Technical Assistance Consultant's Report

Project Number: 40682
January 2009

PRC: Preparing the Integrated Renewable Biomass Energy Development Project

Prepared by:

SINOC & HASSAL Associates International, PRC

For the Ministry of Agriculture

Asian Development Bank

ASIAN DEVELOPMENT BANK **Project Number 40682**

ADB PPTA 4939
Preparing the
INTEGRATED RENEWABLE
BIOMASS ENERGY DEVELOPMENT PROJECT

Final Report

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FINAL REPORT

January 2009

Report submitted by **SINOC & HASSALL Ass. Int., Beijing**

This report has been prepared by a team of consultants contracted under ADB financed Project Preparation Technical Assistance (PPTA 4939-PRC) “Preparing the Integrated Renewable Biomass Energy Development Project". The views expressed in this report are those of the consultants and not necessarily those of the Government of the People’s Republic of China or the Asian Development Bank.

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SINOC Investment Consulting Co., Ltd.

Attention: Kunhamboo Kannan
Director, EAAE
Asian Development Bank
P.O. Box 789
0980 Manila, Philippines

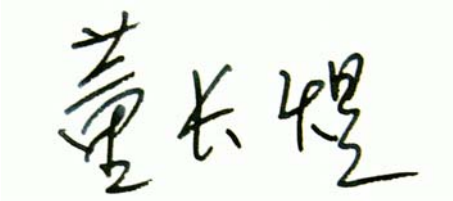
Jan. 24, 2009

Dear Sir,

Re.: TA 4939-PRC: Preparing the Renewable Biomass Energy Development Project
Submission of Draft Final Report

In accordance with Clause 2 (i) of our Contract dated 7th December 2007, please find enclosed our Final Report for your approval.

Yours faithfully,



Dong Changyu, General Manager

Encl. Final Report

Cc: Yue-Lang Feng, EAAE, ADB

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QUALITY ASSURANCE STATEMENT

Report		Status		Date
Final Report		First submission: of Final Report e-Version		Feb. 3, 2009
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Report		Status		Date
Final Report		Submission: of Final Report Hard Copy		
	Name	**Position**	**Signature**	**Date**
Prepared by:	Raninger Bernhard	Team Leader		
Checked by:	SINOC/HASSAL	Project Director		

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EXECUTIVE SUMMARY

Project Background

During the 2006 Country Programming Mission, the Government of the People's Republic of China (PRC) requested the Asian Development Bank's (ADB) assistance to prepare an 'Integrated Renewable Biomass Energy Development Project'. A Project Preparation Technical Assistance (PPTA) team prepared the project proposal which also addressed the PRC's goals of (a) reducing the ecological impact of agriculture, (b) promoting renewable energy, and (c) addressed the ADB's overarching goals of poverty reduction and environmental sustainability.

Pollution from animal waste is one of the most serious environmental problems in China. In 2006, 519 million pigs were raised representing approximately 49% of the worlds pig production, with an annual average increase in pig production of approximately 3.5%. According to the State Environmental Protection Agency (SEPA) the volume of China's animal waste and excreta exceeded 2.7 billion tons in 2006 (3.4 times the volume of China's industrial solid waste). This volume is expected to increase as the country moves to become the world's top meat and egg producer and takes greater action to overcome the countries milk shortage.

In 2007 China had more than 20,000 large and medium-sized livestock farms, but only 3% were equipped with appropriate waste treatment facilities. The Food and Agriculture Organization of the United Nations (FAO) stated that animal husbandry had become one of the most important factors contributing to global environmental pollution with the livestock industry now producing more greenhouse gas than the transportation sectors[1].

The estimated annual Chemical Oxygen Demand (COD) emission from manure in China, in 2001, exceeded 7.28 million tons and the loss of Nitrogen (as NH_3-N) 1.32 million tons. The COD pollution from manure is comparable to the volume of COD produced by industrial and municipal waste water. In areas where concentrated livestock operations exist such as in the pig-belts of the cities, animal waste is entering surface and underground water bodies This is causing eutrophication of the water bodies and damaging the wetland and aquatic ecosystems. This is effecting drinking water supplies and impacting on bio-diversity. Such widespread contamination of water has prompted the Chinese government to develop far stronger regulations and practices to restrict the spread of livestock pollution. Shanghai Municipal government first issued regional standards to control discharges of manure in 1995. Since 2008 the State Environmental Protection Agency (SEPA), and the Ministry of Environmental Protection, has issued the national Diffuse Pollution Standards to control manure discharge 2002[2],[3].

China's energy demand is also growing dramatically (15% in 2005). This growth is contributing to China's Greenhouse Gas (GHG) emissions from fossil energy combustion and compounding the global environmental problem of Climate Change. To reduce China's reliance on fossil fuels the percent of renewable energy in the overall energy mix has to be

[1] - Steinfeld H, et al. 2006. Livestock's Long Shadow: Environmental Issues and Options. Food and Agriculture Organization of the United Nations, Rome

[2] - SEPA, 2002, Discharge standard of pollutants for livestock and poultry breeding, GB 18596-2001
- SEPA, 2002, Status and Prospect of Disposal and Utilization of Animal Wastes in Concentrated Livestock Operations in China. Published for the State Environmental Protection Administration by the China Environmental Science Press, Beijing, China.

[3] - Xiaoyan WANG, 2003, Diffuse Pollution From Livestock Feeding In China, Diffuse Pollution Conference Dublin

increased. The goal is to increase renewable energy use from 7% in 2005 to 15% in 2020 with the tripling of biogas production to 24 bn nm^3/yr[4] by 2020.

The energy policies from the National Development and Reform Commission (NDRC), the Ministry of Agriculture (MOA) and the Ministry of Environmental Protection (MEP) on Renewable Energy (2006) [5], Rural Energy Development [6], National Rural Biogas Construction[7], Pollution Abatement[8], Climate Protection[9] and Circular Economy (2007)[10] are all strong drivers of the need to further develop renewable energy production and to tackle environmental protection measures through the use of biomass wastes from animal breeding, agro-industry and other anthropogenic sources.

Biogas production and the application of anaerobic digestion to reduce pollution from organic wastes and to generate renewable energy were intensively developed in the rural areas of China. In 2007 over 24 million small scale biogas units were built, predominantly in the southern provinces. This number is projected to increase under the support of the current governmental policies and programmes[11].

In the course of agriculture modernisation the number of households suitable for small scale biogas production will decrease from 139 million in 2010 to 121 million in 2020, with further reductions expected until 2050. At the same time there will be an increased demand for meat because of a strong and progressive urbanisation. It is therefore projected that the number of middle and large scale animal husbandries will increase, and therefore the consequent need to establish manure treatment facilities.

Status and Development of Middle and Large scale Biogas Technology

Historically middle and large scale biogas plants (MLBGPs) were set up mainly for processing liquid effluents from the agricultural sector, for the purpose of environmental protection. Between 2001 and 2006 about 4,000 MLBGPs were built, with a capacity to treat about 130 million tons of mainly waste water, with an average treatment capacity of 32,000t/yr. The biogas production in 2006 was 362 million nm^3 of which about 30% was used for power generation. According to the MOA[12] by 2020 the number of MLBPs in large-scale livestock farms should reach 10,000 with an annual biogas yield of 14 billion m^3 and an electric power generation capacity of 3.000 MW.

Therefore the newly adopted energy oriented targets in biogas plant construction[13] require a new conceptual understanding in project design and the development and adoption of new and emerging technologies with increased performance in biogas and power generation. To ensure the biogas power plants are eligible for the Clean Development Mechanism (CDM) and carbon green house gas emission trading, well operated state of the art technologies are required to obtain the expected financial benefits from energy sales (based on the

[4] - China National Development and Reform Commission, 2006, The Renewable Energy Law, PRC
[5] China National Development and Reform Commission, Medium and Long-Term Development Plan for Renewable Energy in China, 2007
[6] MOA, National Strategy for Renewable Rural Biomass Energy Development (NSRRBED), 2008
[7] MOA, China Agricultural Development Report 2007
- MOA, Development Plan on Agricultural Biomass Industry, 2007-2015, July 2007
- MOA, National Rural Biogas Construction Plan, China, 2003 and 2007
[8] GB 18596-2001, SEPA, Discharge standard of pollutants for livestock and poultry breeding, effect Jan. 1, 2003
[9] China's National Climate Change Programme (CNCCP) Prepared under the Auspices of National Development and Reform Commission, People's Republic of China, June 2007
[10] MEP, Circular Economy Promotion law, People's Republic of China, August 2008
[11] - ADB, Report and Recommendation of the President to the Board of Directors on a proposed Loan to PRC for the Efficient Utilization of Agricultural Waste Project, Phase I, 9/2001,
- World Bank Ecofarming Project WB, Project appraisal document , November 2008
[12] -MOA, National Rural Biogas Construction Plan, China, 2003 and 2007
[13] -China National Standard NY/T1222-2006: Design Standards for Biogas Projects in Large Livestock and Poultry Breeding Farms, 2006

renewable energy law 0.25 CNY per kWh based upon feed-in electricity price from coal power plants in the province) and Certified Emission Reductions (CERs).

Objectives of the 'Integrated Renewable Biomass Energy Development Project'
The 'Integrated Renewable Biomass Energy Development Project' aims to set up the necessary infrastructure to: (i) treduce environmental pollution and mitigate green house gas emissions from animal waste disposal, (ii) contribute to rural renewable energy production, (iii) support a circular economy by targeting as the overall objective a higher economic and socio-economic sustainability in the animal farming sector and (iv) contribute to the reduction in rural poverty and improve the community wellbeing and viability of the farming areas. These objectives should be reached by setting up viable and sustainable MLBGPs, based on 'worlds best practice' that are operated using 'state of the art' technologies.

A condition of the ADB sector loan, is that within the next 6 years about 154 MLBGPs will be established in 6 project provinces (Heilongjiang, Henan, Jiangsu, Jiangxi Shanxi and Shandong) representing 32% of the population, 12% of China's land area and 30% of the national livestock and national agro-produce, with a projected growth (regionally) above that of the national average.

The challenges of the Projects are (i) to demonstrate the feasibility of enterprises under the cold climatic conditions of Northern China, (ii) to demonstrate the feasibility of centralised biogas plants and (iii) to prove that biogas projects which produce small amounts of surplus electricity (below 0.5 MWe) can supply their power to the grid and (iv) the sound application of the eco-fertilizer for ecofarming.

Ecofarming
Intensive farming is degrading the soils with over 50% of the arable land in China now affected by soil erosion and desertification. The specific use of mineral N-fertilizer in China is three times that of the world average. The increased production and use of ecofertilizer will contribute to the sustainable use of the soil and improve the quality and market value of the agro produce in the project area.

Ecofarming has developed rapidly during recent years in the PRC and in particular in the project area. In the project area the cultivation has increased by a factor of 7.5 with, crop output by a factor of 15, while value of the produce has risen 11 times reaching a total of CNY130 million in 2006. The Government places great importance on the development of eco-farming. At present, there are 102 national level and 300 provincial level ecofarming demonstration counties. The MOA has developed 10 ecofarming models and the promotion of demonstration areas has reached 6.7 million ha. By the end of 2006, the number of green food enterprises had reached 4,615, with 12,686 products, and an annual output of 72 million tons, with sales valued at CNY150 billion.

Key Problems and Opportunities
Despite the Government's policy and financial supports for the establishment of biogas plants, the uses of biogas as a renewable energy, the practice of eco-farming, and the design and operation and management of medium and large biogas plants are still insufficient. Furthermore, while the treatment of livestock and agro-processing wastes using the biogas plants could be eligible for the Clean Development Mechanism (CDM) financing, and generating carbon emission reductions (ERs), few biogas plants in PRC have been applying for the CDM financing or are capable of generating a sufficient amount to qualify as Certified Emission Reduction (CER) enterprises.

The following weaknesses, barriers and constraints have been observed: (i) the scale of the biogas plants is usually comparatively small, which makes the investment hardly economical and the costs high for the CDM preparation; (ii) there are no mechanisms in place to ensure

a reliable performance of the biogas plants; (iii) there are no standards for or guidance on the best practices of eco-farming, and monitoring requirements for eco-farming (such as those to avoid secondary impacts on the soil and groundwater); and (iv) the investment on the biogas plants still focuses on pollution treatment and lacks the concept of making the investment as a commercial business (via energy- and fertilizer sales, co-feedstock treatment fees, CERs etc.) as in many advanced countries.

Assessment of Core subprojects

Eleven core subprojects (CSP) (see Table1), out of 19 CCSPs proposed by the TIOs from 6 provinces, were selected to represent the expected 154 subprojects to be implemented under the ADB loan. During the acceptance and valuation process eight projects were removed from the candidate list, as they could not provide suitable EIAs, or simply could not follow the projects time schedule. Finally 11 CSPs remained and provided their English FSRs. Six of them, one in each province, were chosen as a demonstration project for the Initial Environmental Examination, following the ADB safeguard procedures.

The CSPs selected represent 7% of 154 subprojects and are located in the six project provinces. The projects contain the main types of feedstock, and 21% of the total feedstock quantity. The CSPS comprise of 2.6% pigs, 13.4% dairy cattle, 20% beef cattle, 22.5% chicken, 7.6% ducks and 59.5% of the agro-industrial waste. One third of the CSPs are Co-processing plants using chicken/pig, duck/slaughterhouse or duck/chicken waste. All main five biogas technologies are used, with an average fermenter size of 180.000 t/yr, which is 3 times larger than the average subproject size. Within the CSPs 15% of the total fermenter capacity, with nine days average hydraulic retention time (HRT), (the average in the subprojects is 18 days if UASB waste water technology is excluded), with an fermenter productivity of 0.9 $nm^3/BG/m^3$ FV*d will be built up. The CSPs will produce 19% of the total biogas (19mn m^3/yr), and 95% of the biogas will be used for electric power generation and 5% will go into the local gas grid or used for heating. 12% of the eco-fertilizer is produced by the CSPs. Only one CSP does not intend to produce solid fertilizer and one CSP will upgrade the solid fertilizer with mineral fertilizer to a high quality organic fertilizer product for marketing.

The CSPs will achieve about a 7.4% emission reduction of GHG or about 90.000 tCO_{2e}/yr. 50% of the CSPs are seen as potential CDM projects, based on existing methodologies, with each CERs between 54,000 - <70,000 tCO_{2e}/yr.

The 11 CSPs will occupy 16.5% of the total investment (CHY241 mn = US$35 mn) and the specific investment costs of the CSPs are in the average 123 CHY per annual ton treatment capacity of the plant. This is due to the bigger size of the CSPs but below the average of all subprojects (155 CHY/tyr). The financial internal rate of return (FIRR) of the CSPs is between 1-10% without CDM and 2.6 – 20.9% including CDM.

The subprojects

The ADB loan project will support the implementation of about 154 MLBGP, which are based on the ‘Selection criteria for loan beneficiaries’ (see Appendix 4A) set by the provincial TIOs and based on due diligence and plausibility checks by the PPTA team. The total quantity of agricultural and agro-industry waste treated will be 9.4 million tons per year, from which about 21% will be derived from agro-industries.

In terms of number of enterprises the subproject comprise of 68.8% pig farms with 2,600 – 120,000 head slaughtered per year, 20% dairy cattle and 9% beef cattle, 13% chicken, 9% duck farms and 11% agro-industrial waste from slaughter houses, bio-ethanol production, vegetable processing plant.

In terms of feedstock quantity the projects will be using 46.1% pig manure, 14.4% dairy cattle manure, 3.6% beef cattle manure, 3.5% chicken and 11.8% duck manure and 20.9% agro-industrial waste or 1.9 million t/yr. About 10% of the projects are co-processing plants with more than one type of feedstock feed to the fermenter. Most of the feedstock is trucked in from Henan (31.3%), followed by Shandong (27.7%), Shanxi (15.9%), Heilongjiang (10.2%) Jiangxi with (7.8%) and finally Jiangsu with (7.1%).

The distribution of subprojects, the share of feedstock processed and the loan proportion among the Project Provinces is shown in Table 1.

The projects will comprise a total anaerobic digestion (AD) fermenter volume of more than 333.000 m^3 with an average treatment capacity of 61.700 t/yr which is about twice the specific size of the existing MLBGPs in China. The performance of these projects, especially those which expect CDM support, may perform with an average fermenter biogas production capacity of 0.9 m^3 biogas per m^3 fermenter volume per day, by holding an average hydraulic

Table 1: Subprojects number, share of feedstock processing capacity and loan proportion per Province

Province	Biogasplant Enterprises (n)	ADB loan proportion US$ million	Feedstock processing (%)
Heilongjiang	14	11.0	10.2
Henan	40	22.2	31.3
Jiangsu	12	11.0	7.1
Jiangxi	51	16.1 *	7.8
Shandong	23	24.2	27.7
Shanxi	14	15.4	15.9
	154	100.0 mn	100%

* Additional loan for Ecofarming development required
** 100% = 9.4 million t/yr

retention time of 13 days to achieve a COD conversion of at least 60% into biogas. In total about 100 million m^3 of biogas per year will be produced, from which about 14% will be directly used in local gas grids, 2% for heating and direct gas use and 83% to generate at least 130 million kWh electric power. The installed electric power generation capacity will be about 20 MW (without stand-bye capacity), which is about the total amount of biogas electricity generation installed in 2005.

These MLBGPs will increase the manure and organic waste treatment and recycling ratio in China. About 6 million tons of liquid and solid fermenter residues per year will be derived as organic fertilizers after the fermentation process. This is about the amount produced by MLBGPs in China in 2005, to the benefit of:
- ecofarming development and 'green food' production
- ground and surface water protection by avoiding uncontrolled manure and waste water discharge
- maintaining soil quality by increasing soil organic matter and carbon sequestration
- reducing the amount of Nitrogen – Phosphorus – Potassium fertilizer (NPK) mineral fertilizer, pesticides and other agro-chemicals.

Impact and Outcome of the proposed Project

The expected impact of the Project will be the sustainable rural development in the six participating Provinces. The outcome of the Project will be a reduction in pollution and Green House Gas (GHG) emissions from the agricultural wastes of 154 livestock farms. This will be

achieved through a sustainable integrated renewable biomass energy system, which supports the Government's policy of a circular economy. The goal of the Project is to establish a market for biomass energy development for large and medium-size livestock farms. In addition the project will contribute to the agro-product processing enterprises, and develop an integrated eco-farming system. These outcomes will also contribute the improvement of rural community wellbeing and long term viability. The benefits of the Project will be (i) replacing fossil fuel energy with renewable biomass energy in the Project area to achieve a low-carbon economy, (ii) reducing the impacts of the country's economic growth on global warming by collecting and using methane gas generated from the animal wastes of livestock farms, and (iii) ensuring the sustainability of the recycle economy by developing science-based eco-farming systems and practices. The design and monitoring framework is in Appendix 4.

Anticipated impact from MLBGPs implemented under the ADB loan in 2015

The project impact analysis (see Table 27) shows that compared to the MLBGP status in 2005, the Asian Development Bank (ADB) AD projects will increase the number of MLBGPs by 5%. The available digester volume will increase by 19% whilst the amount of waste treated by AD processing will increase by 8%. The average treatment capacity of all SP plants will be 61,700 t/yr or about two times the average capacity of the existing installations in 2005. The impact on household biogas distribution will be about 10% when compared to the figure of 2005. However the electric power generation will be with 130 million kWh which is a three fold increase.

The expected electric power generation capacities as well as the quantity of eco-fertilizer will double the amount generated in 2005. The average employment will increase from 2.6 to 11 people per plant and the indirect beneficiaries will be more than 280,000 people from the rural population. The green house gas reductions and potentially the CDM eligible CO_2 emission reduction is estimated to be about 1.2 million t/yr. This is about 17% of the amount achieved in this sector in 2005. About 0.45 million t/yr of COD will be converted into biogas which relates to about 5.5% of the COD emission caused by the animal husbandry sector in 2001 for all of China.

Conditions for Large scale Biogas Technology application under the ADB loan

An assessment of existing medium and large-scale Biogas Plant (MLBGP) projects in China (see Supplementary Appendix K1, Table: Reference Plants) has shown that most of these projects, apart from a small number of internationally supported demonstration projects (such as Shandong MinHe Livestock Co. Ltd. project with specific investment costs of 700 CNY/t annual feedstock treatment capacity, and a plant size of 55.000 t/a), are based on low-cost technologies without performance specification and low efficiency. Most of these projects are operated under low safety and environmental standard conditions. These projects do not meet the criteria of 'state of the art' technology and would not match the requirements of MLBGPs CDM projects under the ADB loan due. This is mainly due the low level of financial viability, the low operating standards and lack of verifiable performance.

In the course of the PPTA the design of the CSPs were further developed and progress been made in understanding and applying 'new conceptual approaches' to biogas plant design for power generation and GHG mitigation (CDM). Due to the improved design and the need for quality and comprehensiveness, the number of subprojects was reduced from 196 to 154 within the same investment budget. As each Core-subproject (CSP) is highly individual in its technological approach a detail design could not be expected at that time. The technological gab analysis could only focus on main equipment, from which items such as GHP stand-by capacity for electricity production, slurry storage and farmland distribution equipment, biogas emergency flairs, spare part management and safety technology where shown to be lagging behind.

The 'Guidelines for Technical Specification, Performance, Implementation and Operation of Medium and Large Scale Biogas Plants (MLBGP) under the ADB Loan' (Appendix 4B) is considering process and technology performance, safety and management standards, and managerial conditions. These aspects will also be considered during the loan subproject acceptance and implementation.

A life-cycle cost-benefit analysis will be used to justify the higher investment costs required and ensure the necessary operational plant viability and performance.

The capacity to plan, manage, build and operate middle and large scale biogas plants (MLBGPs) is in an early stages of development in China. The project will provide support through FA and TA, jointly provided by the ADB, the Chinese Government, GEF and the Gesellschaft fuer Technische Zusammanarbeit (GTZ).

Outputs of the proposed Project

Component 1: Construction of Medium and Large-size Biogas Plants. The proposed investment project will assist 154 agro-enterprises in the six participating provinces to construct medium and large-size biogas plants. These plants will be designed to treat biomass and livestock wastes to meet the national effluent standards and utilize the methane gas properly to minimize greenhouse gas emissions. The subproject investments will include (i) anaerobic digesters, (ii) power generation; (iii) gas supply for heating; and (iv) slurry storage and transport. The agro-enterprises will be provided with an option to receive additional support (GEF grant financing) to upscale their facilities to introduce co-fermentation and/or centralized systems to increase the efficiency and effectiveness of the sub-projects.

Component 2: Eco-farming promotion and improvement of rural livelihoods. The slurry generated from the biogas plants contains nitrogen, phosphorus, potassium and organic materials, which are a valuable substitutes for chemical fertilizers. The subprojects enterprises will provide their biogas sludge to local farmers as fertilizer.The utilization of the slurry as fertilizer will increase carbon sequestration in the soil by building up the organic fraction. This will assist in contributing to climate change mitigation, improve soil fertility and structure and improve agricultural productivity. This is line with the Government's existing eco-farming policies and will support improvement in the efficiency of use of the organic fertilizers produced by the subproject enterprises. The initiative will also reduce the demand and use of mineral fertilizers and pesticides. Through supporting enterprises, particularly in Jiangxi Province, it is intended to make specific investments to improve the eco-farming of orchards, fishponds, greenhouses and reaforestation. Improvements will also be made to the distribution and storage of bio-digester effluent, and soil condition.

Component 3: Capacity Building and Development of Technical Services. This component will complement the construction of the biogas plants with a range of capacity building activities through the support and development of technical services. The Project will strengthen the capacity of training centers in the participating provinces and provide laboratory and monitoring equipment to supervise and support the operations of the biogas plants. The Project will also set up one provincial biogas training centre at one voluntary subproject site in each province to conduct training programs. The training programs will improve local technicians' design and operational capacity of the biogas plants, improve business practices and develop the operational models required for the centralized biogas plants. The training centres will be financed through the collection of fees from participants on a cost-recovery basis. This component will also provide consulting services to study the policy and technical barriers to the commercialization of biogas plants. In addition business handbooks for centralized biogas plants will be developed to promote these plants to the Government.

Component 4: Project Implementation Support. To ensure the success and timely implementation of the Project, the PMO and PIOs will need consultant' support during the first two years of project's implementation. The support will be required to assist in the evaluation and acceptance of non-core subprojects, bidding and procurement and to assist in the construction, start up-phase and long term operation of the biogas plants.

Project Investment Plan

The total cost of the Project is estimated at $233.3 million, including taxes and duties ($5.1 million), contingencies ($16.4 million), and interest and other charges ($10.4 million). A summary of cost estimates is shown in Table 2.

Table 2: Project Investment Plan

($ million)

Item		Amount [a]
A.	Base Costs [b]	
	1. Development of Medium- and Large-scale Bio-digesters	192.5
	2. Eco-farming and On-farm Emission Reduction	6.5
	3. Capacity Building and Development of Technical Services	3.9
	4. Project Implementation Support	3.6
	Subtotal (A)	**206.5**
B.	**Contingencies**	**16.4**
C.	**Financial Charges During Implementation [d]**	**10.4**
	Total (A+B+C)[e] 合计	**233.3**

Notes:

[a] Includes taxes and duties of $5.1 million.

[b] In mid-2008 prices.

[c] Contingencies will be financed by the Beneficiaries for Components 1 & 2 and the Government for Components 3 & 4. Price contingencies on local currency are 2% for all years. On foreign exchange, 0.7%, 1.4%, 0.4%, 0.5%, and 0.5% for 2009 and onward. Physical contingencies are 5% on all Component 1 expenditures and 0% on Components 2 to 4.

[d] Includes interest during construction computed at the five-year forward London interbank offered rate (LIBOR), with a spread of 0.2%. Commitment charges were computed at 0.15% on undisbursed amounts.

[e] Figures may not add up due to rounding.

Source: Consultant's estimates.

Financing Plan

The financing plan is based on the estimated project cost of $233.3 million, including contingencies and financial charges. The ADB portion of the investment in the construction of biogas plants in Component 1 and eco-farming in Component 2, excluding the demonstration centralized bio-digesters is estimated at 52%, excluding contingencies. Beneficiaries and provincial grants will finance the remaining 48% of the construction costs plus subproject preparation costs, surveys, design and supervision, and contingencies. Demonstration of the centralized bio-digesters will be partially financed by GEF under a similar arrangement. The financing plan is presented Table 3.

Table 3: Draft Financing Plan

($ million)

Source	Total	%
Asian Development Bank	100.0	42.8
Global Environment Facility	9.2	3.9
Gesellschaft für Technische Zusammenarbeit (GTZ)	4.6	2.1
Beneficiaries & Provincial Grants	118.2	53.0
Government	1.4	0.6
Total	233.3	100.0

Note: Figures may not add up due to rounding.
Source: Consultant's estimates.
Under the draft financing plan the ADB loan will finance 40.8% of the total project costs and the GEF grant will finance 3.2%. The remaining costs will be financed by the Central and six provincial Governments (2.0%) and the biogas plant beneficiaries (54.1%) covering base costs, and physical and price contingencies.

Financial Analysis

Financial analysis is undertaken to assess the viability and sustainability of the proposed Project. The analysis comprises of: (i) an evaluation of the financial management capacity of the CSP enterprises including their financial situation, (ii) an assessment of their capacity to finance the counterpart contributions during the construction period, (iii) loan repayment capacity, and (iv) an assessment of the financial viability of the investment with and without payment for the CERs.

The CSPs were assessed and found to be acceptable on the basis of the Financial Management Assessment Questionnaire. However, enterprise staff have limited experience in the management of ADB-financed projects and will require training to ensure success. Analysis of the capacity of the enterprizes to finance counterpart contributions indicate that 2 of the 11 CSPs - Weiwei and Lvyuan only, generate sufficient annual profits for this purpose. Seven CSPs generate annual profits of more that 10% but less than 100% of the counterpart contributions, while the annual profits of two CSPs - Hexie and Jinli – are less than 10% of the required counterpart contributions. In terms of loan repayment capacity, the analysis indicates that, other than Zhongkang, all enterprises are expected to be able to generate sufficient income from biogas/electricity, the sale of organic fertilizer and carbon credits to repay the loan. The assessment of the financial viability indicates that, based on a weighted average cost of capital (WACC) of 7.83%, only two of the CSPs - Hexie and Huimin – are financially viable without income from the CERs. With the income of the CERs all CSPs except Weiwei and Zhongkang are financially viable. Weiwei is considered marginal. Sensitivity tests indicate that the financial analyses are sufficiently robust.

Economic Analysis

Economic analysis was conducted by including and excluding CER revenue. In addition to CERs, the direct economic benefits include energy (biogas and electricity) and fertilizer (biogas slurry and organic fertilizer). The internal rates of return (EIRRs) and economic net present values (ENPVs) were estimated using a discount rate of 12%. Based on the results of the analysis none of the CSPs are economically viable if the value of the CERs is excluded, although Hexie (11.1%) and Huimin (10.9%) are marginal. Inclusion of the value of CERs improves the economic viability of all the CSPs. Other than Zhongkang and Lvyuan, all CSPs are economically viable with EIRRs ranging from 13.8% (Haoyun) to 22.8% (Huimin). Lvyuan is marginal, with an Economic Internal Rate of Return (EIRR) of 12.0% but a negative ENPV. However this plant should be accepted based on the extent of non-quantified benefits. Zhongkang should be re-evaluated before a decision is made on its inclusion. Sensitivity tests indicate that the CSPs are sufficiently robust with respect to cost increases, benefit decreases, or lags in benefits. Analysis of the distribution of benefits indicates that the project population at large will receive substantial benefits. However, the poverty impact is limited; the poverty impact ratio for all CSPs is less than 0.07, due to the relatively low poverty incidence in the project area.

Social Benefits and Poverty Reduction

A social assessment of the 11 core subprojects was undertaken[14] and the findings are summarized in the Initial Social Assessment (Appendix 10). Based on these findings a Summary Poverty Reduction and Social Strategy have been prepared (Appendix 11).

The Project is expected to result in improved environmental conditions from which the surrounding communities will benefit. Further the benefits are the supply of clean energy replacing their current use of coal, fire wood and corn stark as well as by enhanced eco-farming based on the use of processed biogas effluent. The Project will further enable beneficiary enterprises to maintain present employment as well as create new employment. Of note is that the current situation with waste disposal is not sustainable and unless actions are taken enterprises are risking the threat of contraction or even closure. Many are currently paying a substantial pollution levy, which negatively impacts on their development. Most of the employed workers are rural residents and the number of employees of all proposed subprojects is about 26,000. The per capita incomes are about CNY13,000 per year, indicating a major impact of these enterprises on the local economies.

The Project is expected to directly generate about 6,000 temporary full-time jobs during construction and 1,700 permanent full-time jobs during operation. The permanent jobs will predominantly need well-trained employees and as a result will require applicants to have a reasonable education level.

About 280,000 surrounding households will benefit from the promotion of eco-farming, 100,000 from expansion of livestock breeding and 600,000 from improved crop production. Of these the eco-farming beneficiaries include 33,000 livestock breeders and 18,000 crop farmers. These benefits are expected to be incremental.

The Project will have a positive impact on the poorer sectors of the surrounding communities. However, the impact of these benefits is not readily quantifiable since the statistics for the core subprojects indicate that (i) none of the core subprojects in Shandong or Jiangsu Provinces are located in poverty-stricken areas; and (ii) the core subprojects in the other provinces are predominantly located in developed countries or developed areas of poverty countries. Examination of specific data for the other proposed subprojects confirms a similar situation. However, the relatively small proportion of households below the national low income population threshold should not be interpreted to mean that a significant part of the population of the surrounding communities is not living in relative poverty, but interviews with the enterprise owners and their feedback questionnaires indicated that the Project will have a positive impact on the poorer sections of the local communities.

No land acquisition or resettlement is planned for the core subprojects as all have been confirmed to have sufficient land available. The provincial offices have indicated that no land acquisition or resettlement is required for the non-core subprojects, but this will need to be confirmed during project implementation.

There are 55 ethnic minorities in the project provinces but they number only 4.54 million people or about 2.9% of the population of the provinces. None of the 154 proposed subprojects are located in minority autonomous areas and there are no ethnic minority communities located in the nearby communities. Consequently there are no anticipated impacts on the ethnic minorities.

Environmental Benefits and Impacts

[14] ADB's Handbook for Incorporation of Social Dimensions in Projects, 1994

The Project is expected to produce a number of environmental benefits, including non-point source pollution abatement, water and air pollution reductions, public health improvement, eco-farming expansion and reduction in GHG emissions.

Non-Point Source Pollution. The quality of PRC's surface water is generally low. According to the 2006 State of the Water Environmental Quality Report[15] the overall quality of surface water across China is under intermediate pollution. Among the 745 monitoring sections of surface water under the national environmental monitoring program, 40% meet Grade I～III National Surface Water Quality Standard, 32% meet Grade IV~V and 28% fail to meet Grade V. 60% of the 754 surface water monitoring stations cannot meet the Class III surface water quality standards. In recent years, non-point source loadings, particularly wastes from livestock operations, have grown to become a major source of water pollution for PRC's water environment. By targeting the major livestock operations in the subproject regions, the Project will greatly reduce pollution from livestock wastes and improve the quality of the water environment.

Air Pollution. Studies have shown that livestock feeding operations are a source of air pollutants, including NH_3, H_2S, particulate matter PM10 and PM2.5, odour and volatile organic compounds (VOCs). These contaminants cause respiratory, cardiovascular and immune illnesses, and spread infectious diseases.

Anaerobic digestion will significantly reduce the generation of these air pollutants, thus reducing the risk to public health. Meanwhile the biogas and electricity produced under the Project will replace the use of coal or other fire-biomass which is a major source of air pollution for Chinese cities and households. It is estimated that the total annual pollution reduction resulting from the replaced coal use will amount to 235 tons of SO_2, 369 tons of NOx and 255 tons of total solid particles (TSP). The health benefits of the emission reductions are difficult to quantify as they depend on population density and distribution and a variety of other factors, but the health and social economic benefits are believed to be significant.

Public Health: In addition to the public health benefits derived from the reduced water and air pollution, the anaerobic fermentation is known to reduce disease-causing pathogens and virus by 90.6% to 99.9%, the removal rate by anaerobic digestion for coliforms by up to 99.9% and ascarid eggs by up to 93.3%. The anaerobic digestion technology will greatly reduce the risk of water-borne and infectious diseases for animals and local residents. If an additional hygiene process step is operated, all pathogens will be removed.

GHG Reduction: A study sponsored by the United Nations Food and Agriculture Organization (FAO) has revealed that animal husbandry had become one of the most important factors in global environmental pollution and the breeding industry now produces more greenhouse gas than the transportation sectors. This figure accounts for the animal agriculture sectors direct impacts as well as the impacts of feeding the world's 63 billion farm animals. Specifically, animal agriculture accounts for: 9% of annual human-induced CO_2 emissions, 37% of methane (CH_4) emissions, which has more than 20 times the global warming potential of CO_2, and 65% of nitrous oxide (N_2O) emissions, which has almost a 300 time multiplier of CO_2' global warming potential. The Project is estimated to produce 101 million m^3 of biogas per year. It is estimated that annual GHG reduction benefits from the Project will amount to 1.2 million t of CO_2 equivalent.

Initial Environmental Examinations (IEEs) have been prepared for the six sample subprojects (Supplementary Appendix J1-6). Possible adverse environmental impacts during the construction and operation of the subproject facilities, include soil erosion, surface runoff and

[15] SEPA, State Council Information Office, 2007, State of the Environment in China 2006

foul odour from the application of biogas residues, noise, fire and explosion hazards. However these are expected to be localized and temporary. Mitigation measures, institutional arrangements, environmental monitoring and adjustment mechanisms, capacity building for the executing agencies (EA), implementing agencies (IAs), and public consultations have been proposed. The residual adverse environmental impacts are assessed to be insignificant, and a Summary Environmental Impact assessment (EIA) is therefore not recommended.

