CDM PERSPECTIVES IN CHINA

OPPORTUNITIES FOR GERMAN KNOW-HOW AND CDM APPLICATION

THE CHINESE BIOMASS SECTOR

May 2009

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PREFACE

The global carbon market, with an estimated value of US$ 84 billion in 2009, is highly lucrative, not only for carbon buyers and financial institutions, but also for service providers and for tech-nology transfer.

So far the participation of German companies in the flexible mechanisms established under the Kyoto Protocol remains low. Out of almost 1,600 globally registered CDM Projects only 87 have German involvement.

In 2008 the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) launched the CDM initiative in order to encourage the participation of German companies in the CDM market and to enable market players to make full use of opportunities presented by the CDM in respective host countries.

The CDM Service Unit China operates under the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and is part of a Global Network with CDM country units in India, Brazil and MENA.

In order to establish clear fundamentals for promoting CER trading among German companies and partners in China, the CDM Service Unit China launched a series of studies to contribute to a better understanding of the market and framework conditions.

In December 2008 the CDM Service Unit China published "Country Study China – A CDM Market Overview".

Now the CDM Service Unit China will publish a series of studies under the title "CDM Perspectives in China for German Know-How".

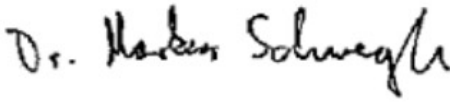
The following study is entitled "The Chinese Biomass Sector - Opportunities for German Know-How and CDM application". It elaborates on the potential to develop CDM projects in the sector of biomass.

According to this study the potential for the biomass sector is high with an estimated biogas installation capacity of 200 MW until 2015.

The CDM methodology portfolio for biomass and biogas CDM application has an abundance of different biomass and biogas treatment technologies which are ready to be applied by project developers.

The German Development Cooperation is already successfully involved in the sector through the Shenyang integrated Biotechnological Municipal Waste Treatment Demonstration Project, some landfill biogas recovery projects, and with some private joint ventures in the farm biogas and industrial biogas sector, and through a sustainable transport fuel partnership. Furthermore, several German Integrated Experts (CIM) work in institutions related to the biomass energy sector.

Through this study CDM Service Unit China would like to enhance understanding and magnify the opportunities and challenges of the market. And furthermore, it hopes to make a significant contribution to the implementation of new types of projects within the CDM framework.



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Beijing, May 2009

ABSTRACT

The target of the following study is to evaluate the market potential of biomass and biogas power generation projects in China with regards to the Clean Development Mechanism (CDM) for German entities.
The study paper extends to four chapters: CDM feasibility of biomass utilization concepts, technology evaluation of Chinese biomass and biogas power plants, and market potential of CDM biomass utilization.
The first chapter outlines all available CDM methodologies and gives a comprehensive overview of application opportunities for different technologies of biomass utilization for energy generation. So far, five methodologies related to the biomass sector are accepted by CDM EB. Among them four methodologies are related to landfill GHG emission reductions and one is applicable to solid reduction in waste water streams. The chapter also outlines the legal and business situation of waste water treatment and lists the applicable Chinese laws and most common business models (BOT and TOT) for construction and operation of biomass and biogas power plants.
Chapter 1 further evaluates CDM validation reports from existing CDM project activities and describes biomass sources and baseline scenario challenges for project developers. Finally, small scale opportunities are described and a table for Certified Emission Reduction (CER) calculation from biomass utilization is provided for a quick overall CER estimation depending on the amount of used biomass. Chapter 1 gives a comprehensive overview for German companies with the interest to invest in or provide technologies to the Chinese CDM biomass-to-energy sector.

Chapter 2 analyses the situation of China's biomass and biogas energy production facilities from a technology point of view. It summarizes the number and capacity of biomass and biogas power plants in operation and currently being constructed. It also provides an overview of possible bio-mass handling processes in China.
The third chapter provides an outlook on Chinese biomass energy generation capacity and displays key findings of the study such as, most suitable provinces for construction of biomass power facilities with regard to different technologies, available support from governmental site, legal pitfalls and rules for biomass and biogas utilization.

Key findings of the desk study are:
- More than 80 biomass combustion power plants with 6, 12, 25 or 50 MW each are operating or have been approved. The overall potential is estimated for 30 GW.
- Based on that figure it is expected that the biogas installation potential will be 200 MW in 2015, 1/3 for agricultural large scale biogas power plants, 2/3 for agro-industrial plants. And for 2020 then 1500 MW with 1/2 agriculture and livestock and 1/2 agro-industry.
- The required CDM methodologies are up-to-date and ready for application.
- The Chinese government is aware of the huge implementation potential and facilitates foreign engagement.

The study acts as a guidebook for German entities that are looking for investment opportunities in the Chinese biomass and biogas sector.

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ABBREVIATIONS

AD	Anaerobic digestion (fermentation)
ADB	Asian Development Bank
BG	Biogas
BPG	Biomass Power Generation
BPP	Biomass power plants
BMW	Biodegradable Municipal Waste
CAAE	Chinese Academy of Agricultural Engineering
CDM	Clean Development Mechanism (emission trade under the Kyoto protocol)
CN	China
CNY	Chinese Yuan, Chinese Currency (RMB Yuan)
CHP	Combined heat and power
EMS	Environmental Management System
EU	European Union
GEF	Global Environment Facility
GHG	Greenhouse gas
ICEEE	Institute Clean Energy and Environmental Engineering, SYIAE
NDRC	National Development and Reform Commission, China
CREIA	Chinese Renewable Energy Industry Association
MSW	Municipal Solid Waste
MW	Megawatt
MWp	Megawatt peak
IEEP	Institute of Energy and Environmental Protection (CAAE)
US	United States
USD	United States Dollar
WB	World Bank

1. CDM feasibility of biomass energy generation concepts

Climate change is a fact. Theoretically, mitigation can be envisaged in three ways: (1) protection and development of carbon sinks, (2) capture and geological sequestration of CO_2, and (3) reduction of emissions at the source. Among these, only the reduction of greenhouse gas emissions (GHG) offers a structural solution, and the reduction of emissions caused by direct burning of fossil fuels is a priority. The Clean Development Mechanism (CDM) allows emission reduction (or emission removal) projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO_2. These CERs can be traded and sold, and used by industrialized countries to a meet part of their emission reduction targets under the Kyoto Protocol. The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction limitation targets. The projects must qualify through rigorous and public registration and issuance processes designed to ensure real, measurable and verifiable emission reductions that are additional to what would have occurred without the project.
"Biomass" refers to renewable organic matter. Sustainable available biomass includes fast-growing trees and plants, wood and wood waste, agricultural crops and residues, aquatic plants and algae, animal wastes, and organic municipal and industrial wastes. Mankind has relied on biomass energy throughout history. Today, environmental and economic concerns have created new opportunities for the use of biomass and assign to biomass an important role in reducing greenhouse gas emissions and air pollution.
At the 21st meeting[1] of the CDM Executive Board it was decided to remove non-renewable biomass as a baseline methodology for small scale activities. At the 23rd meeting a definition of renewable biomass was provided.[2] As stipulated in the glossary of CDM terms[3], biomass is "renewable" if one of the following five conditions applies:

1. The biomass is originating from land areas that are **forests** where:
   a) The land area remains a forest.
   b) Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas do not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting).
   c) Any national or regional forestry and nature conservation regulations are complied with.

2. The biomass is woody biomass and originates from croplands and/or grasslands where:
   a) The land area remains cropland and/or grassland or is reverted to forest.
   b) Sustainable management practices are undertaken on these land areas to ensure in particular that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting).
   c) Any national or regional forestry, agriculture and nature conservation regulations are complied with.

3. The biomass is non-woody biomass and originates from croplands and/or grasslands where:
   a) The land area remains cropland and/or grassland or is reverted to forest.

[1] EB21, Annex 22: Indicative Simplified Baseline and Monitoring methodologies for selected Small-Scale CDM project activity categories: http://cdm.unfccc.int/EB/021/eb21repan22.pdf
[2] EB23, Annex 18: Definition of renewable biomass: http://cdm.unfccc.int/EB/023/eb23_repan18.pdf
[3] Glossary of CDM terms: http://cdm.unfccc.int/Reference/Guidclarif/glos_CDM_v04.pdf

b) Sustainable management practices are undertaken on these land areas to ensure in particular that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting).
c) Any national or regional forestry, agriculture and nature conservation regulations are complied with.

4. The biomass is a **biomass residue** and the use of that biomass residue in the project activity does not involve a decrease of carbon pools, in particular dead wood, litter or soil organic carbon, on the land areas where the biomass residues are originating from[4]. In contrast, where a CDM project involves the collection of dead wood from a forest, which would not be collected in the absence of the CDM, the extracted biomass cannot be regarded as renewable, since it would result in a decrease of carbon stocks.

5. The biomass is the non-fossil fraction of **industrial or municipal waste**.

Where none of these conditions applies, the biomass is considered as "non-renewable".
The following figure presents the most common and basic steps of biomass and biogas production. The numbers highlighted refer to the different GHG reduction potential according to the CDM definition of respective methodologies.

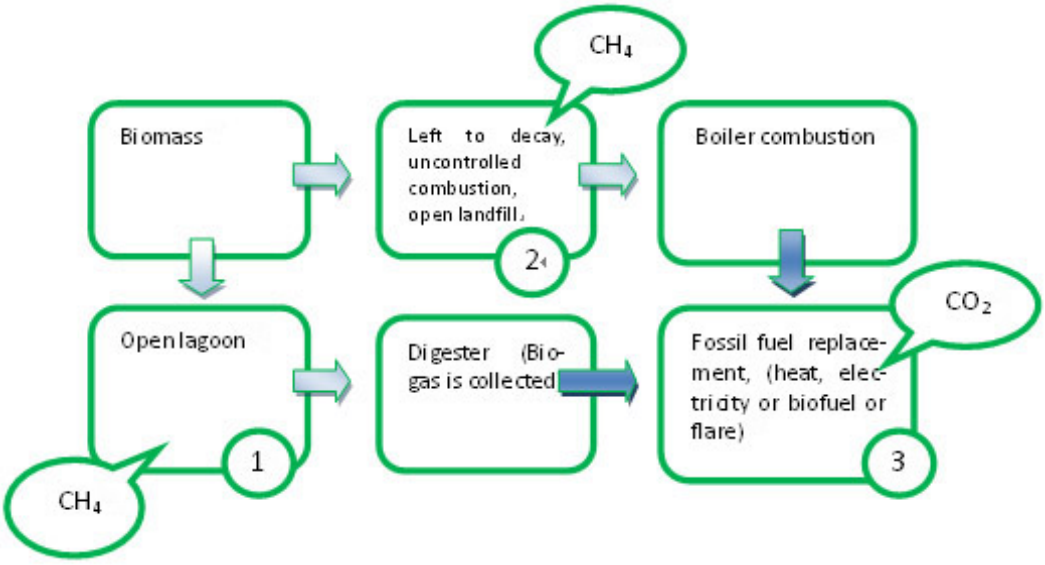

Figure 1: Biomass and biogas production process

[4] For example, if bagasse from sugar production would, in the absence of the CDM, be dumped or left to decay, but is used for energy genera-tion under the CDM, it can be assumed that the use of the bagasse does not affect the sugar cane cultivation practices and hence the carbon pools of the respective soils.

