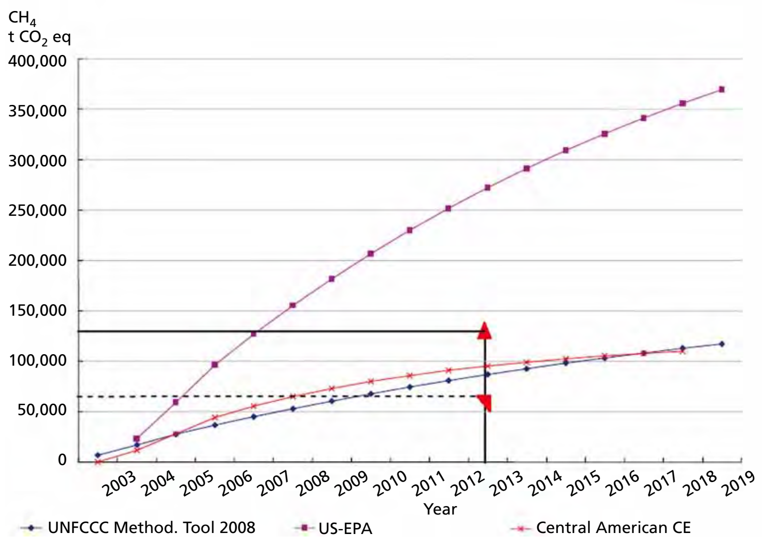

Figure 3: Comparison of three landfill gas calculation models (US-EPA 2005, US-EPA Central American Model 2007 and UNFCCC 2008) on the example of Shenyang, Laochuchong Landfill, PDD estimation and expected CER result

Source: Chen, X.; Raninger, B.; Feng, L.; Li, R.: Why Chinese MSW Landfills do not generate the expected amount of Certified Emission Reduction (CERs). ORBIT China, 2009

The EPA LFG recovery projection, which was so far mostly used for CDM projects in China, results in about five times higher amounts than the calculations based on the latest UNFCCC methodological tool [17]. But also the UNFCCC methodology, the Central American and the EPA model are still overestimating the real net CERs generation in China by about 100 % (Figure 3). In order to understand better the problem of low landfill gas capture rates in China, the biodegradation behavior of EU and Chinese MSW was analyzed and compared in the ICEEE biotechnological laboratory by landfill simulation tests. After 500 days in the *western* MSW landfill 90 m/m% of the TOC of the MSW was still remaining in the landfill body, whilst in the Chinese MSW only 66 m/m% of the TOC remains. In the Chinese MSW 22 m/m% (25 m/m% after 750 days) of the TOC was lost through leachate and 12 m/m% through other not biogas related losses (Figure 4). Biogas was not identified during that time, one reason is the low pH between 5.2 – 6.2 in both cases.

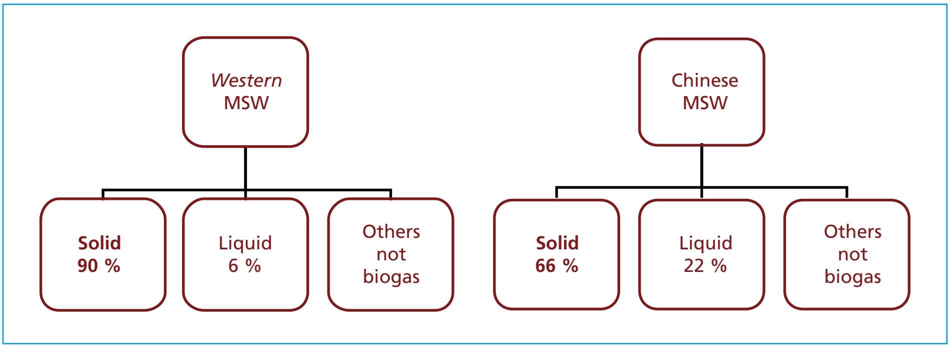

Figure 4: The TOC mass balance of the EU MSW and Chinese MSW after 500 days, landfill simulation including rainfall 600 mm/year, 37 °C, pressure load of 3.5 tons/m², biogas inoculums used

Source: Chen, X.; Raninger, B.; Feng, L.; Li, R.: Why Chinese MSW Landfills do not generate the expected amount of Certified Emission Reduction (CERs). ORBIT China, 2009

6. Biogaspotential from Chinese MSW and BMW

The biogas generation potential of the source separated bio-waste fraction of MSW (BMW which contains about 3 – 6 m/m% ballast matter) and of unsorted MSW (with about 20 m/m% ballast matter, see Table 6) from Shenyang was analyzed within the RRU-BMW project (13, 14). The characteristics and results for BMW are displayed in Table 5, showing that the biogas generation potential of fresh bio-waste with 117 nm³ biogas per ton of feedstock is comparable with BMW from Europe [19].

A gas yield comparison with other feedstock materials available in China, such as sewage sludge or cow manure, has shown that BMW and its co-digestion with manure provide the highest biogas yields. The landfill gas collection potential and the biogas yield from EU MSW landfills, from Chinese MSW landfills and Chinese MSW anaerobic digestion plants is estimated in Table 7.