An environmental assessment and review procedure has been developed. The procedure has synchronized both PRC and ADB regulatory and policy requirements. Where the ADB and PRC requirements differ, the more stringent is applied. The Framework also includes the authority and responsibilities of the domestic institutions and ADB departments involved in the environmental assessment and review processes. The review procedure are set out in Appendix 13.

Clean Development Mechanism

The reduction of greenhouse gas (GHG) emissions from improving the baseline conditions of the current waste treatment practice and/or replacement of fossil fuels by clean renewable energy can generate carbon credits for trading. Certified emission reduction (CERs) brings additional economic benefits to the project. All well operated subprojects will reduce GHG emissions, but not all projects can be developed for CDM.

The potential of CER revenues based on existing methodologies over a crediting period of 10 years is estimated to be US$101 million (see Table 27). If the small projects and projects which require new methodologies are included the total ERs may amount to at least US$120 million CER equivalents, which can be used as an ecological value for the economic analysis of the projects.

The consideration of the subprojects for further development will depend upon a range of factors. Among the most important is the applicability of the CDM methodologies. In addition consideration will need to be given to the development of new methodologies by the project owner, the volume of potential CERs, the technology and the capacity of the project owners to operate the projects according best practice and to deal with CDM. Detailed case studies will be further carried out to estimate the possibility of the CDM implementation. More information will be provided in the CDM final report. However consideration of CDM will be a valuable option for each subproject enterprise, and should be considered seriously, however the ADB subprojects will be implemented independent of CDM involvement.

Assumptions and Risks

Based on investigation findings, the major risks for the Project are: (i) the assurances about the availability of counterpart funds; (ii) the technical design capacity to plan and the operational practice to run MLBGP as biogas power plants under CDM conditions; (iii) the project proposals (draft feasibility studies) of core-subprojects and subprojects do not currently meet the standard requirements to be approved by ADB nor by the Chinese authorities; (iv) the Project required staff for plant design, operation and maintenance (v) if the equipment suppliers are able to deliver reliable engineering quality and they are in the position to bear and provide plant performance guaranties, maintenance and costs guaranties, technical after sales services, training to the equipment users, spare part holding for reasonable and competitive costs; (vi) centralized AD projects, as the future business model, appropriate to process the manure from live stock animals are raised, middle scale farms are not included; (vii) the grid companies are currently not willing to buy energy from plants which can supply energy below 0.5 MW; (vii) the establishment of a multitask biogas sector technical committee to better facilitate a business and the operational environment for the sustainable implementation and operation of MLBPs under defined competitive political and technical framework conditions; (iix) eco-farming and the willingness of farmers to

accept and pay for a sustainable slurry utilization to ensure the required income of the biogas plants; (ix) social aspects of (a) vulnerable groups, such as poor and women, may be excluded from employment during project construction; (b) eco-farming social effects may be decreased due to product market and production cost; (c) limited stimulation effect on industry development in poverty-stricken areas and unstable relations between farmers and enterprises; and (d) enterprises may not fulfill their commitment, such as harmless emissions; (x) CDM projects have potential risks as a financial support to ensure the viability of the projects (a) awareness, motivation and capacity of local authorities and enterprises is quite low; (b) certain projects needs new methodologies which have to be developed by CDM consulting companies and approved by UNFCCC; (c) plants engineering design and operation of a medium and large biogas plant to ensure the operation of the plant to generate CERs; (d) a sufficient monitoring to be applied for a CDM projects, requiring more reliable operation and the continuous data recording required to claim the CERs; (e) uncertainty of post Kyoto negotiation which may have impacts on the CDM carbon trading markets after 2012; (f) capacity for understanding CDM carbon market and trading negotiation needs to be improved for the project owners to avoid the risk during the trading process; (g) institutional conditions especially if the bundle approach is applied to the implementation of small CDM projects.

Assurances and Conditions

In addition to standard assurances, the Government, EA and the IAs have given the following assurances, which will be incorporated into the Loan and Project Agreements.

Counterpart Financing. The Government shall cause the EA and IAs to ensure that (a) all domestic financing necessary for the Project be provided in a timely manner, and (b) additional counterpart financing be provided in the event of any shortfall of funds or cost overruns to complete the Project. Each IA will ensure that adequate counterpart funds are made available in a timely manner for the concerned PIOs to implement planned Project activities, as well as maintenance and management of all Project assets.

Land Acquisition and Resettlement. Each IA will ensure that (a) no land acquisition is required for all the subprojects, and (b) no resettlement is required for all the subprojects.

Environment. Each IA will ensure that the facilities are constructed, maintained and operated in strict conformity to (a) all applicable national and local government environmental laws, regulations, standards and procedures; (b) ADB's Environmental Policy (2002) and guidelines; and (c) the environmental mitigation and monitoring measures set out in the relevant IEE or an Environmental Impact Assessment (EIA) for the Project. In case that any subproject is cited for a violation of any law, regulation, standard, or ordinance related to environmental protection within the reporting period, a certification from the environmental authorities concerned shall be included in the reports showing that the defect has been corrected or a corrective action plan has been accepted or approved.

Environmental review of non-core subprojects. The EA will ensure that all IAs will apply environmental safeguard screening procedures of non-core subprojects in compliance with the Environmental Assessment and Review Procedures (EARP), which requires adequate consultations and the establishment of an environmental management plan (EMP).

'State of the art' Technology and 'best practice' operation of biogas plants. In order to achieve the expected result to operate the MLSBP sustainably in terms of environmental and economic conditions the design and operation has to follow the Chinese National Standards and the 'Guidelines for Technical Specification, Performance, Implementation and Operation of Medium and Large Scale Biogas Plants (MLBGP) under the ADB Loan' (Appendix 4B), considering process and technology performance, safety and management standards, and managerial conditions.

Gender Development. Each IA will follow ADB's Policy on Gender Development during implementation of the Project and take all necessary actions to encourage women living in the Project areas to participate in planning and implementing the Project.

These assurances and the proposed project components 2 – 4 are to provide the required support to overcome the weaknesses and risks to implement the loan project successfully and to provide the conditions for the future development of the middle and large scale biogas plant sector in China.

TABLE OF CONTENTS

Letter of Submission

LIST OF APPENDIXES

LIST OF SUPPLEMENTARY APPENDIXES

LIST OF TABLES AND FIGURES

List of Tables

List of Figures

CURRENCY EQUIVALENTS
(Prevailing rate 2008)

Currency Unit – Chinese Yuan (CNY)
1 CNY = $0.145
$1.00 = CNY 6.9

ABBREVIATIONS AND ACRONYMS

These Abbreviations are used in the main text and in the Appendixes and Supplementary Appendixes.

AD	Anaerobic Digestion
ADB	Asian Development Bank
AF	Anaerobic Filter
AS	Australian Standard
BGP	Biogas Plant
BMW	Bioorganic Municipal Waste
BOD	Biological Oxygen Demand
BOW	Bioorganic Waste
CAAA	Chinese Agriculture Animal Association
CAFO	Concentrated Animal Feeding Operation
CCSP	Candidate Core Subproject
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CDMF	China Clean Development Mechanism Fund of MOF
CEAF	Candidate subproject Evaluation and Assessment form
CER	Certified Emission Reduction (CDM)
CH_4	Methane
CHP	Combined Heat and Power
CMI	Carbon Market Initiative (ADB)
CMS	Control & Monitoring system
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CPF	Counterpart Fund
CREA	China Rural Energy Association
CSP	Core Subproject
CSSC	Core-subproject selection criteria
CSTR	Continuous Stirred Tank Reactor
DNA	Designated National Authority under the Kyoto Protocol, Parties
DOE	Designated Operation Entity responsible for validating CDM projects etc.
EA	Executing Agency
EARP	Environmental Assessment and Review Procedure
EGSB	Expanded Granular Sludge Bed reactor
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPB	Environmental Protection Bureau (provincial level)
ER	Emission Reduction
ERPA	Emission Reduction Purchase Agreement
ESC	Enterprise selection criteria
EU	European Union
FAO	Nations Food and Agriculture Organization
FCUP	Foreign capital utilization plan
FECC	Foreign Economic Cooperation Center of MOA

FIDIC	International Federation of Consulting Engineers
FIRR	Financial Internal Rate of Return
FNPV	Financial net present value
FSR	Feasibility Study Report
FYP	Five Years Plan
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GTZ	German Technical Cooperation of BMZ (Gesellschaft für Technische Zusammenarbeit)
HCF	High Concentration Flow Reactor
HH	Households
HRT	Hydraulic Retention Time
IA	Implementing Agency
IC	Internal Circulation Reactor
IEE	Initial Environmental Examination
IRR	Financial Return Rate
LPG	Liquid Petroleum Gas
LSU	Livestock units (1 LSU = 500 kg)
MCF	Methane Conversion Factor
MEP	Ministry of Environmental Protection
MFF	Multitranche Financing Facility
MLBGP	Medium- and Large-scale Biogas Plants
MOA	Ministry of Agriculture
MOF	Ministry of Finance
MOFCOM	Ministry of Foreign Cooperation and Commerce
MOU	Memorandum of understanding
MPF	Modified Plug Flow
MRT	Microbial Retention Time
MSW	Municipal Solid Waste
N_2O	Nitrous Oxide
NDRC	National Development and Reform Commission
NGO	Nongovernmental Organization
NH_4	Ammonium
NMVOC	Non methane volatile organic carbons
NPK	Nitrogen – Phoshorus – Kalium fertilizer
NTP	Normal Temperature & Pressure
O&M	Operation and Maintenance
ON	Austrian Standard
PAM	Project Administration Memorandum
PCCA	Pig - cattle-chicken- agro industry waste
PDD	Project Design Document (CDM)
PIF	Project Identification Form (GEF)
PIN	Project Identification Note (CDM)
PIO	Project Implementation Office
PIU	Project Implementation Unit
PMO	Project Management Office (at FECC)
PPMS	Program Performance Monitoring System
PPTA	Project Preparation Technical Assistance
PRC	Peoples Republic of China
PSP	Private Sector Participation
R&D	Research and Development
RD&D	Research, Development and Demonstration
RE	Renewable Energy
RF-AR	Round flow Anaerobic Reactor
RP	Resettlement Plan
RRP	Report and Recommendation to the President (ADB procedure)

SBR	Sequencing Batch Reactor
SEA	Strategic Environmental Assessment
SEPA	State Environmental Protection Agency (now Ministry of Environment)
SIEE	Summary initial Environmental Examination
SRT	Sludge retention time
SS	Suspended solids
TA	Technical Assistance
TIO	Technical Assistance Implementation Office (6 Provinces)
TMO	Technical Assistance Management Office
TNA	Training Needs Assessment
TPM	Total particulate matter (air pollution)
UASB	Up-flow Anaerobic Sludge Blanket Reactor
UBF	Up-flow Sludge Bed Filter
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
USR	Up-flow Sludge Reactor
VDI	Verein Deutscher Ingenieure
VOCs	Volatile Organic Compounds
WB	World Bank
WWTP	Wastewater Treatment Plant

$	US dollars (USD)	m^3/yr (a)	cubic meters per year (annum)
bn	billion	mg	milligram
btce	billion metric tons of coal equivalent	mg/l	milligram per liter
btoe	billion metric tons of oil equivalent	mn	million
d	day	Mtce	million tons coal equivalent
DM	dry matter (substance)	mu	Chinese area unit, 1 mu = 1/15 ha
FM	fresh matter (substance)	MW	mega watt, electric power capacity
g	gram	nm^3/yr	norm cubic meter (of gas) per year
g/kg	gram per kilogram	pm	person month
GW	giga watt, electric power capacity	ppm	part per million (mg/l, mg/kg)
h	hour	SCMH	Standard cubic meter per hour
ha	hectare	t	ton
kg	kilogram	t/yr (a)	tons per year (annum)
kg/ha	kilogram per hectare	tC/TJ	ton carbon per trillion jeules
kW	kilowatt, electric power capacity	tce	ton coal equivalent
kWh	kilowatt hour	TJ/Mt	trillion joules per million tons
kWh/yr	kilowatt hour per year	TW	terawatt
m	meter	yr	year
m^2	square meter		
m^3	cubic meter		

1. INTRODUCTION

1.1 Project Background

During the 2006 Country Programming Mission, the Government of the People's Republic of China (PRC) requested the Asian Development Bank (ADB) assistance to prepare the Integrated Renewable Biomass Energy Development Project in five participating provinces of Heilongjiang, Henan, Jiangsu, Jiangxi, and Shanxi. The project preparatory technical assistance (PPTA) prepared a project to meet PRC's goals of improving ecological impact of agriculture, promoting renewable energy, and addressing ADB's overarching goals of poverty reduction and environmental sustainability. The concept paper was approved by the Vice President and included in the country strategy and program update.

At the request of the Government, ADB fielded a fact-finding mission in January 2007. The Mission held discussions with representatives of the Government and the five provinces. An understanding was reached on the Technical Assistance (TA) required, the impact, outcome, implementation arrangements, cost estimates, and consultant's terms of reference.

In December 2007 the ADB awarded the contract for the PPTA to Beijing SINOC Investment Consulting Ltd (PRC) in association with Hassall & Associates International Beijing (PRC) through a Quality and Cost-based Selection process. During the contract negotiations in December 2007 the number of provinces to be targeted was increased to 6, by selecting Shandong as an additional Project Province. The merged mobilization/inception phase of the PPTA commenced on 17 December 2007, the inception mission took place from 26 January till 02 February, the Interim Mission from 22 May to 28 May 2008 and the ADB Mission visited the People's Republic of China (PRC) during 20 November till 9 December 2008 to undertake the final review of the subject project preparatory technical assistance (TA) and conducted a -fact finding mission.

1.2 Organization of the Final Report

This Final Report summarizes the work of the team during the PPTA and sets out the Project in the agreed format and is in accordance with ADB's Review Mission for the Draft Final Report. Preparation of the Final Report has benefitted from the comments received on the Draft Report submitted to ADB in October 2008. The Report is divided into five chapters. Following this introductory chapter, which sets out the overall objectives of the PPTA, the Project and the PPTA key activities, the second chapter focuses on the rationale of the proposed Project including sector analysis for the livestock and livestock waste performance, the technical aspects of biogas production in the agricultural sector in China and abroad, This chapter also provides information on the:

- trends in Biogas utilization,
- an analysis of Ecofarming,
- status and challenges for integration of CDM,
- a review of Government policies and practices relating to the sector
- the international assistance provided to this sector and
- an analysis of the key problems and opportunities of the sector.
-

Chapter 3 presents the framework of the proposed Project including the justification for the proposed sector investment approach, details of the impact and outcome, and an outline of the outputs anticipated from the three project components. This is followed by an identification of the special features of the project together with the presentation of the project investment and financing plan. The chapter concludes with details of the implementation arrangements, such as project management issues, procurement, consulting services, accounting and project performance monitoring.

Chapter 4 elaborates on the project benefits and impacts relating specifically to the financial, economic, social, environmental benefits and a CDM impact forecast and concludes with an assessment of the assumptions and risks. Chapter 5, the final chapter, outlines the Consultant's assessment of the outstanding issues and suggests assurances that are considered necessary for project success. The Main Report is supported by 22 Appendices, the English version of the CSPs and 14 Supplementary Appendices that provide elaboration of the conclusions. Figure one presents a map of the location and name of the provinces involved in this project.

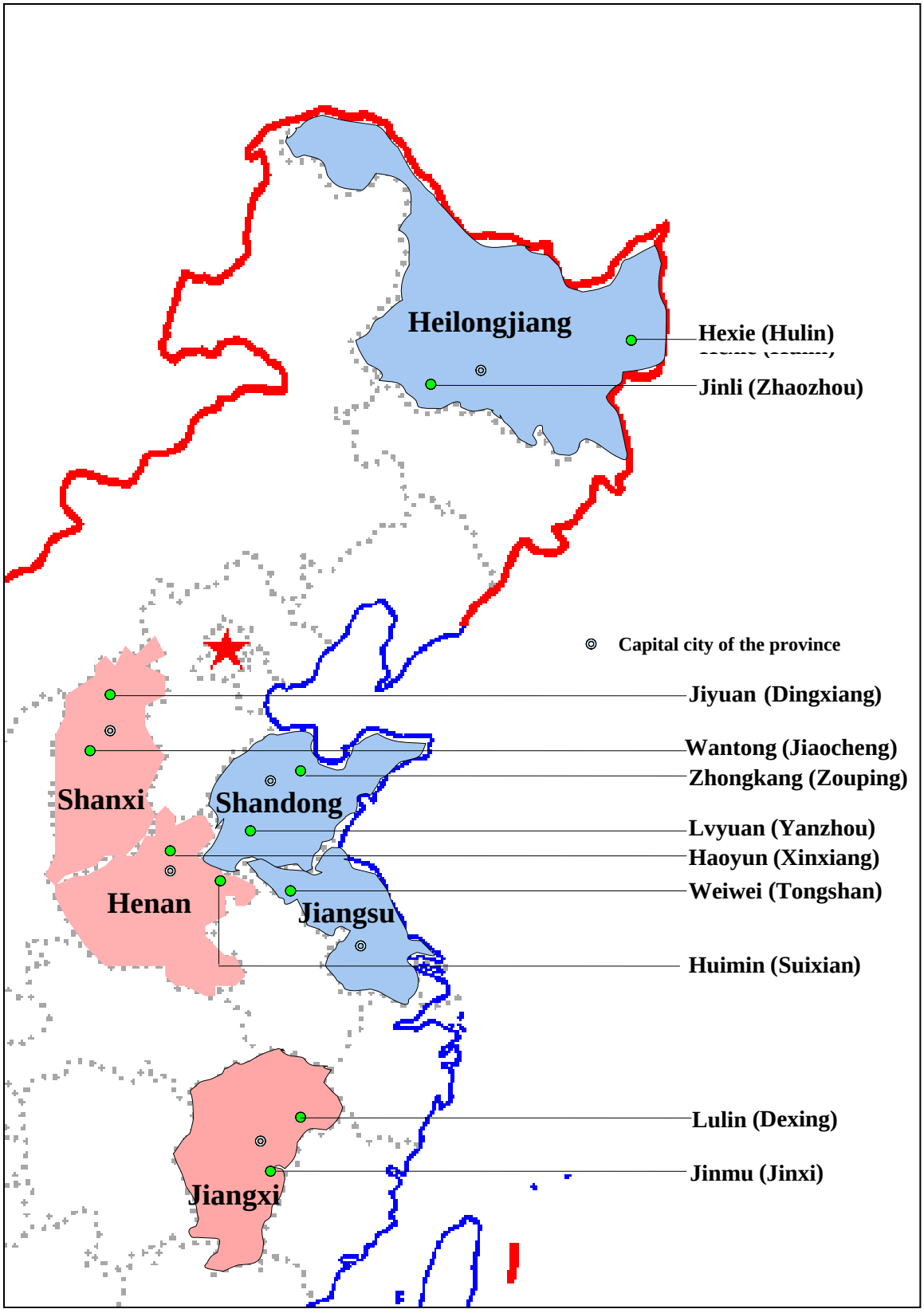

Figure 1: The Project area of Six Provinces and the location of 11 Core Subprojects

1.3 Description of PPTA Activities

1.3.1 Objectives

The main objectives of the PPTA are to prepare a project proposal to implement medium- and large-scale biogas plants (MLBGP) in the agricultural sector which will utilize the manure from middle and large size livestock enterprises and from agro industry waste for energy (biogas) and fertilizer production. Based on national policy initiatives such as environmental protection and pollution control (since 1996), renewable energy production (since 2006), circular economy (since 2008), ecological farming and rural socioeconomic development, medium- and large-scale anaerobic digestion (AD) technology, and the capacity to design and implement those projects, has been the subject of development in China during the recent years.

The Chengdu Biogas Institute BIOMA/BRTC (established 1979), which has supported rural biogas development mainly using small household-scale biogas digesters for 30 years, indicated just a few years ago that China lacks the technology and operational expertise to establish MLBGPs successfully [16],[17]. However a number of pilot projects, to reduce the environment pollution from animal breeding, which were not designed to generate high biogas yields, have been established[18], the performance of these plants[19] is still lagging behind the technologies applied in other industrialized countries (see Appendix 2C).

The most successful MLBGP biogas projects so far undertaken have been supported by donors (e.g. ADB and Global Environment Facility [GEF] supported the Efficient Utilization of Agriculture Waste Project in Henan and the Government of the Netherlands supported a project in Gansu, see Supplementary Appendices E, K1), or by national or provincial governments (e.g. Jiangsu, Heilongjiang, Beijing). However these projects are now considered not to be viable without external financial support, technical assistance and CDM support. Projects currently developed at the domestic level in China still lack professional experience and are mainly based on wastewater technologies for environmental protection, and were not designed for energy production.

To support the development of biogas energy production through state of the art biogas technology (as anticipated on national level[20]) the PPTA Consultants are providing:

i) Technical and managerial support to prepare a loan project comprising about 200 subprojects initially in six provinces. These projects will be implemented over four to six years subject to feasibility, agreement of loans and institutional capacity, viability and environmentally and socially sound.

ii) Assistance in the preparation of documents, including feasibility study reports (FSRs) for the core subprojects, draft tender documents, EIAs and Initial Environmental Examination (IEE), etc., required of the ADB standard and the preparatory work required to approach CDM funding (Project Identification Note - PIN, PDDs).

[16] http://www.biogas.gov.cn
[17] International Seminar on Biogas Technology for Poverty Reduction and Sustainable Development 17-20 October 2005, Beijing, Discussion how to promote Biogas Technology in rural Area in China by Mr. Deng Guanglian, BIOMA (Biogas Institute of Ministry of Agriculture), China
[18] see Table 16 of the report and the list of selected reference projects in Supplementary Appendix L
[19] see the result of the technical analysis of proposed core-subprojects in Supplementary Appendix M2 (CSP upgrade needs assessment)
[20] NY/T1222-2006: Design Standards for Biogas Projects in Large scale Livestock and poultry breeding farms.

iii) *Identification of the institutional arrangements, capacity building, etc. required to implement the Project.* Subprojects were selected based on an evaluation of documentation for candidate subprojects submitted by potential beneficiary enterprises via the TIOs that intend to participate in project. Agreed criteria were used to select an appropriate number of core subprojects to be prepared and implemented in the first phase of the proposed Project (see Appendix 4A).

The main innovative approaches for the selected subprojects include:

i) Establishing state of the art medium- and large-scale biogas plants, focusing on renewable energy production in the sense of the Renewable Energy Law (National Development and Reform Commission NDRC, 2007[21]) in the agriculture sector in six provinces.[22]

ii) CDM support as an integrated planning approach for medium- and large-scale biogas projects.[23]

The proposed Project had to consider:

i) The application of medium- and large-scale biogas technology as appropriate to different feedstock and climatic situations in the six provinces and based on the recent Chinese experience with AD technologies Selecting a design and operation 'best practice' that will allow these plants to operated under internationally comparable performance conditions, including high operational availability, high COD into biogas conversion rates, an efficient power generation and heat utilization and a plant operation for at a depreciation period of at least 20 years (see Appendix 4B).

ii) The financial and economic viability of the biogas plants required for consideration of CDM financial support. This implies acceptance of the transparency required including allowing technical, environmental and financial monitoring of the subproject by the beneficiary. In addition requiring high performance of the plants to claim the revenues/benefits from energy (power and heat) sales, fertilizer application and certified emission reduction (CERs). Where possible this needs to consider waste fees when suitable biomass waste from third parties is provided.

iii) Environmental pollution prevention and the avoidance of secondary pollution caused by waste from large animal husbandries and agro-industries. The plants should approach ecological sustainability locally and even globally by reducing green house gas (GHG) emissions relevant to this sector.

iv) Renewable energy production under NDRC (the Chinese Renewable Energy law provides financial benefits for grid connected energy) and MOA rural development policies and support.

[21] http://ndrcredp.com/english/download/The%20Renewable%20Energy%20Law.doc

[22] Mainly small household-scale digesters were built under the Phase 1 of the ADB Efficient Utilization of Agriculture Waste Project (Loan 1924), the Hainan Agriculture and Natural Resources Management project (Loan 1372), and various other programmes supported by World Bank, EU and the Chinese Government (Suppl. Appendix E).

[23] References see Supplementary Annex L, such as 6 MLBPS supported by WB, Netherlands, Japan and 16 medium- and large-scale biogas plants were facilitated by the ADB Phase 1 project (Loan 1924), but PDD not completed .

v) Eco-farming and resource conservation as well as long term soil protection under the policy of circular economy development

vi) Contribution to global GHG reduction by supporting national (so far voluntary) obligations (NDRC [24]) to global climate change abatement by improving the bioorganic waste management, processing and utilization and generate CERs as valuable financial incentive.

vii) Contribution to rural poverty reduction and rural quality of life improvement under the aspect of balancing and developing harmonious urban and rural areas in China.[25]

1.3.2 Key Activities

The time and the milestone schedule, as agreed between all three parties of the PPTA are presented in Table 1 The milestones to achieve loan effectiveness after the TA Review meeting in December 2008 are also presented in Table 2.

Table 1: Milestone schedule and status of implementation based on Memoranda of understanding (MOU 01-02-2008, MOU 04-06-2008 and MOU 09-12-2008)

Date	Milestones	Responsibilities	Remarks *
17 12 2007	PPTA Team mobilization	SINOC	
19-21 12 2007	PPTA commencement meeting with 6 Provinces, Jiangxi	MOA	
15 01 2008	Inception Report	PPTA team	20 01 2008
27 01–02 02 08	Inception Mission	ADB	
03 02 2008	Draft **selection criteria of core-subprojects, table for subprojects** and submit to ADB and PMO for agreement;	PPTA Team	03 02 2008
06 02 2008	Communicate to PMO and Consultants their comments on/ agreement with the selection criteria of sample core-subprojects	ADB	Ok
	Provide written comments on the inception report, particularly on the preliminary project proposal to ADB and PPTA team	PMO/TIOs	MOU attachment
	PMO and Consulting firm to sign the **contracts** with CDM specialists		
	Provide the ADB with a draft **table of contents** (TOC) of the subproject feasibility study reports for the core subprojects	PPTA Team	03 02 2008 submitted
	PPTA Consultants need to generate a **detailed work plan for the next phase** and enhancing collaboration both within the PPTA team and with external government agencies and enterprises		09 02 2008 submitted
10 02 2008	Communicate with COSO/ADB on the possibility of contracting with CDM specialists separately	ADB	
15 02 2008	Agree with Consultants on the **selection criteria of sample core-subprojects**	PMO/TIOs	Agreed

[24] China's National Climate Change Programme (CNCCP) Prepared under the Auspices of National Development and Reform Commission, People's Republic of China, June 2007

[25] Weigelin-Schwiedrzik S: The Distance between State and Rural Society in the PRC, University of Vienna. Department of East Asian Studies, February 2004.

Date	Milestones	Responsibilities	Remarks *
20 02 2008	Based on the submitted TOC for the draft subproject feasibility reports, provide the Consultants/PMO with guidance on additional documents that are required.	ADB	20 12 2008 and ongoing
29 02 2008	Communicate with GEF focal point of ADB and draft the timeline for GEF development, and inform PMO the results. ADB will mobilize resources to prepare the GEF documentations		
	CDM Requirements for PPTA Project Selection, CDM consultants will provide CDM requirements and input data forms for the data collection by provinces	CDM Team	
	Guided by the NDRC and MOA, TIOs to consult with PDRC and PEPBs and agree on the requirements of domestic approval process	PMO/TIOs	
01 03 2008	Coordinate with PDRC and PEPB to agree on the necessary requirements for domestic approval		
	Agree with the consultants on the **candidate core subprojects** for each province		
	Based on the agreed selection criteria, review and agree with PMO/TIOs **candidate core subprojects** (about 5);for each province	PPTA Team	06 03 2008
10 03 2008	Coordinated by the NDRC, MOF and MOA, determine the ways of securing the national bonds as counterpart funds to co-financing with ADB lending	PMO/TIOs	
	Recruit the technical, financial, procurement, environment and CDM staffs, submit the name list and their positions/responsibilities to ADB		
15 03 2008	Coordinate with PRCM to develop a plan for training courses on ADB procedures, policy and guidelines	ADB	
	Selection of core-subprojects and **submission of long list** of all proposed **subprojects** (acc. the requirements set out in the enterprise selection criteria)	PMO, TIOs, Consultants	
	Based on the consultant's evaluation of the submitted documents **agree on the core subprojects**	PMO/TIOs	14 C-CSPs agreed
	based on evaluation of the submitted documents agree with PMO on the **core subprojects**;	PPTA Team	
25 03 2008	**Submit the FSRs** (CEAS, EIA,) of the selected core subprojects to the Consultants	PMO/TIOs	CHN versions 1 months delayed
30 03 2008	Prepare the provincial proposal, taking into consideration of the comments from PPTA team and preliminary concept from the Inception Report		
22 05 2008	PPTA Interim Report (IR) and the related IR supplements to ADB and PMO. These documents need to take into consideration the comments and recommendations of the Mission as expressed in this MOU; measures are incorporated into the design of all Project components that improve their viability and institutional arrangements for effectiveness.	PPTA Team, Consultants	
25-30 05 2008	Interim Review Mission	ADB	
30 06 2008	Preparation and submission of subprojects proposals to	TMO/TIOs	28-08 not

Date	Milestones	Responsibilities	Remarks *
	PDRC		completed, Jiangsu English FSR missing
	Finalization of the FSRs (English translation) by incorporating TA national consultants' comments		
15 08 2008	Finalization of EIAs of 11 core-subprojects by incorporating TA consultants' comments		2 EIAs missing
30 08 2008	Approval of subprojects proposals by PDRC	TMO/TIOs	
	Submission of a consolidated draft SIEE and IEEs of 6 core subprojects to ADB	TA Environ. Consultants	
15 08 2008	Submission of domestic EIAs of core subprojects to Provincial EPBs	TIOs/Design institutes	
	Submission of TA zero draft final report	TA Consultants	26 08 08
15 09 2008	Submission of TA Draft Final Report and related appendixes		24 10 08
01-14 11 2008	Biogas Technology Study tour to Europe	GTZ	
08 - 20 10 2008	Final TA Review (and Loan Fact Finding Mission)	ADB/Government	18-11 till 10 12 08
20 10 2008	Submission of TA Final Report and related appendixes	TA Consultant	24 01 09

* Only the PPTA related issues can be considered

Table 2: The milestones to achieve loan effectiveness after the TA Review meeting in December 2008

Actions/Approvals	Timelines	
	Government	ADB
Preparation and submission of investment summary and loan allocation of each province by provincial DOA to provincial DOF	II Dec 2008	
Approval of Provincial proposals by PDRC	II Dec 2008	
Submission of domestic IEEs of subprojects to Provincial EPBs	III Dec 2008	
Fact-finding Mission		III Jan 09
Approval of domestic IEEs by provincial EPBs	II Feb 2009	
Completion of provincial and subproject draft FSRs	II Feb 2009	
Management Review Meeting		II Feb 09
Loan Appraisal Mission		III-IVFeb09
Submission of provincial FSRs and all subproject FSRs to PDRC (could be by batches)	IV Feb 2009	
Approval of provincial FSRs and all subproject FSRs by PDRC	III Mar 2009	
Submission of each Provincial DOF's Review Opinion to MOF	IV Mar 2009	
Submission of Foreign Capital Utilization Plan (FCUP) to PDRC & MOA	IV Mar 2009	
Submission of Consolidated FCUP by MOA to NDRC	II Apr 2009	
Staff Review Committee Meeting		III Apr 09
Approval of Foreign Capital Utilization Plan by NDRC	II May 2009	
Loan Negotiations	II Jun 2009	II Jun 09
ADB Board Circulation		Jul 2009
ADB Board Consideration		Jul 2009
Loan Effectiveness		Nov 09

1.3.3 Progress of CDM Tasks

A primary objective was to integrate CDM aspects as early as possible into project preparation, to assess the feasibility of CDM support and to value the benefits to the financial viability of the projects. While CDM task plays a specific role due to its own timely characteristics the detailed analysis and draft Project Design Documents (PDDs) can only be developed when the project's characteristics and design features are available. Despite this, a joint Inception Report was drawn up to analyze how the technical and financial analysis of the project could be integrated into the CDM procedures and vice versa. Due to problems with contracting the domestic CDM experts and uncertainties regarding their possible inputs, the TORs of the CDM team had to be adjusted during the inception mission to reflect the (i) approach for the current Project CDM activities; (ii) revision of the Project Design Document (PDD) of Henan CDM Pilot under Loan 1924-PRC: Efficient Utilization of Agriculture Wastes; (iii) CDM methodology (including e.g. regular CDM ACM0010, small scale, or Programmatic CDM); (iv) cooperation between TA CDM activities and ADB Carbon Market Initiative (CMI); and (v) integration of CDM activities with other activities under this TA.

The TA requires reliable CER estimations, based on the existing baseline situation of the 11 core-subprojects in order to assess the financial viability of the Project. In addition this information is required to build the capacity of the provinces and improve their awareness on how to integrate CDM into the project planning phase.

Clean Development Mechanism (CDM) has been included in the PPTA as one of the innovative features of the Project. In addition to the environmental advantages this provides for the reduction of greenhouse gases emission through CDM implementation, CDM can also offer economic benefits via credit trading of carbon emission reduction. In this case livestock farms who implement the biogas technologies for biogas energy, thereby reducing animal waste and reducing greenhouse gases emissions improve their current situation (baseline).

However, the development of a CDM project involves complex processes including, for example, the application for registration, validation, approval, monitoring, verification and trading of certified emission reduction (CERs). Thus, it needs upfront investment for the preparation of the project with CDM consultants to provide professional technical assistance to the project owner. CDM involvement requires a certain capacity of a CDM project participant. Therefore, the CDM consulting team is to provide the support required to address the above issues. In addition this includes providing technical assistance for the preparation of the CDM documents to NDRC and United Nations Framework Convention on Climate Change (UNFCCC), necessary capacity building, and evaluation of potential candidates for CDM projects.

The detailed tasks of the CDM team were to:

(i) make studies of current status of CDM project development related to medium and large scale biogas plants in China;
(ii) propose initial recommendation and guideline for developing biogas CDM projects as a basis for the further implementation of CDM projects integrated with loan project implementation;
(iii) develop the data forms/sheets for input data collection for the determination of baseline for the selected CDM project candidates;
(iv) revise the PDD based on new version of methodology for the Henan CDM pilot project developed under Phase I ;
(v) evaluate and select CDM project candidates among the core sub-projects (CSPs) and non-core subprojects based on information and data provided from the Project provinces;

(vi) develop PDDs from the selected projects; and
(vii) Identify the capacity building needs/gaps for CDM project development at local provinces.

CDM activities in the PPTA were finally arranged as a separate activity because of a different time schedule required to complete the technical assistance for the development of CDM projects. The main outputs are:

(i) Revision of PDD from the Henan Pilot Project - the methodology applied in the new PDD was changed to “small-scale” CDM project;
(ii) Verification and update of input data from the Henan Pilot Projects to assure the high quality of the PDD.
(iii) Evaluation of core subprojects and recommendation of candidate CDM projects based on information provided by the project provinces including estimation of the potential emission reduction of core subprojects (Appendix 15).
(iv) Evaluation of non-core subprojects based on the information provided from the project provinces including estimation of the GHG emission reduction potential of non-core subprojects (Supplementary Appendix L).
(v) Status survey and review of CDM projects related to the medium and large scale biogas plants in China (Appendix 13).
(vi) Preliminary institutional arrangement recommendation of implementation of CDM projects (Appendix 13).
(vii) Determination of environmental and economic benefits of CDM and the Identification of the capacity gaps for the implementation of CDM projects

2. Rationale: Livestock Waste Sector Performance, Indicators and Analysis

2.1 Agricultural Waste for Biogas Energy Production

China is historically well known for its millions of small-scale biogas units in the rural areas predominantly in the southern provinces. The application of anaerobic digestion to reduce pollution from organic wastes and to generate renewable energy has developed historically, and in the rural areas of China. In 2007 there were 24 millions small scale biogas units, predominantly in the southern provinces where natural climatic conditions are favourable. These plants were built and are still being built and supported under the governmental policies and programmes (including the ADB AGRO_WASTE I project, and the World Bank Ecofarming Project[26]. These initiatives are supporting the government's efforts to deliver environmental and economic benefits from the integration of biogas in farming and cooking in rural households. In addition, the project aims to reduce greenhouse gas emissions through methane combustion and reduced burning of coal and firewood in the project areas and by integrating CDM).