The potential sources of GHG emissions (number 1 and 2) can be avoided if suitable technologies are adopted to improve the current situation. Number 3 shows the potential of replacing fossil fuels by using biomass or biomass based fuels (like biogas or biodiesel). From a CDM point of view, avoiding CH_4 emissions is very attractive since the Global Warming Potential (GWP) of Methane is 21 times higher than that of CO_2. During CDM project development, project developers have to analyse very carefully the sources of CH_4 emission following the strict requirements of the approved methodologies. Biomass for energy is obtained from organic matter either directly from plants or indirectly from industrial, commercial, domestic or agricultural products. The use of biomass for energy generation is classified as a 'carbon neutral' process because the CO_2 released during this process is balanced by the CO_2 absorbed by plants during their growth. However, this carbon-neutral character depends on specific farming methods applied.

This study focuses on[5]
(a) Biogas recovery and reuse from organic waste and wastewater.
(b) Agricultural waste and forest residue biomass combustion for heat and power generation.

1.1. CDM methodologies

Generally, the important point when accounting the "emission reductions" from the project is to clarify which level is the reduction occurring. CDM chose an approach to propose "methodology" in order to identify baseline. In other words, methodology is trying to standardize the calculation method by applying "common" methodology to a certain "similar" type of project. Thus to assure its quality, methodology needs approval from the CDM Executive Board. The CDM categorizes three different methodology types:

AM: Approved Methodologies for projects without any limitations concerning their size,

AMS: Approved Methodologies Small scale for activities with simplified project conditions and a limited maximum amount of emission reductions. These were implemented in order to facilitate small scale projects without the scaling effects as regular sized projects, and

ACM: Approved Consolidated Methodologies that are a combination of several AMs.

[5] Other biomass topics and energy crop production, liquid biofuels (plant oil production, biodiesel, bioethanol, biomass-to-liquid), biomass gasification and pyrolysis, landfill biogas recovery and reuse, municipal solid waste incineration, and waste biomass composting are not subject to detailed research in the framework of this study.

Table 1: Applicable CDM methodologies for biomass and biogas projects (March 2009)

1	ACM0001	Consolidated baseline and monitoring methodology for landfill gas project activities, v 9.1
2	ACM0006	Consolidated methodology for electricity generation from biomass residues v 7
3	ACM0010	Consolidated baseline methodology for GHG emission reductions from manure management
4	AM0007	Analysis of the least-cost fuel option for seasonally-operating biomass cogeneration plants
5	AM0036	Fuel switch from fossil fuels to biomass residues in boilers for heat generation
6	AM0042	Grid-connected electricity generation using biomass from newly developed dedicated plantations, v 2
7	AM0053	Biogenic methane injection to a natural gas distribution grid, v 1.1
8	AM0057	Avoided emissions from biomass wastes through use as feed stock in pulp and paper production or in bio-oil production
9	AM0073	GHG emission reductions through multi-site manure collection and treatment in a central plant, v 1
10	AM0075	Methodology for collection, processing and supply of biogas to end-users for production of heat, v 1
11	AMS II G	Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass
12	AMS III D	Methane recovery in animal manure management systems, v 14
13	AMS III E	Avoidance of methane production from decay of biomass through controlled combustion
14	AMS III F	Avoidance of methane emissions through controlled biological treatment of biomass, v 6
15	AMS III G	Landfill Methane Recovery, v 6
16	AMS III H	Methane Recovery in Wastewater Treatment, v 11
17	AMS III L	Avoidance of methane production from biomass decay through controlled pyrolysis, v 2
18	AMS III R	Methane recovery in agricultural activities at household or small farm level, v 1
19	AMS III Y	Methane avoidance through separation of solids from wastewater or manure treatment systems
20	ACM 0014	Mitigation of green house gas emissions from treatment of industrial wastewater, v 3

Table 2: Methodology application conditions

Category	Methodology	Baseline activity	Project activity	Option for power production	Newly built or upgrade	What kind of material may be used?	Project size (CER)	Scenario acc. to graphic1
Biomass	AM0007	Seasonally operating plants for an electricity grid	Fuel switching and refurbishment	Yes	Upgrade only	Off-season: Non-biomass applicable	Large scale	2, 3
Biomass	AM0036	Fossil fuel heat generation	Heat boilers replaced/upgraded	Yes, but no electricity output increase caused by project activity	Both	Chemically untreated biomass	Large scale	2, 3
Biomass	AM0042	Green field	Installation of a new biomass power plant, co-firing option is available	Yes	Newly built	Chemically untreated biomass residues, plantation must be new established	Large scale	2, 3
Biomass	AM0057	Biomass wastes have to be left to decay in anaerobic manner	Biomass wastes in pulp/paper or bio-oil production	Yes, if applied amount of biomass is considered in the baseline	Newly built	Biomass wastes from pulp/ paper or bio oil production	Large scale	2, 3
Biomass	ACM0006	Greenfield/existing fossil fuel power plant or biomass fuel power plant	Upgrade, energy efficiency measure or newly built biomass fuel power plant	Yes	Both	Biomass and biomass residues	Large scale	2, 3
Biomass	AMS II G	Existing biomass plant for thermal energy production	Energy efficiency measures	No, only thermal application	Upgrade only	Non-renewable biomass	Small scale	2, 3
Biomass	AMS III E	Biomass wastes to be left to decay in anaerobic conditions in a solid waste disposal plant	Controlled combustion, gasification or thermal treatment	Refuse derived fuel and stabilized biomass applied to combustion	Upgrade only	Biomass and other organic matter	Small scale	2, 3
Biomass	AMS III F	Biomass wastes to be left to decay in anaerobic conditions in a solid waste disposal plant	Aerobic: Composting and soil application, Anaerobic: Biogas digestion incl. combustion	Yes, if anaerobically treated	Both	Biomass and other organic matter	Small scale	2, 3
Biomass	AMS III L	Biomass wastes to be left to decay in anaerobic conditions in a solid waste disposal plant without Methane recovery	Decay is prevented through controlled pyrolysis	No heat or electricity production	Newly built	Biomass and other organic matter	Small scale	1
Biogas	AM0053	Natural gas distribution network	Biogenic Methane injection into a natural gas distribution grid	No (assumed that all biogas feeds to natural gas grid will be used and destroyed by the end-user	Both	Biogas	Large scale	1
Biogas	AM0073	Multiple livestock farms with anaerobic manure treatment systems	Centralized anaerobic treatment facility with transportation possibility	Thermal electrical production	Newly built	Biogenetic material from livestock farms	Large scale	1, 3
Biogas	ACM0010	Anaerobic manure treatment system	Multiple anaerobic manure treatment systems	Thermal electricity generation	Newly built	Biogenetic material from livestock farms	Large scale	1, 3

Biogas	AMS III D	Existing anaerobic Biogas manure management system	Upgrade or modification of existing AWMS	Thermal or electrical energy generation	Upgrade only	Manure from livestock population at project site	SSC	1, 3
Biogas	AMS III R	Uncontrolled Methane emissions in small farms and households	Recovery and destruction of Methane emissions in small farms and households	Thermal energy production (applying AMS I C)	Both	Manure wastes from agricultural activities	SSC	1, 3
Landfill	ACM0001	Partial or total release of biogas to the atmosphere	Biogas is captured and flared/used for energy generation	Yes	Both	Biomass and biomass residues	Large scale	1, 3
Landfill	AMS III G	Landfills used for disposal of organic matter	Methane recovery from landfills	Thermal or electrical application (bottling)	Both	-	SSC	1, 3

In the worldwide CDM business biomass, biogas and landfill biogas sectors are well developed. In China, the biogas situation is far more underdeveloped than the biomass sector. The Chinese biomass CDM sector has a total of 25 projects UNFCCC registered, two of them for agricultural biogas. The projects "in pipeline" are similar: the majority applying within biomass combustion and landfill methodologies. Most important methodologies in both sectors (biomass power and biogas) are ACM0006 for biomass and AMS III D for biogas.

Table 3: Overview on Biomass projects in China (March 2009)

Chinese DNA approved	Overview on Biomass projects in China (March 2009)	UNFCCC registered
1	Biodegradable Municipal Solid Waste biogas digestion plants project	
1	Biodiesel Plant project	
10	Agricultural Biogas Plant projects	2
14	Municipal Solid Waste Incineration plant projects	1
17	Anaerobic Wastewater Treatment plants projects	
3	Biodegradable Municipal Solid Waste composting plants projects	1
72	Biomass combustion power plant projects	6
33	Landfill biogas projects	15
151	Total	25

1.2. CDM opportunities in the Chinese biomass energy sector: analysis of the financial and legal situation

This section provides an overview on main laws and regulations with regard to biomass and biogas which will influence the additionality check - as mentioned before landfill, energy crops, gasification, pyrolysis and biofuels are not considered in detail.

1. **PRC Renewable Energy Law**[6] promotes Chinese governmental encouragement to develop and effectively utilize clean biomass energy, and the plantation of energy crops.
2. **Guidance Categories of Renewable Energy Industry Development** lists the equipment manufacturers for renewable energy projects which are supported by the government. Targeted projects include biogas for gas pipelines and power generation, straw-fired power plants, gasification of biomass for pipeline and power application, and liquid bio-fuels. The document provides guidance for local governments to draft policies and measures that encourage institutions and enterprises to engage in research, investment and development of pilot projects.
3. **Regulations on Management of Renewable Energy to Power Projects,** together with **"Measures for Allocation of Prices and Expenses for Generating Electricity by Renewable Energy"** give principles of allocating prices and expenses for electricity generation from renewable biomass. In case of supplying power to the grid, project owners are entitled to receive an additional 0.25CNY/kWh preferential electricity tariff during its first 15 years of operation.
4. **Medium and Long Term Plan of Renewable Energy Development,** setting the goal to achieve in 2010 a share of renewable energy utilization of 10% of the total energy consumption. In 2015, this result should be increased to 15%. In order to realise these goals, promotion of biomass power industry as well as other renewable energy industries must be undertaken.
5. Ideas of implementing **financial supporting policies** of bio-energy includes the plan that government will urge the enforcement of biomass related financial policies such as flexible subsidies for enterprises, raw material subsidies, and tax preferences in order to improve the economical development of bio-energy industries.
6. **"Plan of Biogas Construction in Rural Areas in China, 2007 - 2010" and "Plan of developing national biomass energy industry, 2007 - 2015"**: it is estimated that by 2010 40 million household biogas digesters will be installed in rural areas with an annual yield of 15.4 billion m^3, substituting 24.2 million tonnes of standard coal consumption. It is aimed to increase the number of household biogas plants until 2015 up to 60 million, yielding a biogas production of 23.3 billion m^3.
7. China started to establish a policy system to enhance biomass energy utilization although barriers still hinder biomass energy to achieve large scale implementation. The feed-in-grid price of bio-electricity is too low to cover the production cost even with renewable energy subsidies; the issuance of tax preferences and other preferential policies is slow, and the country still lacks a clear structure for the application of bio-renewable energy related funds even though these funds already exist.

These barriers are well known and further improvements can be expected. An additional feed in subsidy of 0.10 CNY/kWh for biomass power plants has been agreed for the years 2008 and 2009 in order to support existing power plants.

[6] Renewable Energy Law of the People's Republic of China: http://www.gov.cn/ziliao/flfg/2005-06/21/content_8275.htm

By March 2009 there were 118 biomass CDM projects that had been approved by the National and Local Development and Reform Commissions (NDRC and LDRC). The total installed capacity is higher than 2,000MW. 19 of these projects have been constructed and are operational. 95 of these projects are already published on the UNFCCC website, including 76 projects under validation processes.