Under consideration of the MSW composition (mainly the H_2O and TOCbio content) and the practical circumstances at the landfills, respectively the biogas plants, it is evident, that the landfill gas yield at Chinese landfills is very low, but in the case that the same feedstock is processed in closed biogas plants, full use can be made of the BMW biogas potential. Figure 5 shows the Whenzhou Landfill where the pressure water scrubbing (PWS) landfillgas

Table 6: BMW characterization and biogas potential, Shenyang (RRU-BMW, 2008)

Parameter	Unit	Value
Dry matter (DM)	m/m% FS	25 – 30
Organic matter (OM)	m/m% DM	78 – 85
pH	–	5.2 – 5.8
Conductivity	mS/cm	1.2
Total organic carbon (TOC)	m/m% DM	43 – 46
C/N ratio	–	18 – 23
Biogas potential (50 days) per FM	Nl/kg FM	117
Biogas potential (50 days) per DM	Nl/kg DM	474
Biogas potential (50 days) per VS	Nl/kg VS (Ignition loss)	600 – 700
Methane, CH_4 generation	Nl/kg DM	249
Biogas methane, CH_4 concentration	v/v%	53

Source: Raninger, B.; Li, R.: Municipal Waste degradation at engineered landfills and its impact on the generation of greenhouse gas emission reduction in China. ORBIT e.V., Germany, 2008

Table 7: Landfill gas (LFG) collection and biogas (BG) yields from EU and Chinese MSW landfills and biogas generated at biogas plants BGPs).

MSW	TOC_{bio}	LFG/BG Potential**	H_2O	LFG/BG Potential*	LFG/BG Recovery rates	Total BG/LFG yield
	m/m% DM	nm^3/t DM	m/m% FM	nm^3/t FM	%	nm^3/t FM
EU LF****	27	500	40	330	50	165
China LF	38***	700	70	200	10	20
China BGPs	43	800	80	160	60**	98**

* 1 g TOC_{bio}/VS produces under normal conditions 0oC, 1 atm, 1.868 lt LFG

** VS (550 oC) in m/m% DM = TOC in Chinese MSW (VS=Volatile Solids)

*** Cumulated biogas potential, acc. biogas generation test 50 days, 37oC (Raninger, et.al. 2006)

**** Average EU countries (Germany, Austria, EU) 1993-1996 (no BMW separation at that time)

upgrading system with a capacity of up to 1,000 nm^3/h can only be operated for some hours a day with 300 nm^3/h, due to the low LFG production. High N_2 contents in the LFG indicate the over exploration.

7. Potential of Compressed Biomethane (CBM) in China

The market of biomethane in Germany and Europe is increasing. Within Europe, Germany has the largest grid feed-in capacity of biomethane, which has since 2006 increased from about 1,000 nm^3/h up to 30,000 nm^3/h. This massive extension derives from the *National Plan of Action of the Federal Government*, which says that 7 v/v% by 2020 and 11.5 v/v% by 2030 of the market demand of the national natural gas consumption should be substituted with biomethane, which means a feed in of 6 billion nm^3/yr in 2020 and 10 billion nm^3/yr in 2030 [21].

According to the estimation, in 2020 China will need 5.6 x 10^8 t petrol, but the domestic production will be only 1.9 x 10^8 t. The import dependence will reach 65 %. From 2000 to 2008, the average annual growth rate of natural gas consumption was 16 %, reaching about

Figure 5: Test operation of PWS landfillgas upgrading facility at Whenzhou Landfill, Zhejiang Province China, Design CUP Beijing

220 billion nm^3/yr. China has to satisfy the recent demand of 218 billion nm^3/yr with about 222 billion nm^3/yr of available natural gas supply comprising domestic gas production and LNG contracts that have already been firmed, for the next three years [20]. It is estimated that in 2020, especially when gas will be used for more than the existing 12 gas-fired power plants (installed capacity 7,120 MW, but 12.580 MW are under construction or planning) the natural gas consumption will be reach 2-3 x 1011 nm^3 per year [22] (Figure 6).

After removing the CO_2 from biogas, the biomethane has the same composition as natural gas and can be seen a substitute of natural gas (see requirements on the NG and CNG=CBM in China in Table 8). The biomethane can be used in CHP for generating power and heat, used as a vehicle fuel in the traffic sector (about 3,000 CNG filling stations do exist in China), supplied to households for cooking (see Deqingyuan Phase II project) and injected into the natural gas grid.

Biogas use for rural electrification faces still the problem of the unwillingness of the grid companies to connect and the obstacle of low grid-feed in tariffs. The heat from CHPs can mostly not be used. Compared with the power generation, biomethane has an easier market access and it's more profitable, as the gas price is linked with the NG market. According to calculations by the GIZ Biomass Project [24], with purification and sales of CBM under the current price situation (04/2012) 1 nm^3 biogas can generate about 1 CNY more profit than through power generation with makes larger biogasplants profitable with an IRR of 10 years [23, 26].