As a consequence of agriculture modernisation and progressing urbanisation the number of households suitable for small scale biogas production will decrease (from 139 million in 2010 to 121 million in 2020 This number will further reduce until 2050. However based on an increasing demand on meat supply the number of middle and large scale animal husbandries is expected to increase.

The global demand on Energy is growing continuously and even with the current 'financial crisis' this is not expected to change or affect long-term infrastructure development, such as renewable energy production[27]. This is a perspective shared by the central government in China. The PRC Government emphasizes that to overcome such kinds of crisis more investment will be required for environmental protection and rural development[28]. The central government has allocated at the end of 2008 additional CHY100bn for immediate infrastructure investment, from which CHY3bn are earmarked for Biogas Development[29]. China has limited resources and is experiencing increasing environment problems. As such China needs faster reform of its economic growth pattern to achieve the desired sustainable development. This reform needs to include efficient resource utilization and environmental protection as part of China's industrialization and modernization strategy in both rural and urban areas.

The energy policies from the National Development and Reform Commission (NDRC) the Ministry of Agriculture (MOA) and the Ministry of Environmental Protection (MEP) on Renewable Energy (2006) [30], Rural energy development [31], National Rural Biogas Construction[32], Pollution Abatement[33], Climate Protection[34] and Circular Economy (2007)[35]

[26] WB Project appraisal document , November 2008
[27] Kabelitz K.R., Renewable natural gas as an important trigger for sustainable energy supply, E.ON Ruhrgas, Germany, BioEnergy Europe 2008, Hannover, 11/2008
[28] Hu: China's economic development faces challenges(Xinhua), 2008-11-30
[29] MOA Department of S&E, verbal information 03/12/2008
[30] China National Development and Reform Commission, Medium and Long-Term Development Plan for Renewable Energy in China, 2007
- China National Development and Reform Commission, The Renewable Energy Law, the People's Republic of China, 2006, *http://ndrcredp.com/english/download/The%20Renewable%20Energy%20Law.doc*
[31] MOA, National Strategy for Renewable Rural Biomass Energy Development (NSRRBED), 2008
[32] MOA, China Agricultural Development Report 2007
- MOA, Development Plan on Agricultural Biomass Industry, 2007-2015, July 2007
- MOA, National Rural Biogas Construction Plan, China, 2003 and 2007
[33] GB 18596-2001, SEPA, Discharge standard of pollutants for livestock and poultry breeding, effect Jan. 1, 2003
[34] China's National Climate Change Programme (CNCCP) Prepared under the Auspices of National Development and Reform Commission, People's Republic of China, June 2007
[35] MEP, Circular Economy Promotion law, People's Republic of China, August 2008

are strong drivers to further develop the approach to tackle environmental protection measures, jointly with the generation of Renewable Energy and to reuse better biomass wastes from animal breeding, agro-industry and other anthropogenic sources.

In the 'Renewable Energy Law (2007) the overall 2010 target is 19 billion m^3 biogas production and the 2020 goal is to produce 48 billion m^3 biogas from various waste based sources including biogas from animal farms, agro-processing, municipal waste, sewage sludge, etc. Food based energy crops stay in competition with the food prices and can't be used anymore according to the governmental policies in 2007[36]. Food security is the number one priority for the Chinese Government and therefore bio energy production will be only promoted if it does not compromise this. The Renewable Energy Law 2007 provides the financial incentives for biogas producers through energy sales (0.25 CNY per kWh based upon the provincial average grid feed-in electricity price from coal power plants)(see Table 17)[37]. Various bilateral and international cooperation programs have been launched in this area supported by ADB, World Bank (WB), European Union (EU), GEF, United Nations Development Program (UNDP), The Netherlands, Australia, (see Supplementary Appendix E), or are planned to be implemented, such as the ADB 'Integrated Renewable Biomass Energy Development Project', also called AGRO WASTE II project and the Sino-German Biomass Utilisation Project of the 'Gesellschaft fuer technische Zusammenarbeit (GTZ)'[38].

The China national target in 2020 is to develop 10,000 MLBGPs with an annual production of 1 billion nm^3 of biogas. Besides of financial incentives through energy sales, taxes and other preferential policies (see Table 17) this development is supported by bilateral and international cooperation, such as the proposed project. This initiative aims to strengthen the capacity to develop and implement appropriate technologies that consider environmental and socioeconomic impact, technical and financial viability, and include the benefits from Certified Emission Reductions (CER) claimed under the Clean Development Mechanism (CDM). This Project intends to implement about 154 MLBGPs in 6 provinces, Heilongjiang, Henan, Jiangsu, Jiangxi, Shandong, and Shanxi (Figure 1) under the ADB loan. Most of them are decentralized plants, but as an option in every province is to set up under the centralized approach, by demonstrating the business model required to ensure a smooth expansion of the MLBGP development in the future and not only related to large scale animal farms.

A byproduct of manure and organic waste treatment is organic fertilizer. About 5 million tons of organic fertilizers are produced per year from AD plants in 2005. This figure is expected to be doubled by this Project, and will benefit eco-farming development. The use of processed manure will support ground and surface-water protection directly and indirectly while maintaining soil quality and the reduction in demand and use of mineral fertilizers and other agro-chemicals use. The organic fertilizers will also l contribute to food quality and safety.

2.2 Agricultural Biomass Waste

2.2.1 Livestock Industry Sector

Livestock production plays an important role in the development of agriculture and society in China. The development of livestock husbandry is entering a new stage of steady progress in production where commercial production for an urbanizing society is rapidly replacing

[36] China Daily June 11, 2007
[37] Renewable Energy Business Partnerships in China, National Renewable Energy Laboratory, Colorado 80401-3393, Operated for the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy by Midwest Research Institute, Battelle, NREL/FS-710-35785, April 2004
[38] Approved by the German Ministry for International Cooperation and Development (BMZ) in December 2008

traditional backyard production. At the same time the increase in urban per capita income is leading to changes in consumption patterns and an increase in out-of-home consumption. Both of which are resulting in increased demand for livestock products, traditional pork, other meats and more recently dairy products [39] (Appendix 2B). To satisfy this increased demand there has been a steady increase in the number of large commercial livestock farms with improved quality and increased productivity. However, as production progresses, there are constantly changing conditions and new problems are emerging. One of the most critical of these is the production of large volumes of livestock waste (feces, urine, and waste water from cleaning), which have been largely untreated or only partially treated and have polluted the surrounding soil, water and air environment. The problem is not unique or limited to China[40].

Development of husbandry related agro produce

The recent 2005 – 2008 development of livestock, meat, egg and milk production and the annual changes all over China and in the Project provinces are shown in Table 3 and Table 4Table 4. On the average the 6 provinces produce about 30% of the national livestock and of the national agro products. The Government projects that by 2010 meat production in China will reach 84 million tons, egg production 30 million tons, and milk production 42 million tons, increasing annually by 1.6%, 1.0% and 8.0%, respectively.

Item	Unit (mn)	2005	2006	2005/2006 %	2006/2007 % [41]	2007/2008 % [42] *	2010
Pig for sale	n	661	681	*3.0*		*5.8*	
Cattle for sale	n	53	56	*6.0*			
Sheep for sale	n	308	330	*7.0*			
Poultry for sale	n	9,900	10,200	*3.1*			

Table 3: The production of livestock, meat, eggs and milk in 2005 till 2008 and 2010 forecast (in million heads or tons per year)

[39] Ma, H., A. Rae, J. Huang and S. Rozelle, 2004, Chinese Agriculture Product Consumption in the late 1990s, *The Australian Journal of Agricultural and Resource Economics*, 44:4, pp569-590; also Gale, F and K. Huang, 2007, *Demand for Food Quantity and Quality in China*, Economic Research Report No. 32, Economic Research Service, USDA.

[40] Steinfeld H, et al. 2006. Livestock's Long Shadow: Environmental Issues and Options. Food and Agriculture Organization of the United Nations, Rome

Production of meat	t/yr	77	81	*4.0*	*-3.2*		85
there into：pork	t/yr	50	52	*3.7*	*-7.8*	*5.7*	
beef	t/yr	7	7.5	*5.4*	*6.4*		
mutton	t/yr	4.4	4.7	*7.8*	*5.2*		
poultry	t/yr		15				
Production of milk	t/y	27.5	33	*16.5*	*10.4*	*11*	42
Production of eggs	t/yr	28.8	29.5	*2.3*	*4.3*	*5.4*	30

Source: website of MOA, http://www.agri.gov.cn/sjzl/2006/195.htm
* based on January – September 2008

The number of commercial livestock farms[43] in China has increased rapidly in recent years from about 2.4 million in 2002 to about 4.3 million in 2006 (Table 4)[44] . Although this increase is affected by a change in definition in 2003, the number of commercial farms has increased by about 50%. The six proposed project provinces have also experienced a large increase in commercial livestock farms from about 1.0 to 1.4 million, and together account for about one third of the commercial livestock farms in China. Large livestock farms' represent a relatively small proportion of the total number of commercial farms[45]: The 12,600 large livestock farms in China represent just 0.3% of the number of commercial livestock farms, while in the project area the 3,500 large livestock farms represent about 0.25%.

While the percentage has remained static at the national level, there has been a significant increase in the proportion of large farms in the project area. However, the number of farms understates their importance since, due to their large livestock numbers, these farms account for about 12.5% of the livestock numbers in commercial livestock farms.

Table 4: Livestock products production and growth of the provinces in 2006 (t/yr)

Provinces	Meat		Meat				Eggs		Milk	
	Output (k ton)	2005/ 2006 (%)	Pork (k ton)	Beef (k ton)	Mutton (k ton)	Poultry (k ton)	Output (k ton)	2005/ 2006 (%)	Output (k ton)	2005/ 2006 (%)
Heilongjiang	1,778	4.3	1,017	323	120	300	1,076	4.8	4,646	4.6
Shanxi	725	3.3	511	72	77	-	524	-7.9	834	13.7
Shandong	7,661	3.0	3,807	811	366	2,548	4,305	2.6	2,387	8.0
Henan	7,365	7.0	4,703	1,093	512	-	4,008	6.8	1,541	42.0
Jiangsu	3,514	0.0	2,187	54	180	1,037	1,855	1.9	598	7.4
Jiangxi	2,491	2.2	1,853	107	17	-	433	2.9	139	11.2
Sub total	*23,534*	-	*14,077*	*2,460*	*1,272*	-	*12,201*	-	*10,145*	-
proportion all China %	29.2	-	27.1	32.8	27.1		41.4	-	30.7	-

[41] CAAA: China Animal Agriculture Association http://www.caaa.cn/show/newsarticle.php?ID=117151
[42] CAAA: China Animal Agriculture Association http://www.caaa.cn/show/newsarticle.php?ID=134832
[43] Commercial livestock-raising farms are defined as those with an annual slaughter of over 50 pigs, 2,000 broilers, or 10 beef cattle, or an annual inventory of more than 500 layers or 5 dairy cattle.
[44] Numbers are not strictly comparable since the definition of a commercial beef farm was in 2002 included only farms with more than 50 animals. The change in definition resulted in the introduction of about 390,000 farms in the national total and about 135,000 farms in the project area total.
[45] Large livestock-raising farms are defined as those with an annual slaughter of more than 3,000 pigs, 100,000 broilers, or 500 beef cattle, or an annual inventory of more than 50,000 layers or 200 dairy cattle.

Sources: *China Statistical Yearbook 2007 and the Statistical Yearbooks of the six provinces*

The common definition of medium and large scale farms in China (no source could be identified), based on the number of animals and annual sales (slaughtered) is shown in Table 5. The table includes the 'subproject selection criteria' (Appendix 4A) and the actual size of the 156 subprojects by livestock used in the ADB Project.

The concentration of so many animals into a relatively small area results in major environmental impact on the surrounding area. Production and disposal of manure, urine and flushing water are major problems as evidenced by the quantities produced per animal (see Table 7: Average Production of Waste from Livestock Activities in China). These volumes are large and exceed the national standard for farm operation. Large quantities of water are also discharged daily (see Table 7: Average Production of Waste from Livestock Activities in China. Table 8: Water Quantity Discharge Standard for 'Wet' and 'Dry' Livestock Husbandry Manure Management).

State Environmental Protection Agency (SEPA), now the MEP, has established standards for livestock and poultry breeding with which the farms must comply.[46] These include a maximum of 150 mg/l of Biological Oxygen Demand (BOD), 400 mg/l of COD,

[46] SEPA, Discharge standard of pollutants for livestock and poultry breeding, GB 18596-2001 put into effect as of Jan. 1, 2003.

Table 5: Size of 156 subprojects by livestock, ADB subproject selection criteria and the common definition of medium and large scale farms in China, (inventory = on-hand, and annual sales = slaughtered).

	Breeding Pig	Beef Cattle	Milk Cattle	Chicken		Duck
ADB Loan: 156 Subprojects inventory	*inventory* 3,000 – 120,000	inventory 600 – 9,000	inventory 580 – 10,000	*inventory* 60,000 – 420,000 *		*inventory* 100,000 – 1,500,000 **
ADB Subproject selection criteria * **	*annual sales* > 3,000	annual sales > 500	*inventory* >200	**broilers** *annual sales* > 100,000	**layers** *inventory* >50.000	-
China Definition: medium and large scale husbanderies	*annual sales* midium: 3,000 – 10,000 large: >10,000	annual sales midium: 500 – 1,000 large: >1,000	*inventory* midium: 200 - 1,000 large: >1,000	*annual sales* midium: 50,000 - 100,000 large: >100,000	*inventory* midium: 25,000 - 50,000 large: >50,000	

* can't be specified by (some farms have both, FSRs not clear)
** different subproject sites
*** Appendix 4A

200 mg/l of SS, 80 mg/l of NH4N, 80 mg/l of TP, 1,000 feces coliform/1000 ml and 2 ascarid ovum/l. In terms of water consumption and water quantity discharge the farms are to be operated according to the standard quantities shown in Table 8.

Table 6: Trend in Commercial and Large Farms in the Project Area and Nationally

Year	Helongjiang	Henan	Jiangsu	Jiangxi	Shandong	Shanxi	Project Area	National
	Commercial Farms (000s)							
2002	143	136	35	384	239	33	970	2,422
2003	232	130	46	391	299	39	1,138	2,999
2004	207	140	61	408	326	43	1,185	3,362
2005	247	153	60	469	379	70	1,379	3,910
2006	255	161	62	468	406	69	1,421	4,262
	Large farms (number)							
2002	409	207	199	541	713	38	2,107	8,241
2003	345	236	242	570	870	62	2,325	8,883
2004	263	263	418	549	946	53	2,492	10,532
2005	287	351	467	924	1,124	122	3,275	11,952
2006	277	425	532	736	1,442	119	3,531	12,604

Source: China Livestock Statistical Yearbook, various issues.

Table 7: Average Production of Waste from Livestock Activities in China

Animal		Av. live weigh (kg/d.c)	Manure (kg/d.c)	Urine (kg/d.c)	Flushing water (kg/d.c)	Total [b] (kg/d.c)	Total [b] (kg/d.c)	COD [c] (kg/d.c)
Standard			CHINA				US [d]	
Pig	Fattening	61 [d]	3	4	5	12	7.4	0.5
	Sow	150	6	10	14	30	14.8	1.25
	Piglets	18	1	1.5	3	5	2.46	0.16
Cow	Dairy	580 - 640 [d]	30-35	30-35	< 25	> 70	71.6	7.0
	Cattle	324 - 360 [d]	20	20	< 25	> 40	40.3	2.8
Chicken	Layer	1.8 [d]	0.12	-	> 0.2	> 0.2	0.12	0.02
	Broiler	0.9 [d]	0.1	-	> 0.2	> 0.2	0.08	0.014
Duck	Layer	2	0.17	-	< 3.8 [e]	< 4.0 [e]	0.15	0.038
	Meat	1.4 [d]	0.1	-	> 0.8	> 0.9		
Sheep		15 - 27 [d]	0.6 - 2	0.2 - 1	< 4.0	< 5	1.1	0.19

Notes: [a] Relevant for hydraulic retention time design (HRT)
[b] Excludes washing water
[c] relevant for biogas building
[d] US ASAE Standard 2003
[e] Based on Shandong Province

The quantity of livestock waste produced in 2006 was estimated at 2.7 billion tons, which tends to be concentrated in areas where these large commercial farms are located. Expansion of the number of farms as China's economy develops will exacerbate the environmental impact due to increases in livestock waste.

Table 8: Water Quantity Discharge Standard for 'Wet' and 'Dry' Livestock Husbandry Manure Management

Type	Pigs (m^3/1008*day)		Chicken (m^3/1000*day)		Cattle (m^3/100*day)	
Season	winter	summer	winter	summer	winter	summer
Dry standard	1.2	1.8	0.5	0.7	17	20
Wet standard	2.5	3.5	0.8	1.2	20	30

2.2.2 Agro-industry Sector

Agro-industries and industries producing organic waste from agriculture or forest produce cover a wide range of activities from production and supply of inputs through to the processing of raw agricultural outputs and the manufacture of food (including canning and freezing, of crops and vegetables, production of sugar, slaughtering, processing of meat, manufacture of beverages (alcohol, bear,), tobacco, textile (cotton, silk,)). Leather manufacturing and manufacture of paper and wood, bamboo, straw are also sources of biomass waste.

The number of agro-enterprises in China has been growing rapidly in recent years in line with the development of the economy and the growing urban demand for livestock products. These trends are expected to continue as the rapid urbanization of China's society progresses. Table 9 presents some key parameters for state and non-state owned enterprises, as well as for private enterprises, in 2005 and 2006. While comparable data for earlier years are not available due to changes in the information reported, these values indicate the growth of the sector and the average size of individual enterprises. With over 16,000 enterprises processing food from agricultural products, and more than 9,000 in the private sector, and these enterprises are producing an average output of CNY79 million per enterprise.

Table 9: Characteristics of State- and Non-state Owned Agro-enterprises.

Sector	Year	Enterprises (no.)	Gross output value	Value added	Revenue	Profit	Employees (no.)
			<----------(CNY million)---------->				
State and non-state owned enterprises							
Processing of food from agricultural products	2006	16,356	79.3	21.4	77.6	3.5	145.9
	2005	14,575	72.8	18.8	71.1	2.7	152.7
Manufacture of food	2006	6,056	77.8	24.2	76.0	4.5	211.6
	2005	5,553	68.1	21.0	66.0	3.7	217.9
Manufacture of beverages	2006	3,914	99.6	36.8	100.3	7.7	235.7
	2005	3,519	87.8	33.1	86.8	6.3	252.9
Private enterprises							
Processing of food from agricultural products	2006	9,256	51.5	14.6	49.6	2.3	100.6
	2005	7,615	45.1	12.0	43.4	1.8	102.0
Manufacture of food	2006	2,757	43.5	13.4	41.3	2.3	143.8
	2005	2,307	36.3	10.5	34.5	1.8	150.9
Manufacture of beverages	2006	1,819	39.0	12.9	36.6	2.2	113.2
	2005	1,486	31.3	10.0	29.2	1.6	119.2

Source: *China Statistical Yearbooks, 2006 and 2007*

The quantities of solid biomass waste derived from industrial activities, according the annual Statistical Yearbook of China between 2003 and 2006 are presented in Table 10. However, it is acknowledged that not all of these industries generate 'wet' organic agro-industry waste that requires treatment using bio-digesters. Based on review of the long-list of proposed subprojects (Supplementary Appendix K1), the types of agro-industries proposed for inclusion in the Project include mainly industrial alcohol production, vegetable processing and livestock slaughter, the latter being the most common (Appendix 6).

The amount of agro-industrial waste from farm produce processing industry, including rice hulls, corn cobs, bagasse (sugarcane dust), cotton seeds waste, etc. is significant, with about 112,000,000 t/yr produced in 2005/6[47]. This however does not include waste from meat, vegetable and fruit processing (including bear-, wine- and alcohol production).

[47] Statistic Bureau of China, Jan. 2006
MOA, The Agricultural Biologic Energy Industry's Development Plan (2007 Year - 2015 Year)"

The number of livestock slaughtered increased between 2005 and 2006. Pigs increased by 2.95%, cattle by 5.96% and poultry by 3.06% (Table 3**Error! Reference source not found.**, and Appendix 2A). The central government is taking measures to prohibit private slaughter and are closing down small-scale slaughtering houses. The Government are also limiting the numbers of large-scale slaughtering enterprises, and stopping production in mid-small slaughtering houses due to the tight pig supply and high pork prices. The livestock slaughter industry is currently faced severe procurement problems, causing halts to production in small-scale slaughterhouses.

Table 10: Production of Industrial Solid Biomass Wastes by Sector, 2003 and 2006,

Production of Industrial Solid Wastes by Sector	t/yr			
	*2003 **	2004	2005	2006
Processing of Food from Agricultural Products	*3,400,000*	12,370,000	13,170,000	14,500,000
Manufacture of Foods	*5,670,000*	3,530,000	4,310,000	3,620,000
Manufacture of Beverages	*450,000*	5,920,000	6,750,000	8,110,000
Manufacture of Tobacco	*5,290,000*	550,000	1,100,000	400,000
Manufacture of Textile	*440,000*	9,040,000	7,200,000	6,790,000
Manufacture of Leather, Fur, Feather, etc.	*1,370,000*	940,000	850,000	590,000
Processing of Timber, Wood, Bamboo, Straw	*90,000*	1,490,000	1,550,000	1,340,000
Manufacture of Paper and Paper Products	*450,000*	11,770,000	12,430,000	15,960,000
* different data basis	***17,160,000***	**44,670,000**	**47,360,000**	**51,310,000**

Source: China Statistical Yearbook 2004 – 2007, National Bureau of Statistics China.

The total number of slaughtering and processing firms decreased from more than 30,000 in 2004 to 25,000 in 2006 due to the restructure and merger encouraged by the government. On the other hand, number of slaughtering and processing firms with annual sales of more than CNY5 million has increased continuously since 2000, from 1,844 in 2001 to 1,889 in 2003, 2,155 in 2004, and 2,686 in 2006. The growth of the total number of livestock slaughtering firms increased from 6.3% in 2003 to 10.7% in 2006 and the share in production value is likely much higher. In 2005 the largest 5% of livestock slaughtering and processing companies accounted for over 40% of total production.

In addition to solid waste, agro-industries produce large volumes of high organically contaminated wastewater. This water is treated efficiently in a relatively short period of time using anaerobic processing such as Up-flow Anaerobic Sludge Blanket Reactors (UASB) to produce biogas. The sewage sludge produced can be used as organic fertilizer and the liquid effluent remains to be used for reuse, for irrigation or is discharged into natural water bodies. While the organic fertilizer may not have a market due to the low volume, the water can normally be reused in the agro-industry or irrigation. This re-use can result in significant savings in the demand for fresh water, having both financial and economic benefits to the farmer, the economy, environment and the community.

2.3 Livestock and Agro-industry Waste Treatment Technology and Models

Given the need to address environmental concerns and meet energy demands the biogas technology, in its various conceptual and technological applications, is being acknowledged as the sound solution. Globally different financial incentives are provided by European and other countries to support these solutions. Agricultural biogas projects are well approved and

acknowledged in various developing countries as evident in the CDM projects which require being a least-cost solution based on legal compliance.

2.3.1 Status of Biogas Technology in China

Anaerobic biological treatment technology is applied to livestock farms for treating highly organically polluted liquid and solid waste. This approach is in line with the need for efficient resource utilization (manure to fertilizer and energy) and limits environmental pollution. Farms with biogas projects applied successful models [48].and have demonstrated success with using biogas fertilizer as organic fertilizers

The New Chinese Standard for designing biogas plant for live stock and poultry farms is diversifying. Two models commonly used are the (i) Energy-Ecological Type of Biogas Plant. This plant is characterized by using the digester effluent to drain and irrigate farmland, fish ponds or water plants ponds, and providing fertilizer for pollution-free agricultural products and realizing "zero emissions" of the animal- and agro-industrial waste where the effluent is used as eco-fertilizer and (ii) the Energy-Environmental Type Biogas Plant. This plant treats the effluent by aerobic and physical-chemical treatment to meet the state's emission liquid discharge standards for discharged [49] (see also Appendix 2B).

From the beginning of the 1990s until the end of 2006, 4000 MLBPGs were developed on livestock farms in China, and this number is expected to increase to 4,700 by 2010 and to 10,000 by 2020 (Table 11).

Table 11: Number of Medium- and Large-scale Biogas Plants in China

Year	Number of Projects	Total Reactor Volume (m^3)	Waste treated (million t/yr)	Av. AD project size (t/plant)	Biogas Yield (million m^3/yr)
2001	1359	639,200	34.04	25,000	168.69
2003	2355	882,900	58.01	25,000	183.92
2004	2671	1,094,300	71.90	27,000	176.19
2005	3764	1,724,100	122.82	32,500	341.14
2006	4000	1,900,000	130.00	32,500	362.50
2010	4700				
2020	10000				1,000.00

Source: Biogas Institute Chengdu, Wu Libin, 2006, amended

The capacity to build and operate middle and large scale biogas plants (MLBGPs) to control pollution from a rapidly rising animal husbandry sector is still insufficient, and using animal waste to generate biogas to displace fossil grid connected energy is in an early stage of development.

To tackle the pollution from an expanding livestock husbandry sector by using medium-and large-scale biogas plants (MLBGPs) is the favored option. Due to the 'economy of scale' [50] larger scale AD plants are more cost efficient than smaller plants. In the case of smaller plants which are based on simple 'low-cost/ low-tech solutions', such as those used for household scale digesters, these cannot be employed due to their low efficiency, high space demand and environmental considerations. If the farm size does not allow a cost efficient biogas project scale, the centralized project approach and/or the use of co-feedstock

[48] Li Kangmin, MaemW.Ho, Biogas in China, The Institute of Science in Society, London, 2006
[49] NY/T 1222, Criteria for Designing of Biogas Plant in Scale Livestock and Poultry breeding Farms, China National standard, 2006
[50] The effect of economy of scale in regard to the current project can be seen at Figure 6 - 8 in Annex 6: Description of subprojects proposed under the ADB loan

processing derived from third parties should be chosen. Plants with up to 20 MW energy productions are preferred in many European countries such as in Denmark, Germany[51], Finland[52], Austria and Sweden[53]. Large scale biogas plants are the best solution to overcome the disadvantages of the cost inefficiencies of the smaller AD projects (see economy of scale of subprojects in Figure 7). These inefficiencies are most evident when combined heat and power (CHP) production or biogas refining to bio-methane for gas grid feeding or vehicle use is applied. Aerobic processing of wastes from animal breeding- and agro-industries is technically feasible, but requires a similar investment without the financial benefits of energy recovery. Usually the fermenter output should be used as eco-fertilizer. In cases where an eco-fertilizer cannot be used, a further aerobic treatment will convert the solid materials into compost and/or allow for the processing of the liquid digester effluent up to the environmental standard for discharging waste water.

However, the technology development and operational experience is in an early stage in China. In recent years biogas plants in the agricultural sector were built mainly to lessen the environmental impact of the liquid effluent through anaerobic (wastewater) treatment, whilst the unprocessed or just stockpiled solid manure is applied to the farmland directly. Between 2001 and 2005 about 3,764 MLBGPs were implemented, treating annually 760,000 tons of feedstock. Biogas production was 341 million m^3 of which about 29% was used for electricity power generation, equivalent to a capacity of 19 MW. In 2006 the treatment capacity was increased by another 6% and up to 130 million tons of waste was processed at some 4,000 plants. But to comply with the recent more energy-oriented targets, a new conceptual understanding and a more advanced technical design which focuses on high biogas yields is required.

Some domestic biogas engineering companies have started to introduce European technology with local modifications, or represent international biogas system suppliers (Supplementary Appendix N) and have constructed medium and large scale demonstration projects in China. Some European biogas equipment suppliers also have founded a Chinese company (e.g. ENVITEC, Beijing; COWATEC Shanghai,). During the last years the China State Government has provided financial support to enhance biogas projects, local governments have also developed policies in response and provided financial contributions. The motivation of livestock enterprises to build medium and large scale biogas plants is high, and large-scale Chinese biogas plants have good market prospects. However, issues such as safety and in particular emission biogas production efficiency in the terms power production and CDM relevant ER along with a stable year-round operation with high availability and performance, as well as operational practices still need considerable attention (Appendix 4B).

2.3.2 International Development of anaerobic treatment of Agricultural Waste

The **European Union** has committed itself to an average reduction of GHG emissions of 8% by 2008-2012 relative to 1990 and to limiting global warming to a maximum of 2°C average temperature increase above preindustrial temperatures (Council 2005)[54]. According to most recent research, keeping within this threshold requires that global green house gas (GHG) emissions be cut approximately in half by 2050[55]. In fact, global emissions will have to peak and decline in the next one to two decades for temperatures to stay below the 2°C threshold.

[51] Ott, Markus, Claudius da Costa Gomez, 'Anaerobic digestion: biogas and biofuels - background, situation and potential in Germany', Moving Organic Waste Recycling towards Resource Management and for the Biobased Economy, Proceedings of the Int. Conference ORBIT 2008, Wageningen, Niederlande,10/2008
[52] JSB, Biogas in Finland –production and utilization, Nordic Bioenergy Conference, Trondheim 25 -27 Oct., 2005
[53] Swedish Gas Association, Biogas from manure and waste products - Swedish case studies, May 2008
[54] Lechtenböhmer S., Target 2020: a Quantitative Scenario on Greenhouse Gas Emission Reductions for the EU 25, Wuppertal Institute for Climate Energy Environment, info@www.wupperinst.org, 2/2008
[55] Hare, B. and M. Meinshausen 2004, "How much warming are we committed to and how much can be avoided?, PIK-Report No. 93, http://www.pik-potsdam.de/publications/pik_reports.

This consequently indicates that industrialized countries will have to reduce their GHG emissions by approximately 60-80% by 2050 in order to leave room for legitimate economic growth and ensuing higher emissions in developing countries (European Commission 2004).

EU Agriculture is currently projected to obtain a 17% reduction in GHG emissions, partly due to decreasing use of mineral fertilizers and an increasing productivity. The agricultural sector is responsible for more than 40% of anthropogenic methane emissions and more than 50% of nitrous oxide emissions. These emissions are derived from the turnover of nitrogen in fertilizers, manure and crop residues, and indirectly from the turnover of nitrogen lost to the environment via ammonia volatilization or nitrate leaching. Both methane (CH_4) and nitrous oxide (N_2O) are potent greenhouse gases. These gases have global warming potentials (for a 100-year time horizon) that are, 21 – 24 and 310 times respectively greater than that of CO_2. Significant reductions in GHG emissions are therefore possible if methane and nitrous oxide emissions can be reduced via improved farm management practices.

Biogas production and utilization constitutes, in all its complexity (Figure 1 in Appendix 2C), a sizeable and renewable form of energy. The total biogas production in the European Union (25 European countries = EU 25) was due to the supporting policies equivalent to 5.3 million tons oil (mtoe) in 2006, which is more than double the capacity produced in 2001 [56].

The complexity lies in the correlation between the different organic waste sources and consideration of co-processing (highly important to achieve a stabile process and high biogas yields). In addition consideration needs to be given to the pollution level of biomass sources determining the use of the end product as eco-fertilizer and for land application. Furthermore the biogas technology under different regional and technological conditions, as well as the options on processing and utilization of gas and the energies derived from the gas and the environmental benefits related to waters and the global green house gas emission reduction also need to be considered. The rapid development of anaerobic treatment of Agricultural Waste and other biomass wastes in Europe and the USA is described in (Appendix 2C).

Anaerobic digestion (AD), as an option to process biomass wastes, provides possibilities to produce renewable energy. Apart from supplying renewable energy biogas plants have other additional positive impact on strengthening of circular economy, reducing emissions from manure storage and producing a valuable organic fertilizer. Biomass waste treatment from third parties (farms, agro-enterprises, restaurants, markets and from residential areas) can also create new sources of income for farmers. Countries like Denmark, Germany, Austria and Sweden promote politically effective mechanisms to produce biogas from organic wastes through economic incentives (energy tariffs). Not-recycling oriented waste processing technologies are more expensive than for example composting and anaerobic digestion, it is this factor of 'cost saving' which drives biomass recovery and utilization.

Compared to EU, the **United States** don't have any significant history in the development in biogas production and utilization. However the current increase in demand for energy independency by through the use of renewable energy coupled with the increasing environmental awareness is driving the interest in the use of bio-methane from landfills (Landfill methane gas outreach program, LMOP [57]) and bio-digesters. As of April 2008, the AgSTAR Program [58], a voluntary effort jointly sponsored by the U.S. Environmental Protection Agency (EPA), as well as the U.S. Department of Agriculture, and the U.S. Department of Energy, to encourage the use of methane recovery (biogas) technologies at

[56] EurObser'ER 2007, Renewable Energy in Europe, http://www.erec.org/projects/ongoing-projects/eurobserver.html
[57] US EPA, Landfill Methane Outreach Program (LMOP), http://www.epa.gov/lmop/
[58] US, EPA, AgSTAR Handbook and Software, Appendix F National Resource Conservation Service Practice Standards, 2nd Edition, http://www.epa.gov/agstar/resources/handbook.html.

the confined animal feeding operations that manage manure as liquids or slurries. Estimates are that there are now 114 farm-scale digesters operating at commercial livestock farms (Dairy 88, Swine 18, caged layer 3, Duck 2, Broiler 1, Beef 1, and Mixed 1) in the U.S. Four of these installations are centralized systems that provide manure treatment for multiple farms.

In July 2008 the **G8 countries** under the leadership of the US, plus Indonesia, South Korea and Australia, in the presence of China, India and Brazil, agreed to "seriously consider" the decisions made by the European Union, Canada and Japan of cutting carbon emissions by 50 percent below 1990 levels by 2050. They also agreed to tackle climate change within the framework of the United Nations[59].

2.3.3 Biogas conversion to Energy

Options for energy utilization using anaerobic digestion (AD) provides renewable energy from organic wastes locally. The process is capable of producing a methane rich biogas from manure (human and animal) and other wet biomass such as crop residues, kitchen waste, etc. The specific biogas production depends on the calorific value of the bioorganic waste material and reaches up to 800 nm^3/t dm biogas and the energy value of the biogas correlated directly to the CH_4 content and has on the average an energy content of 6 kW.h/$m^{3.}$ When converted to electricity 1.5 – 1.8 kW/h can be used as power (depending on the generator efficiency) and about 2 kW/h can be used as heat and Bio-methane with >98% CH_4 after purification is equal to natural gas.

There are the possibilities to directly use the biogas in gas burners for cooking and heating, in industrial gas boilers and gas turbines, or for electricity production in combustion engines (combined heat and power (CHP) production), which is useful when (i) power production is the target and (ii) the heat can be used under economically useful conditions. The heat co-generated with the electricity contains at least the same amount of energy. Up to 15% biogas can be mixed with natural gas for gas grid distribution. If more biogas is feed into the grid refining of biogas to bi-methane with a CH_4 content of > 97% +/- 1-2% is required.

Refining technologies are
- pressure swing adsorption (PSA)
- absorption by scrubbing processes with Polyethylene glycol or Monoethanol amine-polyglycol
- Cryogenic separation
- In-situ methane enrichment (pilot technology)

These technologies yield costs of about 10 €c per nm^3 biogas or 1-2 €c per kW/h. The technologies are developing with increasing efficiency Water and hydrogen sulphide (H_2S <1000 ppm) are removed in one standard treatment step before the upgrading[60].