Table 4: CDM biomass project overview

Total (DNA approved, March 2009)	**118**	**UNFCCC situation (March 2009)**	**95**
MSW incineration for power	14	Validation	76
BMW composting	3	Registered and 1st CER request	5
Biodiesel production	1	Registered and 1st CER issued	1
Biomass combustion power	72	Registered and 2nd CER issued	1
Biogas (Agriculture and Wastewater)	28	Request registration	2
		Registered and Review requested	2
		Registered	8

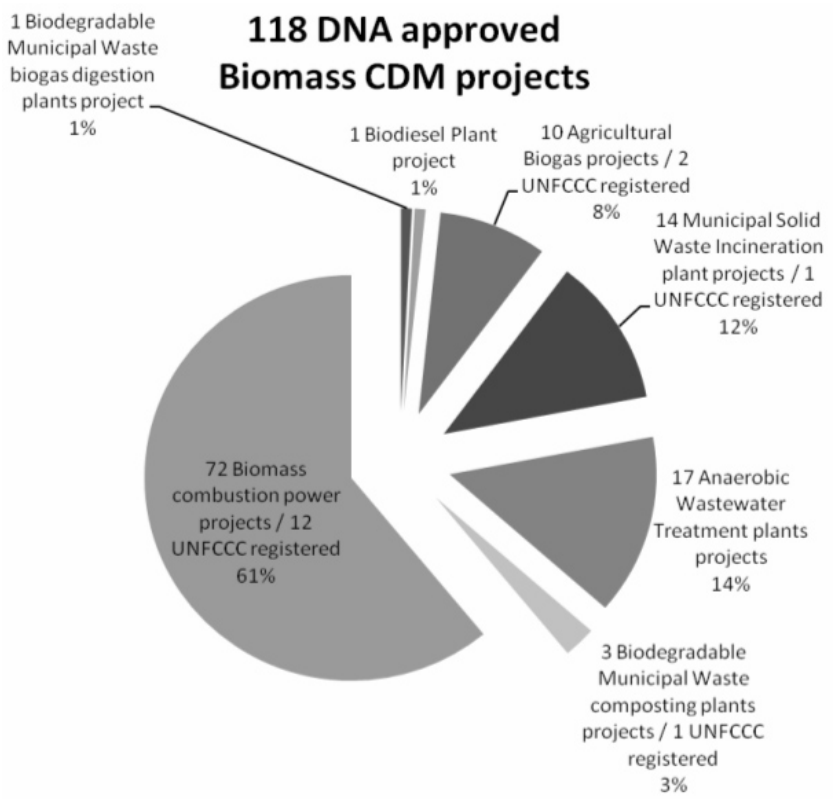

Figure 2: DNA approved biomass CDM projects in China
(source: China DNA website & own calculations)

Combined Chinese electricity price policies and characteristics of electricity generated by biomass combustion, the fundamental financial figures[7] concerning Chinese bio-fired power plants are as follows:

Table 5: Average financial parameters related to electricity cost for Chinese biomass combustion power plants

Item	Unit	Value		Item	Unit	Value
Installed capacity per plant	kW	25,000		Annual electricity output	MWh	150,000
Annual operation hours	Hours	6,000		On-grid electricity	MWh	138,000
Efficiency of engines	Per cent	21		Annual consumption	10^3 t	175
Electricity consumed on-site	Per cent	8		Fuel cost	10^3 CNY	52,643.6
Heat value of straws	kJ/kg	14,653.8		Average production cost	CNY/MWh	589.81
Straw price	CNY/t	240		Average financial cost	CNY/MWh	34.40
Project investment	CNY/kW	10,000		Sales tax and surtax	CNY/MWh	1.25
Engine overhaul period	Years	15		Total cost	CNY/MWh	625.46

Four major factors have great impact on the biomass combustion power generation cost, namely annual operational hours, initial equipment investment, fuel price and engine efficiency.
The price elasticity depends largely on the operational hours of the generator. In order to control the operation cost at least 5,000 to 5,500 hours of operation should be guaranteed per year. Also the biomass raw material price has a large influence on the operation cost per output capacity. Both reducing the fuel cost and increasing engine efficiency will have a positive effect to bring down the biomass based electricity production cost. Research shows that amongst operational hours, on-grid electricity price, additional tax, equipment investment, fuel price and engine efficiency on-grid electricity price is the most sensitive factor on the overall outcome of the financial internal rate of return (FIRR). There are two major ways of improving economic return of biomass combustion power projects in China. One is to reduce the cost and the second is to increase feed-in-grid electricity price. Currently the average electricity production cost of Chinese biomass combustion projects is higher than 550 CNY/MWh.

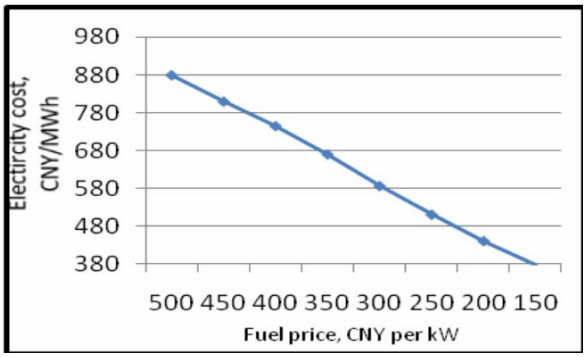

Figure 3: Fuel price influencing the electricity costs

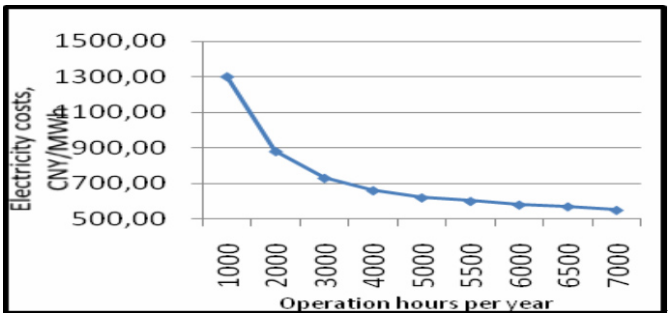

Figure 4: Operational costs depending on engine workload

If the annual target of 5,500 operation hours can be met, and applying an existing straw price of 300 CNY/t, and achieving 8 per cent FIRR, the electricity price should be raised to at least 700 to 800 CNY/MWh[8]. But regarding the current energy situation in China, this price could be very hard to achieve within the near future.
Therefore the financial situation of biomass power projects shows that without additional income or sufficient subsidies the renewable energy source biomass can hardly compete with conventional power technologies like coal fired power plants.

[7] Jia Xiaoli, Ding Hang, Primary calculation of on-gird electricity price of straw combustion power generation project, Renewable Energy Resources, 2006,24(1): 50-55
[8] Huang Jintao, "economic evaluation and influence factors analysis on Biomass combustion for power generation", Renewable Energy Resources, 2008, 4, Vol. 26, No.2

1.3. Evaluation of biofuels and biomass energy related CDM-project validation reports: challenges for Chinese biofuel and biomass energy projects

Chinese biomass power projects

By February 27th 2009 11 Chinese biomass projects had been registered on EB and one is currently requesting registration. All projects apply for ACM0006. Among these 12 projects, there are four located in Shandong province, four in Jiangsu province, two in Hebei province, one in Henan province and one in Heilongjiang province.

25 MW installed capacity is the common practice among these projects; feedstock are mainly cotton straw with an average purchase price of 250 CNY/t. The average investment cost of those projects is about 10million/MW; 8% IRR benchmark is widely adopted since it abides by the "Interim Rules on Economic Assessment of Electric Engineering Retrofit Projects"[9]. The consumption rate per installed capacity is 6,379 t/$MW_{el\ installed}$ on average while the mean CERs production rate is 5,694 tCO_2e/$MW_{el\ installed}$.

From the validation reports of these projects the conclusion can be drawn that biomass power projects have an advantage in terms of additionality in China, since the investment cost is very high compared to coal-fired power plant; even with governmental preferential feed-in-grid price or subsides, the initial return rate is still very low. Besides there are two projects that have already received CERs issuance, but the issuance rate (calculated by quantity of issuance CERs dividing ex-ante calculated CERs) is rather low: Hebei Jiizhou power plant realizes 10.1%, the Jiangsu Suqian power plant realizes approximately 64.45%.

Table 6: Chinese CDM biomass projects

Location	CERs estimated (tCO_2e/y)	Installed capacity (MW)	Total investment (million CNY)	Main biomass type	Material price (CNY/t)	Electricity input into grid (MWh/y)	Electricity price (CNY/ kwh)	IRR benchmark for additionality check (%)
Hebei Jinzhou	178,626	24	259.42	straw	190	132,000	0.51	8
Shandong Yucheng	189,552	15	121.56	Xylose, furfural residues (corn cob)	n/a	71,422	0.26	8
Henan Luyi	185,664	25	244.87	straw, cotton stalks	209	120,000	0.57	8
Jiangsu Suqian	123,055	24	241.34	straw, cotton stalks	300	132,600	0.64	7
Jiangsu Jurong	123,558	24	242.79	straw, cotton stalks	300	132,600	0.64	7
Shandong Shanxian	127,102	25	294.18	straw, cotton stalks	300	127,500	0.66	8
Shandong Wudi	113,433	24	247.74	cotton stalks	200	112,086	0.60	8
Heilongjiang Tangyuan	183,692	24	269.42	straw	150	124,000	0.50	8
Shandong Gaotang	140,695	30	290.96	cotton stalks	280	145,000	0.59	8
Jiangsu Sheyang	109,105	25	276.09	cotton stalks	240	126,500	0.64	8
Hebei Wei county	130,638	25	264.02	cotton stalks	208	126,500	0.59	8
Jiangsu Rudong	143,751	25	290.63	straw, cotton stalks	258	156,937	0.64	8
Total	**1,748,871**	**Average**	**253.59**	**Average**	**240**	**125,595**		

[9] "Interim Rules on Economic Assessment of Electric Engineering Retrofit project" published 2003 by Operation Department of Power Generation and Transmission, State Power Corporation.

Chinese biogas projects

There is one biogas project that was registered at EB in December 2007 using methodology ACM0010 located in Henan province. It is the only project worldwide that successfully adopted ACM0010. The project upgrades an existing animal manure management system with open lagoon to anaerobic digester and uses the produced biogas to generate electricity so as to reduce emissions from waste decay and to replace fossil fuel electricity. The designed installed capacity is 1 MW and it is estimated to reduce emissions 110,461 tCO_2e per year. The project owner has submitted a monitoring plan from December 2007 to May 2008 to apply CERs issuance. No CERs have been issued until now, but the monitoring plan stipulates that the project will heavily fail the targeted CERs. Another project, Shandong Minhe biogas project, which applies the same methodology, is under correction right now due to additionality and monitoring methodology issues.

Table 7: CDM biogas projects

Project Name	Project Type	Project Owner	CER Buyer	UNFCCC registered GHG Reduction (tCO_2e/y)	Situation UNFCCC	% success rate of CER
Methane Recovery and Utilization CDM Project, Muyuan Swine Farm, Henan Province	Methane recovery & utilization	Muyuan Livestock Feeding Co.,Ltd.,Neixiang County,Henan Province	Marubeni Corporation (Japan)	110,461	1st CER request	45%
Hubei Eco-Farming Biogas Project Phase I (33 000 household units)	Methane recovery & utilization	Hubei Qingjiang Zhongye Company Ltd	The International Bank for Reconstruction and Development as trustee of Community	58,444	Registered	

One small scale household biogas digesters project located at Hubei, which uses pig manure was registered by adopting AMS III R in Feb 2009. It is the first case for household digesters and provides guidance and experience for other similar projects in China in terms of setting up a baseline and monitoring plan. The registration of this project is significant for a large number of household livestock projects. The project is expected to substitute fossil fuel used for cooking and heating by the biogas produced by digesters in 33,000 farm households and to claim 58,444 tCO_2e annually.