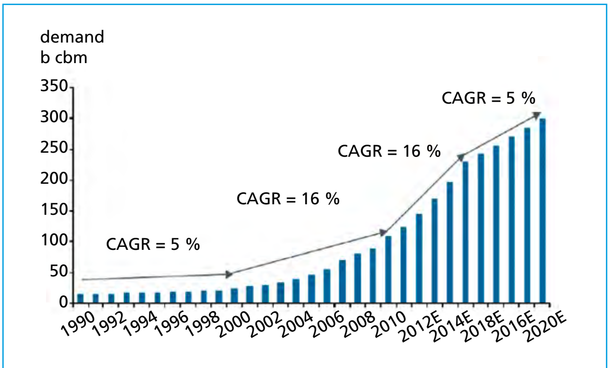

Figure 6:

China Natural Gas demand 1990 to 2020, NDRC 2011 (NDRC, 2011).

Table 8: China national standards of natural gas (GB 17820-200x, GB17820-1999) and Compressed Natural Gas (CNG) as Vehicle Fuel (GB 18047-2000)

Parameter	Unit	NG			CNG
		C I	C II	C III	
Heat value	MJ/nm^3	> 31.4			
Tot. S	mg/nm^3	≤ 100	≤ 200	≤ 460	≤ 200
H_2S	mg/nm^3	≤ 6	≤ 20	≤ 460	≤ 15
CO_2	v/v%	≤ 3.0		-	≤ 3.0
O_2	v/v%				≤ 0.5
H_2O dew point	°C	5 °C below lowest ambient temperature			below -13 °C
The conditions of the gas volume in comparison 101.325 kPa, 20 °C					

8. Adjustment of the Industrial Scale Biogas Policy

The Ministry of Agriculture (MoA), which is leading the biogas development in China, has summarized the needs to leverage better the biomass resources and to develop the sector of agricultural large scale biogas plants through international cooperation and by adopting the following policies [25, 26]:

1. The investment scale of biogas plants needs to be enlarged by 2.5 times in average
2. The types of feedstock materials need to be expanded: besides of manure and straw, alternative feedstock materials from the agro-industry, municipal sources and, up to a certain extent, energy crops, should be included.
3. Biogas plant efficiency and gas yields need to be improved to international performance practice
4. Public subsidies must be performance and end product related und be extended to biogas purification, thermal energy recovery, fertilizer use, etc. Further the current power generation grid feed-in price is low, so the policy incentive's effect is insufficient.
5. A quality monitoring and operation evaluation mechanism for biogas plants has to be established and publicly funded biogas projects, not operated properly or underperforming, shall receive penalties.

The forecast of the biogas production shows that the resources are far from being fully exploited, that the actual policy targets to develop sustainable biogas energy could be easily reached and should be much more ambitious. European biogas policy, business concepts and advanced technology shall be used supportively to achieve Chinas targets [3].

9. Conclusions

In 2010 the Chinese Ministry of Environmental Protection estimates the annual economic loss through environmental damages from wastes disposal to be CNY 25-30 billion (EUR 3.5 billion). Although existing LGF collection is certain a contribution to environmental protection, the waste management strategy has to be changed in a way that the biogas potential of MSW can be used more efficiently through biogas plants prior landfilling and not after. From the point of landfillgas collection engineered landfills in China do not operate well.

During the last decade China has made big progress in developing the rural biogas sector for both environmental protection reasons as well as recently for renewable energy production. The central government has supported the construction of biogas plants in all scales, but due to the weak process performance the biogas and biogas energy generation and contribution to the expected climate change mitigation is still below expectations. Only four projects are registered CDM projects and only a few biogas plants are connected to the public electricity grid.

China has abundant feedstock resources for producing biogas. Based on the conventional feedstock (animal manure, crop residue and solid waste, sewage sludge), 261 billion m^3 biogas can be produced every year, which can cover 6 % of the overall energy demand. Therefore, an energy production oriented, vigorous development of biomass energy, especially biogas energy, adapting *best-practice* technologies and a sustainable and efficient operational performance, will contribute tremendously to energy security, sustainable rural social and economic development, environmental protection and greenhouse gas mitigation. The use of biomethane in the traffic sector will make the Chinese biogas industry more profitable in the future.

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11. Abbreviations

BMW	Bioorganic Municipal Waste
CBM	Compressed Biomethane
CDM	Clean Development Mechanism (UNFCCC)
CER	Certified Emission Reduction (CDM)
CHP	Cogeneration of Heat and Power
CNY	Chinese Yuan – Renminbi, Chinese currency
CUP	China University of Petroleum, Beijing
DM	Dry Matter Content
FM	Fresh Matter Content
FYP	Five-year Plan of the Chinese Government (2011-2015)
GIZ	Gesellschaft für Internationale Zusammenarbeit (GmbH), Deutschland
LFG	Landfill Gas
LNG	Liquefied Natural Gas
MSW	Municipal Solid Waste
NDRC	National Development and Reform Commission
NG	Natural Gas
PDD	Project Design Document (CDM)
RRUBMW	Resource Recovery and Utilization (Project)
UNFCCC	United Nations Framework Convention on Climate Change