The replacement of natural gas in public gas grids and the use of compressed biogas as vehicle fuel for bottling for vehicle fuel use (like liquid natural gas, NGP) is for example increasingly being adopted as standard practice in Switzerland (40% of bio-methane in the public natural gas grid, 35% of gas cars are fueled by bio-methane,)[61], Germany and Austria (both countries anticipate 20% bio-methane in the auto-gas). In Sweden [62] cars are using

[59] http://www.ccchina.gov.cn/cn/NewsInfo.asp?NewsId=8049
[60] Persson Margareta, Owe Joensson, Arthur Wellinger, Biogas Upgrading to Vehicle Fuel Standards and Grid Injection, IEA Bioenergy, Task 37 - Energy from Biogas and Landfill Gas, December 2006
[61] Seifert Martin, Biogas as fuel - biogas feed-in to the gas distribution system in Switzerland, Schweizerischer Verein des Gas- und Wasserfaches SVGW, Schwerzenbach, Switzerland, Gas- und Wasserfach. Gas - Erdgas , ISSN 0016-4909, Erfahrungsaustauschs der Chemiker und Ingenieure des Gasfachs (EAG). Vortrag, Koblenz , ALLEMAGNE (09/2005), 2006, vol. 147, no3, pp. 171-183 [13 page(s) (article)] (9 ref.)
[62] Held J., Biomethane Development in Sweden, Swedish Gas Centre, www.sgc.se, 2006

biogas since 1992 [63] and in 2006 54% of the gas cars are operated with bio-methane. In Sweden amounts the biogas energy production to approx. 1.5 TWh/year (equivalent to 150 million nm^3 biogas), from which 16 million nm^3 were used as vehicle fuel (158 GWh/year), the rest for space heating, electricity production or the unused part must be flared.

The priorities in Germany are CHP for heating f(space heating in public or residential facilities, heat for industries, glasshouses), and the electricity and heat sales base on the feed-in tariffs provided in the new EEG 2009 for up to 20 years of operation. In Germany in 2008 the renewable energy mix included 8.6 TWh energy from biogas (see the 2007 situation in Appendix 2C); from which 69% was derive from biomass (including waste biomass). About 3% of the household electricity consumption is born from biogas derived from 3,900 biogas plants, with a total installed electrical capacity of 1,400 MW[64] and operated based on energy crops and waste biomass. Another 780 new biogas plants (in total 200 MW el.) are currently in the planning phase or under construction.

To establish biogas plants as an economic part of modern agricultural industries the new German Renewable Energy law (EEG, 2009[65]) provides a basic renewable energy feed-in price of 9.18 €c/kWh. An additional bonus for smaller biogas pants is also provided with an electricity generation <150 kW/h of 0.1 €c/kWh. Also another compensation of 2 €c/kWh for biogas generation from animal residues such as manure is provided. This is expected to reduce the methane emissions from animal farming. Such a reduction is seen as a key technology for climate protection in agriculture. To promote CHP the new EEG also contains an additional incentive for heat usage in biogas cogeneration. Every kilowatt-hour of electricity gets a bonus of up to 3 €c if the corresponding heat is used. In the best case scenario biogas plants <150 kW/h with a clean air bonus and using innovative technologies, an electricity compensation price of 30.67€c/kWh can be achieved, and this for the next 20 years.

In April 2008 in the USA in 108 of the 114 operational biogas systems, the captured biogas is used to generate electrical power, with many of the farms recovering waste heat for the electricity generating equipment for on-farm use. These systems generate about 182,000 MWh of electricity per year. The remaining six systems use the gas in boilers, upgrade the gas for injection into the natural gas pipeline, or simply flare the gas captured gas for odour control and greenhouse gas emission reduction. In total, the combustion of biogas at the digesters prevents the emission of about 36,600 metric tons of methane annually (768,600 metric tons of CO_2 equivalent). In addition, this biogas utilization displaces the use of fossil fuels, thus achieving additional emissions reductions of greenhouse gases and air pollutants.

External Assistance to the Sector

The Government is actively involved in promoting biogas plants both at the rural household level and large-scale livestock farms and agro-industries. In addressing its targets for the promotion of renewable energy and environmental improvement, the Government has actively encouraged international partners to participate in the development of medium and large-scale bio-digesters for large-scale livestock farms. To gain from this international experience the Government has entered into strategic partnerships with the Global Environmental Facility (GEF) to strengthen its capacity for biogas generation. The ADB, WB, UNEP (Clean Energy Service Initiative - CESI for the biogas manufacturers are medium and large-scale biogas project developments. The projects involve working closely together with

[63] Persson Margareta, Biogas upgrading and utilization as vehicle fuel, Swedish Gas Center, European Biogas Workshop, The Future of Biogas in Europe III, 2007-06-14

[64] Ott, Markus, Claudius da Costa Gomez, 'Anaerobic digestion: biogas and biofuels - background, situation and potential in Germany', Moving Organic Waste Recycling towards Resource Management and for the Biobased Economy, Proceedings of the Int. Conference ORBIT 2008, Wageningen, Niederlande,10/2008

[65] German Renewable Energy Act (EEG), 2009

the Environmental Protection Bureau in Yunnan and Guizhou,)[66]. Other international agencies have provided a number of technical assistance and loan projects to assist the PRC in promoting renewable energy and environmental projects. An overview of these projects with ADB involvement is seen in Table 12, Table 13 shows the involvement of other donor organizations and more details are provided in Supplementary Appendix E, Table 1).

Table 12: ADB Lending and Technical Assistance to the Sector

Loan No.	Project Title	Year	Amount ($ million)
1372-PRC	Hainan Agriculture and Natural Resources Management	1996	53.0
1924-PRC	Efficient Utilization of Agricultural Wastes Project	2003	33.1
2032-PRC	Gansu Clean Energy Development Project	2004	35.0
2395-PRC	Henan Sustainable Agriculture and Productivity Improvement Project (Sanmenxia Area)	2008	66.7

TA No.	TA Title	Year	Amount ($'000s)
3370-PRC	Preparing the Efficient Utilization of Agricultural Wastes Project	1999	703
4939-PRC	Preparing the Integrated Renewable Biomass Energy Development Project	2007	

PRC = People's Republic of China

Table 13: Other Donor Lending and Grants to the Sector

Loan/ Grant No.	Project Title	Year	Amount ($ million)
	Efficient Utilization of Agricultural Wastes Project (GEF)	2003	6.4
	China Renewable Energy Scale-up Program (WB)	2005	87.0
	China Renewable Energy Scale-up Program (GEF)	2005	40.2
	EU-China Energy Environment Programme (EC)	2003	30.0
	Promotion of Rural Renewable Energy in Western China (GON)	2003	7.5
	Capacity Building Rapid Commercialization of Renewable Energy in China (GEF)	1999	8.5
	Capacity Building Rapid Commercialization of Renewable Energy in China (Australia)	1999	3.0
	Capacity Building Rapid Commercialization of Renewable Energy in China (GON)	1999	2.53

GEF = Global Environment Facility; WB = World Bank; EC = European Commission; GON = Government of the Netherlands.

Biogas energy utilization in China.

In addition to the industrialized world, developing countries will also need to commit to taking steps toward a less carbon intensive development strategy. To achieve this challenging goal, rapid action is needed. Future commitment periods under the Kyoto Protocol with a likely time horizon of 2013 to 2017 and 2018 to 2022 will thus need to see substantial reduction targets by developed countries. This will be a precursor of further action and commitments on the part of developing countries. China, as the worldwide largest CO_2 emitter, signed the Kyoto Protocol in 1998 and ratified it in 2002 and has announced its responsibility and voluntary contribution to global greenhouse gas (GHG) reduction (MOST[67], NDRC [68]). The

[66] UNEP, Clean Energy Services Initiative (CESI), A China Rural Energy Enterprises Development (CREED) Initiative, 2005

[67] MOST, China's National Assessment Report on Climate Change, December 2006

[68] China's National Climate Change Programme (CNCCP) Prepared under the Auspices of National Development and Reform Commission, People's Republic of China, June 2007

goals are that between 2005-2010: China will achieve a 20% cut in per unit Gross Domestic Product (GDP) energy consumption. Renewal energies will account for 10% of the energy structure, and achieve at least a 20% forest coverage[69]. China will invest 2 trillion CHY to achieve these goals. Biogas from improved bioorganic waste management, processing and utilization is part of the national strategy[70]. 3bn CHY was allocated for immediate investment into Biogas development in December 2008[71] as action to respond to the global financial crisis.

In 2005 biogas utilization in China (Table 14) was 341 million nm^3 from MLBPs annually 40% of which was used by local households. The anticipated percentage of households using biogas from the subprojects will drop to 20%, following NDRC intentions to produce more grid connected renewable power via CHP.

In terms of GHG emission reduction the project will achieve at least 1.2 million tons of $CO_{2\ equ.}$/yr, regardless of which portion is eligible to be certified as CDM project intervention based on UNFCCC methodologies and procedures.

Table 14: Biogas utilization from MLBGP in China in 2005

Performance of MLSBPs	MLBGP performance in 2005	%
Number of MLBG plants (n)	3,764	
Waste Treatment Amount (t/yr)	122,820,000	
Biogas Output (nm^3/yr)	341,142,400	
Biogas Supply to Households (nm^3)	138,366,200	40
Biogas Power Generation (mn kWh)	40	
Installed Capacity (MW)	19.2	
Source: Biogas Institute Chengdu, Wu Libin, 2006, amended		

2.4 Status of Eco-farming

The liquid and solids in the digester is a treasure trove of valuable resources for soil improvement. These include major nutrients for crops such as nitrogen (N), phosphorus (P) and potassium (K), as well as trace elements (Zn, Mb, Cu, Fe,) that can stimulate seed germination and plant growth. Also present are biologically active compounds such amino acids, growth hormones, gibberelins, sugars, humic acid, unsaturated fatty acids, vitamins, cellulose and other enzymes and antibiotics that may suppress the growth of pathogens, which benefit both plants and soil microorganisms and animals. The digested slurry can be used as organic manure in the sowing season and as a source of water in other seasons. Seeds submerged in slurry germinate better and the seedlings grow stronger. Used as a spray for plants, the slurry inhibits disease and boosts yields[72].

A sustainable agricultural biogas slurry application to the benefit of soil quality and plant safety requires strong consideration of standards in terms of

- per ha application rates of N and P and
- inorganic and organic pollution levels [73]

[69] China National 11th 5 year plan, and China's National Climate Change Program
[70] Zhang Boju, Friends of Nature (FON), Fu Tao, China Development Brief (CDB), Response to Climate Change: China's Policies and Actions, 7/2008
[71] MOA S&E Department, verbal information 03/12/2008
[72] Li K., Maem W.Ho, Biogas in China, The Institute of Science in Society, London, 2006
[73] Austria BLFUW, Richtlinie des Fachbeirat für Bodenfruchtbarkeit und Bodenschutz, 'Der sachgerechte Einsatz von Biogasgülle and Gärruckständen im Acker und Grünland', (Safe application of Biogas slurry and residues on farm and green land), 2001

In many European countries, like in Germany, The Netherlands, Austria, a quality insurance system is established to monitor the eco-fertilizer quality by independent laboratories[74].
Farmers in China have benefited significantly from eco-farming activities. To help promote sustainable development through the dissemination of information on best practices that could be replicable in other areas commissioned a study on the eco-farming technology and methods used in China[75]. Eco-farming has developed very rapidly since the years 2000, both in all China and in particular in the project area: in the project area the eco-farming cultivation area has between 2000 and 2006 increased by 5 times to 5.7 mn ha, the crop output by 11 times to 41.7 mn t/yr and the economic value by 7 times to CNY130 million in 2006 (see Table 1 in Appendix 2D).

The definition of eco-farming in China remains descriptive and lacks strict standards. The main principles are:

(i) chemical fertilizer input is below 225 kg/ha;
(ii) pesticides are reduced by more than 40% compared traditional technology;
(iii) nitrogen fertilizer input is reduced by >30% - nitrogen use for crops drops to 180 kg/ha and for vegetables to 600 kg/ha, while use of P_2O_5 fertilizer is <300 kg/ha;
(iv) organic fertilizer accounts for at least two thirds of total fertilizer applied.

Investigation of the eco-farming situation and the possibilities to apply biogas residues as eco-fertilizer show that the biogas projects will provide additional ecological and economic benefits, such as:

(i) the market situation for 'green pollution-free products' is further increasing as people's income level continues to rise and the quality requirements of the people on food is increasing,
(ii) the agricultural production scale in China is significantly increasing which requires the use of high quantities of organic fertilizers and other agrochemicals at these large scale farms,
(iii) the rise of oil prices is supportive to improve the market competitiveness of eco-fertilizer from biogas residues, as mineral fertilizer production depends on mineral oil prices.

The prices which might be achieved for selling eco-fertilizer are in terms if income crucial for the revenues of eco-farming. According to the experts judgments under consideration of the individual situation at the CSPs the following per unit prices and the following price development of the time (see Table 15) under the support of an Eco-farming component is expected.

The Chinese Government attaches great importance to eco-farming. At present, there are 102 national-level and 300 is provincial-level eco-farming demonstration counties. The MOA has developed 10 eco-farming models and promotion of demonstration areas has reached 6.7 million ha. By the end of 2006, the number of green food enterprises reached 4,615, with 12,686 products, annual; output of 72 million tons, and annual sales of CNY150 billion.

The price of eco-farming produce is relatively high, which promotes agriculture efficiency and increases farmers' incomes, as well as improving quality of their livelihoods and promoting social progress in rural areas. The development of eco-farming is conducive to making full use of organic fertilizer resources, which will help to increase the permeability of soil, keep soil from compacting, and enhance the capacity for maintaining soil moisture and fertilizer. The development of eco-farming is conducive to reducing chemical fertilizer use and protecting the ecological environment. Organic fertilizers are relatively complete in nutrients

[74] Bundesgütegemeinschaft Kompost e.V., Verzeichnis der Kompostierungs- und Vergärungsanlagen in Germany, Cologne, Germany, 2002
[75] UNEP, Ecofarming : The Chinese Experience, 81ff, ISBN No: 92807216582002, 2002

and can meet crop needs. They are reported to improve the quality of produce, reduce chemical residues, and improve food safety. However, the amount of labor required for applying organic fertilizers is comparatively large, which can provide employment opportunities in areas of labor abundance but may act as a deterrent in areas of labor shortage.

Defining the quality of eco-farming produce is not easy. Good marketing is required for

		Hexie	**Jinli**	**Haoyun**	**Huimin**	**Weiwei**	**Jinmu**	**Lulin**	**Lvyuan**	**Zhongkang**	**Jiyuan**	**Wantong**
		HLJ	HLJ	HN	HN	JS	JX	JX	SD	SD	SX	SX
Dried dung		*35*	*0*	*75*	*200*	*25*	*0*		*0*	*0*		*30*
1st year	Liquid	0.0	0	0.1	0	0	0	*0*	0	0	0	0
	Solid	35.0		75	400	25.0	0		0	0		0
2nd year	Liquid	3.0	3.5	0.1	3.0	1.0	1.0	*3.0*	1.0	1.0	0	1.0
	Solid	46.5		82.5	450	40.0	22.5		15.0	15.0		15.0
3rd year	Liquid	7.5	8.8	0.1	7.5	2.5	2.5	*7.5*	2.5	2.5	0	2.5
	Solid	63.8		93.8	500	62.5	56.3		37.5	37.5		37.5
4th year	Liquid	13.5	15.8	0.1	13.5	4.5	4.5	*13.5*	4.5	4.5	0	4.5
	Solid	86.8		18.8	550	92.5	101.3		67.5	67.5		67.5
5th	Liquid	21.0	22.5	0.1	21.0	7.0	7.0	*21.0*	7.0	7.0	0	7.0

consumers to accept such produce. At this stage in China the demand for eco-farming produce is relatively small and competition between suppliers is relatively intense. The long-term prospects for eco-farming are very good but in the short-term the required investments are large. A more detailed analysis is provided in Appendix 2D.

Table 15: Current (in FSRs) and for the up-coming 6 years estimated eco-fertilizer prices for biogas solid residues and liquid slurry for 11 CSPs (CNY/t)

year	Solid	1115.5		127.5	600	130.0	157.5		105.0	105.0		105.0
6th year	Liquid	30.0	35	0.1	30	10	10	*30*	10.0	10.0	0	10.0
	Solid	150.0		150.0	600	175	225		150.0	150.0		150.0
FSR Current	*Liquid*	*30*		*0*	*61*	*40*	*10*	*50*	*10*	*15*	*0*	*10*
	Solid	*200*	*35*	*150*	*600*	*60*	*225*		*250*	*350*		*300*

* Not applicable

2.5 Clean Development Mechanism

The Clean Development Mechanism (CDM) allows net global greenhouse gas emissions to be reduced at much lower global cost by financing emissions reduction projects in developing countries where costs are lower than in industrialized countries. Including CDM in the PPTA is one of the innovative components for the loan project development as CDM for large scale biogas plants in China is still not common practice.

Implementation of medium- and large-scale biogas projects contributes to the reduction of greenhouse gases emissions by methane reduction of the livestock industry (manure management and disposal) and renewable bio-energy fuel to replace fossil fuel based electricity and heat. Introducing CDM into the loan project will bring several benefits for the implementation of biogas project, for example,

(i) Environmental advantages for the reduction of GHGs emissions by advanced treatment of the livestock wastes.
(ii) Improvement of the economic benefits for the project owners with additional potential income from the GHGs emission reduction (CERs).
(iii) Due to the high requirements for the approval of CDM projects, preparation, installation, operation and monitoring of a biogas project will require to be conducted under higher standard, which will improve the quality of the implementation of the loan projects.
(iv) Technology transfer is encouraged in the CDM project[76]. Thus more advanced technologies can be possible to be integrated with the project implementation. This will be helpful to improve the biogas technologies in China.
(v) Capacity building with the CDM project will significantly improve skills and competences for the CDM project owners and people involved in the project, such as designers and CDM consultants.
(vi) New CDM methodologies will be required, as well as new CDM concepts (such as programmatic CDM) which will broaden the applicability of CDM.

CDM project development involves different steps such as PDD development, validation, application and registration, monitoring and verification of emissions, etc. Therefore, technical assistance is necessary and important to the project developers and project owners, especially for demonstration projects in a new sector, which shall provide a successful example for the future implementation.

Accurate CERs need to be estimated on the basis of individual projects with complete input data for the baseline determination. However, some generic estimation of potential emission reduction can be obtained from (i) estimation based on the default values and assumed baseline, (ii) previous projects that have been registered at CDM EB (see Table 16) under similar conditions, or (iii) estimated CERs from Henan Pilot Project.

[76] Stephen Seres, et. Ali, Analysis of Technology Transfer in CDM Projects, UNFCCC Registration & Issuance Unit, Climate Change Economist, Montreal, Canada, etc., 12/2007

By using assumed input data and IPCC default values, preliminary estimates for the long-list subprojects are seen in Appendix 13 and Supplementary Appendix L.

Table 16: Overview of the CDM projects development by using ACM010

Project title	Current status [a]	Host and other parties	Annual CERs (tCO2e/yr)
Methane Recovery and Utilization CDM Project at Muyuan Swine Farm in Henan Province (CDM EB P1301)	Registered Dec. 21, 2007	Henan + Japan	110,461
The Inner Mongolia Mengniu Aoya Biogas Power Project (1.36MW)	Validation for comments *(DNV 18 Dec 07 - 16 Jan 08)*	Inner-Mongolia Mengniu Biogas Power Co. Ltd + China Carbon N.V. (The Netherlands)	22,968
The Beijing Deqingyuan Chicken Farm 2.4MW Biogas Power Project (2.4MW)	Validation for comments *(DNV, 21 Dec 07 - 19 Jan 08)*	Beijing Deqingyuan Agricultural Scientific Co. Ltd + IFC-Netherlands Carbon Facility	94,833

[a] The CDM Project's status can be one of the followings:
- Registered projects:
- CDM projects for which review has been requested:
- Projects under review
- Withdrawn projects
- Request for registration of CDM project:
- Corrections requested
- Rejected projects
- Project has been validated

2.6 Government Policies and Practices Relating to the Sector

In recent years, the importance of renewable energy development for environmental improvement has been recognized by the national government. A series of policies on renewable energy and biomass development have been issued to support the development. At the same time, renewable energy and biomass development has been prioritized in development strategies and plans by many ministries, government agencies and provincial governments. The following are the most relevant policy documents of the national government on renewable energy and biomass development. The *Agriculture Law*, *Energy Conservation Law* and other strategies and plans approved by the national government all include renewable energy development as a priority area and emphases renewable energy is an important strategy to contribute for environment protection energy development. *China Renewable Energy Action* has given a clear guidance to implement the national policies and strategies.

2.6.1 National Policies

2002: The *Agricultural Law* [77] (Section 54) provides that: "The government at all levels should develop regional plans about agricultural resources, plans for environmental protection in agriculture and plans for rural renewable energy development"

2002: the Chinese Government ratified the Kyoto Protocol and it and has announced its responsibility and voluntary contribution to global greenhouse gas (GHG) reduction (MOST[78], NDRC [79]). The goals are 2005 - 2010: 20% cut in per unit GDP energy consumption, Renewal energies account for 10% of Energy structure, 20% forest coverage[80]. China will invest 2 trillion CHY to achieve these goals. Biogas from improved bioorganic waste management, processing and utilization is part of the national strategy[81].

[77] PRC, Agriculture Law of the People's Republic of China, December 28, 2002
[78] MOST, China's National Assessment Report on Climate Change, December 2006
[79] China's National Climate Change Programme (CNCCP) prepared under the auspices of National Development and Reform Commission, People's Republic of China, June 2007
[80] China National 11th 5 year plan, and China's National Climate Change Program
[81] Zhang Boju, Friends of Nature (FON), Fu Tao, China Development Brief (CDB), Response to Climate Change: China's Policies and Actions, 7/2008

2003: The CPC Central Committee and State Council, with regard to the agricultural and rural work ([2003] 3) pointed out that "Rural small and medium-sized infrastructure construction, which directly support the increasing farmers' income and evidently improve rural production and living conditions, should be speed up their production and development." The document also states that national investment and financial support for agriculture should continue to focus on the six small projects, i.e. water-saving irrigation, drinking water, rural roads, rural biogas, rural water power, and pasture fence. The investment scale should be expanded and the contents of construction should be enriched.

2004: Opinion about the Policy of Increasing Farmer's Income by the CPC Central Committee and the State Council ([2004] 1) pointed out that the rural six small projects should play an active role "to improve agriculture production and farmers' living conditions, to increase of farmer's incomes and labor transfer to urban labor market. It is necessary to further increase the investment on agriculture infrastructure and renewable energy development."

2005: The *CPC Central Committee and the State Council on Further Strengthening Rural Work and Improving the Comprehensive Capacity in Agricultural Production* ([2005] 1) promotes again to "speed up the development of rural energy construction especially the construction of rural biogas."

2005: The *Notice about Recent Work of Constructing a Conservation-oriented Society by the State Council* ([2005] 21) requests "household biogas in the rural areas and large and medium-sized digester biogas project in livestock farms should be vigorously developed."

2006: *Renewable Energy* Promotion *Law of China* by NDRC the 18th Chapter of the states that the government encourages and supports renewable energy utilization which includes biogas systems. Also in the law, it's clearly stated that government above county level should provide financial support for renewable energy utilization in rural areas. According the Regulation on the Issues of Renewable Energy Power Generation promulgated by NDRC the biomass power generation project (including agricultural and forest waste direct-combustion power plant and gasification power plant, refuse burning and landfill biogas power plant, biogas power plant) are to be subsidized by CNY0.25 per kWh based upon feed-in electricity price of the coal power plant in the province, and the subsidy will last for 15 years from the start of project operation. In Clause 12 of the 'Management Guidelines Administrative Provisions for Renewable Energy Power Generation' it is written that "power grid enterprises should be responsible for building the connection systems for biogas power generation projects directly connected to power grids."

2006: The *Renewable Energy Development Action Plan* (Article 18) stipulates "The state encourages and supports the development and utilization of renewable energy in rural areas. The energy management sector together with the concerned departments at or above county level make up the development plan for renewable energy in rural areas according to the actual situation of local economic and social development, ecology protection and comprehensive management needs, and promote the technology of using methane, solar energy, small wind energy, small hydro power energy etc, according to local conditions."

2006: Energy development plan in 11th Five-Year Plan by NDRC states that, in accordance with the principle of "conditioned and diversified development", China, besides continuing to speed up construction of small hydropower and rural power grids, will vigorously develop wind power, biomass, solar and other renewable energy that suitable for villages, towns or farmers.

2006: *National Environmental Protection Planning in 11th Five-Year Plan* ([2007] No. 37) states that China will strengthen the construction of rural biogas and recovery and utilization of urban landfill gas, and effectively control the growth of methane emissions. China will

promote the conservation and comprehensive utilization of agricultural resources, and vigorously develop the circular economy in agriculture. Taking biogas as the link, China will strengthen the reasonable use of crop straw, wastewater and manure in livestock form.

2006: The *National Economic and Social Development Program for the 11th Five-Year Plan* states that "speeding up the development of biomass energy, supporting the development of power generation from straw, waste incineration and landfill, constructing a number of power stations of wood and straw, and increasing the production capacity of solid-forming biomass fuel, ethanol and biodiesel fuel."

2006: National Rural Biomass Projects Planning (2006-2010)[82], by MOA states that, during the 11th Five-Year Plan, the state will speed up construction of household biogas units in rural areas, large and medium-sized biogas plants in large-scale livestock farm, and the service system for rural biogas. The Plan takes the construction of methane technical support system and service system as an important content. It's further indicated that the government would support commercial livestock farms (more than 3000 pigs annual output or equivalent) to build up medium- or large-scale biogas plants. It is planned that 4000 biogas plants will be established national wide on livestock farms from 2006 to 2010, which would represent more than one third of the of the commercial livestock farms.

2006: The CPC Central Committee and the State Council on Promoting the Building of a *New Socialist Countryside* ([2006] 1) pointed out that speeding up the construction of rural energy, extending biogas in suitable rural areas, increasing investment in rural biogas, popularizing household biogas in areas where conditions permit, and supporting the building of large and medium-sized biogas in livestock farm.

2006: The Fifth Plenary Session of the 16th CPC requests "vigorously popularizing the rural biogas, and positively developing the clean energy adapting to rural characteristics."

2007: The *Agricultural Biomass Industrial Development Plan* (2007 to 2015) by MOA suggests that, in the near future, China's agriculture biomass industry, under the security supply of national food, will focus on the full use of agricultural waste, vigorously strengthening methane development, actively promoting straw gasification and solidifying fuel, besides the appropriate development of energy crops. The future direction of the agricultural biomass industrial development is the energy use from agricultural wastes. MOA will focus on promoting rural biomass projects, scientific and technological supported biomass energy projects, crop stalks energy utilization demonstration bases construction projects, and energy crop breeding and planting demonstration bases.

2007: The *Medium and Long-Term Development Plan for Renewable Energy in China* by NDRC states that the Government will adopt an incentive policy to promote the utilization of renewable energy technologies to address issues of energy shortage and lack of access to electricity in rural areas, also supporting development of a "recyclable economy". At the same time, the Government will set up a market mechanism for promoting renewable energy development, using market measures to stimulate the participation of investors. This will also raise the technical level of renewable energy technologies, promote the development of the renewable energy equipment industry, continuously improve the competitiveness of renewable energy, and cause renewable energy, under the support of the nation's policies, to achieve large-scale development. Comprehensive treatment of agricultural or other kinds of organic wastes and to the biogas project construction at commercial livestock husbandry farms, at the industrial organic waste water treatment plant or at municipal sewage plant, and to set up the reasonable matched electricity power generation systems is promoted. According to the plan, 10,000 biogas plants will be set up by 2020 at large-scale animal

[82] MOA, National Rural Biogas Construction Plan, China, 2003 and 2007

farms, and 6,000 biogas plants at industrial organic sewage treatment plants, with an annual biogas yield of 14 billion m^3 biogas resulting in 3 million kW of electric power generation.

2007: The document issued by MOA and NDRC on *Further Strengthening the Construction and Management of the Rural Biogas* (2007-9-30) urges all relevant agencies should unify their thinking, pay great attention strengthen leadership, and take rural biogas as important projects in the building of a new socialist countryside. All localities should conscientiously learn how to speed up the construction of biogas project in livestock farms, strengthen the comprehensive utilization of organic waste such as animal manure, and control the pollution from livestock farms.

2007: The *No. 1 Document* (2007) from the CPC Central Committee and the State Council promulgates to "accelerate the development of clean energy in rural areas, continue to increase investment in rural biogas, and support the building of large and medium-sized biogas digester in qualified livestock farms."

2007: The *Energy Conservation Law* [83] stipulates that: "The state encourages the development and use of new and renewable sources of energy" in Article 4.

2007 the Ministry of Environment issued the *'Circular Economy Promotion law, People's Republic of China'* [84], and in these measures the 3R principle, reducing, reusing and recycling, conducted in the process of production, circulation and consumption is a generic objective. The use of agriculture waste for fertilizer and the production of 'green' Energy are within the scope of this law.

2008: The *Enterprise Income Tax Law of the People's Republic of China* and the *Provisional Regulations on Enterprise Income Tax* came into force. Based on this law and the provisional regulations, (Article 86) tax privileges can be actualized on livestock and poultry farms for the animal keeping income with income tax exemption, and (Article 88 of the provisional regulation) on the enterprise that engages in a qualified project in of environmental protection, energy saving and water conservation (including public sewage treatment, municipal waste treatment, biogas comprehensive development, energy saving and pollution reduction technological reform, sea water desalination, and other similar projects,) for project income with income tax exemption from the first to third year, and 50% income tax exemption from the forth to six year.

According to the statement of the State Administration of Taxation, since January 1, 2001, electricity generation projects which make use of the municipal wastes could receive preferential treatment for valued added tax reimbursement once levied. This is also being applicable to biogas power project with the animal wastes.

Tax breaks were given to wind turbine imports, small hydropower- and biogas projects. Following the implementation of the new tax-sharing system introduced in January 1, 1994, taxation in China can be classified as shown in Table 17: Classification of taxation in China.

2008: the Central Government increased besides of other infrastructure investment the promotion of large-scale biogas plant construction on livestock farms as a counter measure responding to the global financial crisis. MOA reports that CNY180 million will be budgeted from the national annual budget plan as subsidies for construction of new large scale biogas plants on livestock farms, which is far higher than that in recent years, when CNY30 million to CNY40 million CNY has been allocated.

[83] PRC, Energy Conservation Law 10-28-2007, Effective: 04-01-2008, Standing Committee of the National People's Congress,

[84] MEP, Circular Economy Promotion Law, People's Republic of China, August 2008

Table 17: Classification of taxation in China[85]

Item	Value Added tax (VAT)	Value Added annex tax	Income tax
General	17%	8% of VAT	33%
Hydropower	6%	8% of VAT	33%
Biogas	13%	8% of VAT	15%
Wind	8.5%	8% of VAT	15%
Landfill biogas	0%	0%	15%

2.6.2 Provincial policies and regulations about biomass and rural biogas

Following up the national government requirements, provincial governments have developed provincial policies, strategies and plans on renewable energy development according to the local situation. Renewable energy and biomass development are included into the provincial development plans as the priority area.

2.6.2.1 Heilongjiang

Heilongjiang Economic and Social Development Outline in the 11th Five-Year indicated that Heilongjiang will strongly support the development of rural clean energy such as water power, biogas and so on that is suit to the rural characteristics, and effectively improve the energy consumption structure in rural areas. They will encourage production and consumption of renewable energy, utilization of wind power, solar energy, geothermal energy, biomass energy, and research new energy-saving technologies and products.

Heilongjiang Environmental Protection 11th Five-Year Plan states that Heilongjiang will strengthen the pollution prevention from livestock and poultry industry, and promote resource-like and harmless use of livestock and poultry manure, crop straw and waste plastic sheeting.

Heilongjiang Rural Energy Middle and Long-term Development Plan stated that from 2008 to 2015, large- and medium-sized biogas projects will be introduced to the areas with intensive animal farms and with large-scale livestock and poultry farms or farming communities. Taking agriculture circular economy as a guide, they will combine animal raising, biogas project and the surrounding farmlands for unified planning and arrangements. Besides providing clean fuel for residents around the livestock farms, they will develop ecological agriculture by comprehensively utilizing biogas residue. By 2015, Heilongjiang will construct 700,000 household biogas digesters and 320 large and medium-sized methane projects in intensive animal raising farms or farming communities.

2.6.2.2 Henan Province

"*Henan Agriculture and Rural Economic Development 11th Five-Year Plan*" states that: Henan province will support and promote the development of agricultural clean production, straw gasification, curing, power generation and other technologies, develop biomass energy sources, and cultivate biomass industry. With crop residues and animal waste treatment, they will vigorously develop organic fertilizer and biogas, promote garbage processing, and improve level of waste recycling.

[85] The VAT on wind power was issued in 2001, the tax on landfill biogas started in 2002, and the rest started in 1994 (Source: CREIA, 2006)

Henan Energy Development 11th Five-Year Plan indicated that Henan will promote use of solar energy, biomass, wind, small hydropower and other renewable sources of energy, and increase renewable energy in the proportion of the energy structure. Given the advantages of biomass energy resources in Henan, they will accelerate promotion of rural household and large- and medium-sized biogas projects, actively develop power generation from renewable energy sources such as straw, biogas, garbage and others, and encourage development and utilization of biological liquid fuel and solid fuel molding.

The Henan provincial government document on *Views on Further Strengthening the Construction and Management of Biogas* states that Henan will make active use of capital, credit, tax and other economic means to encourage and guide various kinds of social financial resources to invest in biogas construction. In accordance with national policies, the Department of Industry and Commerce, Taxation, etc. must give priority to the registration of establishment of methane service stations (company) or the association of methane gas. Financial departments at all levels should arrange special funds to support the new technologies, new products, new materials, research and development, experiments and demonstrations, and technical services in biogas. Developments, such as development and reform, agriculture, health, forestry, environmental protection, construction, animal husbandry, poverty alleviation and development, must use their respective advantages to support the construction of biogas.

Henan Rural Biogas Development Plan (2005-2010) (Trial) states that by 2010, the biogas digesters in the province will increase to 4 million, about 20% of the rural households will use biogas, and the gas use rate will research to 40% in appropriate areas. At the same time, 600 various biogas projects will be implemented in Zhengzhou city (the provincial capital), suburb of big cities, large-scale livestock farms and animal raising centralized areas.

2.6.2.3 Jiangsu Province

Jiangsu Agriculture and Rural Economic Development 11th Five-Year Plan states that Jiangsu will promote ecological farming and the comprehensive use of manure, develop various kinds of biogas projects to make full use of rural wastes, and control pollution from feces. More than 80% of rural households are equipped with improved latrines, pig sties and kitchens, the treatment of feces in large-scale farms meets the state standards, and more than 80% of the feces are comprehensively utilized.

Jiangsu Outline of the 11th Five-Year Plan indicated that Jiangsu will promote rural biogas application and develop clean energy fitting to rural characteristics.

Jiangsu Circular Economy Development Planning states that Jiangsu will set up patterns featured in both the unification of cropping, animal raising and processing and the integrated utilization of wastes. Based on the combination of cropping, animal rising, they will focus on the unification of cropping, animal raising and processing. Taking waste utilization as a link, Jiangsu will try to achieve the goal of recycling used materials, preventing and controlling pollution in the entire process, and getting sound benefits.

2.6.2.4 Jiangxi Province

Jiangxi Agricultural and Rural Economic Development Special Plan in 11th Five-Year states that agriculture investment in Jiangxi will focus on improving the production and living conditions in rural areas. They will strengthen construction of irrigation and water conservation infrastructure, in particular, intensify construction of small infrastructure facilities in rural areas, and accelerate the construction of "6 small projects" such as water-saving irrigation, drinking water, rural marsh gas, rural waterpower and rural roads.

Views about Accelerating Rural Energy and Agro-ecological Environment Construction, a notice from Jiangxi Provincial Government, states that Jiangxi will look for more channels to

raise funds to increase the inputs for renewable energy. The Finance Departments at all levels should gradually increase the inputs for rural energy and the construction of agricultural ecological environment. Agriculture-related projects in the various funds should be appropriately used for rural energy and agro-ecological environment construction. Departments in charge of rural energy and agriculture ecological environment should make preparatory work for the projects; do a good job in project reservation and getting more support from the state. At the same time, Jiangxi encourages, including foreign investment, various social forces to participate in construction of rural energy and agro-ecological environment.