1.4. Experiences from Small Scale Activities in the biomass energy sector

CDM defines small scale (SSC) project activities in order to lower transaction costs and time for activities with a considerably small CER potential. Therefore, the CDM approval and registration process requirements for SSC project activities are not as strict as for large scale activities; simplified modalities and procedures are as follows:

- A simplified Project Design Document may be applied
- Simplified methodologies for baseline determination in order to reduce the transaction costs of developing a project baseline
- Simplified monitoring plans/requirements
- Simplified provisions for environmental impact analysis
- Provisions for bundling of project activities are lowered, SSC activities may bundled at the stage of PDD writing, validation, registration, monitoring, verification and certification
- Lower project registration fee
- Shorter review period for registration
- The same DOE can validate as well as verify and certify occurred emission reductions for one specific SSC project activity.

Based on the above mentioned SSC methodology criteria, the UNFCCC defined 3 criteria to distinguish SSC activities from regular projects. The applicable criterion in the field of biomass energy generation is the total amount of CERs produced in one year. The produced CERs must not exceed the limit of 60,000CERs/year. Furthermore, based on SSC methodologies AMS III E and AMS III F the evaluation of the requested amount of biomass used to produce CERs could be carried out only in international projects, not yet in Chinese projects. Therefore, only the most recently registered five activities have been reviewed. On average, AMS III E produces 0.50 CERs per tonne of biomass. The most efficient biomass type is wood wastes from Imbituva Biomass project in Brazil. All other evaluated projects clearly show a less efficient CER production. At the time of finalization of this report no CER issuance requests and affiliated monitoring reports were available in order to show achieved emission reductions of AMS III E projects.
Projects that apply AMS III F on average produce 0.25 CERs per tonne of biomass material. Parallel to AMS III E no monitoring reports have been issued thus far in order to show the achieved CO_2e reductions.

1.5. CER estimation tool and its application in the biomass energy sector

Performance of CDM project activities concerning CER issuance success

Most project activities do not achieve the GHG emission reduction as estimated in the PDD. The following table gives an overview over the current performance situation in the biomass sector. Only projects that apply ACM0001 and ACM0006 have so far requested CER issuance. All other project activities have not so far requested CER issuance.

Table 8: Performance of CER issuance of biomass project activities

Project activity	CERs estimated per year	Monitoring period	CERs issued total	CERs issued/year (calculated)	Issuance success rate
Hebei Jinzhou 24MW Straw-Fired Power Project (ACM0006)	178,626	4 Mar 07 – 20 Mar 08	18,044	17,241	10 %
Zhongjieneng Suqian 2*12MW Biomass Direct Burning Power Plant Project (ACM0006)	123,055	18 Mar 07 – 31 Jul 08	108,860	79,309	64 %
Nanjing Tianjing Landfill Gas to Electricity Project (ACM0001)	214,741	1 May 05 – 29 Oct 07	91,890	36,817	17 %
Meizhou Landfills Gas Recovery and Utilization as Energy (ACM0001)	286,525	1 Dec 05 – 31 Dec 07	101,908	48,943	17 %
Anding Landfill Gas Recovery and Utilisation Project (ACM0001)	75,557	1 Jan 05 – 30 Apr 06	13,295	10,026	13 %
Shenzhen Xiaping Landfill Gas Collection and Utilization Project (ACM0001)	471,619	1 Jul 07 – 1 Jan 08	53,509	106,146	23 %
Jinan Landfill Gas to Energy Project (ACM0001)	112,908	13 May 07 – 30 Apr 08	28,333	29,296	26 %

The projects listed above were compared with their validated CER estimations. The overall success rate amounts to 24.30%, although the project portfolio shows a very high variance with Jiangsu Suqian (64%) and Hebei Jinzhou (10%) by far failing the expected CER result.

Referring to the opportunities of biomass and biogas CDM application, the CDM methodology portfolio has an abundance of different biomass and biogas treatment technologies which are ready to be applied by project developers. Detailed project evaluation shows though that achieved CER production by far misses the targeted GHG emission reduction before projects start. China has a legal system which includes biomass and biogas power feed-in-grid tariffs, and guidelines to facilitate the future growth of the sector. Areas targeted include biogas for gas pipelines and power generation, straw-fired power plants, gasification of biomass for pipeline and power application, and liquid bio-fuels.

2. Suitable and currently applied technologies in China in the biogas and biomass energy sector

2.1. Technology evaluation of suitable and currently applied technologies in China

Basic and general process of direct-fired biomass power generation:

Biomass power generation uses biomass feedstock (crop stalks, fruit tree branches, forestry processing waste, municipal and industrial organic waste, livestock manure, or others) to generate power. The basic and general process of direct-fired biomass power generation uses the heat generated during the direct combustion of biomass in the biomass boiler to produce steam, and the steam will push gas turbines to generate power.

The major types of the biomass boilers currently adopted in China are as follows:

1. Technology imported from Denmark
   The water-cooling vibration grate boiler is manufactured by Danish technology, adopting high pressure and high temperature parameters while steam pressure 92MPa, temperature 540°C, output 130t/h and 48t/h, with 25MW and 12MW turbine respectively. This kind of boiler has been adopted in many projects invested in NBE with good performance.
2. Domestic CFB boiler
   The biomass power plant CFB boiler technology is co-developed by China Energy Conservation Investment Corporation (CECIC) and Zhejiang University, adopting medium temperature and medium pressure parameters with steam pressure 3.9MPa, temperature 450°C, and output 75t/h with 12MW turbine, which has been put into operation in Jiangsu Suqian Biomass Power Plant.
3. Domestic water-cooling vibration grate boiler
   The biomass power generation water-cooling vibration grate boiler is independently developed by Huaguang boiler group Co. Ltd, Beijing Guodian Longyuan Hangguo Lankun Energy Engineering Company and Huaxi Energy Group Co., Ltd etc. The boiler has two parameters (so-called secondary high temperature and secondary high pressure, medium temperature and medium pressure) and two kinds of output 110t/h and 75t/h, with 25MW and 12MW turbine respectively, which have been utilized in the projects located in Jinzhou in Hebei province, Donghai and Hongze of Jiangsu province.
4. Reconstruction of small thermal power unit
   Sifang Boiler Plant under Shanghai Electrical (Group) Corporation reconstruct chain boilers for small thermal power unit into biomass combustion boiler with 75t/h medium temperature and medium-pressure, which has been applied in Chang'ge project in Henan Province.

Biogas generated in medium and large scale plants is planned to be utilized in two forms:

1. Distribution in a **biogas grid at village or township** level to provide thermal cooking fuel to households and cantinas, or as a heat process source to small and medium sized enterprises. 200 medium pressure biogas cooking grids exist at village level none of them mix biogas with other gas sources. 1.4 million users directly apply biogas as cooking fuel provided through village biogas grids.

2. Electricity power generation in **"island" mode**, mainly on South Chinese livestock farms in Guangdong province, and in island mode operated demonstration units in Beijing and Gansu provinces. No feasible demonstration of heat use from CHP units has been identified so far, apart from some application in food processing industries. If there is no demand for the 'waste' heat about 2/3 of the energy are lost. A significant percentage of the biogas production from medium and large scale digesters is used for generating 400 Mio kWh per year. Only in the land-fill biogas sector electricity is generated to be fed into the public grid.

Table 9: Statistics on large and medium size biogas engineering

	Number of Projects	Total Volume (m^3)	Waste Treated (million tonnes)	Biogas Yield (million m^3)
2001	1359	639,200	34.039	168.69
2003	2355	882,900	58.01	183.9243
2004	2671	1,094,300	71.9	176.1892
2005	3764	1,724,100	122.82	341.1424
2006	4000	1,900,000	130	362.5

*Sewage sludge from centralized waste water treatment plants is not included in the table.

Especially in Chinese city suburbs, much of the increased risk of pollution is caused by rupturing the traditional "short cycle" between livestock production and crop production. In less intensive, mixed rural farming systems animal waste is recycled as fertilizer by farmers who have direct knowledge and control of their value and environmental impact. Industrialized livestock and dairy production leads to a longer cycle in which large quantities of wastes accumulate far from croplands where they could be safely and productively recycled. So even though intensive systems tend to make more efficient use of resources, with lower levels of water use, nutrient excretion and gas emissions per kilogram of meat or milk produced, they often generate more pollution than less intensive farms where manure is better managed. Dense concentrations of industrial livestock production create regions surrounding the Chinese cities with vast quantities of excess manure. Although much lower on a national scale, concentration of pig and poultry production in parts of China is approaching and surpassing levels found in Europe and North America. This pollution poses threats to water, soil and air from concentrations of animal wastes.[10]

[10] Henning Steinfeld & Pierre Gerber: Livestock Policy Briefs series 02, FAO - Food and Agriculture Organization, Rome, Italy, 2005

Energy Approach

This option prevents releasing animal waste to surface water bodies. After treatment of the semisolid or liquid animal wastes in a biogas digester, the effluent is applied as bio-fertilizer for food production farms in the vicinity of the biogas plant. This model has significant economic benefit while realizing a zero emission target of the organic waste treatment. But it fits only in locations where sufficient agricultural lands, fish ponds or productive lagoons are available for further post-treatment. Biogas output is higher compared to the environmental optimized approach described second.

Environmental Approach

After initial separation of liquid and solid wastes, the liquid part is sent to the anaerobic treatment and aerobic post-treatment to accomplish with the national standards for waste water effluent discharge at least for irrigation purposes. The solid parts are marketed as organic fertilizer after composting or drying. The cost of installation and operation is higher and the biogas output is lower than for the previously described energy optimized approach due to separation and the necessity for two process lines for liquid and solids.

Table 10: Chinese biogas CDM projects

Project Name	Province	Project Type	Project Owner	CER Buyer	Estimated Ave. GHG Reduction (tCO CO_2e/y)	plant type	Sector	Situation UNFCCC
Beijing Deqingyuan Chicken Farm 2.4MW Biogas Power Project	Beijing	Energy saving and efficiency im-provement	Beijing Deqingyuan Agricultural Scientific Co. Ltd	IFC-Netherlands Carbon Facility(The Netherlands)	87,784	BG	AG	Validation
Mashan Wasterwater Treatment Project	Guangxi	Methane recovery & utilization	Guangxi Mashan County Yuanyang Industrial and Business Co. Ltd	Equity+Environmental Assets Ireland Ltd (R.Ireland)	49,437	BG	WW	Validation
Project of Wastewater Treatment in Anning of Guangxi	Guangxi	Energy saving and efficiency im-provement	Guangxi Wuming County Anning Starch Co. Ltd	Trading Emission PLC(UK)	55,092	BG	WW	Validation
Guangzhou Zhujiang Beer Methane Recovery Project	Guangzhou	Methane recovery & utilization	Guangzhou Zhujiang Brewery Co. Ltd	South Pole Carbon Asset Management Ltd (Switzerland)	44,578	BG	WW	Validation
Recovery and Utilization of biogas from wastewater treatment in Luohe	Henan	Renewable energy	Shineway-IBET Bio-Environmental Co. Ltd	Unilateral Project	21,465	BG	AG	Validation
Beixu Group Methane to Energy Project	Henan	Methane recovery & utilization	Beixu Group Co. Ltd	South Pole Carbon Asset Management Ltd. (Switzerland)	64,378	BG	AG	Validation
Yongcheng Yudong Municipal Solid Waste("MSW") Treatment Plant Project	Henan	Methane recovery & utilization	Yongcheng Jincai Investment Development Co. Ltd.	Climate Bridge Ltd.	17,03	BG	BMW	Validation
Methane Recovery and Power Generation Project in High-concentrated Organic Waste-water Treatment in Hubei, China	Hubei	Methane recovery & utilization	Huangshi Xinghua Biochemical Ltd.	Climate Bridge Ltd.	30,972	BG	WW	Validation
Inner-Mongolia Mengniu Aoya Biomass Power Project (1.36MW)	Inner Mongolia	Energy saving and efficiency im-provement	Inner Mongolia Mengniu Biogas Power Co. Ltd	China Carbon N.V. (The Netherlands)	21,402	BG	AG	Validation
Methane Recovery Project of Chifeng Ruiyang Chemical Co.,Ltd.	Inner Mongolia	Methane recovery & utilization	Chifeng Ruiyang Chemical Co. Ltd.	Energy Initiative Japan Inc.	39,551	BG	WW	Validation

Methane Recovery Project of Donghai Taihe Agricultural Products Co.,Ltd	Jiangsu	Methane recovery & utilization	Donghai Taihe Agricultural Products Co. Ltd	Energy Initiative Japan Inc. (Japan)	59,49	BG	WW	Validation
Methane Recovery Project of Lianyungang Jinchanglin Alcohol CO.,Ltd	Jiangsu	Methane recovery & utilization	Lianyungang Jinchanglin Alcohol Co. Ltd	Energy Initiative Japan Inc. (Japan)	77,169	BG	WW	Validation
Methane Recovery Project of Jiangsu Fenjinting Qilong Brewing Co.,Ltd	Jiangsu	Methane recovery & utilization	Jiangsu Fenjinting Qilong Brewing Co. Ltd	Energy Initiative Japan Inc. (Japan)	63,203	BG	WW	Validation
Methane Recovery Project of Jiangsu Lianhai Bioengineering CO.Ltd	Jiangsu	Methane recovery & utilization	Jiangsu Lianhai Bioengineering Co. Ltd	Energy Initiative Japan Inc. (Japan)	95,009	BG	WW	Validation
Methane Recovery Project of Fuyu Huihai Alcohol Co.,Ltd	Jilin	Methane recovery & utilization	Fuyu County Huihai Alcohol Co. Ltd	Energy Initiative Japan Inc. (Japan)	68,233	BG	WW	Validation
Shaanxi Methane Recovery and Electricity Generation Project in Xi'an Guowei Starch Co.,Ltd	Shaanxi	Methane recovery & utilization	Xi'an Guowei Starch Co. Ltd	Electric Power Development Co.,Ltd (Japan)	53,685	BG	WW	Validation
Shandong Chenming Paper Holding Ltd Biogas Co-generation Project	Shandong	Energy saving and efficiency im-provement	Shandong Chenming Paper Holding Ltd	Vitol S.A. (Switzerlands)	33,096	BG	WW	Validation
Shandong Nenghuan Swine Manure Management Project	Shandong	Methane recovery & utilization	Shandong Nenghuan Eco-Agriculture Engineering Co. Ltd	Arreon Carbon UK Ltd (UK) & Credit Su-isse International (UK)	221,215	BG	AG	Validation
Methane Recovery from Wastewater Treatment Reactor at Linqing Galaxy Paper Mill	Shandong	Methane recovery & utilization	Linqing Xinneng Natural Gas Co. Ltd	Sumitomo Corporation (Japan)	96,225	BG	WW	Validation
Ju County Biomass Utilization Project	Shandong	Methane recovery & utilization	Shandong Yuantong Bio-energy Co. Ltd, Ju County Branch	EcoSecurities Group PLC(UK)	54,457	BG	WW	Validation
Methane Recovery Project of Linqu Qinchi Biological Co.,Ltd.	Shandong	Methane recovery & utilization	Linqu Qinchi Biological Co. Ltd.	Energy Initiative Japan Inc.	76,65	BG	WW	Validation
Methane Recovery Project of Huguan Yufeng Brewing Co.,Ltd.	Shanxi	Methane recovery & utilization	Huguan Yufeng Brewing Co. Ltd.	Energy Initiative Japan Inc.	72,483	BG	WW	Validation
Tianjin TEDA Sewage Methane Recovery Project	Tianjin	Methane recovery & utilization	Tianjin TEDA Alcohol Co. Ltd	EcoSecurities Group PLC (UK)	52,857	BG	WW	Validation
Animal Manure Management System(AMMS) GHG Mitigation Project, Shandong Minhe Livestock Co.,Ltd.,Penglai,Shandong Province,P.R.China	Shandong	Methane recovery & utilization	Shandong Minhe Live-stock Co. Ltd	The International Bank for Reconstruction and Development (IBRD)as trustee of Community Development Carbon Fund(The Netherlands)	84,882	BG	AG	Review requested
Hubei Eco-Farming Biogas Project Phase I	Hubei	Methane recovery & utilization	Hubei Qingjiang Zhongye Company Ltd	The International Bank for Reconstruction and Development as trustee of Community	59,153	BG	AG	Registered
Methane Recovery and Utilization CDM Project at Muyuan Swine Farm in Henan Province	Henan	Methane recovery & utilization	Muyuan Livestock Feeding Co. Ltd., Neixiang County,Henan Province	Marubeni Corporation (Japan)	110,461	BG	AG	1st CER request
Kaiyang 15100 Rural Methane Digesters Project in Guizhou Province, China	Guizhou	Methane recovery & utilization	Guizhou Haikang Marsh Gas Material Trade Co. Ltd.	Global Environmental Development Incorporation	22,942	BG	AG	-
Qixian Swine Manure Management Project	Henan	Methane recovery & utilization	Henan Qixian Xingnong Biogas Technology and Service Co. Ltd	Arreon Carbon UK Ltd (UK) & Credit Suisse International(UK)	68,731	BG	AG	-

2.2. Needs and demands in the Chinese market (North, South, West)

Agricultural straws

Grain production is mainly located at provinces of Hebei, Inner Mongolia, Liaoning, Jiling, Jiangsu, Henan, Shandong, Hubei, Jiangxi, Sichuan, Yunnan etc. Considering the collection costs, the regions with the highest density of straw per capita are Jilin, Heilongjiang, Xinjiang, Liaoning, Shangxi, Henan, Hebei, as shown in the following figure.

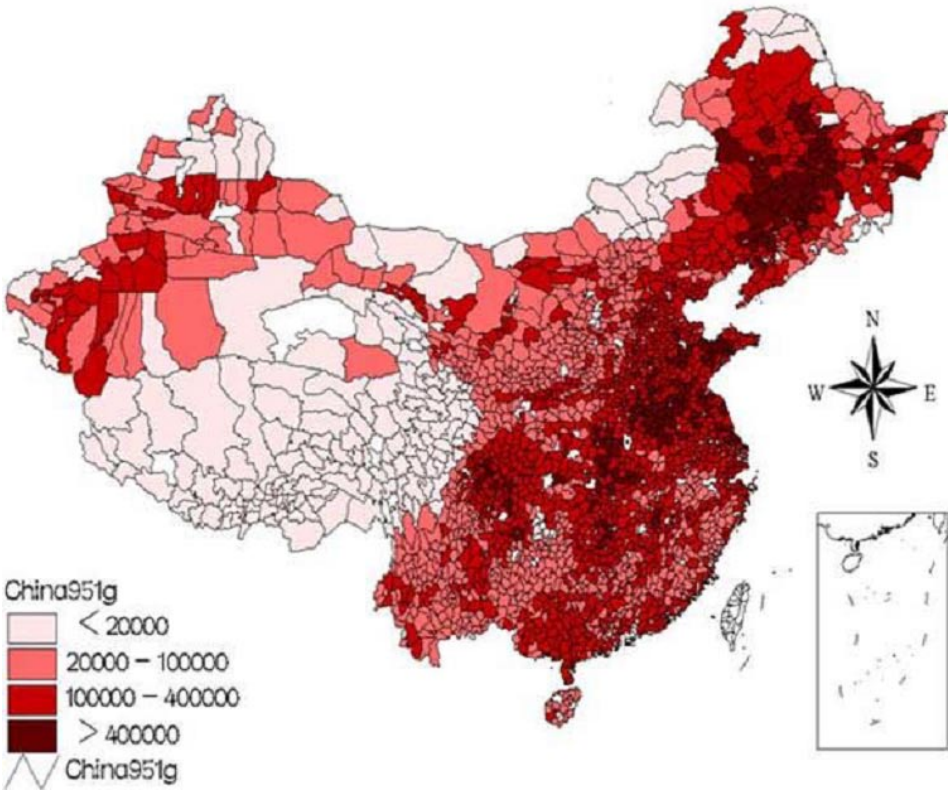

Figure 5: Geographic Distribution of agricultural straw

Table 11: Straw and stalk resource distribution in Chinese regions (million t[11])

	Total straw and stalk output	Fertilizer / collection loss	Use as fodder	Use as paper raw material	Use as fuel (cooking & heating)	Others
East China	**184.759**	27.715	42.125	4.291	110.628	
South China	**147.503**	22.126	56.296	7.170	61.911	
Northeast China	**100.646**	15.097	1.934	2.579	63.636	17.400
North China	**86.786**	13.018	13.646	3.105	57.017	
Southwest China	**82.666**	12.400	41.555	2.112	26.599	
Northwest China	**45.566**	6.836	4.910	1.744	26.518	5.558
total	**647.926**	97.192	160.466	21.001	346.309	22.958

[11]Xiao Ming Song, 2006

Agricultural residues

Apart from the stalks and straws listed above, there are other agricultural residues which offer potential feedstock for bioenergy production.

- Cotton: in 2003 the production of cotton in the provinces of Hebei, Jiangsu, Anhui, Shandong, Henan, Hubei, Tianjin and Hunan achieved 4.86 million tonnes[12], generating stalks and cotton-seed husks which could be used as feedstock for bioethanol production. Cottonseed oil is the second main product of this industry. Low-grade oil can be used for biodiesel feedstock. De-tailed data, separated from the overall market for low-grade oil, are not available at present.
- Fibre crops: jute and ambary hemp fibres normally represent only 4% of the total leaf weight. The waste generated annually from this sector in China fluctuated between 1997 from 10.32 million t/a to 2.4 million t/a in 2003, mainly in Hubei, Henan, Guangxi and Anhui.
- Coffee: only produced in Hainan Island; coffee husks represent 20% of the harvested gross weight. National data is not available.
- Rice: husk production per tonne of grain is estimated at 0.33t, resulting in an annual biomass production of 53 million tonnes, mainly in Heilongjiang, Jiangsu, Anhui, Jiangxi, Hubei, Hunan, Guangdong, Guangxi and Sichuan.
- Cashew nut: yields a large quantity of shells and husks, which are potential bioethanol feedstock for cellulose rich process technologies. In 2003 the national yield ranged at 13.42 million tonnes of raw nuts generating about 4.47Mio t of residues in the provinces of Hebei, Shandong and Henan.
- According to NDRC 900 million t/a of these types of residues are available for biomass energy projects[13]. With the implementation of China's Natural Forest Protection Programme and its Sloping Cropland Conversion Programme, it is expected that the amount of scraps from forestry and forest product industries to be used in energy applications will increase substantially, with the potential of reaching 12,000 PJ/a by 2020.