Jiangxi National Economic and Social Development Outline of the 11th Five-Year Plan indicated that Jiangxi will actively develop clean energy in rural areas, popularize the rural biogas, and construct 450 large and medium-sized biogas projects.

Jiangxi Biogas Development Plan (2006-2010) pointed out that Jiangxi will construct four types of projects, i.e. rural household digesters, large and medium-sized biogas projects, sewage biogas purification projects and capacity building. In the construction of large- and medium-sized biogas projects in large-scale intensive livestock and poultry farms, they will, according to the basic principle of ecology and ecological economics, do the unified planning and construction by combination of the animal husbandry industry, biogas works and the surrounding farmlands and fishponds. Biogas produced will be either used as fuel by residents around the livestock and poultry farms, or used for power generation in suitable regions. The biogas slurry, biogas residue will be used as fertilizer for planting and breeding industry, feed or in pollution-free agricultural production.

2.6.2.5 Shandong Province

Shandong Provincial Environmental Protection 11th Five-Year Plan states that Shandong will pay attention to development and utilization of renewable energy, such as wind, solar, biomass, geothermal and other renewable energy, and constantly improve the quality of clean energy in the proportion of the energy structure. They will, focusing on the development of biogas and actively develop clean energy in rural areas. By 2010, 1.8 million new rural households will use biogas, large and medium-sized biogas projects will be increased to 3,300 and 20% of farmers in the province will use clean energy.

Shandong Rural Renewable Energy Ordinance (Article 17) states that large and medium-sized animal raising enterprises and standardized livestock and poultry breeding areas should adopt environmentally friendly energy technologies to produce biogas by using animal wastes; Encouraging the rural collective economic organizations, enterprises and individuals to produce biogas by using anaerobic fermentation technology treatment of organic waste and sewage, and use the produced gas to supply to the local residents or to generate electricity.

On further accelerating the development of rural renewable energy such as biogas by Shandong provincial government states that those in animal husbandry areas, the main grain-producing areas, and mountainous areas should make full use of the advantages in resources focusing on the development of rural households biogas and building large and medium-sized biogas projects. For rural methane, and other renewable energy development, they will establish a multi-channel and diversified investment and financing mechanism. The biogas enterprises, if they concentrate supply of gas to local households, will receive support from the government according to their size. Enterprises using renewable energy for electricity generation will be processed and helped to join to grid in accordance with the relevant national regulations and they can also get subsidies. In accordance with the regulations, the enterprises invested in renewable energy, such as biogas, can be subsidized for administrative fees during construction and operation period. Enterprises

engaged in renewable energy, such as marsh gas projects, will be given the top priority in the approval procedures for land requisition.

2.6.2.6 Shanxi Province

Management Approach of Shanxi Rural Renewable Energy Construction (2006) states that Shanxi will vigorously develop household biogas digesters and biogas purification projects, gradually take them into village construction planning with synchronization design and construction. The administrative departments in charge of biogas above the county level should maintain relatively stable agencies responsible for rural renewable energy management and technology promotion, and township agricultural technology popularization stations should have full-time or part-time staff in charge of rural renewable energy technology promotion.

Views on Promoting Biogas Construction in Rural Areas by Shanxi Provincial Government (2007) pointed out that Shanxi will make great efforts to enforce the demonstration and construction of biogas in rural areas, together with the new rural construction, popularize biogas technology in 2,000 villages each year, and promote the improvement of rural environment. Household biogas will be developed in scattered animal raising villages, and large- and medium-sized or small biogas project will be promoted in large-scale animal raising villages or districts where condition permits.

Shanxi Agricultural Development 11th Five-Year Plan indicated that Shanxi will promote rural biogas project in sustainable way. First, 1,057,700 rural household will use biogas. Second, large and small anaerobic fermentation tower biogas projects will be constructed in large-scale livestock and poultry farms, comprising 489 small biogas projects and 98 large-scale biogas projects. Third, rural renewable energy technology service systems will be established at provincial, city and county level. By the year 2010, new biogas users will reach to 1.15 million in the province.

Shanxi Circular Economy Development Plan (2006-2010) indicated that Shanxi Province's rural economic will take the energy-ecology model to actively develop solar energy, wind energy, bio-energy, biogas, and other power generation projects, and give full play to its advantages in resources for the development of clean and renewable energy. Solar, biomass, wind power, and other renewable energy will be the main technologies to restructure the energy supply in the rural areas of the province. Increasing the Biogas from animal solid waste, refuse, or straw will become the main energy sources in the rural areas.

2.7 Selection of six Project Provinces

The proposed project area comprises six provinces, Heilongjiang, Henan, Jiangsu, Jiangxi Shanxi and Shandong with 32% of the population and 12% of the land area of PR China. The six target project provinces as shown in Figure 1 and Table 18 represent different climatic regions in PRC. Jiangsu and Jiangxi provinces are in the southern subtropical zone; Henan, Shanxi and Shandong are in the northern temperate zone, and Heilongjiang northern cold and temperate zone. The later is seen as a special consideration of the project to demonstrate the applicability of large scale biogas technology under cold climatic conditions in North China.

Table 18: Population, area and average temperatures of the project area provinces

	Population (mn)	Area (,000. km^2)	Average temperatures (^{o}C)	
			January	July
Heilongjiang	83.0	460.0	- 32 to -17	16 to 23
Shanxi	31.4	150.0	-16 to -2,	19 to 28
Shandong	90.8	150.0	-5 to -1	24 to 28
Henan	96.5	160.0	-3 to 3	24 to 29

Jiangsu	74.3	100.0	-2 to 4	26 to 29
Jiangxi	42.8	160.0	3 to 9	27 to 31
TOTAL	418.8	1,180.0		
China	1,300.0	9,600.0		
% of China	**32.0**	**12.0**		

The Project provinces represent further the main agro produce generating areas on PRC. In the average the six provinces hold about 30% of the national livestock and of the national agro-produce. These provinces were facing a significant increase in commercial livestock farms from about 1.0 to 1.4 million between 2002 and 2006. Large scale farms were developing in this period by 68%, whilst in comparison the growth all over China was 53%. The farming and husbandry systems in the six provinces are also different, which might require different considerations for the design, operation and maintenances of the MLBGPs, as well as new CDM methodologies.

2.8 Lessons Learned

The ADB *Hainan Agriculture and Natural Resources Development* Project (Loan-1372 PRC)[86] was one of ADB's earliest projects in the agriculture sector on China. On completion the project was assessed to be overly ambitious, resulting in unrealistic output targets from the outset. The dual purpose of income generation and environmental protection was also ambitious, adding to implementation difficulties of inexperienced companies. The project experience three major implementation delays due to: (i) prolonged debate over Government procedures to meet the conditions for loan effectiveness; (ii) institutional arrangements needed for project implementation; and (iii) switching of responsibility for the project. Implementation of the ADB *Efficient Utilization of Agricultural Wastes Project* (Loan-1924 PRC)[87] started in 2003 and is expected to be completed in 2009. The project focuses predominantly on small-scale biogas plants but one component has supported the pilot development of 16 MLBGPs (type III bio-digesters), 11 of which are being bundled as a CDM project. The experience learned from implementation of the project shows the need for (i) continuous promotion of local and national awareness of the advantages of household biogas system development; (ii) extensive technical support and training to establish adequate technical services to ensure the sustainability of the biogas systems; and (iii) the need for an energy and environment monitoring plan. Recent experience in the promotion of CDM demonstrates the need for careful planning and implementation of this activity in order to avoid large delays.

Lessons learned from the *Promotion of Rural Renewable Energy in Western China* (with the Netherlands Government) have demonstrated (i) the need for meticulous planning and programmatic measures to guarantee smooth project implementation; (ii) the key role of an expert team in ensuring the quality of the project; (iii) the need for high quality supervision and inspection to realize the project objectives; and (iv) the need to focus on sustainable development.

The multinational support for *Capacity Building for Rapid Commercialization of Renewable Energy in China* (UNDP, GEF, Australia, and Netherlands) concluded that (i) industrial-scale investments are feasible by the top 20% of financially sound large-scale livestock and industrial firms; (ii) village-scale power continues to be one of the biggest challenges; and (iii) greater attention is required to capacity building for resource assessment.

The lessons learned, which are described in greater detail in Supplementary Appendix E, have been taken into account in defining the proposed Project.

[86] ADB (PCR: PRC 26453), Project Completion Report on the Hainan Agriculture And Natural Resources Development Project (loan 1372-PRC), September 2004

[87] ADB (RRP:PRC 33443) Report and Recommendation of the President to the Board of Directors on A Proposed Loan to The People's Republic of China for The Efficient Utilization of Agricultural Wastes Project, September 2002

2.9 Problems and Opportunities

2.9.1 Key Problems

Use of the biogas energy. Usually, the medium- and large -scale livestock husbandry farms are far away from the urban area and the local villages are either too far away or insufficient to make full use of the biogas . If there is no suitable way to use the biogas, the biogas plant must flare the surplus methane gas so that it does not discharge to the air, resulting in more greenhouse gas emission. This will decrease the project's revenue.

Electricity feed into the grid. In most cases, biogas produced by the enterprises will be and shall be used for electricity generation by gas engines or other kinds of generators to realize the cogeneration of heat and power (CHP). In addition to electricity generation, use can be made of the thermal energy recovered from the exhaust gas and the engine cooling system to keep the fermentation temperature and elevate the gas yield. The use of the remaining heat for space heating or industrial purposes is essential for the economic performance of the biogas project.

At the same time, problems may be experienced if there is insufficient electricity load in the beneficiary enterprise to make full use of the electricity produced. Since biogas CHP plants typically only have an electric power output capacity of about 100kW, they are too small to connect to the public electric grid according to current practice. At present, usually only decentralized generator sets with a capacity of 500 kW or more are accepted by the grid companies be connected.

Technical Capacity and Services. Biogas plants at large livestock farms are a relatively new undertaking which require a lot of professional experts, technicians and management personnel for proper development. At the present time, the limited capacity of technical service for project operation creates a bottleneck to the rapid development of biogas projects, which may lead to poor maintenance and a shortened project life as demonstrated by the fact that some biogas systems established in recent years have already ceased operating. In addition, there is a shortage of capable design engineers since are experienced in design of industrial wastewater treatment processes and do not have sufficient experience to deal with designing 'biogas-power plants'. Therefore, it is important to focus capacity building of human resources and technical service system development on improved design and operation of biogas plants for livestock farms.

2.9.2 Opportunities

Environmental Protection

The pollution from animal waste is one of the most serious environmental problems in China. According to SEPA[88] China's animal waste and excreta was to about 1.9 billion tons in 2004, 2.1 bn t/yr in 2005 and 2.7 billion tons in 2006 (China's Concentrated Animal Feeding Operations (CAFOs) produce 40 times more nitrogen pollution and amounts to 3.4 times the solid waste of industrial factories)[89], as the country became the world's top meat and egg producer and has overcome the countries shortage on milk. China has in 2007 more than 20,000 large and medium-sized livestock farms, but only 3% are equipped with appropriate waste treatment facilities[90],[91].

Renewable Energy Production

[88] Ellis Linden, a China Environmental Health Project Research Brief, Environmental Health and China's Concentrated Animal Feeding Operations (CAFOs), China Environment Forum's, Western Kentucky University on the USAID-supported China Environmental Health Project, February 28, 2007

[89] Wu Weixiang, China Needs a New Type of Livestock Revolution, Zhejiang University China, 12/ 2006

[90] Xinhua News, Beijing, Wu Weixiang,Animal waste a heavy burden for environment, Zheijiang University, 2007

[91] Steinfeld, Henning, Wassenaar, Tom, The Role of Livestock Production in Carbon and Nitrogen Cycles. Annual Review of Environment and Resources, Vol. 32, November 2007. http://ssrn.com/abstract=1077245

In the course of modernization and industrialization of the agriculture and the general urbanization trend, animal husbandries are still growing and the negative environmental impact is evident. On the other hand there is, based on the Renewable Energy Law from 2006, a urgent demand to generate renewable energy, including biogas (in targeted 24 bn nm^3 in 2020) from biomass wastes (and not from energy crops!).

Grid-connection of power from renewable energy
NDRC supports with the Renewable Energy Promotion Law 2006, grid-connected biomass energy. The Project will support the facilitation of biogas electricity connection to the public grid from GHP units producing less than 0.5 MW.

CDM for biogas plants at Large scale animal farms
The reduction of methane emission from uncontrolled (animal) waste disposal (baseline emission) and the displacement of fossil energy by renewable biogas are a contribution to mitigate global green house gas emissions. China has signed the Kyoto Protocol (enforcement 16 February 2005) and is as a Non-Annex 1 country eligible for CDM support.

Ecofarming
Biogas slurry used as eco-fertilizer will support sustainable soil maintenance by reducing the risk of desertification (more than 50% of the soil in China are endangered), will reduce the amount of chemical fertilizer and pesticides and improve the quality of agro produce, which can be marketed as bio- or green- products with added market value. The agricultural sector will benefit from using pretreated manure and the global climate from carbon sequestration...

Demonstration of large scale biogas technology under the cold climatic conditions
To demonstrate that in North China, Heilongjiang province, advanced biogas technology can be successfully operated is another important target of this Project. In China there is still the opinion that Biogas Plants cannot be operated in the northern areas under long cold winter conditions, though in North European countries such as in Finland, Sweden, Denmark, but also in Canada biogas plants are part of the rural and energy infrastructure. By using appropriate technologies and energy saving measures biogas technology will be operational under conditions comparable to the other parts in China. To adopt CDM requires again additional effort as the existing methodologies are not tailored to cold climatic conditions.

Sustainability of large scale animal farms
Appropriate ‘best practice’ technologies to convert animal manure from middle and large scale husbandries into Energy, Eco-fertilizer and/or wastewater, which can be discharged to the environment will not only contribute to the enforcement of the Circular Economy Law (2008) and support various other Governmental Policies, but also make the animal husbandry sector compliant with environmental performance regulations, better acceptable by the neighborhood, etc., and therefore the animal husbandry sector will get more sustainable

Improvement of rural livelihood
The local farmer’s rural households in the surroundings will benefit as indirect beneficiaries from improved environmental conditions (life quality), local energy supply via electricity or direct gas supply, eco-fertilizer application, finding employment at the biogas plants and during construction.

Capacity building in state of the art project design and operation
Chinas capacities to implement and operate large scale biogas plants which shall function as biomass power plants and reduce significant GHG emissions, if possible certified as CERs under CDM are insufficient. The Project, with its components, will support the facilitation and implementation of advanced state of the art biogas-technology, based on the new conceptual approach. Large scale biogas technology was so far applied under the aspect of pollution control and usually not in the context of ‘Biomass – to Methane power plants’, with high performance. Some provinces do still not support the Energy-Ecology model. The

application of the new technological approach will be supported by the Project components aiming to create demonstration projects, which be replicable good showcases for a wide spread application in China.

Support of Government sector policies and strategies and to overcome barriers
Since 2003 a high number of governmental policies and legislation have been drawn up to support the rural energy development including middle and large scale biogas plants (see chapter 2.4.). The ADB loan jointly with the financial resources of the Chinese Government and the enterprises will implement an infrastructure of biogas plants in line with all the relevant governmental strategies. Biogas large scale technology applies the cooperation from various stakeholders in both, vertical and horizontal directions (see Figure 2) which must be seen as a barrier. To overcome those barriers ADB is providing the required financial and TA support for a successful implementation of those innovative demonstration projects.

2.9.3 ADB's Role

ADB's role in the proposed Project is consistent with the Government's overall plan with respect to external assistance, which recommends borrowing for projects that have high economic and social returns and that introduce advanced technology, new knowledge, international management experience, and other innovations. The goal of ADB's Country Partnership Strategy [92] is to help the Government by supporting measures aimed at promoting environmentally sustainable and inclusive growth. To achieve its goal the strategy identifies four strategic pillars that will orient ADB's operations. The proposed Project addresses the pillar of resource efficiency and environmental sustainability. Due to the need to refocus AD technology on renewable energy and organic fertilizer production and use compared to the current environmental approach, which can be achieved with less-sophisticated technologies, the proposed Project will strengthen ADB's role in supporting projects using advanced technology. However, to full realize this role there is a need to provide sufficient and timely consulting services with the required expertise.

[92] ADB, 2008, *Country Partnership Strategy, People's Republic of China*, 2008-2010, Manila.

3. The Proposed Project

3.1 Justification of the Sector Investment Approach

The proposed Project will support the National and Provincial Governments policies on the treatment of livestock and agro-industry wastes, biomass energy generation and rural biomass utilization. Key national laws - including the Agriculture Law (2002), Energy Conservation law (2007), the Renewable Energy Promotion Law (2006) and the Circular Economy Law (2007). All these laws include renewable energy development as a priority area and emphasize renewable energy as an important strategy to contribute to environmental protection. The Number 1 Document of the Central Committee of the Chinese Communist Party (CCP) and the State Council of China for 2007 stressed the need to "accelerate the development of clean energy in rural areas, continue to increase investment in rural biogas, and support the building of large and medium-sized biogas plants at qualified livestock farms."

The joint MOA and NDRC document of 30 September 2007 titled "On further strengthening the construction and management of the rural biogas project", urged all local governments to pay more attention to, and strengthen leadership on rural biogas projects for building a new socialist countryside. Local authorities were further encouraged to increase their efforts on the comprehensive utilization of organic wastes such as livestock manure so as to control pollution from livestock farms. The MOA's *Development Plan of Agricultural Biomass Industry in China (2007 to 2015)* further reinforces the need to promote biogas plants while the NDRC's *Medium- and Long-Term Renewable Energy Development Planning in China*, 2007, indicates that by 2020 there will be a total of 10,000 MLBGP set up at middle and large-scale livestock farms in the country.

The voluntary commitment of the Chinese government to reduce GHG emissions after 2012 is also beneficial to MLBGP development. To further promote biogas projects the Government has introduced income tax privileges, price subsidies and a large-scale biogas plant project fund. Provincial governments have developed provincial policies, strategies and plans on renewable energy development according to the local situation (see chapter 2.6 and Appendix 2E).

An analysis of the Foreign Economic Cooperation Center of MOA (FECC) of MOA was conducted to assess its willingness and capacity to take the lead in implementing the project along with its capacities for project management, financial management, procurement, and safeguard issues. In addition an assessment was made of the six provincial Departments of Agriculture to assess their willingness and capacity to implement the project within their provinces (see Appendix 7 and Supplementary Appendix C). The overall assessment was positive although there is a substantial need for capacity building at both at the central and provincial level. The capacity building will need to place particular emphasis on the two provinces – Heilongjiang and Jiangsu – that have not previously participated in ADB projects. There will be a particular need at both levels to enhance the capacity to critically appraise the subproject feasibility study reports. A substantial consulting package for project implementation support is therefore proposed to be based in the Project Implementation Office (PMO) but to provide regular capacity building to the PIOs.

3.2 Selection of Sector Loan Modality

The sector loan project covers six provinces that include Heilongjiang, Henan, Jiangsu, Jiangxi, Shandong and Shanxi. It includes a total of 154 subprojects with a total of 1,358,844 pigs, 78,180 dairy cows, 40,100 beef cattle, 2,666,600 chickens, 4,760,000 ducks, and 1,927,015 tons of agro-processing wastes.

A review of possible loan modalities considered the options of a standard investment loan, a sector loan, and the new Multitranche Finance Facility (MFF). Based on the proposed size and duration of the proposed loan (US$ 100m) and the likelihood of further investments in the sector, as well as the likely scope of the proposed project – investment of about 154 subprojects together with capacity building of the project agencies, beneficiaries and service providers a sector loan was recommended. This argument is further strengthened by the continuing uncertainty concerning the exact subprojects to be included in the course of project implementation till 2015. During the Inception period the sector loan type was accepted subject to an agreement being reached on the number of subprojects to be selected for further detailed analysis as indicative subprojects or core-subprojects representing the expected sub-projects. The project implementation schedule Figure 6: Project implementation schedule 2009 - 2015 is based on the sector loan modality.

3.3 Impact and Outcome

The impact of the proposed Project is the improvement of environmental sustainability and rural livelihoods in the six project provinces. This will be achieved through the anaerobic digestion of the vast quantities of agricultural wastes that are currently polluting the environment around large-scale livestock farms and agro-processors. The project outcome will see a reduction in pollution from agricultural wastes (8.4 million t/yr), an increase in production of renewable biomass energy (>100 million nm3 biogas) and increase in production of organic fertilizers (>6 million t/yr) in the project area. The environmental improvements will have a direct impact on the communities surrounding the beneficiary enterprises through improving living conditions and promoting new economic opportunities. The global environmental impact will be, regardless of any CMD certification, the ecologically relevant GHG emission reduction of at least 1.2 million t $CO_{2\ equiv}$/yr.

By adopting an integrated approach involving the treatment of agricultural wastes and promotion of CDM at the beneficiary enterprise level in parallel with the production and use of renewable energy as well as the conversion of bio-digester effluent into organic fertilizers, the project will ensure that benefits to both the enterprises and surrounding communities are maximized. The promotion of eco-farming in the surrounding communities will reinforce the Government's policies relating to the promotion of a circular economy (Circular Economy Promotion Law, 2008). The project design and monitoring framework is shown in Appendix 1.

3.4 Outputs

The Project will adopt an integrated approach to reduce the environmental problems caused by pollution from agricultural wastes and efficiently using the outputs from the bio-digesters in order to maximize the environmental and economic benefits from the project. The project outputs will comprise of the development of medium and large-scale bio-gas plants including some centralized systems for treatment of livestock waste from several farms. In addition, improvement of eco-farming and on-farm emission reduction, capacity building and development of technical services will be achieved along with the provision of support for project implementation. The outputs of the components are summarized in the following sections based in the component description elaborated in Supplementary Appendix F and the costs shown in Appendix 3.

3.4.1 Component1: Construction of Medium- and Large-size Biogas plants

China is historically well known for its millions of small-scale biogas units in rural areas, which are still further expanding based on strong governmental and external support. In order to better control the pollution and to use the huge amount of manure derived from a rapidly expanding middle and large scale animal husbandry sector, the application of MLBGPs is required (see chapter 2.1). Under this component, the Project aims to set up financially and economically viable MLBGPs based on appropriate 'state of the art' technologies that have sound environmental and socioeconomic impacts. The Loan will

provide funds agricultural enterprises to build about 154 MLBGPs in 6 provinces. These large and medium-size livestock farms and agro-product processing enterprises to be funded under the Project will treat livestock wastes preferably from their own farms to generate biogas and electricity. The Project will support the enterprises to reach agreements with power-grid companies to enable delivery of surplus energy to the electricity or gas-grid. In addition, once the technology has matured, the Project will aim to benefit from Certified Emission Reduction (CER) under the Clean Development Mechanism (CDM) as part of an integrated project development. A large demonstration effect within and beyond the targeted 6 provinces is expected, and the outputs under the Loan aims to convince the government and agro-enterprises on the efficiency of the MLBGPs.

Project component 1 Development of MLBGPs (US$192.5 million) will support (i) the development of about 154 medium and large-scale bio-digesters as detailed in Supplementary Appendix F1, including the 11 core subprojects assessed during project preparation; and (ii) support the development of up to 24 centralized bio-digesters to be supported by Component 3 of the Project. The bio-digesters developed under the component 1 will have the capacity to treat about 9.5 million tons of agricultural wastes annually comprising 1.9 million tons of agro-industrial waste and 7.5 million tons of livestock waste.[93] The average annual treatment capacity of the bio-digesters is 61,000 tons. Annual outputs from the subprojects are estimated at 131 million kWh of electricity generated from biogas, 17.5 million m^3 of biogas for directly used for heating or local gas grids, and 6 million tons of organic fertilizer - 4.7 million tons of liquid and 0.9 million tons of solid commercial fertilizer are provided for external use. The annual greenhouse gas emission reductions are estimated to be at least 1.2 million tons.

About 84% of the biogas produced by the all subprojects will be used for electric power generation. This power from renewable sources biogas shall will be feed into the local/provincial electricity grid This will substitute for energy currently produced from mainly from coal (acc. to the local mix of energy production) and will be feed into the grid using the preferential grid-feed-in tariffs provided through the Renewable Energy Law 2006[94] (this follows also the German model acc. to the EEG law, 2004 and 2009 [95]).

In projects where the electricity is not accepted by the grid operator (which should not be the case, and to overcome these barriers to supply electric power below 0.5 MW to the grid will be the target of one project activity), or biogas plant operator does not like to feed the electricity produced to the grid, the subprojects might use the biogas for their own livestock breeding and agro-industrial facilities and about 14% of the total biogas produced, or 14.9 million nm^3/yr is supplied to local communities.

Of the total annual production of organic fertilizers (6 mn t/yr), the enterprises will use about 15% or 950,000 t/yr on their own land, and (5 mn t/yr) will be supplied to the surrounding farmers at the local communities. The number of projects where solid organic fertilizer is processed through blending and mixing with additives to a high quality end-product is at present limited to one core-subproject, Huimin in Henan province.

3.4.2 Component 2: Eco-farming and improvement of rural livelihood

Under Component 2 (US$6.5 million) the use of eco-fertilizer in the project area and the on-farm management in terms of emission reduction should be supported.

[93] These estimates exclude the centralized bio-digesters, which will be identified with GEF support during project implementation.
[94] NDRC, Renewable Energy Promotion Law, 2006
[95] Federal Ministry for Environment and Nuclear Safety, Germany, EEG－The Renewable energy sources act, 2000, amended 2004 and 2007

The slurry generated from the biogas plants contains nitrogen, phosphorus, potassium and humus, which has been proven to be a valuable replacement of chemical fertilizers to provide nutrients to crops and improve soil fertility and contributes by carbon sequestration to GHG emission mitigation (CH_4 and N_2O emission reduced and carbon stored in the soil)[96]. On-farm management includes further the reduction of emissions, in particular GHG from manure and fertilizer handling.

The revenues from Eco-farming are essential for the financial viability of the biogas plants. MLBGPs producing a big amount of biogas slurry at one location (depending on the dm contend and its biodegradation in the average 95% of the input will remain as fermenter output) the sustainable use in the project surrounding in combination of the expected market prices is essential for the successful long-term operation of these projects. In the case eco-farming cannot be applied for all the AD output materials during the year the surplus effluent has to be treated This results in additional costs and does not meet the expected targets of agricultural waste recycling within the policy of circular economy. Nor does this address the need for sustainable soil maintenance/protection to prevent soil erosion and desertification. Strong efforts shall be made to achieve a good cooperation between the animal farmers (husbandries) and the crop farmers. The later have cost savings by using less mineral fertilizer and less pesticide, to the benefit of the environment and the quality of the 'green' agro-produce.

This component will support improvements in the efficiency of use of the organic fertilizers produced by the subproject enterprises. This component will also reduce the need to use of mineral fertilizers and pesticides, through supporting enterprises, particularly in Jiangxi Province, that wish to make specific investments in improvement of eco-farming activities by their enterprises. For Lulin core subproject this includes investment in improved eco-farming of orchards and fishponds. While for Jinmu core subproject the proposed investments include a greenhouse, improved distribution and storage of bio-digester effluent, forestation and improvements to soil condition. Jiangxi indicated that its subprojects would invest around $6.5 million in total on ecofarming for slurry storage, land preparation, purchase of seedlings and farm road rehabilitation.

3.4.3 Component 3: Capacity Building and Development of Technical Services

Project component 3 (US$3.9 million) will complement the construction of the expected 154 MLBGP with a range of capacity building activities and through the support for development of technical services. The outputs to be supported under the component include development of technical services and provincial training centers (one in each province), strengthening policy evaluation, and technical & business designs, alleviation of barriers to on-grid electricity connections, alleviation of barriers to establishment of decentralized MLBPGs, establishment of new/adapted CDM methodologies and to support the operational skills of the project owners. The scope of the component is outlined below, the objective, input and expected output of this component is elaborated on in Supplementary Appendix F3.

(i) Development of Technical Services and Training Centers. The main objective of this subcomponent is to enable the technical staff of MLBGPs to operate and to steer the process based on a theoretical and practical understanding of electro-mechanical and bio-technology, based on process monitoring and actual plant performance. A Biogas Laboratory, office equipment and training will be provided to an operational unit for technical guidance to be established within the Provincial Department of Agriculture of each of the project provinces. The operational unit will be closely linked to the PIUs to ensure the maximization of benefits for the project. Regular training support will be provided through project

[96] John M. Kimble, Rattan Lal, Ronald F. Follett, Agricultural Practices and Policies for Carbon Sequestration in Soil, ISBN: 1566705819, 2002, 536ff

consultants. In addition one subproject will be selected in each province to be the location of a Provincial Biogas Training Center. Following agreement with the subproject owner on the long-term objectives of the training center, additional facilities and equipment will be provided and the project will also support the training of trainers. The training centers will be financed through providing training to other beneficiary enterprises on a cost recovery basis.

(ii) Strengthening Policy Evaluation, Technical skills and Business Designs. The capacity of central and provincial agencies as well as of the beneficiary enterprises will be developed through programs of training, demonstrations, workshops and study tours, as well as production of best-practice MLBGP operation handbooks and videos by a team of international and national consultants.

A nation-wide stakeholder communication and networking **MLBGP technical committee** is to be established under the direct guidance (at least under the support and mandate) of NDRC. NDRC may entrust another organization, such as the China Standard Certification Center (CSC), the China Center for Energy and Environmental Protection under the Chinese Academy of Agricultural engineering, or the China Biogas Association, to carry out this activity. However it would be the most effective solution if this committee were established under the NDRC Energy Bureau.

The basic network structure and information flow and the link to the project activities can be seen in Figure 2. After the project the committee should sustain and further support the MLBGP sector according to actual priorities. In Europe such technical working groups may work over decades to provide coordination to the benefit of all stakeholders involved.

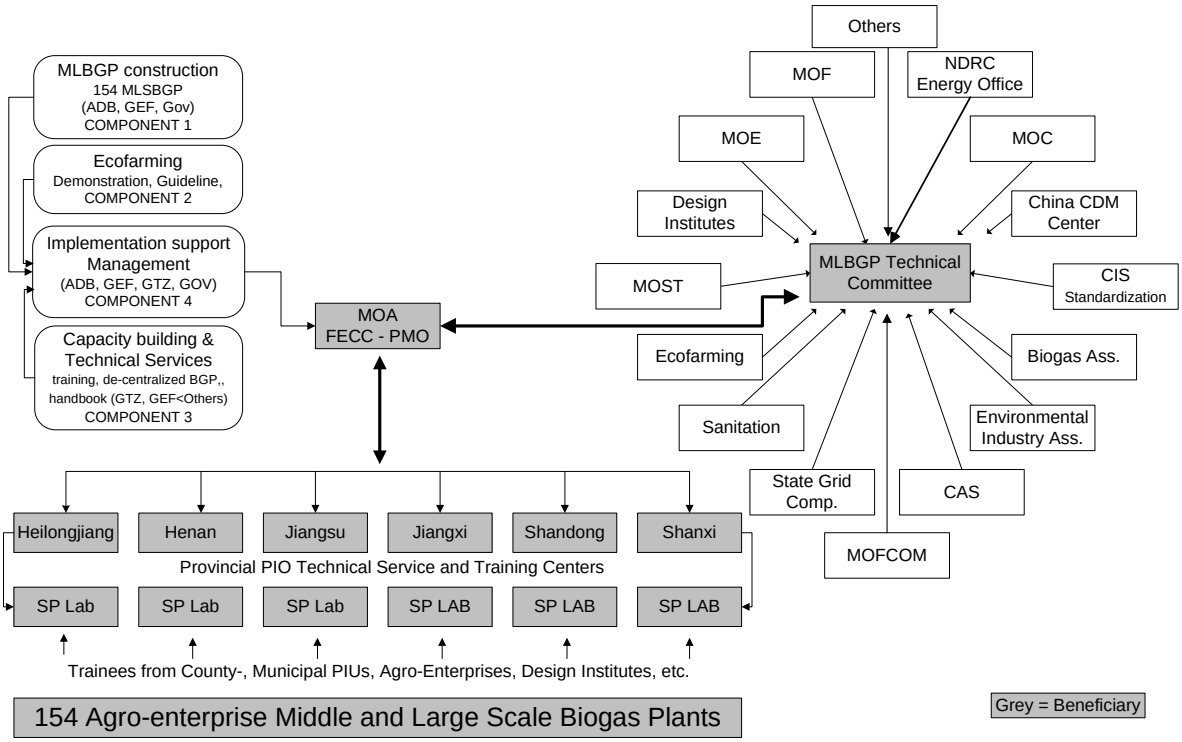

Figure 2: Information flow between Component 3 (MLBGP's technical service systems), the other project components, PMO, PIOs and sector stakeholders.

The communication between relevant main stakeholders is important and will underpin the success of the project Key stakeholders in this communication include the NDRC, MOA, MEP, MOF, Ministry of Foreign Cooperation and Commerce - MOFCOM, Ministry of Science

and Technology - MOST, and others, CDM bureau, the industry- and environmental associations, plant operators, equipment suppliers, designers, researchers, biogas and fertilizer users. These parties will come together from all over China to support the sustainable long-term development of MLBGP's in the project provinces and all over China. This will be achieved by providing guidance on policies, administrative and technical aspects through to standards, benchmarks and business concepts. Performance parameters will also be provided. Techniques and strategies to be used will include conducting public relations via outreach programs, websites, national and international conferences and workshops. This will be required to extend the MLBGP's infrastructure in China.

Representatives of the participating institutions will be invited to voluntarily participate to link the various stakeholders and to develop jointly incentives to achieve the required sector support and policy development. The work of the technical working groups under the Committee will be to set up operational, technical and monitoring guidelines, quality standards (covering feedstock, effluent, safety, business models for grid connection, biogas plant operators as service providers, centralized biogas plant model, co feed-stock processing, laboratory analysis, emission regulations, etc.). The technical committee shall be facilitated under the support of the international and national key experts (the team leaders) of the TA components under the ADB project. During the project duration various project outputs, developed based on the experience from the enterprises and input from the Provinces and international development in this sector, will be monitored and evaluated by the committee. This applies to the MLBGP manual, the eco-fertilizer handbook, etc. The outputs elaborated under the project but coordinated and confirmed by the technical committee to be applicable nationally with a wide dissemination of the results. The Project will provide some support to the committee - meeting two to three times a year. The information and working documents will be made available via a web page with password access of the working group and committee members.

(iii) Alleviation of Barriers to On-grid Electricity Connections.
A goal is to establish grid connection through the provision of technical assistance and development of the required business models to establish a long term relationship between grid companies and biogas plant operators. The responsibilities to realize electricity grid feed-in, regardless the amount of electricity produced, rests with, the producer (transformer, measurement equipment,) and the grid company (grid access,). The investment at the biogas plant side will be included in the ADB loan, whilst the grid companies have based their obligations on the PRC Renewable Energy Promotion Law to facilitate the connection. The grid-feed-in demonstration projects in each province will receive additional support to monitor the performance.

A study will be undertaken to identify the current actual or perceived barriers restricting the on-grid electricity connection of small-scale producers of power derived from renewable energy, including national and international study tours for concerned officials to be informed on the situation elsewhere. Pilot activities will be developed based on the findings of the study in each province and the recommendations to the government will be compiled in the MLBGP handbook.

(iv) Alleviation of Barriers to Establishment of Decentralized MLBPGs and apply co-feedstock processing.
In areas where smaller and middle-size livestock farms do not possess appropriate waste treatment facilities, it will be useful to develop a centralized waste management system as a business model. Under this model an enterprise or larger farm can collect and treat biomass wastes from third parties located in a distance which allows for the economic transportation of the waste. This model has particular application in areas where smaller farmers are geographically clustered and the manure utilization is not facilitated, establishing. A centralized system will be an important contribution to improving the environmental situation

and more economical than installing various small-scale biogas digesters in individual farms. In general small scale farms often have maintenance problems and do not generate sufficient energy to be economic. Moreover, investment and operation costs would be lower as the small scale farms under a centralized model can take advantage of the economies of scale.