Table 12: Biomass Power Plants (source: ADB PPTA4939)

No	Project	Project	Current Status	Commission time	Capacity MW
1	NBE Shanxia	Shandong	Operating	2006.12	1×25
2	NBE Weixian	Hebei	Operating	2007.3	1×24
3	NBE Chengan	Hebei	Operating	2007.3	1×24
4	NBE Gaotang	Shandong	Operating	2007.3	1×30
5	NBE Kenli	Shandong	Operating	2007.3	1×25
6	NBE Sheyang	Jiangsu	Operating	2007.5	1×25
7	NBE Wangkui	Heilongjiang	Operating	2007.11	1×25
8	NBE Liaoyuan	Jiling	Operating	2007.11	1×25
9	NBE Junxian	Henan	Operating	2007.12	1×25
10	NBE Luyi	Henan	Operating	2007.12	1×25
11	NBE Juye	Shandong	Operating	2008.4	1×12
12	NBE Fugao	Henan	Operating	2008.4	1×12
13	NBE Bachu	Xiangjiang	Operating	2008.9	1×12
14	Jiatao Jinzhou	Hebei	Operating		2×12.5
15	Rudong	Jiangsu	Operating		1×25
16	HuadianShiliquan	Shandong	Operating		140
17	Xinhua IGCC	Jiangsu	Operating		4
18	Gunaiqi	Inner Mongolia	Operating		2×12
19	Guoxin Huainan	Jiangsu	Operating	2007.11	2×15

[12]: in 2003, CSY 2004
[13]Credit Suisse: China's Renewable Energy Sector, 2006

Livestock waste for biogas production

There are generally two levels of raising domestic feedstock:

- Traditional method; individual small-sized farms and families' excrements are scattered or collected in household small-scale biogas plants.
- Industrial scale: large and medium-sized farms where manure is available in large quantities.

Table 13: Total number of livestock in 2004[14]

Animals	Estimated number
Pigs	~ 482 million
Cows	~ 138 million

The amount of livestock waste is expected to increase in relation to improving living standards and changing meat consumption habits. The industrial livestock breeding facilities are facing severe problems due to non-utilization of waste, as farms are either agro-industrial parks for animal production without fields, or the adjacent fields are not capable of bearing the organic load[15].
Based on that figure it is expected that the biogas installation potential is 200 MW in 2015, 1/3 for agricultural large scale biogas power plants, 2/3 for agro-industrial plants, and for 2020 then 1500 MW with 1/2 agriculture and livestock and 1/2 agro-industry.

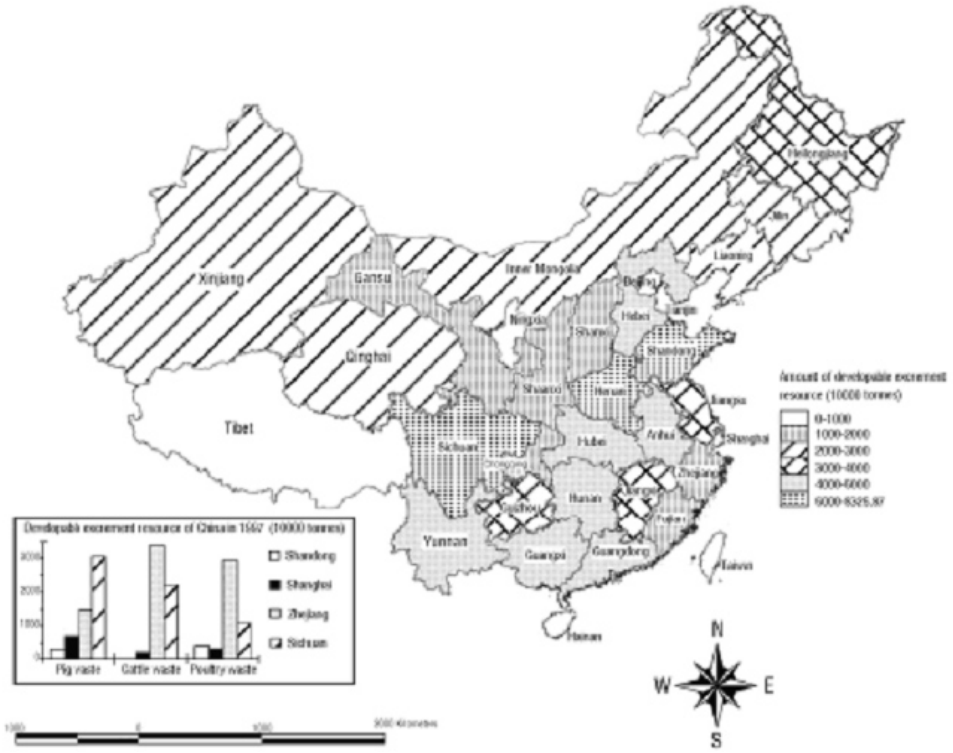

Figure 6: Distribution of animal manure by province[16]

[14]China Livestock Statistical Yearbook, 2005
[15]Over 90% of these plants are not equipped with adequate pollution prevention systems. Furthermore, farmland is often distributed among different private households; therefore, the application of animal waste as organic fertilizer is complicated by operational and administration procedures and costs.
[16]unit: tce; 1 tce = 29.3 Gga Joule (GJ) from: Li Jingjing et al, Biomass in China and its potential, in: Energy for Sustainable Development, Volume V No. 4, December 2001

2.3. Existing German contribution to Chinese biomass energy sector

Germany's development cooperation is already actively and successfully involved in the sector through the RRU-BMW Project (Resource Recovery of Bioorganic Municipal Waste), some landfill biogas recovery projects, and with some private joint ventures in the farm biogas and industrial biogas sector, and through a sustainable transport fuel partnership. Furthermore, several German Integrated Experts (CIM) work in institutions related to the biomass energy sector.

The only German company involved in a biomass power project is Eckrohrkessel GmbH, delivering two boilers to Yangcheng. The construction is currently halted because of financial problems. Copies of the German technology have been offered in the Chinese market.

Jiangsu Suqian 24MW biomass combustion power plant, located in the south east of Suqian City, Jiangsu Province of China, was established in 2006 by China Energy Conservation Investment Corporation (CECIC) Biomass Energy Investment Company with a total investment of 241 million RMB. The plant utilizes two 75t/h vibrating chain type middle-temperature, middle pressure Circulating Fluid Bed boilers which are co-developed by CECIC and Zhejiang University and allowed to handle various types of biomass resources. Meanwhile it has installed an extraction stream turbine and a condensing turbine with each rated power capacity of 12MWe. The main biomass resources used in the Suqian plant are wheat and rice straws which are collected and transported by farmers or other biomass trading agencies. The straws are cut into pieces inside of the plant site and fed into the boiler directly when they are sent to the plant, and the heat value of the straws is analyzed by the plant every day.

The plant has been running successfully since the very first day they produced electricity in 2007. During the first year of operation, 2007 - 2008, the Suqian plant consumed 210,000 tonnes of straw and sent about 170million kwh electricity onto the North China Grid. The plant engines are overhauled once a year and they carry out their general maintenance every two months in accordance with the real maintenance requirement. Currently the plant does not utilize the waste heat from the engines due to the fact that there are no end users for heat near the plant site so far. The ashes produced by the plant are carried away for free by local fertilizer companies for research and will be processed into fertilizer in the future.

The plant achieved CDM registration in March 2007 and received CERs issuance from March 2007 - July 2008 with 108,860 tCO_2e. Compared with its ex-ante annual CERs of 123,055 tCO_2e, the real CERs issuance rate is around 65%. The major practical reason is that the real annual operational hours of the engine are 6,000 instead of 6,500, as estimated in the Project Design Documents. The monitoring parameters are strictly carried out. The on-grid electricity is monitored at the local grid company, which deducts the electricity lost during the transmission from the plant to the grid, and the electricity meters are calibrated every year both on the plant site and at the grid company. The diesel consumption for starting up the engines is monitored continuously. The heat value of the straws is monitored every day inside the plant and once a month in the certificated institute.

Based on the on-site interview, we found that pelletising of their rice straw resources has been offered to them but they still consider all the offers to be too expensive and not so effective for rice straws as for corn straws. When it comes to shredder the local technology is not adapted because of smaller sized machines with low output and larger sized machines with weak cutting capacity so the right size of the rice straw resources can't be ensured. They have been to Denmark to get to know foreign technology but this technology again is considered too expensive. All in all, the Suqian plant is a good example of biomass combustion to power project in China, and with the financial assistance of CDM the project is running economically.

2.4. Potential German contribution to the Chinese biomass energy sector

Successful commercial engagements are limited by Chinese energy market monopolization, the low degree of law and regulation implementation, the lack of technological, social and ecological standards. Economic incentives, practical and economical technology and professional personnel are still missing in the Chinese bioenergy sector, thus characterizing the biomass energy business currently as a risky business where most of the involved firms are operating at marginal profit. German companies established in the biomass energy sector can bring in their years of technological experience when competing in China. China could further benefit from Germany's ground-breaking role in renewable energy and environmental legislation, and private-public partnerships. The German Development Cooperation's role in the biomass energy sector could be performed as a contribution to the development and implementation of social, ecological and technical standards.

Combustion technique

- Ash and corrosion in process of biomass (straw) combustion is a key issue.
- Foreign companies only sell boiler equipment but no technical transfer.
- Lack of experience in respect of straw boiler production and operation.
- Lack of feedstock technique and equipment.

Co-firing technique

- Co-firing less than 20% biomass of the total caloric value in coal boil is technically mature.
- With larger percentage of biomass fuels mixed, the problem reveals in straw pre-treatment.

Biogas plants

- All kinds of mixing devices.
- Sludge pump technology and products, especially for the transportation of biogas slurry with TS% > 8%.
- Biogas co-generation units (CHP) with more than 8,000 hours per year operational time.
- Biogas purification technology and relevant equipments.
- Biogas slurry post-treatment and equipments.
- Biogas engineering and plant process optimization, especially for colder regions.
- Optimization of waste heat utilization.
- Impact analysis of mixing systems on anaerobic treatment and relevant technology.
- Peak load parameters for typical crops to consume biogas slurry and dregs as fertilizers.

LIPP Biogas System: Since 1994 the enterprise has been in joint venture with a Chinese partner (Anyang-Lipp Ing. Co.), who already have over 15 years experience working with the LIPP system. As a result, the products of the LIPP system are to be found throughout China.

3. Market potential of CDM biogas and biomass energy projects in China

In the biomass power sector the imported boiler and feeding technology continually surpassed the expected CERs due to higher operational hours than originally planned, while the domestic grate boiler technology was far behind expectations, with only 9 % and 20% CERs success rate, obviously due to feeding problems with corn straw. The Chinese CFB boiler technology reached 65% and 80% of the CER expectations as documented in UNFCCC published monitoring reports. Experience with already registered and monitored biomass and biogas CDM projects are showing that the domestic large scale biogas technology (UASB and IC reactors) reaches 45% of the expected CERs.

At present, National Bio Energy Co. Ltd (NBE) is the biggest investor of biomass combustion power generation projects in China, with 39 approved projects by the government, and ten projects put into operation. Among these; six projects in Shandong, Hebei and Jiangsu province (Shandong: Shanxian, Gaotang, Kenli, Hebei: Weixian, Chengan, Jiangsu: Sheyang) use cotton straw as major fuel, four projects in Henan, Heilongjiang and Jilin provinces (Henan: Junxian, Luyi; Heilongjiang: Wangkui, Jilin: Liaoyuan) use corn straw and wheat straw as main fuels, ten projects are still under construction. Besides NBE, the state-owned energy enterprises such as Huaneng Group, Datang Corporation, China Guodian Corporation and China Power Investment Corporation also tap into the biomass power generation field. Other project entities are still State Owned Enterprises (SOE), they include China Energy Conservation Investment Corporation (CECIC), Hebei Province Construction Investment Company and Jiangsu Province Guoxin New Energy Company. Some private-owned biomass power projects had been approved: Jiangsu Baoying, Jiangsu Lianyungang, Henan Chang'ge projects are under construction with investment from private enterprises.

Table 14: Main Challenges for the Development of Biomass Power Plants and Biogas plants

Areas of Focus	Challenges
Feasibility Studies	Lack of development procedures and feasibility guidelines. Big gap between early stage feedstock investigation and purchase reality. Unable to realize full favorable policy commitment.
Construction	Contracting method shall be reviewed with consideration of the biomass characteristics that are different from the coal or natural gas. Managing equipment procurement methods well developed for smaller projects and rural areas. Contractors are not properly managed. Cost control needs improvement. Design problem feedback needs to be improved, design to be optimized.
Construction Management	Operation responsibility to be emphasized. Plant reliability to be improved. Operational skill to be improved. Housekeeping to be improved. Operational preparation during construction stage to be improved.

(source: ADB PPTA4939)

Table 15: Overview biomass CDM projects and installed technology

Project Name	Province	Project Type	Project Owner	CER Buyer	UNFCCC registered GHG Reduction (tCO CO_2e/y)	plant type	Sector	Situation UNFCCC	% success rate of CER	Boiler origin	main biomass feed
Methane Recovery and Utilization CDM Project at Muyuan Swine Farm in Henan Province	Henan	Methane recovery & utilization	Muyuan Livestock Feeding Co. Ltd.,Neixiang County,Henan Province	Marubeni Corporation (Japan)	110,461	BG	AG	1st CER request	45%	Domestic UASB/ IC	manure
Biomass Generation Project in Wei County, Hebei Province, P.R.China	Hebei	Renewable energy	National Bio Energy Co. Ltd.	Climate Change Capital Carbon Fund II s.a.r.l. & Climate change Capital Carbon Managed Account Ltd	130,638	BM		1st CER request	112%	Import BWE	cotton stalks
Hebei Jinzhou 24MW Straw-fired Power Project	Hebei	Renewable energy	Hebei Jiantou Biomass Power Co. Ltd	IXIS Environment & Infrastructures	178,626	BM		1st CER issued	10%	Domestic Wuxi	corn straw
Henan Luyi 25MW Biomass Cogeneration Project	Henan	Renewable energy	National Bio Energy Co. Ltd.	EDF Trading Ltd(UK)	185,664	BM		1st CER request	20%	Domestic Jinan	corn straw
Shandong Shanxian 1*25MW Biomass Power Plant Project	Shandong	Renewable energy	National Bio Energy Co. Ltd.	Danish Minister of Foreign Affairs	127,102	BM		1st CER request	140%	Import BWE	cotton stalks
Shangdong Yucheng Xinyuan Biomass Heat&Power	Shandong	Energy saving and efficiency improvement	Shangdong Yucheng Xinyuan Heat& Power Co. Ltd	Carbon Resource Management Ltd.	189,552	BM		1st CER request	80%	Domestic CFB	corn cob
Zhongjieneng Suqian 2*12MW Biomass Direct Burning Power Plant Project	Jiangsu	Renewable energy	Zhongjieneng Biomass Energy Investment Corporation	Carbon Resource Management Ltd.	123,055	BM		2nd CER issued	64%	Domestic CFB	rice straw

3.1. Project approval requirements and procedures

International investors often have problems in understanding the project approval procedures. Below a standard project approval procedure is given. For biomass heat and power projects the specific requirement is that besides the normal approval procedures, they should go through a heat and power sales permission procedure.

(1) If the total investment for a project is above or equal to 200 million RMB or the property of the project belongs to the province, or there is provincial equity participation, the project definitely needs to be reported to the province and after provincial examination by the central government.
(2) If the total investment for the project is below 200 million RMB, or the property belongs to the county, or the local government cannot balance the conditions of funds, construction, and production, it also needs to be reported to the province or a national authority for examination and approval.
(3) Renewable energy projects of 50 MW capacity and above are to be reported to the NDRC for approval regardless of the investment volume.

The following five procedures are required for capital construction projects within the province or nation for examination and approval:

(1) project proposal,
(2) feasibility study report (including a bid plan),
(3) initial design,
(4) annual investment plan,
(5) application report for the start of construction (Construction starting report).

The five procedures should be reported to the Development and Planning Committee of the province or else should be reported to the National Planning Committee depending on the size (bigger than 50 MW capacity) and the type of the project. Details of these procedures are given in the attachment.
For other projects, such as building construction projects, undersized agricultural projects (except for water conservancy projects) and high-tech industrialization projects please refer to details given in the attachment.

3.2. Technological areas

Table 16: German contribution and other potential partner countries in the biomass sector

Biomass energy sector	German contribution	Other potential partner countries
1. Biodiesel from waste fat, edible oil and grease	Technology, experience and know-how available and exportable, more than 20 years on the commercial market	Austria: 15 years commercial experience in biodiesel and SVO, Japan started 5 years ago but are fast to extend national use of biodiesel
2. Biogas from Biodegradable Municipal Waste	Technology, experience and know-how available and exportable, most internal patent holders are German companies; first country which introduced source separation	Commercial use on large scale in Austria, Australia, Belgium, Italy, Netherlands, Sweden, and United States
3. Manure Biogas Plants in cold areas	Technology, experience and know-how available and exportable, worldwide leading country in large scale farm biogas, followed by other European countries, worldwide most important professional Biogas Expert Association since 1992	Austria, Denmark
4. Sustainable energy crops and reforestation for biodiesel, bioethanol and biogas	Technology, experience and know-how available and exportable, first country to use energy crops for fermentation	United States: worldwide most experienced in energy cropping; Great Britain, Austria, Australia
5. Energy pellets and briquettes from biomass	Technology, experience and know-how available and exportable, most of newly installed heating systems apply biomass pellet feedstock	Finland, Norway, Austria, Sweden, Switzerland, and Italy
6. Biogas from sanitation	Technology, experience and know-how available and exportable, anaerobic sewage sludge treatment standardized since 1920	Sweden, Norway, Belgium, Finland, Japan. for 30 years, due to decentralized settlement structures, ecological sanitation systems are used for energy generation (heat) by composting or anaerobic processing.
7. Co-Generation from Biomass	Technology, experience and know-how available and exportable, level similar as in Denmark, straw power has been introduced	Denmark, Austria and Sweden are worldwide leading countries due to solid biomass resources which have been used for a long time for decentralized cogeneration plants (heat & steam power generation)
8. Biomass-to-Liquid	Technology, experience and know-how available and exportable, for more than 7 years ongoing research with governmental support, results ready and demonstrated for medium and small scale implementation	Canada: similar research & development as Germany

3.3. Suitable Chinese provinces for biomass-to-energy projects

The biomass combustion provinces in the Northeast region - Heilongjiang, Jilin and Liaoning – are being proposed based on the fact that the Northeast region is the "Grain Base" of China. Heilongjiang is well known for its large scale state farm system, and its high quality of rice, soybean and sugar beet. Jilin is well known as the "Corn Belt" of China, with its high quality and high yield corn production. Although Liaoning is often referred to as a heavy industry province in the Northeast, its high quality rice, corn, soybean and apples are also well known in China.
The proposals of biogas provinces are based on the middle and large scale pig, cattle and chicken livestock farm distribution: dairy and beef production is most prominent in the pastoral provinces and regions including Inner Mongolia Autonomous Region, Xinjiang Uyghur Autonomous Region, Tibet Autonomous Region, Qinghai Province, Sichuan Province and Gansu Province.
The eastern and southeastern parts of China are characterized by intensive arable farming in which livestock is kept in either mixed farming systems, in which the larger part of the total value of production comes from non-livestock farming activities, and land-less livestock production systems, in which animals are fed by products not produced at the same farm. Based on experiences we propose Jiangsu and Guangxi.

4. Summary

- China's bioenergy industry is a new industry with relatively strong foundation but, exception of the basically matured small scale biogas technology on farm household and wastewater treatment level, modern biomass energy technologies are still in the early stages of industrial development.
- Social and ecological standards are not yet established and technical quality standards are not implemented in all biomass energy sectors.
- Technology and equipment with Chinese intellectual property rights to reduce investment and production costs are non-existent so far.
- Missing intellectual property rights and legal certainty prevents investments by foreign companies.
- Demonstration projects to attract foreign investment for dissemination are mostly at laboratory or pilot scale, and even in those districts which have resource advantages and good basic conditions, large scale biogas demonstration has hardly overcome the initial pilot or demonstration stage.
- There is no reward system in place based on the actual output of the applied technology system for renewable energy.
- The risks related to biomass qualities and deliveries as feedstock for energy generation are not yet reflected in market prices and trading rules, but must be considered as important obstacles for permanent and secured bioenergy production and delivery.
- China significantly lacks implementation expertise on modern bioenergy technologies and their management. Vocational training centres in this sector rarely exist, although scientific research has been carried out for about 15 years.
- Technical implementation is largely unsupported by domestic commercial bank institutes as the bioenergy market is still a risky business and biomass energy-projects do not look very promising for profit maximization.
- Bioenergy firms need to provide a great share of their own investment capital for purchasing improved technology equipment that guarantee high yields. Where domestic investment capital is limited, no advanced technology equipment can be acquired from abroad. Nationally produced equipment often does not correspond to the required quality standards conditioned by long term financing strategies as CDM and Equity Investment.
- The focus of the driving force for the development of the bioenergy sector is put on the increasing price for imported fossil oil, thus underlining the importance of the economic development of the cities. Meanwhile, the relation between biomass production for energy purposes in the countryside and poverty reduction and food security is seldom reflected in policies and incentives.
- Interdisciplinary work approach integrating disciplines such as economics, transportation, accounting, city planning are often not involved in getting a successful biomass energy project started.
- Source separated biomass waste collection is not established, apart from a few demonstration areas in some cities.
- The use of bio-waste for livestock feeding is uncontrolled and not regulated by laws. Hygienisation processes are not controlled when using food leftovers for pig feeding. No pest control of livestock feed.
- Land use planning does not include landscaping and erosion control measures through planting of energy crops. Only energy forest is already considered.
- Biogas technology performance problems in cold areas due to insufficient heating & insulation systems. No technical standards for biogas in cold areas have been established.
- UASB (Upflow Anerobic Sludge Blankets) are not able to treat high solid contents. Solid-liquid separation placed before the treatment step. Consequently huge amounts of solids are discharged. Consequently there are reduced biogas production and only benefits in the form of soil improver.
- At most UASB plants are already constructed, water saving measures required in appropriate animal husbandry are difficult to introduce.

5. Annex

Project approval requirements and procedures

International investors often have problems in understanding the project approval procedures. Below a standard project approval procedure is given. For biomass heat and power projects the specific requirement is that besides the normal approval procedures, they should go through a heat and power sales permission procedure. It means that the investor must negotiate regarding the utility for heat and power connection.