These centralized systems would be able to generate enough electricity to be connected to the grid. GEF funds would therefore be used to first assess the efficiency of such a centralized system and to indentify further more co-fermentation possibilities. Under such a model the geographical proximity of farms and the collection site is crucial. Should the cost-benefit analysis prove favorably, the centralized waste management system will be piloted in 18 sites (if feasible 3 in each province) among the 154 Project target subprojects. Bio-energy generated from these plants will either be sold to the grid or to the local neighborhoods.

A team of international and national consultants will conduct a study of the issues and constraints for constructing centralized bio-digesters. Recommendations for improvements will be made on the institutional and management arrangements. In addition a review and recommendations will be made on the hygiene and quarantine requirements, operating procedures, ownership, financing, etc. that will result from the construction of up to 6 demonstration projects (one in each participating province) under Component 1. Experience from these pilots will be consolidated into a set of policy recommendations for government consideration.

3.4.4 Component 4: Project Implementation Support

To ensure the success of and timely implementation of the Project, the PMO and PIOs will need consultants' support. This support will be needed during the first two years of project implementation. Such support will assist in the bidding and procurements of core-subprojects and evaluation and acceptance of non-core subprojects. The support will also assist in the construction and operation of the centralized biogas plants. This component will provide for the strengthening the project (Section 3.8.6) Training and workshops will be provided at the central level with the provision of equipment, training and workshops provided at the provincial level (see Supplementary Appendix F4).

3.5 Special Features

Medium to Large-Scale Bio-digester Technology. While about 4,000 medium to large-scale biogas plants have been established in China in recent years the purpose of these has been predominantly the reduction of environmental pollution and the technology level has been adequate for this purpose. The proposed Project will also focus on producing renewable energy and organic residues as well as CERs. To maximize output, the bio-digesters will need to use higher levels of technology and improve the current levels of management. The reliability of the systems will also need to be improved. Appropriate technology will need to be sourced locally or imported if it is not available.

Decentralized Bio-digesters. MLBGPs have traditionally been operated for single large-scale farms due to the management and quarantine problems of transporting livestock waste between farms. Even with the rapid development of large-scale livestock farming the scope for additional plants is limited.[97] This situation is very different to Europe where centralized plants are common. The development and piloting of an approach to centralized treatment of livestock waste that is suited to the Chinese situation will offer the opportunity for a greatly expanded market from smaller farms, which will greatly increase the quantity of livestock waste that can be treated and hence the positive impacts on the environment and opportunity for producing renewable energy.

[97] Also many of the smaller large-scale livestock farms are marginal with respect to the requirements of MLBPGs.

Private Sector Participation. Private sector participation is a key feature of the Project. All of the proposed MLBGPs will be owned and operated by private sector enterprises that obtain financing at commercial rates of interest and seek a financial return from their investment. These enterprises are expected to be proactive in maximizing revenue, including the sale of CERs, and achieving efficient operation.

Clean Development Mechanism. The Project represents the first attempt by ADB in China to promote CDM on a wide scale. This is a major challenge given the number of PDDs that will need to be developed during project implementation even if the bundling procedures can be successfully adopted. While individual subprojects may not generate a large number of CERs, the aggregate impact all subprojects will be significant.

On-line Electricity Grid Connections. Currently operators of MLBGPs in the project provinces experience problems with supplying any surplus electricity to the grid due to restrictions on connections where the supply is less than 500 kWh. The Project will seek to demonstrate the opportunities for benefiting from these small-scale suppliers through developing and demonstrating appropriate methodologies.

3.6 Project Investment Plan

The total cost of the Project is estimated at $233.3 million equivalent, including taxes and duties ($5.1 million), contingencies ($16.4 million), and financial charges during implementation ($10.4 million). A summary of cost estimates is shown in Table 19 and details are provided in Appendix 3 and Supplementary Appendix B.

Table 19 : Project Investment Plan

($ million)

Item			Amount[a]
A.	**Base Cost**[b]		
	1.	Development of Medium and Large-scale Bio-digesters	192.5
	2.	Eco-farming and On-farm Emission Reduction	6.5
	3.	Capacity Building and Development of Technical Services	3.9
	4.	Project Implementation Support	3.6
		Subtotal (A)	**206.5**
B.	**Contingencies**[c]		**16.4**
C.	**Financing Charges During Implementation**[d]		**10.4**
		Total (A+B+C)[e]	**233.3**

[a] Includes taxes and duties of $5.1 million.
[b] In mid-2008 prices.
[c] Contingencies will be financed by the Beneficiaries for Component 1 & 2 and by the Government for Components 3 & 4. Price contingencies on local currency are 2% for all years. On foreign exchange, 0.7%, 1.4%, 0.4%, 0.5%, and 0.5% for 2009 and onward. Physical contingencies are 5% on all Component 1 expenditures and 0% on Components 2 to 4.
[d] Includes interest, commitment charges and front end fees. Interest during construction has been computed at the five-year forward London interbank offered rate plus a spread of 0.2%. Commitment charges were computed at 0.15% on undisbursed amounts.
[e] Figures may not add up due to rounding.

Source: ADB estimates

3.7 Financing Plan and Sources

The Government has requested a loan of $100 million from ADB's ordinary capital resources to help finance the Project. The loan will have a 25-year term, including a grace period of 6 years, an interest rate determined in accordance with ADB's London interbank offered rate (LIBOR)-based lending facility, a commitment charge and such other terms and conditions set forth in the draft loan agreement. The Government has provided ADB with (i) the reasons for its decision to borrow under ADB's LIBOR-based lending facility on the basis of these terms and conditions, and (ii) an undertaking that these choices were its own independent decision and not made in reliance on any communication or advice from ADB.

The Government has also requested a GEF grant of $9.2 million to finance the demonstration of centralized and co-processing MLBGPs (in the average US% 0.2 mn to 18 projects, or up to 3 projects per province to invest in additional equipment required to upgrade a decentralized plant under Component 1 into a centralized project). In addition these funds will be used cover part of the cost of capacity building related to grid connection of MLBGPs generating power below 0.5 MW to both, biogas plants and local grid companies to materialize the on-grid supply. The anticipated number of sub-projects receiving support for grid connection is 24, or 4 per province (see also TA support in Component 3, Supplementary Appendix F1, and input acc. Appendix 3). Further the GEF grant will be used for the development of technical services, and project implementation support. The availability, and scope, of this financing is still to be confirmed.

GTZ will provide about $4.6 million in grant funds for capacity building and project implementation. Besides of general support to the projects implementation and capacity building activities it is intended to support particular demonstration projects in the provinces. The contribution from the German government will therefore mainly be allocated to provide capacity building and training to design institutes. This will include implementing and executing agencies, plant operators, laboratories etc. Such funds will be utilized to better understand state of the art biogas technology, operation and process monitoring and to support the further development of technical and environmental standards. The funds will also be used to facilitate technology transfer and the development of private public partnerships (PPP) under the aspect of good plant performance, efficient power generation and successful emission reduction (CDM involvement). The precise allocation of these funds will be determined between GTZ and the MOA prior to loan effectiveness.

Under the **financing plan** the ADB loan will finance 42.8% of the total project costs, the GEF grant will finance 3.9%, and GTZ will finance 2.1%. The remaining costs will be financed by the six provincial Governments (0.6%) and the biogas plant beneficiaries through their own investments and grants from the provincial governments (53.0%). The beneficiaries and provincial governments will finance part of the base investment costs and all of the physical and price contingencies. The beneficiary contributions are expected to be financed from the pre-tax earnings of the livestock farms and agro-processing enterprises. The provincial Financial Departments have provided repayment guarantees for the nominated subprojects, but government assurances confirming the availability of counterpart funds do not exist. The financing plan is in Table 20 and a simplified presentation on how the proposed main activities will be financed is seen in Figure 3.

Table 20: Financing Plan

Source	**Amount** ($ million)	**Share of Total** (%)
Asian Development Bank	100.0	42.8
Global Environment Facility	9.2	3.9
GTZ	4.6	2.1

Beneficiaries & Provincial Grants	118.2	53.0
Government	1.4	0.6
Total[a]	**233.3**	**100.0**

[a] Figures may not add up due to rounding.
Source: ADB Estimates

The Borrower of the ADB loan will be the PRC, which will relend the proceeds of the ADB loan to the six participating provinces Heilongjiang, Henan, Jiangsu, Jiangxi, Shandong, and Shanxi on the same terms and conditions as those of the ADB loan. The provinces will establish imprest accounts in the finance departments of each provincial government. The provincial governments will on lend the loans to enterprise beneficiaries in local currency with a repayment period of 15 years, including a grace period of 5 years, and at the prevailing commercial bank rate fixed for similar loans and terms. Interest incurred during the grace period will be capitalized into the beneficiary loans.

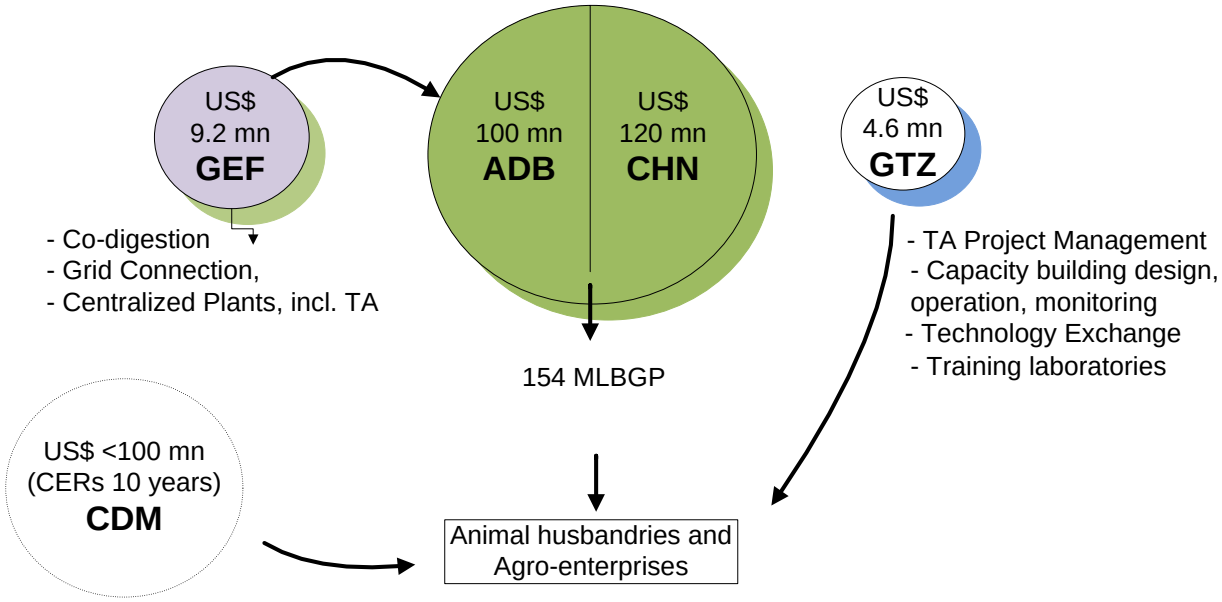

Figure 3: Sources of Finances for Project implementation and main tasks of financiers - simplified overview.

In terms of repayment, the beneficiaries will repay the provincial governments through the provincial finance departments in accordance with the agreed repayment schedules, and will assume the foreign exchange risk. The provincial governments will repay the Central Government in accordance with their repayment schedules. The proposed flow of funds and on lending arrangements are shown in
Figure 4.

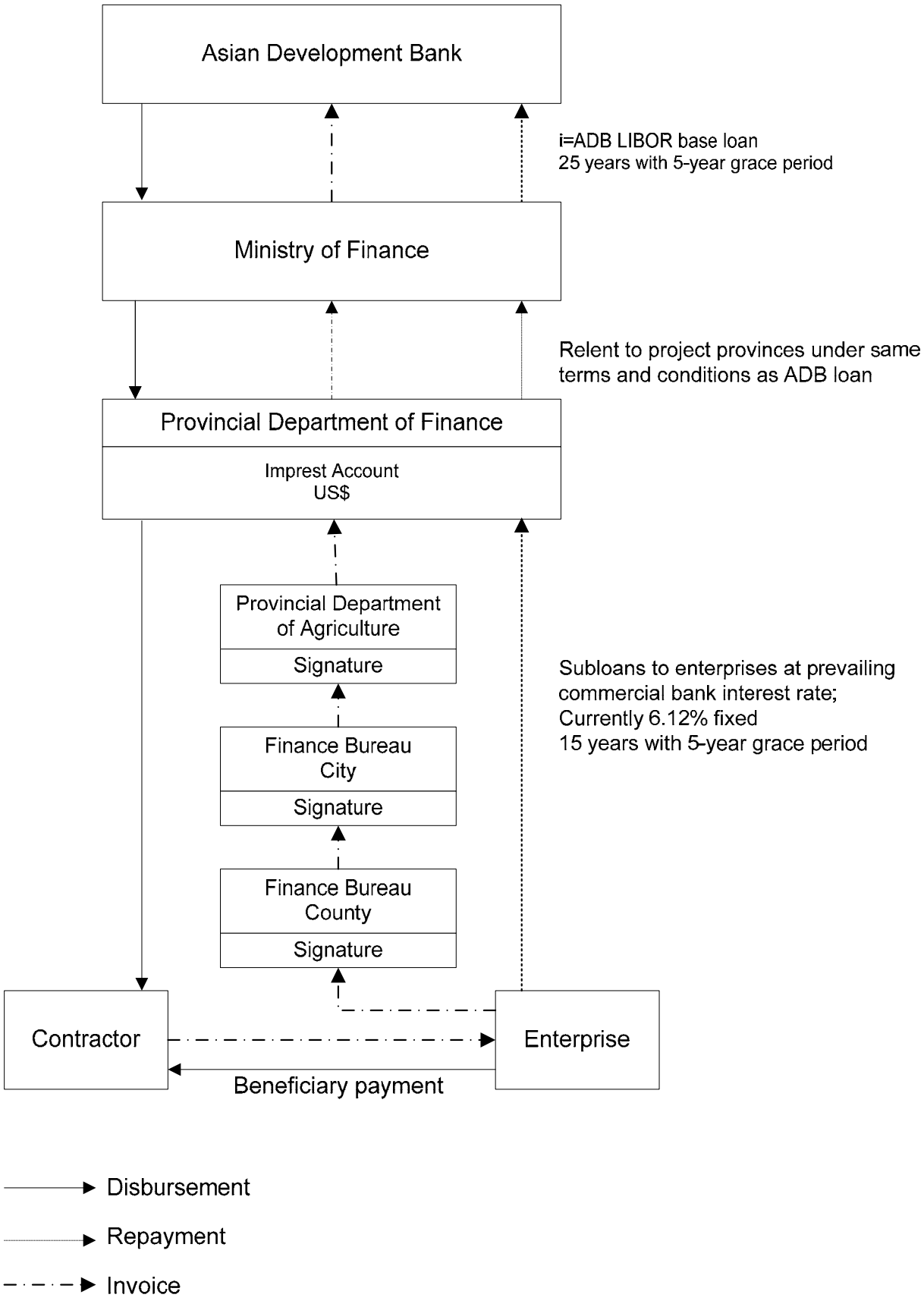

Figure 4: Flow of funds

3.8 Implementation Arrangements

3.8.1 Project Management

The Ministry of Agriculture (MOA) is the Executing Agency (EA) for the Project and the Departments of Agriculture of the 6 participating provinces Implementing Agencies (IAs). Project implementation arrangements are set out in Appendix 14. While details may vary between provinces, the management structure will be consistent.

National Project Management. A National Project Coordination Committee (NPCC), which will serve as the policy-making body of the Project, will be established at the MOA in Beijing to provide guidance on all aspects of policy, implementation, coordination, and issues beyond the control of the provincial governments. Under the leadership of a vice minister of MOA, the NPCC will comprise senior directors from concerned departments such as the National Development and Reform Commission (NDRC); Ministry of Finance (MOF); Ministry of Environmental Protection (MEP); and representatives of MOA from the Department of International Cooperation, Department of Science and Education and Rural Environment, and Foreign Economic Cooperation Center (FECC) as members.

The Project Management Office (PMO) will be established in FECC based on the existing TA Implementation Office. The PMO will be responsible for overall project management, coordination, training, recruitment of consultants, and other implementation and monitoring activities. The PMO will be the secretariat of NPCC, and the PMO director will be appointed from the directors of the Department of Science and Education and Rural Environment of MOA. Two vice-directors will be appointed from FECC and will be responsible for technical affairs and project management issues, respectively. They will be supported by four professional staff, which will be selected from existing FECC staff. The 4 professional staff of PMO will all be full-time and have significant implementation experience.

During project implementation, the functions of the PMO will include (i) review and appraisal of non-core subproject feasibility studies, preparation of summary subproject documents and submission of approved documents to ADB in accordance with the agreements under the loan; (ii) preparation and review of overall project annual work plans and budgets; (iii) supervision of procurement activities; (iv) coordination and compilation of provincial progress reports into the required project reports; (v) establishing and implementing the Project Performance Monitoring System (PPMS); (vi) recruitment and supervision of project consultants; and (vii) organization of national training, workshops, and study tours, including training of provincial officials on use of the PPMS.

The PMO's financial, technical, and institutional capacity was assessed (Supplementary Appendix C). Based on the assessment, the PMO will need training in relevant ADB procedures.

Provincial Project Management. A Provincial Leading Group (PLG) will be established in each province to oversee project implementation, review and approve project plans, source counterpart funding, effect cross-sector coordination, and provide guidance and advice to resolve field-level implementation issues. Each PLG will have the vice governor as the chairperson, with senior directors from the provincial Departments of Agriculture, Development and Reform Commissions, Departments of Finance, Departments of Environment Protection, and other relevant departments and bureaus as members.

Provincial Project Implementation Offices (PIO) will be established in the Department of Agriculture of each of the project provinces to manage and oversee project implementation activities. The PIOs will also serve as the secretariats for the PLGs. Each PIO will be staffed with trained and qualified technical, financial, and management personnel having extensive

project implementation experience. Each Project Implementation Office (PIO) will be headed by a deputy director-general of the provincial Department of Agriculture supported by two deputy directors. To strengthen financial management, each PIO will appoint a senior official from the provincial Department of Finance as deputy director in charge of financial matters. The second deputy director, responsible for technical matters, will generally be appointed from within the Department of Agriculture. 7-10 trained and qualified technical, financial, and project management PIO personnel will be appointed on a full-time basis.

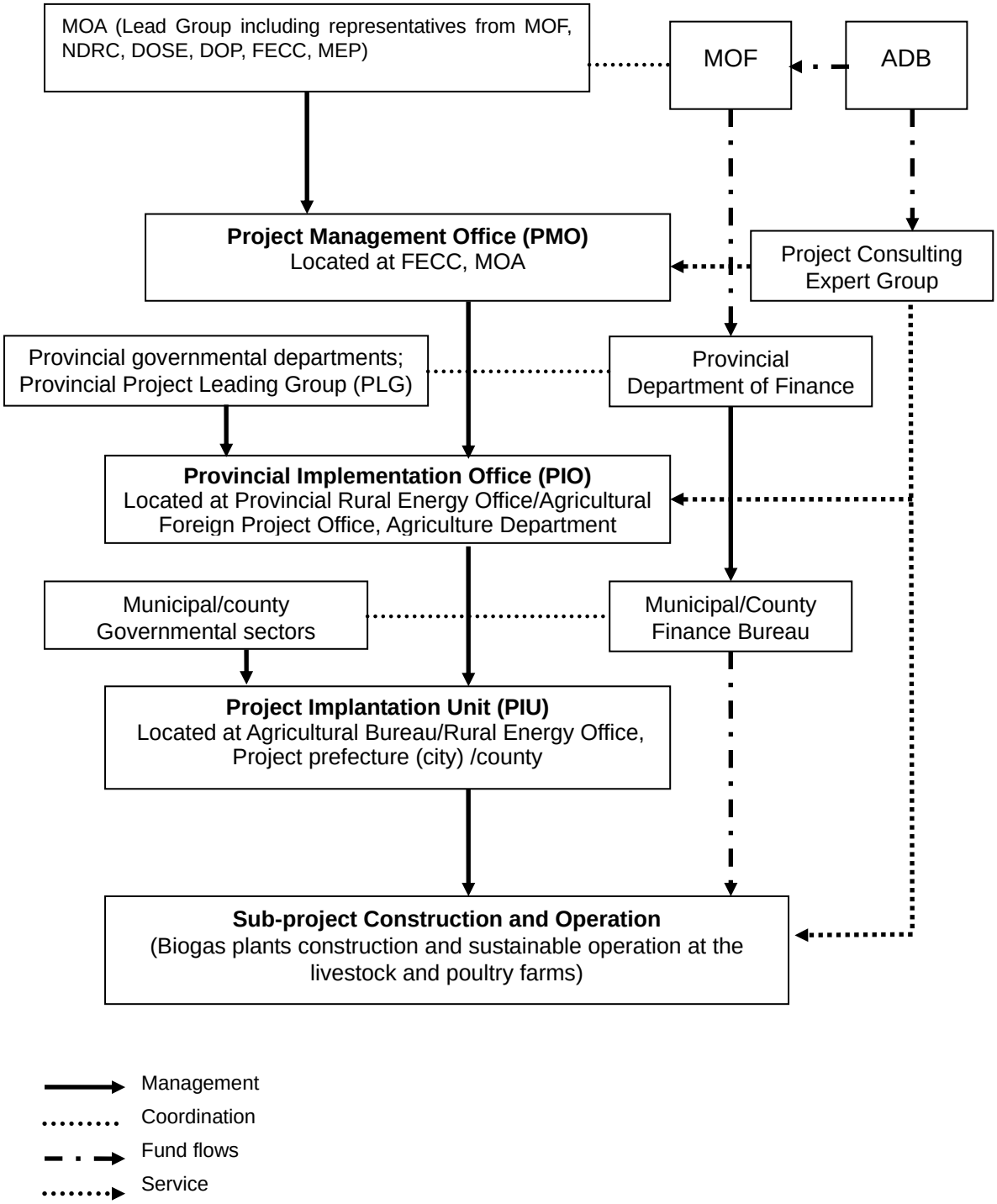

Figure 5 : Organizational Chart and Project Management Arrangements

During project implementation, the duties of the PIO will include (i) organization and supervision of preparation of non-core subproject feasibility studies and investment plans; (ii) review and submission of subproject documentation to PMO; (iii) drawing up provincial annual project work plan and budgets; (iv) reviewing and approving work plans, and verifying the technical details and costs of subprojects submitted by the Project Implantation Units (PIUs) at county and prefecture levels; (v) managing and supervising project procurement activities; (vi) supervision of construction, inspection, and acceptance of subprojects; (vii) setting up the PPMS at provincial level, monitoring physical and financial progress, and monitoring and evaluating project outputs; (viii) compiling provincial project progress reports; (ix) preparing and submitting withdrawal applications; (x) preparing and conducting provincial technical and project management training, workshops and local study tours, (xi) identification and supervision of provincial technical service and training centers; and (xii) provision of logistical support to project consultants.

The PIO will be based in either Provincial Rural Energy Office or Agricultural Foreign Capital Project Office within each provincial Department of Agriculture. Four of them, Jiangxi, Shanxi, Henan, and Shandong PIOs, are experienced with ADB project implementation since they either are implementing ADB Loan 1924 or have implemented other ADB and World Bank projects. As the PIOs in Heilongjiang and Jiangsu provinces are less experienced with international development finance institutions, especially with ADB, substantial training or technical support might be necessary to improve their project management capacity. It is suggested that the EA provide sufficient opportunities for the six PIOs to share their knowledge and experience with each other.

Prefecture and County Project Management. A Project Implementation Unit (PIU) will established in the agriculture bureaus at prefecture and county level for field-level project management activities relating to the enterprises. The PIU will be supported by local financial, technical, and extension agencies, including finance, livestock, rural energy, forestry, etc. The PIUs will work closely with the subproject enterprises and surrounding village committees.

A leading group and a working group for project implementation management will be set up at each enterprise for application and execution of the subprojects.

3.8.2 Subproject Selection, Appraisal, and Approval

Subproject Longlist. Out of an initial proposal for 355 MLBPG subprojects in December 2007, a revised longlist was drawn up in February 2008. The proposed subprojects were further reviewed by the Consultant and recommendations made for further adjustment. As a result of this review, and withdrawals for a variety of reasons, a final longlist of 154 candidate MLBPG subprojects has been identified by the project provinces for inclusion in the Project (see Supplementary Appendix K).

The characteristics of these subprojects are analyzed in Appendix 6. Of the 154 farms, 106 are pig farms, 16 dairy farms, 8 beef cattle farms, 8 chicken farms, 9 duck farms and 13 are agro-waste enterprises.[98] The total livestock and agro-waste to be treated is about 9.5 million tons/year, of which 6.0 million tons is livestock waste and the remainder is agro-industrial waste. The types of technology used by the subprojects include 67 Continuous Stirred Tank Reactors (CSTR), 37 Up-flow Sludge Reactor (USR), 30 High Concentration Flow Reactor (HCF), 15 Up-flow Anaerobic Sludge Blanket Reactor (UASB), 2 Internal Circulation Reactor (IC) and 6 RFR (Taiwan technology). Total fermenter volume is estimated at 298,290m^3. The overall average hydraulic retention time (HRT) is 12.9 days while excluding the UASB anaerobic waste water treatment fermenters the HRT increases to

[98] The total is greater than 154 because some subprojects are included in two categories.

about 18 days. No technology processing solid feedstock with on DM content of >25% DM has been proposed in this project.[99]

Core Subprojects. Candidate core subprojects (CSPs), representing all subprojects under the sector loan were nominated by the project provinces in accordance with the following criteria:

(i) be selected by each province from the 'long list' of proposed subprojects (Supplementary Appendix K) of the loan project and the loan beneficiary enterprises must therefore meet the enterprise selection criteria (Appendix 4A);
(ii) must from its project characteristics reflect the common local conditions (type and quantity of livestock, type and size of biogas technology appropriate to the feedstock, logistical approach centralized or decentralized);
(iii) must demonstrate the scope of energy from biogas and in regard to fertilizer utilization for eco-farming, respectively effluent treatment;
(iv) have demonstration character and shall be replicable or can be considered if highly innovative;
(v) be a potential CDM project;
(vi) provide documentation of sufficient quality to be suitable for preparation of ADB Feasibility Study Report (FSR) and the loan project FSR;[100]
(vii) provide good management practice and sufficient capacity to ensure a smooth project implementation;
(viii) provide a financing plan; and
(ix) subprojects located in national poverty counties areas have preference.

Of the originally 14 nominated candidate CSPs, 11 remained from which FSRs (better project proposals according to NDRC, which do not contain detail design) were received in Chinese and the translated FSRs submitted by the TIOs are presented in Supplementary Appendix A1-11. In terms of technical and financial aspects the FSRs have been reviewed in detail and they provide the basis for the technical evaluation (Supplementary Appendix H), and the financial and economic analysis (Appendix 8 and Supplementary Appendix I), social analysis (Appendix 10) and environmental assessment of 6 core subprojects (Supplementary Appendix J1-6) and to develop the environmental safeguard reports. The Chinese Environmental Impact Assessment (EIA) was provided by all core-subprojects.

The core-projects will proceed with implementation as the first batch of the sector project through the preparation of bidding documents. For the remaining subprojects, preliminary feasibility studies and national IEEs have been prepared to establish the initial portfolio of subprojects for the Loan Project.

Non-Core Subprojects. Non-core subprojects will be implemented in up to 4 batches during the 6 years project implementation period with first feasibility study and EIA preparation, PMO (supported by the external consultants) review and appraisal followed by detailed design starting in the first year and subproject construction starting in the second year.[101] The PIOs, with support from the PMO and in consultation with the PIUs, will be responsible

[99] Weiland P., Stand der Technik bei der Festmistvergärung und der Trockenfermentation, Bundesforschungsanstalt für Landwirtschaft (FAL), KTBL "Biogaserzeugung im ökologischen Landbau", Braunschweig, Germany, 5./6. April 2006
[100] The candidate core-subproject related FSR shall meet the 'Tianren Ltd.' standard and the EIA the provincial requirements and must be on a level to be submitted to the Provincial Government for approval (letter of submission). The Candidate Enterprise assessment form (CEAF) should be completed as applicable.
[101] Two provinces – Heilongjiang and Jiangsu – plan to complete the construction of all of their nominated subprojects in 2 batches.

for the allocation of subprojects in the longlist to each batch.[102] Selection of subprojects to be included in a particular batch will depend on:

(i) The readiness of the beneficiary enterprise to participate in the project in terms of it's willingness to prepare the necessary subproject documentation, including feasibility study report, environmental impact assessment (EIA), project design document (PDD) if relevant, etc.
(ii) Demonstrated financial capacity to provide counterpart funds for construction of the biogas plant.
(iii) Willingness to participate in the necessary capacity building to ensure successful operation of the completed subproject.

Beneficiary enterprises will subcontract preparation of subproject documentation to qualified design institutes and draft copies of all documents will be submitted to the PIO and PMO for review prior to finalization. The structure and contents of the reports will be in a form acceptable to the requirements of both ADB and the Government [103]. Once finalized, they will be submitted through the PIOs for appraisal and recommendations on implementation.
For the purposes of appraisal, the non-core subprojects will be divided into two categories:

1) Subprojects where the base cost of construction (civil works, equipment, and biogas plant vehicles is less than CNY15 million; and

2) Subprojects where the base cost of construction (civil works, equipment, and biogas plant vehicles is equal to or more than CNY15 million.

For the category 1 subprojects the first subproject feasibility report and EIA for each province will be submitted to ADB for review and approval. If found to be acceptable, ADB will agree to subsequent appraisals by the PMO with the assistance of the project implementation consultants. Following this local review, PMO will prepare a brief subproject report for submission to ADB. ADB will reserve the right to request documentation on a random basis for monitoring of the appraisal process.

For category 2 subprojects (about 15, excluding 4 CSPs) all documentation will be sent to ADB for review and appraisal before confirming the acceptability of the subproject. If considered necessary, ADB may contract an expert for review of the documentation.

The PIOs, with support from the PMO, will be responsible for the further preparation and processing of the non-core subprojects. The PIOs will also be responsible for obtaining the necessary clearances prior to starting the bidding process, including environmental safeguard clearance by the respective Provincial Environmental Protection Bureaus.

Each PIO and finance bureaus of the concerned municipalities and counties will be responsible for selecting and approving the sub-loan applications in accordance with the sub-borrowers' and subprojects' criteria set forth in the Figure 5.

The proceeds of the sub-loans and funds provided by the local governments shall be blended in a package for each sub-loan and shall carry the terms as set forth in paragraph below. Each participating province will submit for ADB's review the reports on the first two non-core subprojects approved by the concerned PIO and finance bureau of the concerned municipality and county with sufficient information and justification for approval of the sub-

[102] Due to the nature of the sector project approach, it is to be expected that some subprojects will withdraw from the longlist during implementation and these may be replaced by new subprojects that satisfy the Government's requirements
[103] A standard format for the feasibility study reports was formulated during project preparation but difficulties were experienced in its implementation. This problem will be further addressed and the formats included in the Project Administration Memorandum.

loans. Thereafter, each participating province will require the finance bureaus of the concerned municipality and county to maintain the records of reviewing, selecting and approving the sub-loans for ADB's review. ADB will have the right to refuse provision of funding for those non-core subprojects which fail to meet the sub-loan terms, sub-borrowers' and subprojects' eligibility criteria, and national technical requirements, in which case the finance bureaus of the concerned municipalities and counties will refund the proceeds of the Loan to ADB.

Each non-core subproject will receive the same level of environmental safeguard scrutiny, modeled on the IEE for the core subprojects. The concerned provincial, municipal, city or local environmental protection bureaus will approve the IEE for the non-core subprojects. Upon approval, the IEE will be posted on the ADB website. Due diligence will be conducted of each IA for (i) financial and economic consistency with technical design and viability, (ii) resettlement and safeguard compliance, and (iii) procurement planning for project implementation arrangements

3.8.3 Implementation Period

The Project will be implemented over 6 years from the fourth quarter 2009 to the third quarter 2015 considering that it is a sector loan where non-core subprojects will be appraised after loan approval. The implementation schedule is presented in Figure 6. The implementation period is estimated based on the project scope, the proposed packaging of subprojects, construction requirements, scheduling of eco-farming activities following subproject construction, and ADB's experience with similar projects in the PRC, combined with the knowledge and experience of MOA and the PMO in livestock waste treatment projects. The implementation schedule is considered to be realistic and achievable.

3.8.4 Procurement

All procurement of goods and works shall be carried out in accordance with ADB's *Procurement Guidelines* (2007, as amended from time to time). Contracts for goods estimated to exceed $1.0 million and contracts for works estimated to exceed $10.0 million shall be procured using international competitive bidding (ICB) procedures.

Contracts for goods and works for individual subprojects where the cost of goods is below $1,000,000 and the combined costs of goods and works is below $10,000,000 shall be procured as turnkey contracts using NCB procedures. NCB procedures shall be in accordance with the PRC Tendering and Bidding Law (1999), subject to clarifications and modifications agreed to for subprojects where the cost equipment (goods) exceeds the upper limit for NCB, procurement of civil works and equipment (goods) will be undertaken in two packages. One for the civil works and the other for the supply, installation, and testing of equipment.

Based on detailed analysis of the core subproject proposals it is estimated that five of the equipment contracts – Weiwei, Lvyuan, Zhongkang, Jiyuan and Wantong – involving 3 provinces are larger than the upper limit for NCB and will thus have to be procured by ICB. The related civil works packages are below the upper limit and can thus be procured through NCB. The remaining 6 packages will be tendered as turnkey projects using NCB procedures. Based on analysis of the subproject longlist, about 20-25% of the subprojects will require ICB for equipment procurement. The PIOs will assist the enterprises in the procurement process but the enterprises will assume the final responsibility for awarding of contracts subject to compliance with all ADB and Government requirements.

Purchase of biogas plant vehicles for the subprojects will normally be through shopping, although in a limited number of cases, including one of the core subprojects, NCB will need to be used because of the number of vehicles proposed. Procurement of eco-farming civil

works in Jiangxi Province will be undertaken through separate NCB packages. Procurement work will be assigned to qualified tendering agency with the supervision and guidance from the PIO.