Approval procedures for capital construction projects

For capital construction projects there is case differentiation:
If the total investment for a project is above or equals to 200 million RMB or the property of the project belongs to the province, or there is provincial equity participation, the project definitely needs to be reported to the province and after provincial examination by the central government.
If the total investment of the project is below 200 million RMB, or the property belongs to the county, however the local government cannot balance the conditions of funds, construction and production, it also needs to be reported to the province or a national authority for examination and approval.
Renewable energy projects of 50 MW capacity and above are to be reported to the NDRC for approval re-gardless of the investment volume.
The following five procedures are required for capital construction projects within the province or nation for examination and approval:

a) project proposal
b) feasibility study report (including a bid plan)
c) initial design
d) annual investment plan
e) application report for the start of construction (Construction starting report).

The five procedures should be reported to the Development and Planning Committee of the province or else should be reported to the National Planning Committee depending on the size (bigger than 50 MW capacity) and the type of project.
Projects such as building construction projects, undersized agricultural projects (except for water conservancy projects), and high-tech industrialization projects can be simplified by combining the two procedures of project proposal and feasibility study report. All the biogas electricity and heat cogeneration projects with imported equipment are considered high-tech projects to be promoted by the central and local government. Thus, the simplified procedure is applied.
In contrast to this, the capital construction projects which are included in the middle or long term plan of the province for key and large projects or in the annual pre-work program may not skip the first procedure of the project proposal.
According to "The information for simplification of the examination and approval procedure of capital construction projects" from the National Development & Planning Committee, the possibility research report is the basis of the approval decision, and should attain the required accuracy and depth. The discrepancy of the investment estimation and the budget estimation shall be less than 10%.

a) The project proposal

The project proposal should include the following:

1. When importing advanced technology and equipment an explanation for the need to import and a description of the general situation of the technology gap between China and abroad is necessary.
2. The site plan of the product design, the scale and the location of the construction. In order to build a non-productive construction project within a city planning area the applicant needs to show it to the city planning department and obtain the auditing opinion of the administrative department in charge.
3. The preliminary analysis of the resources, conditions of construction, co-operative relationships, and the countries and manufacturers from which the technology and equipment are imported.
4. The estimate of investment needs of the financial plan. For a foreign capital project, the possibility of using foreign funds and the initial estimation of the ability to repay the loan should be described.
5. The project schedule.
6. The preliminary estimation of the economic and social performance.

Essential documents for project approval include:

1. A brief description and the proposal document. This should include an explanatory statement of the need for the construction, the scale of the construction, the project design of disposal, total investment and the capital recourses. The provincial project proposal should be submitted by the provincial administration supervisory section. For biogas projects the Rural Renewable Energy Office of the local agricultural department in the provincial administration is in charge. In case of provincial equity participation, the project proposal should be submitted by the provincial administration supervisory section and the Planning Commission of the city. In case of a city-level project proposal, it should be submitted by the city Planning Committee and the provincial administration supervisory section should render their opinion after examination.
2. For a non-productive construction project, its contents can be described in a document requesting instructions. The proposal is not necessary in this case.
3. For a non-productive construction project in a city planning area, the applicant should submit the site designation memorandum signed by the administrative department of city planning.
4. For an industrial project, the proposal should have an attachment with an investment agreement or protocol of the national or foreign participator, the initial opinion of the environmental protection sector, and the pre-justification of the territorial planning sector.

b) The feasibility study report

The organization which is, according to the approved project proposal, responsible for organizing the feasibility study, has to consider in this report the feasibility of technique, engineering, finance, and cooperation. In the case of biogas projects, this is the responsibility of the project developer. Once a project is considered as being feasible, the optimal scheme and the research report of feasibility are submitted.

The feasibility study report should include:

1. General introduction:
    - The background of the project (For reconstruction and extension projects, the current situation of the enterprise must be depicted.)
    - The basis and the scope of research.
2. In order to confirm the construction scale and the product design based on the economic and market forecast:
    - An estimation of market requirements.
    - An estimation of the capacities of state and provincial level manufacturers.
    - A sales forecast, price analysis, and a competitive analysis for the products. For export products, an estimation of overseas demand and an analysis of the international market foreground are necessary.
    - The scale of construction, product design, the technique and economic analysis and a comparison of the development direction. For rebuilding and extension projects, the initial fixed assets utilization should be described.
3. The resource situation and public services:
    - The resource extent, variety, component, and the conditions of mining and utilization should officially be approved by the administrative department.
    - The types, quantities, sources and supply possibilities for the raw materials, auxiliary substances, and fuels.
    - The quantity, supply method and supply conditions of the public services.
4. The construction conditions and site alternatives:
    - The geographic location, weather, hydrology, geology, and geography conditions, and the social, economic conditions for the construction.
    - The present situation and the development trend of traffic, transportation and water, electricity, and gas supply.
    - A comparison of potential sites and a discussion of the reasons for choosing the specific site selected.
5. The technology: the chosen equipment, the standards for construction, and targets for technique and economy
    - For projects which import equipment; the arrangement for supplying the materials and fittings, the country of origin, the domestic and international equipment suppliers, and the plan of cooperation with the overseas company.
6. The main project, public ancillary facilities and the overall design.
7. The requirements and the necessary measures applied for environmental protection, city planning, earthquake resistance, flood control, air defense, protection of cultural heritage sites and objects, labor safety, hygiene, the prevention of epidemics, and fire protection.
8. The enterprise's organization, the labor requirements, and the plan for personnel training.
9. The construction period and the construction schedule.
10. Estimated investment requirements and financing.
    - The investment required for the main project and the auxiliary projects (A line of credit is necessary for foreign capital projects and projects importing technology).
    - An estimation of operating funds required for manufacturing.
    - Capital resources, the financing method, the repayment method for domestic and international loans (including economic investments and the enterprise bond).

11. An estimation of economic and social performance.
12. There should be a detailed description of the financial means, including the investors, the financing approach, the financial resources, and the financing process, except for non-profit projects or projects with foreign investment. Besides, both static and dynamic analyses are necessary not only for the micro economic profit of the project but also for the macro benefit with which the project might reward the national economy and society. Calculations of economic benefit should be based on the "Evaluation Approach and Parameter for Construction Projects" issued by the NDRC. The payback period should be included.

The feasibility study report is the basis for decision making, thus it should be concrete and accurate. The discrepancy between investment estimation in the feasibility study report and the following initial design should be within 10%. If the discrepancy exceeds 10% the project will be rejected for re-planning. A feasibility study report should meet the requirements for ordering large professional equipment.

The necessary documents for a feasibility study report are as follows:

1. Recommendation letter drafted by the responsible department. A recommendation letter should include an elaboration of the feasibility study report including; on what assumptions the size estimation of the project was based, comments on the overall design, the site plan, and the sources of resources and fuel, as well as a description of the public infrastructure, an estimation of the total investment needed, the financing approach, the construction schedule, the project owner and the legal representative structure.
    - For provincial projects, the relevant provincial administrative department should submit the feasibility study report.
    - For joint-investment projects, the relevant provincial administrative department together with the municipal Development and Planning Commission should submit the feasibility study report.
    - For municipal projects, the municipal Development Planning Commission should submit the feasibility study report, but the relevant provincial department should also give evaluation comments.
2. An engineering feasibility study report written by qualified consulting companies.
3. For medium and large projects it is necessary to hand in an evaluation of the feasibility study report written by a qualified consulting company.
4. Evaluations written by relevant provincial administrative departments: environmental departments, city planning departments, earthquake abatement departments, flood abatement departments, aerial-defense departments, cultural relic protection departments, resource departments, labor security departments, sanitation epidemic prevention departments, fire control departments and other relevant units.
5. A clear credit commitment made by a local or international quality company, or a loan agreement made by a qualified bank if the financing comes from a loan.
6. Bidding documents, including a characterization of the bidding approach (self-bidding or commission bidding, open bidding or invitation bidding, bidding scope, bidding content, investment for the bidding project and investment resource approval). If self-bidding is adopted, then the documentation required by the "Demonstration Approach for Self-bidding Process of Construction Projects" (No. 5 Article of the NDRC) is to be attached.
7. Legal representative structure of the company.
8. If it is an industry project the internal contract, principles, or a contract signed by joint investors should be attached. If it is a high-tech project then the high-tech identification certificate should be provided.

c) The initial design

The initial design is the concrete project implementation plan based on the approved feasibility study report. It includes the overall target according to the required accurate basic design documents. It also describes the technical and economic feasibility of the project under certain conditions, namely, the site, time, and amount of investment. In addition, an estimation of the total investment costs should be made based on the basic technical requirements. Finally, the initial design should meet the requirements for investment control, bidding, material and equipment ordering, soil application and installation preparation.

Although different projects have different initial designs the principal content is as follows:

- Design reference and guidance.
- Construction size, product plan, quantity and source of raw materials, fuel and power.
- Configuration and selection of the technical process and the main equipment.
- Construction of major building, structure, public infrastructure and residential areas.
- Area of land and how it is to be used.
- General transportation.
- External co-operation.
- Comprehensive application, environmental protection and earthquake abatement actions.
- Production organization, labor required and technical and economic parameters.
- Total estimated investment.

The engineering company that carries out the assignment should be chosen depending on the size and complexity of the project. According to the existing rules, engineering companies are categorized into four classes; A, B, C and D. In principle, lower class companies cannot carry out assignments beyond their work scope. The company should ensure a certain standard of design quality and make sure that each design plan is reasonably made. The design should be based on sufficient and accurate information. The data used should be accurate and reliable, the equipment, materials and installation conditions should be practical, and the design documents should conform to the construction and production requirements.

The initial design should be supervised by development and planning departments together with the relevant administrative departments for the industry according to national supervision procedures. Once the design is approved the following items cannot be easily changed:

- overall factory surface design
- main technical process
- main equipment
- construction areas
- construction structure
- total budget

The following documents are necessary in order to authorize the initial design:

- An application for authorization of the initial design delivered to the department in charge
- An investigation report and initial design documentation from relevant certificated institutions or organizations
- Expert review and comments on the initial design/report
- Memo from the review meeting

d) The annual investment plan

After the project's initial design is authorized the project can be listed in the Official Annual Construction Investment Plan. Still, there are some documents necessary for the application to be listed in the annual construction plan.
The provincial project and stockholder investment project shall provide those planning documents through the provincial administrative department. Local projects shall provide the same through the local Development and Reform Commission.
Moreover, they should hand in permission for the land which is planned for construction, official letters, a red line map, comments from local government or provincial administrative departments, certification of proof of the annual loan capital investment from banks which are authorized to give loans and the approval of the design from relevant institutions, as well as other approval documentation copies.

e) Application report for start of construction

The projects which need provincial authorization are large or medium-sized projects under the administration of provincial or local governments.
For project authorization, the project developer needs to prepare the necessary documentation according to the requirements of construction, and provide the administrative department in charge of the project or district/local Development and Reform Commission with the application report for starting construction. After the report is approved, the report shall be submitted to the provincial level Development and Reform Commission.

The Annex should include the following documents:

1. Review comments from the department in charge in the district DRC or from the construction commission
2. Business license or authorization from all levels of government
3. Project proposal, feasibility study, initial design and general calculation authorization document (copy)
4. Documentation of the practical capital of the project and annual investment plan (copy)
5. Documentation from the planning department (copy)
6. Construction print and construction guideline for when the project will be ready
7. Tender contract for construction (copy)
8. Land use license, immigration and power, water, transportation, communication issues shall all be completed, the main components of the project equipment shall be ordered, and at least three months construction material shall be prepared
9. The monitoring agency of the project construction shall have been determined already by the tender.

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