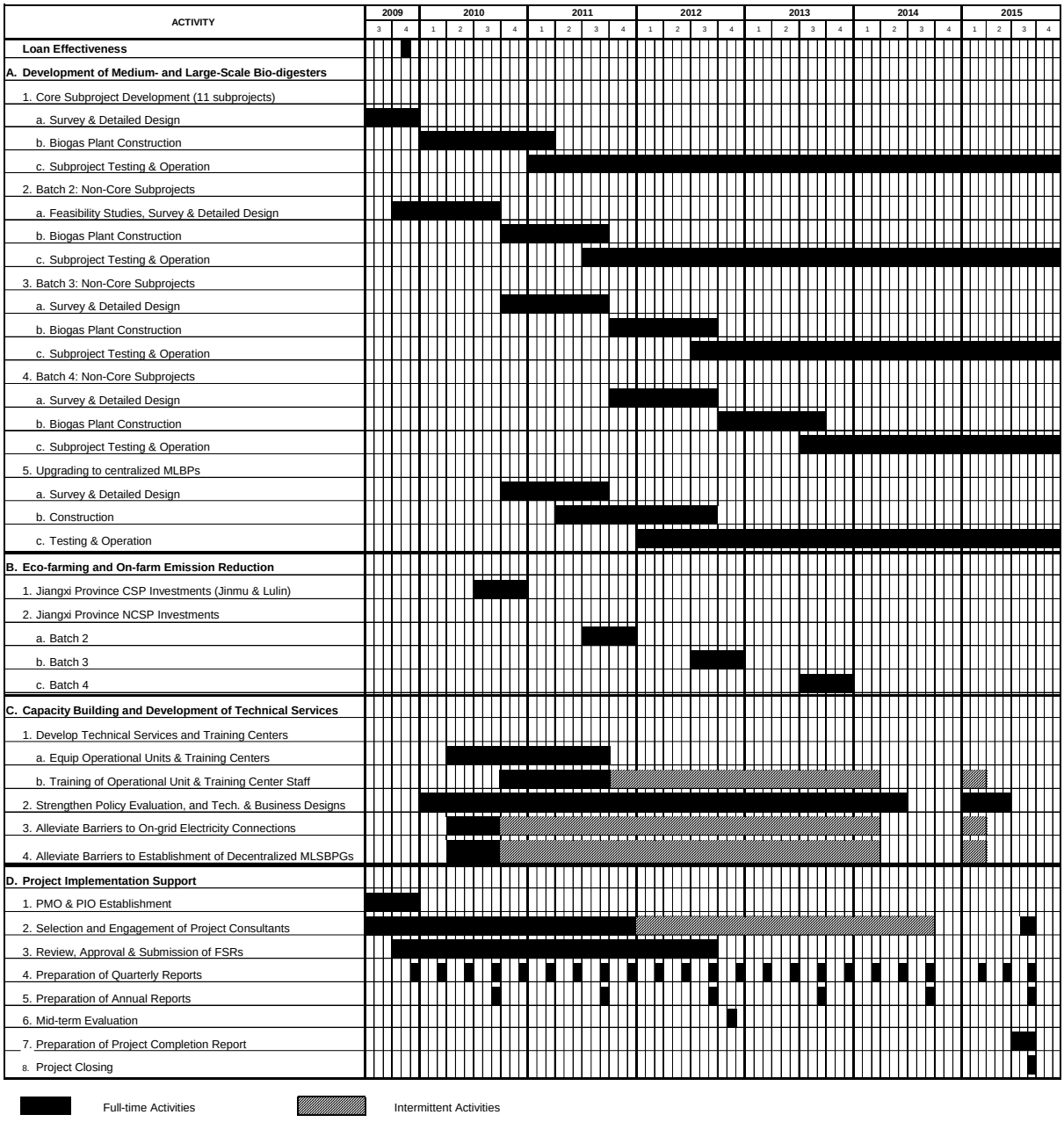

Figure 6: Project implementation schedule 2009 - 2015

3.8.5 Recommendations for Inclusion of CDM

Criteria for the Selection of CDM projects. The selection of CDM projects is based on the estimated CER potential, the willingness of the project owner to implement, operate and maintain the advanced technology required and the financial viability of those projects under consideration of higher investment and operation costs. For example for small-scale projects (with CERs <10.000 t/CO_{2equiv}/yr) are not suitable for the CDM projects because the costs for PDD development, transaction costs etc. are too high. It is recommended to focus on projects where existing CDM methodology can be applied though the possibility of

developing new methodology exists. More detailed project requirements need to be developed by following the approved CDM methodology. The basic criteria for the selection of the livestock farms that might be included in the further development of CDM projects are:

(i) There are available CDM methodologies that have been approved by the *CDM Executive Board*;
(ii) Locations and conditions of the livestock farms meet the requirements of methodologies;
(iii) Baseline data are available or can be collected;
(iv) The project is suitable in size and CER generation;
(v) The project owner is willing to develop a CDM project.

Methodologies that can be applied for CSPs as well as Non-CPS are ACM 0010 (version 4.1) and AMS-III.D (version 14). ACM 0010 methodology is applicable generally to manure management on livestock farms where the existing anaerobic manure treatment system, within the project boundary, is replaced by one or a combination of more than one animal waste management systems (AWMSs) that result in less GHG emissions. AMS-III.D is for small-scale project based on similar requirements as ACM 0010.

The above methodologies are applicable to manure management projects with the following conditions:

(i) Farms where livestock populations, comprising of cattle, beef cattle, pigs, sheep, goats, and/or poultry, are managed under confined conditions.
(ii) Farms where manure is not discharged into natural water resources (e.g. rivers or estuaries).
(iii) In case of existing anaerobic lagoon treatment systems, the depth of the lagoons used for manure management under the baseline scenario should be at least 1 m.
(iv) The annual average temperature at the site where the anaerobic manure treatment facility in the baseline existed is higher than 5°C.
(v) In the baseline case, the minimum retention time of manure waste in the anaerobic treatment system is more than 1 month.
(vi) The AWMS/process in the project case should ensure that no leakage of manure waste into ground water takes place, e.g., the lagoon should have a non-permeable layer at the lagoon bottom.

In addition to the livestock farms, methodology ACM0014 or AMS-III.H can also be considered for the application of agriculture processing plant for claim of CERs generated from renewable electricity. Application of this methodology is recommended to the case where ACM0010 or AMS-III.D are not possible to use or the CERs from the renewable electricity generation for replacing fossil fuel based electricity is larger.

As characterized by CDM project requirements, CDM is “project-based”. This means that a baseline shall always be conducted based on input data of individual projects. Collection of the input data for the baseline determination is important and time-consuming task for using ACM0010 or AMS-III.D which is different from the other CDM methodologies. It is often difficult to draw a generic baseline which can apply all different projects in different locations.

Evaluation of CSPs based on CDM Requirements. Under ADB TA 4939, 154 subprojects were considered in 6 provinces including Heilongjiang, Henan, Jiangsu, Jiangxi, Shandong and Shanxi. These projects comply with the “Selection criteria for Loan Beneficiaries’’ for this loan (see Appendix 4A). Based on the 154 subprojects, 11 core sub-projects were selected based on the ‘CSP selection criteria’ (Supplementary Appendix G), consisting of livestock farms of pigs, cattle, duck, chicken and agriculture processing plants. In 154 subprojects, about 50% pig farms, 20% of cattle/dairy farms, 14 duck farms, a few chicken and agriculture processing farms. Table 21 lists the brief information of CSPs as extracted from

the feasibility study reports. The bottom line of the table gives the recommendation of the further development of CDM projects based on the potential CERs estimation.

Table 21: Data of 11 Core Sub-Projects

Item	1	2	3	4	5	6	7	8	9	10	11
Province	Heilongjiang		Henan		Shandong		Jiangxi		Jiangsu	Shanxi	
Subproject	Hexie	Jinli	Haoyun	Hui-min	Lvyuan	Zhong-kang	Jinmu	Lulin	Weiwei	Wan tong	Jiyuan
Livestock	Dairy	Pig	Pig	Pig & chicken	Duck Chicken	Duck	Pig	Pig	Dairy	Cattle	Agro-proc.
head (1000)	3	10	9	6 & 400	460	100 + slaug	5	6	7.5	8	1 m tons
FIRR (%) No CDM	9.5	8	6.6	10	6.9	1	5.7	6.3	6.5	6	3.3
Electricity production (MWh/yr)	1,479	192	135	1,395	2,874	547	0	496	3000	2,088	17,500
Potential CERs [a] (tCO2e/y)	185	1426	5324	13,300	1,088	115	2,997	4,071	13,906	11,339	16,332
Potential CDM Project?	No	No	Yes	No	Yes/No	No	Yes	Yes	Yes	Yes/No	Yes

Note:

[a] Because all CSP's baselines have not been determined, the "potential CERs" are **estimated** only for the preliminary selection of CDM projects from the CSPs based on the **arbitrary assumptions** of similar cases from other applications. Thus, it is important to note that such data cannot be regarded as the final CERs of the projects because detailed data collection for the determination of baseline is required in the future for the final development of CDM projects.

Analysis of CSPs with the considerations of existing CDM methodologies and potential CERs.

Analysis of CSPs with consideration of potential for CDM project development has been made by the CDM TA team. The key factors to be evaluated for the possibility for developing CDM projects include the climate conditions, livestock types, estimated CERs potential, and availability of methodologies for the specific cases.

In order to make the evaluation of applicability of CSPs for CDM development, we have made a preliminary estimation of the potential CERs (Table 35) based on the assumption of baseline and available data from the Feasibility Study Reports of CSPs provided by provinces. However, the estimated values of CERs can be only used for the determination of the inclusion of CSPs into further CDM development and cannot be regarded as the final CERs estimation because the baseline was arbitrarily assumed. A detailed and accurate baseline determination will be made when the potential CDM CSPs are selected.

CSPs that are not suitable for CDM projects.

The following projects are not suitable for the further development of CDM projects with detailed reason as follows.

(i) CSP 1: Hexie. The livestock farm is located at Hulin City, Heilongjiang province. The annual average temperature is 3.5 °C which is below the required temperature of 5° C by ACM 0010 (version 4.1) or AMS-III.D (Version 14). Thus, none of CERs will be generated in this Project. If Emission Reduction of electricity generated utilizing the biogas is estimated by AMS-I.D (Version 13), the potential CERs are too small to be applied for CDM.

(ii) CSP2: Jinli. The livestock farm is located at Daqing City, Heilongjiang province. The annual average temperature is 4.2 °C. Same as CSP1, this Project does not meet the requirement of 5° C required by used CDM methodologies. If emission

reduction of electricity generated utilizing the biogas for replacing fossil fuel is estimated by AMS-I.D (Version 13). However, the potential CERs are too small to be applied for CDM.

(iii) CSP4: Huimin. Based on the Feasibility Study Report, this Project consists of mixed livestock wastes from both pig and chicken. Parameters to determine the baseline and emission reduction potential are difficult to determine. It is not suitable for the consideration as CDM project.

(iv) CPS6: Zhongkang. No methodology exists for duck farms and only based on electricity displacement the potential CERs seem too small to be applied for CDM.

(v) CSP10: Shanxi Wantong. For beef cattle there are no special data available for the default values, for example, B_0, VS etc in IPCC (2006). Thus it requires collecting large amount data (including historical data of livestock farms) for determining those parameters. It is not feasible at the current step to consider this type of applications for CDM projects. But there are "other cattle" emission factors in IPCC (2006), if these parameters can be used for Beef cattle, it can be considered as potential CDM project. This issue needs to be further investigated.

CSPs that have potential for CDM Projects. Six CSPs are recommended for further development as CDM projects, as follows:

(i) CSP-4: Haoyun, CSP-7: Jinmu, CSP-8: Lulin, and CSP-9: Weiwei. These four pig farms can be considered as potential CDM project, following the similar approach as the Henan CDM Pilot Project. With consideration of the current on-going Henan pilot project, it is recommended to make the Jiangxi projects into a bundle for further development of PDD. Haoyun Project in Henan may wait for later development when the Henan pilot project is submitted for registration.

(ii) CSP-5: Lvyuan. Based on Emissions from Livestock and Manure Management (Chapter 10) of IPCC2006, emission factor for ducks can be applied. The only default value from IPCC2006 Table 10A-9 is for a dry lot. For the actual waste treatment of CSP5, it needs to conduct a field study to confirm the real situation of CSP5. Using AMS-III.D and AMS-I.D, estimated emission reduction is about 7,700 t/yr for uncovered lagoons and about 160 t/yr for dry lots. According to the latest information 200.000 of 460.000 heads are chicken at those sub-subprojects which will result in the need for a re-estimation of the CERs.

(iii) CSP-11: Jiyuan. This subproject does not belong to the livestock waste treatment program. Thus, ACM 0010 or AMS-III.D is not valid for this application. However, with consideration of the large potential CERs, the use ACM 0014 or AMS-III.H is recommended. The CH_4 recovery and renewable electricity production can be claimed for the CERs.

Recommendation for CSPs CDM Development.
Based on the above analysis, following recommended potential CSPs can be considered for CDM project development:

(i) Pig farms of CPS-7, and 8 in Jiangxi Province are considered as a bundle of CDM projects. If data available, it might also be possible to include some of non-CPSs in this bundle.

(ii) Shanxi Jiyuan agro-processing plant shall be considered as a CDM project by applying methodology of AMS-III.H or ACM 0014. This project has the potential to

generate larger CERs when compared to other projects.

(iii) Jiangsu Weiwei Diary plant might be considered as one of potential CDM projects.

Most of CPSs and non-CPSs regarded as greenhouse gas emission reduction projects as they are relatively small plants; even though most of them are regarded as large livestock farms according the Chinese definition.

In order to reduce the CDM development and transaction costs, we shall consider a similar approach to that of "Henan pilot project". This will include the bundling of several projects into one CDM package. We do not recommend developing small individual projects. Issues related to monitoring of CDM projects will need to be considered as the bundled project may consist of a number of different organization institutions and livestock farms. We recommend that a central service and supporting institution shall be established at the provincial level to provide the technical support and service required for the development and monitoring of CDM projects. However the costs of a Bundling Agency are to be taken into account when considering the benefits of CDM project bundling.

We have noticed that IRR (without CERs) presented in the Feasibility Study Reports for all projects are between 1% and 10%. It has to be considered that to claim the additionality for CDM project development, projects which can be operated on a pure economic basis may not be eligible.

Evaluation of non-CSPs based on CDM Requirements. Due to the lack of detailed technical information of the non-CSP projects, the GHG emissions reduction can only be estimated based on the data available so far. Some assumptions have to be made in order to estimate the range of emission reduction potential. Preliminary results with detailed estimations of projects are given in Appendix 13.

Development of New CDM Methodologies. Based on current available CDM methodologies, especially ACM 00010, it is difficult to implement CDM projects in Heilongjiang. This is because the methodology requires the annual average temperature in the site to be higher than 5°C . All the sites in this area are slightly below this temperature.

In principle, a new methodology can be developed for the above situations. The feasibility study of the development of the required new methodology is recommended before any decision. This is due to the long lead time required for the successful development of new methods as well as the uncertainty of the CERs and risks of developing new methodologies.

The only GHG reduction potential that can be claimed is the replacement of fossil fuels by using renewable biogas. However, access to the grid is another issue that needs to be solved as most of the plants are small which make them difficult to connect to the grid. The Project will provide support in this regard.

3.8.6 Consulting Services

Consultants to be financed by the ADB loan, if any and the GEF grant will be recruited by the PMO in line with ADB's Guidelines[104]. The Project will require consulting services to assist in the project implementation and management. These will be financed and engaged by GTZ. The GEF-financed consultants will assist in capacity building and project management for the design, construction and operation of the centralized biogas plants. The PMO and the 6 PIUs will take advance actions towards the recruitment of implementation consultants to reduce start-up delays.

[104] ADB's Guidelines on the Use of Consultants (2007, as amended from time to time)

The Project will finance about 44 person-months of international consulting and 129 person-months of national consulting. This will be directed at the improvement of technical services and part of the project's implementation support through the GEF grant. Details of which will be developed prior to loan effectiveness. The remainder of the consulting services, including the major part of the project implementation support, is expected to also be provided through the GTZ grant. Details of the support will be developed prior to loan effectiveness. Specific consulting services that are expected to be provided under the GEF grant include approximately: (i) alleviation of barriers to on-grid electricity connections (25 person-months of national consulting); (ii) alleviation of barriers to the establishment and operation of centralized bio-digesters (28 person-months of international and 72 person-months of national consulting); and (iii) project implementation support (16 person-months of international and 32 person-months of national consulting). The consultants for project implementation support will specifically support the PMO through providing guidance and capacity building for project implementation, and assist in the review and appraisal of non-core subprojects and in preparation of the subproject reports for the ADB. Contracts for consulting services estimated at $200,000 and above will be awarded to consulting firms using the quality-and cost-based selection procedures (80:20), in accordance with ADB's *Guidelines on the Use of Consultants* (2007, as amended from time to time). Outline consultant terms of reference for the services to be provided under the GEF grant are provided in Appendix 5.

3.8.7 Disbursement Arrangements

The proceeds of the loan will be disbursed in accordance with ADB's *Loan Disbursement Handbook*. Since many of the payments will be made for large contracts — direct payment, reimbursement, and commitment procedures — will be used where appropriate and efficient to withdraw funds from the loan account. To expedite the flow of funds and simplify document processing, the Statement of Expenditure procedure may be used to reimburse eligible expenditures for any individual payment not exceeding $100,000. Payments exceeding this ceiling will be reimbursed based on the full documentation process.

Project Imprest Accounts will be established by the provincial Departments of Finance in a commercial bank acceptable to both the Government and the ADB and in accordance with ADB's *Loan Disbursement Handbook*. The Imprest Accounts will be used to finance construction of the subproject biogas plants. The initial amount to be deposited to each Imprest Account shall not exceed the estimated expenditures for the following 6 months or 10% of the loan amount allocated to the province, whichever is lower.

3.8.8 Accounting, Auditing and Reporting

The PMO and PIOs will maintain records and accounts that identify goods and services from loan proceeds, financing resources received, expenditures incurred, and use of local funds. These accounts will be established and maintained in accordance with sound accounting principles and internationally-accepted accounting standards. The PMO will review each PIOs accounts and consolidate them with the PMO accounts to produce the overall Project accounts. PMO and PIO accounts, as well as the overall accounts, shall be audited annually in accordance with sound accounting practices by the sovereign audit agency of the Government or other auditors acceptable to ADB. The audit report(s) will include a statement verifying whether or not the funds disbursed by ADB were used for the purposes for which they were provided, as well as the auditor's opinion on the use of the imprest account and statement of expenditures procedures. Copies of the audited accounts and auditor's report will be submitted to ADB within 6 months after the end of each financial year.

PMO will prepare consolidated quarterly project reports indicating progress made, problems encountered during the period, steps taken or proposed to remedy the problems, proposed

program of activities, and progress expected for the next quarter. Based on the quarterly reports, PMO will also prepare annual reports summarizing the progress made, problems and remedies of the year, and the proposed work plan for the following year, including the planned activities of each PIO. Within 3 months of physical completion of the Project, PMO will submit to ADB a completion report that describes the achievements in relation to the Project's expected impact, outcome, and outputs.

3.8.9 Project Performance Monitoring and Evaluation

To monitor the progress of the Project in achieving the planned outcome and outputs, PMO will establish and maintain a project performance monitoring system (PPMS). The PPMS, which will be operated at both the PMO and PIO level, will be designed to permit adequate flexibility to adopt remedial action regarding project design, schedules, activities, and development impacts. The PPMS will include the following indicators but may be modified to include additional indicators identified during its detailed formulation: (i) physical progress of subproject implementation; (ii) physical progress of eco-farming and technical services support; (iii) results of capacity development programs; (iv) operational efficiency of bio-digesters, and progress in complying with CDM and generating CERs; (v) progress in eco-farming development in subproject areas; (vi) environmental improvements in subproject areas; and (vii) social development. At project inception, the PMO will formulate comprehensive PPMS procedures to systematically generate data on inputs and outputs of the project activities; and the socioeconomic, health, and environmental indicators to measure project impacts.

With the assistance of the project implementation consultants, PMO will refine the PPMS framework, confirm achievable targets, monitoring and recording arrangements, and establish systems and procedures no later than 6 months after project implementation begins. Baseline and progress data will be collected by the PIOs, and consolidated and reported at the requisite time intervals by PMO, including annual reporting on the environmental management plan. PMO will be responsible for consolidating and analyzing PIO data through its management information system, and for reporting outcomes to ADB through quarterly progress reports.

3.8.10 Project Review

In addition to regular monitoring, project performance will be reviewed at least once a year jointly by ADB and the Government. The review will assess implementation performance and the achievement of progress towards project outcomes and outputs. The review will consider financial progress, and issues and constraints affecting implementation, and work out a time-bound action plan for their resolution. ADB and the Government will undertake a midterm review to assess implementation status and take appropriate measures including modification of scope and implementation arrangements, and reallocation of loan proceeds, as appropriate, to achieve the Project's outcomes and impact.

4. Project Benefits, Impacts, Assumptions and Risks

4.1 Project Benefits and Impacts

The Project will directly benefit about 154 large-scale livestock and agro-processing enterprises through promotion of bio-digesters as well as about 280,000 households in surrounding communities who will benefit from the improved local environment, improved employment opportunities, and increased markets for their livestock and crops, as well as from the increased opportunities for eco-farming.

4.2 Benefits and Impacts to the MLBG Sector

The detailed analysis of subprojects is shown in Appendix 6. The summary of core-subprojects analysis and the impact on the MLBGP sector is shown in Appendix 2C and in Supplementary Appendix H. The conclusions for further consideration during planning and operation as conditions for ANB project approval are compiled in Appendix 4B.

4.2.1 Core – and Subproject analysis

Eleven core-subprojects (CSPs), representing all 154 subprojects, were jointly selected with the provinces according to the 'Core-subprojects Selection Criteria' (Appendix G) These were approved by the project participants as outlined in the Interim Report they were supported by the PPTA experts during Phase 1 of the PPTA. This was done to guide the projects to an appropriate conceptual approach, required to apply state of art technology and to consider 'best practise management and operation. This was required in order to comply with the requirements to operated 'biogas power plants' under CDM conditions [105], [106], [107], [108], [109]. The number of proposed subprojects by province is seen in Table 22 and it shows the development of number of subproject proposed by the provinces and the proposed loan proportion during the course of the project.

Table 22: Core- and subprojects by Province

Province	Number of subprojects (incl. CSPs)	Initial number of CSPs	Final number of CSPs
HEIL – Heilongjiang	14	4	2
HEN – Henan	40	4	2
JIS – Jiangsu	12	2	1
JIX – Jiangxi	51	4	2
SD – Shandong	23	3	2
SANX – Shanxi	14	2	2
TOTAL	**154**	**19**	**11**

4.2.2 How representative are the 11 remaining CSPs

The CSPs cover the following requirements and they represent (see Table 23 and Table 24):

Eleven core subprojects (CSP) (see Table1), out of the 19 CCSPs proposed by the TIOs from 6 provinces, were selected to represent the expected 154 subprojects which are going

[105] Stephen Seres, et. Ali, Analysis of Technology Transfer in CDM Projects, UNFCCC Registration & Issuance Unit, Climate Change Economist, Montreal, Canada, etc., 12/2007
[106] Austrian Standard Institute, ON 19917N0048, Technical requirements for evaluation of Biogasplants, Austrian Ministry for Commerce and Labor, 2007
[107] US, EPA, AgSTAR Handbook and Software, Appendix F National Resource Conservation Service Practice Standards, 2nd Edition, http://www.epa.gov/agstar/resources/handbook.html.
[108] FIDIC, Consultant Selection Guidelines 1st Ed, 2003
[109] Australian Standard (AS) 1375, Rural Industries Research and Development Corporation, RIRDC Publication No. 08/024, Assessment of Australian Biogas Flaring Standards, GHD Pty Ltd., 2008, ISBN1 74151 613 7, 2002

to be implemented under the ADB loan. During the acceptance and valuation process 8 projects of the 19 were removed from the candidate list, as they could not provide suitable EIAs, or simply could not follow the projects time schedule. The remaining 11 CSPs provided their English FSRs. Six of them, one in each province, were chosen as demonstration projects for the Initial Environmental Examination, following ADB safeguard procedures.

Table 23: Number of Subprojects and Loan Proportion development and share of Feedstock Processing among the Project Provinces

Province	Enterprises Biogas Plants (n)	ADB loan proportion first estimations and FECC 12/07 $ million	ADB loan proportion $ million	Feestock processing (%)
Heilongjiang	30 [47] **14**	12 / 10	11.0	10.2
Henan	81 [40] **40**	31 / 22	22.2	31.3
Jiangsu	30 [60] **12**	12 / 12	11.0	7.1
Jiangxi	54 [60] **51**	> 20 / 20	16.1 *	7.8
Shandong	39 [58] **23**	25 / 21	24.2	27.7
Shanxi	35 [49] **14**	15 /15	15.4	15.9
	355/269/**154 12-08/ 01-09/12-09**	**115 / 100**	**100.0 mn**	**100%**

* request for additional loan for Ecofarming development
** 100% = 9.34 million t/yr

The 11 CSPs comprise 7% of 154 subprojects in all 6 Project provinces and contain all main feedstock types and represent 21% of the total feedstock quantity. In terms of animals the CSPS comprise of 2.6% pigs, 13.4% dairy cattle, 20% beef cattle, 22.5% chicken, 7.6% ducks and 59.5% agro-industrial waste. One third of the CSPs are Co-processing plants using chicken/pig, duck/slaughterhouse or duck/chicken waste. All main 5 biogas technologies are used, with an average fermenter size of 180.000 t/yr, which 3 times larger than the average subproject size. Within the CSPs 15% of the total fermenter capacity, with 9 days average HRT (the average in the subprojects is 18 days if UASB waste water technology is excluded), with an fermenter productivity of 0.9 $nm^3/BG/m^3$ FV*d will be built up. The CSPs will produce 19% of the total biogas (19mn m^3/yr), and 95% of the biogas will be used for electric power generation and 5% will go into the local gas grid or used for heating. 12% of the eco-fertilizer is produced by the CSPs. Only one CSP does not intend to produce solid fertilizer and one CSP will upgrade the solid fertilizer with mineral fertilizer to a high quality organic fertilizer product for marketing.

The CSPs will achieve about 7.4% of GHG emission reduction or about 90.000 tCO_{2e}/yr. 50% of the CSPs are seen as potential CDM projects, based on existing methodologies, with each CERs between 54,000 - <70,000 tCO_{2e}/yr.

The 11 CSPs will occupy 16.5% of the total investment (CHY241 mn = US$35 mn) and the specific investment costs of the CSPs are in the average 123 CHY per annual ton treatment capacity of the plant, which is due to the bigger size of the CSPs but below the average of all subprojects (155 CHY/tyr). The financial internal rate of return (FIRR) of the CSPs is between 1-10% without CDM and 2.6 – 20.9% including CDM.

The problem which appears is that the final CSPs does not contain smaller CSPs anymore and the technical/financial analysis are conducted for projects at the higher end of the range as seen Figure 7 and Figure 8 The figures show the specific investment cost per ton of feedstock treatment capacity of the CSPs (labelled round and larger) together with all the other subprojects. So for example the selected swine farm Bolai – Jiujiang (3000 pigs) has withdrawn from the project list.

Table 24: Comparison of performance figures of 11 Core-subprojects and 154 subprojects (Supplementary Appendix K2)

ID	IDN	Name of Enterprise	Sub-project Location	Year of establish-ment	pig on hands (n)	dairy cattle on hands (n)	beef cattle on hands (n)	chicken on hands (n)	duck on hands (n)	agro-ind. Waste type	agro-ind. Waste (t/yr)	Total feedstock (t/yr)
11		TOTAL 11 CSP			36,000	10,500	8,000	600,000	360,000		1,146,000	1,969,151
154		TOTAL 154 SP			1,358,844	78,180	40,100	2,666,600	4,760,000		1,927,015	9,385,457
		CSP % of total			2.6	13.4	20.0	22.5	7.6		59.5	21.0

Fermenter Size acc. TIO (m3)	Fermenter Size adjusted (m3)	Hydraulic Retention time (t/d)	Biogas production (m3/yr)	Specific Fermenter Biogas production (m3BG/m3FV*d)	Biogas utilisation	Electricity production (kWh/yr)	Biogas to village grid (m3/yr)	Biogas for heating, others	Fertilizer liquid produced (<20 % DM), (t/yr)	Fertlizer solid produced (>20 % DM) (t/yr)	Fertilizer Utilisation	Total Ecofarming (t/yr)	Fertlizer self-use (t/yr)
46,000	46,500	9	19,261,650	0.91		29,708,575	875,000	35,000	672,365	49,309		721,674	115,900
298,290	333,750	12.98	101,504,690	0.82		131,179,813	14,903,300	2,476,500	4,677,990	919,951		6,020,331	947,071
15.4	13.9		19.0			22.6	5.9	1.4	14.4	5.4		12.0	12.2

Investment costs acc. FSRs (CNY million)	Investment costs acc. PPTA judgement (CNY mn)	ADB Loan (CNY million)	Specific investment costs per ton of feedstock (CNY/t)	HGH Emission reductions (tCO_2e/y)	PTTA FIRR no CDM (%)	PPTA EIRR (%)
236	242	119	123	89,957	6.3	16.1
1,427	1,458	691	155	1,232,071.00		
16.5	16.6	17.2		7.3		

An additional economic analysis of two smaller non-core subprojects Yingtan Fuxin and Guixi Lianbang, both in Jiangxi These subprojects have an annual pig production of 2600 – 2700,head. The analysis has shown that they are economically viable and as well eligible to be financed under the loan with their EIRRs more than >12%.

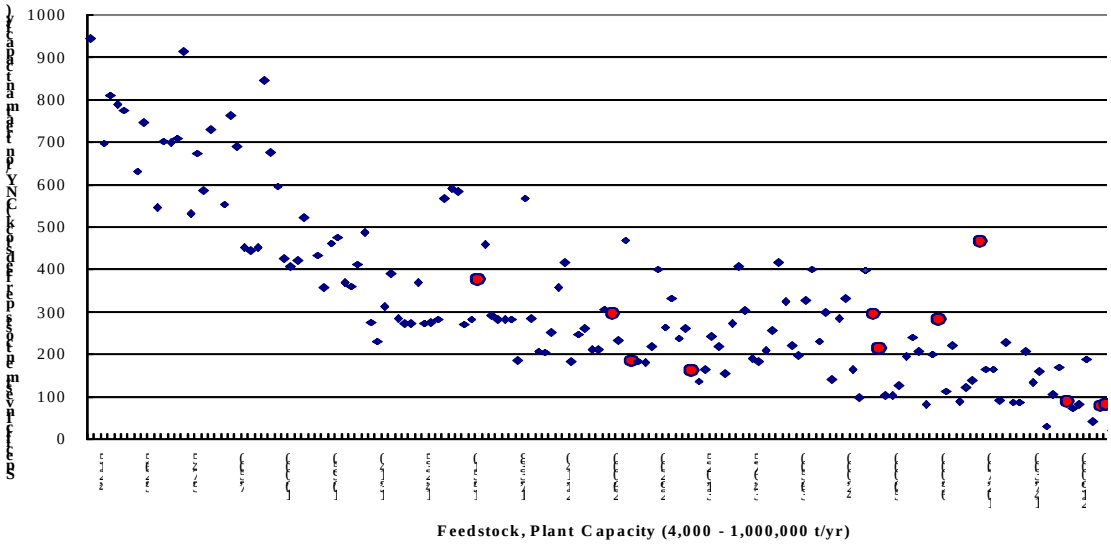

Figure 7: Specific Investment costs of 11CSPs and of 143 subprojects in CHY/t.yr feedstock treatment capacity related to the plant capacity in t/yr

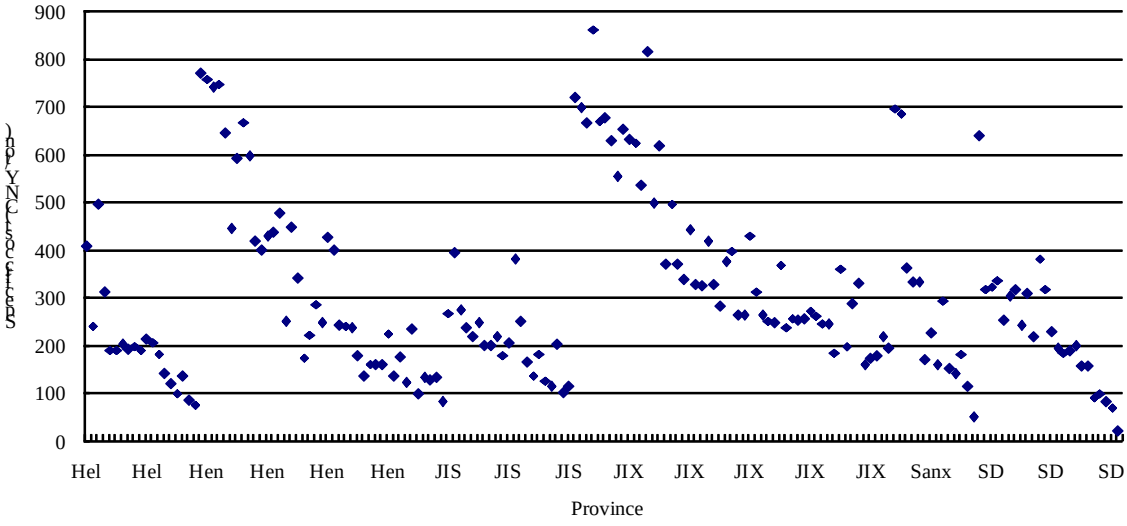

Figure 8: Specific Investment costs of 154 subprojects in CHY against plant capacity (t/yr feedstock treatment capacity per province)

4.2.3 Subproject analysis and 'long list"

A number of about 154 (355 in 12/2007, 269 in 1/2208 and 196 in 03-2008, see Table 23) middle and large scale biogas plants (MLBGP) proposed by the six project provinces, were selected based on the 'Subproject Enterprise Selection Criteria' (see Appendix 4A), and these projects were finally seen as potentially eligible to be financed under the ADB loan. A due diligence and plausibility check of the main process features did lead to the project figures compiled and are as presented in the Supplementary Appendix K1, Subproject Long List, Table 2 for CSPs and in Table 1 for the subprojects and in and Supplementary Appendix

K2 (displayed according CSPs and non–CSPs per province, in ascending order of project/feedstock size).

About 32 key technical and financial features and parameters characterising and describing the subprojects (including the core-subprojects) were listed in the so called 'long list of subprojects' (Supplementary Appendix K1 and K2). The projects were analysed in terms of their technical and cost plausibility and the design parameters modified by the PPTA experts in order to forecast the impact of the Project. A summary of the type of subprojects according feedstock are seen in Table 26.

In terms of number of enterprises the subproject comprises of 68.8% pig farms with 2,600 – 120,000 heads produced (slaughtered) per year, 20% dairy cattle (550 – 10,000) and 9% beef cattle (500 – 10,000 heads on hand), 13% chicken (up to 420,000 heads on hand) and 9% duck farms, 11% agro-industrial waste with up to 1 million t/yr from slaughter houses, bio-ethanol production, vegetable processing plant.

In terms of feedstock quantity the projects using 46.1% pig manure, 14.4% dairy cattle manure, 3.6% beef cattle manure, 3.5% chicken and 11.8% duck manure and 20.9% agro-industrial waste or 1.9 million t/yr. About 14 or 10% of the projects are co-processing plants with more than one type of feedstock. Most of the feedstock derives from Henan (31.3%), followed by Shandong (27.7%), Shanxi (15.9%), Heilongjiang (10.2%) Jiangxi with (7.8%) and finally Jiangsu with (7.1%). To relate the feedstock capacities to the investment costs per province see Table 23.

Specific investment costs: Another important indicator to compare the biogas plants are the specific investment costs (CNY per installed feedstock treatment capacity in tons per year). The specific investment costs of 154 subprojects, including 11 CSPs and 9 existing Chinese MLBGPs (see Supplementary Appendix K1), from which 3 are CDM projects, are shown in Figure 9. The x-axis shows the projects ranked ascending by annual feedstock treatment capacity and the y-axis the specific investment costs. What we can see is that the economy of scale applies clearly to the subprojects and the investment per annual ton of feedstock of smaller projects is much more expensive than those of large projects. Further that the existing CDM projects, which are the 4 green labeled projects, are located at the right side of the table, and which do request a higher technology standard in order to deliver the anticipated emission reduction, also in the average more expensive than the subprojects. The low-cost CDM project shown in the Figure 9 is not operational.

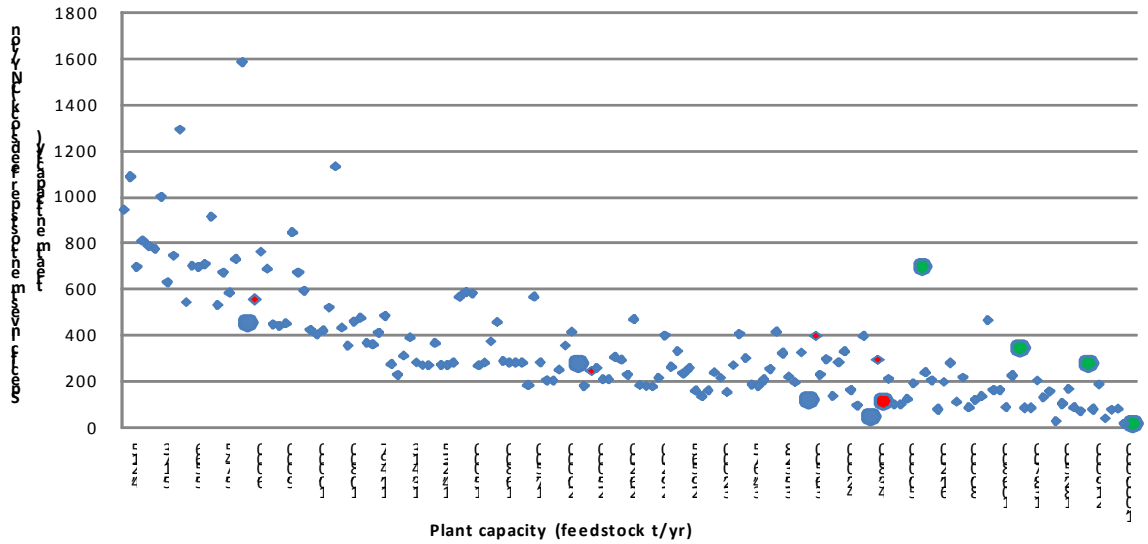

Figure 9: Specific Investment costs of 154 subprojects in CHY per t of feedstock treatment capacity and 9 existing MLBGPs (round blue) including 3 CDM projects(round green).

Table 25: Summary of 154 subprojects including the core-subprojects according type of farm and amount of feedstock per province and in total see (Supplementary Appendix K1)

	Heilongjiang			Henan			Jiangsu			Jiangxi			Shandong			Shanxi			Total		
	Farms (n)	**Heads (n)**	**Feed stock (t/yr)**	**Farms (n)**	**Heads (n)**	**Feed stock (t/yr)**	**Farms (n)**	**Heads (n)**	**Feed stock (t/yr)**	**Farms (n)**	**Heads (n)**	**Feed stock (t/yr)**	**Farms (n)**	**Heads (n)**	**Feed stock (t/yr)**	**Farms (n)**	**Heads (n)**	**Feed stock (t/yr)**	**Farms (n)**	**Heads (n)**	**Feed stock (t/yr)**
Pigs	7	53,000	151,840	30 - 1* chick - 1* dairy	664,600	2,660,520	7 -1* chick	98,500	253,675	47	272,294	650,467	6 -1* duck	119,000	202,290	9 -2* chick	151,450	369,760	106 -1*pig (68.8%)	1,457,684	4,288,552 (46.1%)
Dairy	5	36,000	574,355	6	8,380	199,401	4	20,200	378,320	1	3,000	36,500	4	10,600	166,000	0	0	0	20 - 3* dairy (11.0%)	88,780	1,354,576 (14.4%)
Beef	2 -1*dairy -1*pig	14,000	34,675	1	1500	25,000	0	0	0	0	0	0	4 -1* dairy, -1* agro	16,000	196,853	2	8,600	83,400	9 (5.8%)	40100	339,928 (3.6%)
Chick	0	0	0	5	880,000	47,802	1	360,000	12,775	1	131,600	4,790	2	500,000	221,125	4	795,000	43,025	13 - 5* chick (5.2%)	2,666,600	329,517 (3.5%)
Duck	0	0	0	0	0	0	0	0	0	0	0	0	9 - 3* agro -1* chick	4,760,000	1,107,260	0	0	0	9 -1*duck (3.2%)	4,760,000	1,107,260 (11.8%)
Agro	2	0	199,800	0	0	0	1	0	25,550	2	0	34,565	5	0	705,710	1	0	1,000,000	11 - 4* agro (7.1%)	-	1,965,625 (20.9%)
Total (%)	**14 9%**	**103,000**	**960,670 (10.2%)**	**40 26%**	**1,554,480**	**2,932,723 (31.3%)**	**12 8%**	**478,700**	**670,320 (7.1%)**	**51 33%**	**406,894**	**726,322 (7.8%)**	**23 15%**	**5,405,600**	**2,599,238 (27.7%)**	**14 9%**	**955,050**	**1,496,185 (15.9%)**	**154 (100%)**	**9,013,164**	**9,385,457 (100%)**

* 14 co-processing plants, where at least 2 different feedstock materials will be treated at one AD plant.

4.2.4 Subproject 'Technology Upgrade' Needs Assessment based on CSP analysis

The technical feasibility and viability project analysis is based on site visits, technical evaluation of the feasibility study reports (FSRs), communication with the TIOs and, if it was required, direct talks to project designers and enterprises. The CSP project description is documented in Supplementary Appendix H and the key features are summarised in Table 26 and in Appendix 6.

In 40% of the 156 ADB loan candidate subprojects CSTR technology is used, HCF and USB technologies applied by about 20% each. The use of CSTR where higher dry matter content is processed has increased during the past two years in China (Appendix 2C)[110]. The projects area also required to use mesophilic temperature fermentation with preheating, heat exchanger devices, insulation to ensure temperature stability and energy saving and to ensure overall reactor efficiency (Appendix 2C and 4B).

The 'Technology upgrade needs assessment' was used to assess the status of planning and to estimate the additional base costs, based on project proposals (FSRs) and not on detailed design. By using the check list II: Requirements on MLBGP plant design and operation up-grade (Supplementary Appendix H), each of the 11 CSPs were assessed as to whether the ADB 'best practice' Conditions on Technology, Implementation, Operation and Performances of MLBGP (According Appendix 4B) were met or not. The assessment table considers in Part A selected items/aspects of AD design and management and in Part B adjustments of the basic equipment.

The aim was to advise the provinces how best to up-grade the current project concept of 11 CSP's biogas technology and to ensure they met the 'best practice operation', to meet the required technical standard and plant performance criteria in terms of energy production, GHG emission reduction (including CER benefits) and Eco-farming, and to comply with Appendix 4B. Based on the current project basic design, outlined in the project proposals, the process flow and project concept was evaluated by PPTA experts, with the main items of technology upgrade summarized in Table 26. Supplementary Appendix H shows the 'Core subproject technical evaluation' tables in detail.

The analysis shows that most projects do not comprise a maintenance workshop and spare part storage. Further, all projects lack emergency biogas-flairs, which are necessarily to comply with international environmental standards These are also needed in CDM projects to gain CER's by biogas destruction (as biogas utilization is not provided or operational) to avoid pollution through unprocessed CH_4 emissions. In the case of Jiyuan bio-ethanol factory, alternative biogas utilization (for example in an existing steam boiler, etc.) can be applied for emergency gas utilization and a flair will not be required.

Project performance monitoring, including CDM relevant parameters and the required monitoring and laboratory equipment are also subject of detailed project planning. Five projects may improve their fermenter process performance by extending the HRT to an adequate standard of at least 60% (up to 90%) COD reduction, required to produce biogas for energy utilization and to reduce GHG emissions and to claim the anticipated CER's. Five projects also have to provide more stand-by generator capacity to continuously produce electricity power during gas engines maintenance, overhauling and repair periods. In 4 projects the fertilizer storage capacities are not sufficient and will have to be increased to comply with local fertilizer utilization practices. These practices require an eco-fertilizer storage time of at least 40 days in the south and 150 days in northern China. In two cases the biogas desulphurization capacity is not sufficient. Subject of additional investment are biogas dehydration facilities, the consideration of the local biogas grid, the fertilizer

[110] NY/T1222-2006: Design Standards for Biogas Projects in Large Livestock and Poultry Breeding Farms,

distribution system, feedstock pre-processing, heat exchangers for the sake of energy saving, fertilizer dehydration and the consideration of safety technology aspects and facilities.

Table 26: Summary Indicative needs assessment for technical upgrading of 11 MLBGP CSP's to 'best practice' standard under the ADB loan,

CSP	AD HRT capacity	CHP capacity	Biogas flare	Process monitor ring	Fertilizer storage capacity	Other additional investment to improve / amend	% of base costs
Hexie HEIL		¤	¤	¤		Biogas dehydration	9.1
Jinli HEIL		¤	¤	¤			9.1
Haoyun HEN	¤	¤	¤	¤	¤	Biogas grid, Fertilizer distribution system	17.4
Huimin HEN	¤		¤	¤	¤	Feedstock processing,	14.1
Wei Wei JIS			¤	¤	¤		2.5
Jinmu JIX	¤		¤	¤		Additional biogas desulphurization	7.4
Lulin JIX		¤	¤	¤	¤	Heat exchangers, fertilizer dehydration, no orchards	12.3
Lvyuan SHA	¤		¤	¤		Safety technology	3.4
Zhong-kang SD		¤	¤	¤		Biogas desulphurization	4.2
Jiyuan SHANX			**(¤)**	¤		No flair required if alternative biogas use exists	0.7
Wantong SHANX	¤		¤	¤			4.4
11	**5**	**5**	**10**	**11**	**4**		**3.9%**

(¤ = needs further consideration), see details in Supplementary Appendix H.

Additional investment results of a weighted average increase of 3.9% (between 0.7 and 17.4% of the CSP project base costs) were considered in the Financial Analysis of the CSP's in order to estimate better the real final investment costs and the project viability. Costs such as turnkey delivery, additional studies during planning, possible costs for extended equipment suppliers guarantees, and civil works related to the additional equipments were not included as they were seen as negligible in comparison with the total costs, which may vary as a result of competitive bidding and/or should be covered by project contingencies.

4.2.5 Conditions for Biogas Technology Application

An assessment of the existing MLBGP projects in China shows that most of them, apart from a few newly implemented internationally supported demonstration projects (see Appendix K and Appendix 6, Table 7), are based on weak low cost technologies and are inefficient
. These units often operated lack automatic process control and exhibit poor safety and environmental standards. These projects do not meet 'best practise' technology and would not match the 'Conditions on Technology, Implementation, Operation and Performances of Middle and Large Scale Biogas plants (MLBGP) under the ADB loan for China' (see Appendix 4B) but also, as far as can be seen from the project proposals, not the Chinese Standard requirements[111]. Projects which are not set up at a certain standard will not achieve a 90% (or 8000 h/yr) operational availability and will not produce energy and fertilizer in the expected quantity and quality. Low biogas production leads to low income from energy sales

[111] NY/T1222-2006: Design Standards for Biogas Projects in Large Livestock and Poultry Breeding Farms, NY/T 1221-2006: Technical Standards for Operation, Maintenance and Safety of Biogas Projects in Large Livestock Animal Breeding and Poultry Farms

and CDM revenues, which endangers the financial viability and therefore the sustainable operation of the projects.

In the course of the PPTA project the enterprises improved the conceptual design of the CSPs and even those of the subproject and the number of subprojects was within the same investment budget. Though progress was made in understanding and applying the 'new conceptual approach' of compliant biogas plants most of the CSP feasibility studies are still showing deficiencies.

This has turned out after the English versions of the FSRs were made available, but at that time, within the course of the project, there was no time left to include the required technical improvement into the Chinese Project Proposal (FSRs) anymore. The estimated additional investment (see Supplementary Appendix H) was considered in the PPTAs financial and economic analysis and the technical changes were discussed with the provinces.

As each CSP is highly individual in its technological approach and as a detail design cannot be expected at that time, the process technology gap analysis could focus on the main items of equipment and important performance criteria, such as hydraulic retention time (HRT), specific biogas production rate, amount of electricity and heat production, capacity for electricity production, slurry storage and farmland distribution equipment, biogas emergency flairs, spare part management and safety technology aspects (Supplementary Appendix H).

The general recommendations and requirements to upgrade the MLBGP 'best practice' standard were formulated as a condition for project approval under the ADB loan (Appendix 4B). These conditions are related to process and technology performance, safety and management standards, and other managerial aspects. The check list to evaluate the compliance with these conditions contains 70 criteria. Conditions and requirements outlined in Appendix 4B have to be considered for loan subproject acceptance and during implementation and operation. A life-cycle cost-benefit analysis (under consideration of generating of financial revenues) justifies higher investment costs of on average 4%, which are required to ensure the necessary operational plant availability and performance.

4.2.6 Impact of 154 subprojects on the MLBP sector

An impact analysis of the loan project was made based on the information received from 154 sub-projects including the 11 core-subprojects. The expected impacts of all 154 subprojects and of the 11 core subprojects were compared with the MLBG sector status in 2005 (see Table 26 and detailed project figures in Supplementary Appendix K1 and K2).

The project impact analysis shows that the ADB AD project compare to 2005 increase the quantity of manure treated by 0.01%, but the number of MLBGP will be increased by 5%. The available digester volume will increase by 19% whilst the amount of waste treated by AD processing will increase by 8%. The average treatment capacity of the biogas plants under the ADB loan will be 61,700 t/yr, nearly two times higher than the average capacity of the existing installations in 2005.

The biogas production will be about 25% of the 2005 performance. As most of the biogas will be used for electricity and heat production (CHP), the biogas-electric power generation will be 131 million kWh, an increase by 3 times, with the impact on household biogas distribution being an additional 10% compared to 2005. The expected electricity power generation capacities will be at least doubled. The quantity of eco-fertilizer will be with about 6 million tons per year at least the same amount as in 2005, therefore more than doubled.

The ecologically relevant GHG emission reduction will be, about 1.2 million t CO_2.equiv, which will increase the official sector performance by 17%, however the calculation basis might not be the same.

Due to the higher standard of technology and plant size the average employment will increase from 2.6 to 11 people per plant and the indirect beneficiaries will be more than 280,000 rural households. About 0.45 million t/yr of COD will be converted into biogas which relates to about 5.5% of the COD emission caused by the animal husbandry sector in 2001 all over China.

The key features and status of core- and subproject preparation per province as of December 2008 is show n in Table 27.

Table 27: Status of Project Preparation in Six Provinces (as of 2 Dec 2008)

ITEM	HLJ	HNN	JNS	JNX	SHD	SHX
1. Subprojects	14	40	12	51	23	14
2. Core Subprojects	2	2	1	2	2[a]	2
3. Treatment Volume (million t/yr)	1.107	2.933	0.670	0.697	2.599	1.496
4. Nr. of Plants with Power Generation	11	39	12	28	21	4
5. Power Generation (million kwh/yr)	9.260	34.9	14.388	11.233	30.224	22.281
6. IEEs [b]						
a. Preparation	Done	23 Done 17 Ongoing	CSP, done Non-CSPs ongoing	Done	Done	CSP done Non-core, ongoing
b. Approval				Done		Core, done
7. FSRs						
a. Provincial FSR						
(i) Preparation	On-going	Being revised	On-going	Done	On-going	Done
(ii) Approval						
b. Subproject FSRs						
(i) Preparation	Done	Done	Done	Done	On-going	12 Done 2 Uncertain
(ii) Approval						
8. Financial due diligence of subprojects	Done	Done	Done	Done	Done	Done
9. Local government guarantee	Done	Done	Done	Local to Provinc e, done	Done	Done, to be copied to DOF
10. Setup of PIO	Done	Done	Done	Done	Done	Done

[a] May need to replace one subproject as it is within a protection area.
[b] Some subprojects need to prepare EIAs for the farms, which shall be completed and approved by loan negotiations.

Table 28: ADB project impact on the middle and large-scale biogas plants development after 2015, related to the 2005 performance (based on 11 core- subprojects and all 154 subprojects).

Performance of MLSBPs	[ ]	Total MLBGP performance 2005	Impact of 11 MLBGP core-subprojects after 2014	Increase by (%)	Impact of 154 MLBGP subprojects after 2014	Increase by (%)	Commends
Animal manure in all China	bn t/yr	2.1	0.002	0.1	0.01	0.5	
Number of MLBG plants	n	* 3,764	11	0.3	154	5	
Digester net-volume	m^3	* 1,724,100	46,000	2.5	333,000	19	
Waste Treatment Amount	mn t/yr	* 122,820	1.97	1.6	9.39	8	
Average treatment capacity	t/yr*plant	32,000	179,000	660	61,700	2 x	
Biogas Output	mn nm^3/yr	* 341	19.2	5.6	101.5	25	
Biogas Supply to Households	mn nm^3/yr	* 138	0.87	0.6	14.9	10	
Biogas Power Generation	mn kWh/yr	40	29.7	42	131	3 x	
Installed Capacity	MW	19.2	5	20	20	100	
Commercial Eco-Fertilizer	mn t/yr	4.5	0.72	14	6.0	>120	
Increase of food crop value	%			10 – 20		10 – 20	estimated
GHG emission reduction	mn t CO_2/yr	7	0.090	17	> 1.2	17	
COD emission reduction	mn t COD/yr	7.8	>0.4	0.06	>0.45	5.5	compared to 2001
CDM projects	n	0	6 - 11		> 100		2005 no CDM projects
Employment **	person	10,000	200	2	1,700	2.3	11/ plant = 4x more/ plant
Indirect beneficiaries (households) ***	n		>47,000		> 280.000		

* Source BIOMA, Chengdu Biogas institute, Wu Libin, 2006
** construction workers not included
*** refer to ecofarming beneficiaries (from investigation on core-subprojects) and 280.000 come from ecofarming expert's report

The detailed performance data for MLBGP core-subprojects and subprojects are to be seen in the 'Long List of ADB financed Candidate Sub – and Core-sub projects' (Supplementary Appendix K an L).

4.3 Financial Analysis

The financial analysis is undertaken to assess the financial viability and sustainability of the proposed Project. Support for eco-farming and improved technical services are viewed as additional to the subprojects for construction of bio-digesters, and account for only 7% of base costs. The financial analysis focuses on viability and sustainability of the biogas plant investments, and in particular on the CSP. The analysis comprises (i) evaluation of the financial management capacity of the CSP enterprises including their financial situation, (ii) assessment of their capacity to finance the counterpart contributions during the construction period, (iii) loan repayment capacity, and (iv) assessment of the financial viability of the investment with and without payment for CERs. Details of the first three analyses are in Appendix 7, while financial viability analysis is in Appendix 8.

Financial Costs. Subproject costs were obtained from the provincial feasibility study reports. The data were entered into Costabs for overall Project cost estimates as well as core subproject cost estimates. The main cost categories include civil works; equipment installation; equipment; vehicles; and survey, design and supervision. The breakdown of subproject costs by these categories for the 11 core subprojects is shown in Table 29.The total base cost of the core subprojects is about CNY213.7 million including CNY59.5 million for civil works, CNY128.6 million for equipment, CNY14.2 million for installation and testing, CNY3.5 million for equipment, and $8.0 million for survey, design and supervision. Other than for the Weiwei subproject the expenditure on vehicles for handling of organic fertilizer is negligible. The cost of subprojects ranges from about CNY4.1 million for the Jinmu to CNY71.0 million for Jiyuan.

Table 29: **Summary of Core Subproject Investment Costs**[a]

(CNY000s)

Province/ Subproject	Civil works[b]	Equipment installation	Equipment	Vehicles	Survey, Design & Supervision	Total
Heilongjiang/Hexie	2,739	479	4,748	100	88	8,153
Heilongjiang/Jinli	2,304	175	1,962	100	88	4,628
Henan/Haoyun	1,595	121	4,752	220	120	6,808
Henan/Huimin	7,351	555	3,240	0	180	11,326
Jiangsu/Weiwei	8,905	2,508	24,848	3,000	904	40,165
Jiangxi/Jinmu	2,486	148	1,177	0	271	4,083
Jiangxi/Lulin	2,518	137	1,964	35	310	4,963
Shandong/Lvyuan	6,727	2,000	17,395	0	1,520	27,642
Shandong/Zhongkang	4,838	2,480	8,732	0	902	16,952
Shanxi/Jiyuan	13,790	4,969	49,600	0	2,658	71,017
Shanxi/Wantong	6,259	580	10,173	0	964	17,976
Total	**59,512**	**14,152**	**128,591**	**3,455**	**8,005**	**213,713**

[a] Base costs only, excluding price and physical contingencies as well as financial charges.
Source: Consultant's estimates from Costabs files based on subproject feasibility reports

Financial Management Capacity of the CSP Enterprises. All of the CSP enterprises (selected based on the 'CSP selection criteria' (Supplementary Appendix G) were assessed on the basis of the Financial Management Assessment Questionnaire (see Supplementary Appendix C). All enterprise staff is qualified but have no previous experience of ADB-financed projects. The Project will need to enhance their capacity in terms of policies and procedures to ensure effective project implementation. All of the enterprises have an internal audit system and 9 are externally audited. They also have satisfactory financial management

capacity to (i) record required financial transactions and balances, (ii) provide regular and reliable financial statements and monitoring reports, and (iii) safeguard financial assets.

Analysis of the enterprises' financial statements and balance sheets indicates that, other than Jinli with a ratio of 0.98, all have a liability: equity ratio of 65% or less, which is considered reasonable. Returns on assets are less than 10% in all but four cases – Lulin (23%), Lvyuan (17%), Zhangkong (14%), and Jinmu (10%). Four of the enterprises – Hexie, Jinli, Jinmu and Lulin have – never received a loan from a bank, while of those that have received a loan only Haoyun has not reported a credit rating of AA or higher.[112]

Capacity to Finance Counterpart Contributions. The capacity of the enterprises to finance counterpart contributions is assessed based on comparison of the proposed beneficiary contribution, excluding proposed provincial government grants, as determined in the financing plan of the subproject cost estimates and the income before tax as reported in the most recent annual report of the company. Enterprises that can finance the counterpart contribution from two year's profit before tax are considered to be in a financially sound position, while those that cannot need to be examined more closely. Of the 11 CSPs, only 3 have a ratio of less than 50% - Jinli (48%), Jiyuan (29%), and Huimin (27%). The situation in Jinli is marginal and considered likely to be resolved by increased profits during the implementation years. Jiyuan is a large and highly diversified enterprise with many activities that were not included in the submitted accounts and is not anticipated to have any problems in financing the counterpart contributions. More attention may be required for Huimin.

Loan Repayment Capacity. Loan repayment capacity is assessed by comparison of the estimated loan repayments and operating costs compared to the expected income generated from production of energy (biogas and electricity).[113] The estimated operating costs and incomes are derived from the financial viability estimates and based on information provided by the CSP enterprises. The loan repayment schedule is estimated based on the financing schedule used in the cost estimates but modified to reflect the loan terms and conditions used for the loans to the enterprises.[114] Repayments after the grace period are estimated on a semester basis with 20 equal capital repayments plus the interest incurred in each semester. Income and repayment schedules for each of the CSPs are shown in Appendix 7.

The analysis indicates that, other than Haoyun and Zhongkang, all enterprises will be able to generate sufficient income from biogas/electricity and sale of organic fertilizer to repay the loan. Haoyun is likely to be able to use the income from the early years, when no repayments are due, to finance part of the future commitments but this is not sufficient to cover the full loan repayment costs. If possible CDM income from sale of CERs is included in the analysis the situation improves with Haoyun being included in the group of enterprises able to finance the loan repayment. However, Zhongkang continues to be in a negative position with a cumulative deficit of CNY0.79 million.

Financial Viability of CSPs. The financial viability of the CSP investments is assessed as part of the overall financial and economic analysis and details of the assumptions and calculations are included in Appendix 8 for the overall analysis and in the Supplementary Appendix I for the individual CSPs. The financial analysis is conducted for two alternative scenarios – excluding CERs and including CERs. The estimated investment costs include 10% physical contingencies but exclude price contingencies. The buildup of financial benefits is detailed in Supplementary Appendix I and CERs revenue is included for 10 years.

[112] Credit ratings are provided by banks such as the Agricultural Bank of China, Agricultural Development Bank, and Bank of China.
[113] Including the value of own-use electricity which is assumed to be the saved cost.
[114] For the repayment capacity estimates loans were assumed to be provided over 15 years with an annual interest rate of 7.83% and a 5-year grace period. Interest during the loan period is assumed to be capitalized.

The estimated financial internal rates of return (FIRRs) and financial net present values (FNPVs) for each of the CSPs are shown in Table 30. Financial viability is assessed on the basis of the FIRR being greater that the weighted average cost of capital (WACC) of 5.20% and a positive FNPV. From this it is evident that all of the core subprojects other than Zhongkang in Shandong Province (FIRR = 1.0%) and Jiyuan in Shanxi Province (FIRR = 3.3%) are financially viable without receipt of payments for CERs. The FIRRs of these subprojects range between 5.7% for Jinmu in Jiangxi Province and 10.0% for Huimin in Henan Province. However, 6 of the subprojects have FIRRs of less than 7.0% and could be sensitive to cost overruns or benefit decreases. This is assessed in the sensitivity tests

Table 30 : Estimated Financial Indicators by Core Subproject

Province/ Subproject	Excluding CERs		Including CERs	
	FIRR (%)	FNPV[a] (CNY millions)	FIRR (%)	FNPV[a] (CNY millions)
Heilongjiang/Hexie	9.5	4.19	13.2	7.32
Heilongjiang/Jinli	8.0	1.49	14.3	4.34
Henan/Haoyun	6.6	0.87	13.6	4.84
Henan/Huimin	10.0	5.05	20.9	14.95
Jiangsu/Weiwei	6.5	4.75	10.5	18.01
Jiangxi/Jinmu	5.7	0.20	13.8	3.05
Jiangxi/Lulin	6.3	0.54	13.3	3.52
Shandong/Lvyuan	6.9	4.55	10.3	13.08
Shandong/Zhongkang	1.0	-6.24	2.6	-3.70
Shanxi/Jiyuan	3.3	-10.22	10.9	28.53
Shanxi/Wantong	6.0	1.33	11.7	9.78

FIRR = Financial Internal Rate of Return; FNPV = Financial Net Present Value
[a] The discount rate used for estimating the FNPV is the weighted average cost of capital (5.20%).
Source: Consultant's estimates

Inclusion of receipts from sale of CERs improves the financial assessment with 10 of the core subprojects having FIRRs greater than the WACC and positive FNPVs. The range in FIRRs is from 10.3% for Lvyuan in Shandong Province to 20.9% for Huimin in Henan Province. Only Zhongkang remains financially non-viable with an FIRR of only 2.6%, which is a matter of concern and should be further investigated during detailed design.

Sensitivity tests of key cost and benefit parameters, as well as for lags in benefits, conducted for each of the CSPs under the without CER revenue scenario, indicate that Hexie, Jinli, and Huimin are all relatively robust, requiring a cost increase or benefit decrease of more than 10% to affect their financial viability. All other CSPs are relatively sensitive to both cost increases and benefit decreases. Jiyuan requires a cost decrease or benefit increase of about 7% to achieve financial viability, while Zhongkang requires a cost decrease or benefit increase in excess of 20%. A1-year lag in benefits will affect the financial viability of all subprojects except for Hexie, Jinli, Huimin and Lvyuan. In the with-CER revenue scenario, the sensitivity test indicate that, other than Zhongkang, all of the subprojects are robust with respect to cost increases, benefit decreases, and a 1-year lag in benefits. Cost increases or benefits decreases of the order of 20% are required to affect the financial viability of all subprojects other than Jiyuan, where an approximately 18% change would affect its viability. Zhongkang would require a cost decrease of 12.9% or benefit decrease of 14.8% to achieve financial viability.

Sensitivity tests were also conducted on the impact of reduced CER revenue both alone, due to a decrease in CER price, and together with a decrease in income from biogas/ electricity output, as well as a 1- and 2-year lag in the receipt of CER revenues. The results

indicate that with the exception of Zhongkang, all subprojects are highly robust to changes in CER income and lags in receipt of CER income.

4.4 Economic Analysis

The economic analysis for the proposed Sector Project is based on the assessment of the economic viability of the 11 core subprojects identified and prepared during the PPTA. Details of the analyses are shown in aggregate in Appendix 8, and for the individual subprojects in the Supplementary Appendix I. The analysis is for the core subprojects only and the improved sustainability of the subprojects resulting from successful implementation of Component 3 is considered as additionality for which no economic benefits have been estimated. Similarly the project implementation support costs are not included in the analysis. Since the costs of these two components represent less than 4% of project base costs, their exclusion will not significantly impact on economic viability.

The economic analysis provides a rationale and justification for the Project based on policy and sector analysis. China is the world's second-largest energy producer and consumer. As the main energy source, coal consumption has caused severe air pollution, pressure on sustainable economic development, and significant global greenhouse gas emissions. China has abundant biomass resources that present a widely distributed potential renewable energy resource. Annual production of biomass with potential for energy use includes 300 million tons of crops residues, and 1.1 billion tons of livestock wastes from intensive animal breeding farms[115]. With respect to livestock wastes, the Government has taken steps to strengthen regulation on emissions from the intensive breeding animal farms, which currently account for about 12.5% of commercially produced livestock and are expanding rapidly. The proposed project will assist the Government to demonstrate the potential for developing sound market-based mechanisms for treatment of livestock and agro-industrial waste through promoting construction of improved bio-digesters with an acceptable operational life. The project also addresses key weaknesses that affect the financial sustainability of bio-digesters and facilitate the necessary capacity building.

The Project will generate direct economic benefits from energy (biogas and electricity), fertilizer (biogas slurry and organic fertilizer), global environmental benefit through reduction in greenhouse gas emissions, and livestock health benefits. Due to data limitations, economic benefits from improved livestock health are not included. Recovered biogas (predominantly methane) from the anaerobic digesters will be used either as fuel gas for household cooking or converted into electricity, which can be used directly by the livestock farms as a substitute for currently purchased electricity, sold to local consumers through a special purpose grid, and sold to the public grid. Recovered effluent from the anaerobic digesters will be used directly or separated into liquid and solid forms, which can be used by farmers for vegetable, mushroom and cereal crops plantations. In a limited number of cases the organic fertilizer is proposed to be further processed into high quality organic fertilizer. Reduced greenhouse gas methane emissions from the manure lagoons currently used for storage of the manure sewage as well as from reduction in the use of non-renewable energy sources, particularly coal can be traded through the CDM and generate income for 10 years as a result of CERs. In addition to the economic benefits for the initial 10 years, the reduced emissions will continue to generate these economic benefits beyond the payment period so long as the bio-digesters continue to be operated. Other economic benefits that are applicable to a limited number of subprojects include increased supply of recycled water (particularly agro-industrial subprojects), and reduced costs of wastewater treatment.[116] The

[115] Ministry of Agriculture, 2006, *Development Planning for Agricultural Biomass Industry*, Beijing.
[116] Reduced pollution levy is not included as an economic benefit since it is considered to be a transfer payment. However, if considered as the economic value of damage caused by pollution, the value should be included.

main indirect benefits of the Project include social benefits from more effective production practices and local community health benefits from reduced pollution.

Economic internal rates of return (EIRRs) and economic net present values (ENPVs) are estimated for the 11 CSPs including the economic value of CERs since even if these cannot be sold the economic benefits remain and the market price is considered to be a good indicator of their economic value. The results of the economic analysis indicate that all of the CSPs except Zhongkang are economically viable with EIRRs ranging between 14.0% for Lvyuan and 24.9% for Huimin (Table 31).

Table 31: Estimated Economic Indicators by Core Subproject

Province/ Subproject	Including CERs	
	EIRR (%)	ENPV (CNY millions)
Heilongjiang/Hexie	16.6	3.05
Heilongjiang/Jinli	19.7	2.66
Henan/Haoyun	16.8	2.04
Henan/Huimin	24.9	9.77
Jiangsu/Weiwei	16.8	11.47
Jiangxi/Jinmu	19.8	2.09
Jiangxi/Lulin	17.3	1.75
Shandong/Lvyuan	14.0	3.71
Shandong/Zhongkang	5.0	-6.84
Shanxi/Jiyuan	19.1	30.66
Shanxi/Wantong	17.0	5.39

EIRR = Economic Internal Rate of Return; ENPV = Economic Net Present Value
[a] The discount rate used for estimating the ENPV is the opportunity cost of capital, which is 12%.
Source: Consultant's estimates

Sensitivity tests are conducted for cost increases, benefit decreases, and benefit lags as well as for decreases in individual types of benefits. In addition sensitivity tests are conducted for decreases in CER benefits as well as lags in CER benefits. Details of the results are provided in Appendix 8. The tests indicate that, with the exception of Zhongkang, the CSPs are generally robust with respect to price increases and benefit decreases – Lvyuan is the only viable CSP with a switching value of less than 10% for either of these tests. If a 10% cost increase is combined with a 10% benefit decrease, 7 of the CSPs remain economically viable – Jinli (14.8%) Huimin (17.3%), Weiwei (12.2%), Jinmu (15.4%), Lulin (12.5%), Jiyuan (14.1%) and Wantong (12.5%) – while Hexie is marginal (11.9%). All of the viable CSPs except Lvyuan (11.3%) are viable with a 1-year benefit lag. Sensitivity tests on changes in CER values and lag in CERs revenues again indicate that the viable CSPs are highly robust. One or two year lags in CER revenues do not seriously affect the economic viability of the subprojects.

Estimates of the distribution of benefits indicate that the surrounding communities, as well as the project population at large, will receive substantial benefits from the Project. However, the poverty impact is more limited, with the poverty impact ratio for individual CSPs ranging up to 0.10 largely due to the relatively low poverty incidence, given the low poverty threshold, in the project area.

4.5 Social Dimensions

4.5.1 Social Benefits and Poverty Reduction

A social assessment of the 11 core subprojects was undertaken[117] and the findings are summarized in the Initial Social Assessment (Appendix 10). Based on these findings a Summary Poverty Reduction and Social Strategy have been prepared (Appendix 11).

The Project is expected to result in improved waste treatment and discharge by large livestock and agro-industrial enterprises. The impact will reduce reducing currently high polluting discharge and improve the local environment. Surrounding communities will benefit from the supply of low-cost clean energy such as electricity and biogas from renewable sources. This will replace their current use of coal, wood and crop wastes as well as the promotion of eco-farming based on the use of biogas effluent.

The Project will enable beneficiary enterprises to maintain present employment as well as create new employment opportunities. The current situation with waste disposal is not sustainable and unless actions are taken enterprises are risking the threat of contraction or even closure. Many are currently paying a substantial pollution levy, which negatively impacts their development. Excluding Weiwei,[118] the 10 core subprojects employ about 3,600 workers of whom about 2,400 are rural residents, and the number of employees of all proposed subprojects is around 26,000 of whom about two-thirds are rural residents. Per capita incomes are about CNY13,000 per year, indicating the major impact of these enterprises on the local economies.

The Project is expected to directly generate about 6,000 temporary full-time jobs during construction and 1,700 permanent full-time jobs during operation. The permanent jobs will predominantly need well-trained employees and as a result will require applicants to have a reasonable education level. Biogas maintenance staff must have the appropriate technical certification. As some will be responsible for monitoring CDM, they should have a higher education level. The Project includes support for training of workers in bio-digester operation and maintenance and will encourage a preference for employment of the poorer members of the community.

The surrounding communities will benefit from the promotion of eco-farming, expansion of livestock breeding, and the development of crop production, benefitting about 280,000, 100,000, and 600,000 households respectively. Of all of the eco-farming beneficiaries, 33,000 of the livestock breeders and 18,000 of the crop farmers will benefit incrementally.

The Project will have a positive impact on the poorer sectors of the surrounding communities by providing them with cheaper energy sources for cooking and opportunities to diversify into production of green and organic agricultural products that are expected to provide higher incomes. However, the impact of these benefits is not readily quantifiable since the statistics for the core subprojects indicate that (i) none of the core subprojects in Shandong or Jiangsu Provinces are located in poverty-stricken areas; and (ii) the core subprojects in the other provinces are predominantly located in developed countries or developed areas of poverty countries. Examination of specific data for the other proposed subprojects confirms a similar situation. However, the relatively small proportion of households below the national low income population threshold should not be interpreted to mean that a significant part of the population of the surrounding communities is not living in relative poverty. Interviews with the enterprise owners and their feedback questionnaires indicated that the Project will have a positive impact on the poorer sections of the local communities through:

[117] ADB's Handbook for Incorporation of Social Dimensions in Projects, 1994

[118] Weiwei employment of 5,500 persons is excluded since most of the staff is engaged in non livestock production activities.

(i) Expansion of eco-farming opportunities. Eco-farming is expected to benefit about 950 poor households in the core subproject areas and to provide an incremental income of about CNY527/year. About 11,000 households are expected to benefit from the overall Project.

(ii) Increased employment opportunities. Of the current employees of the core subproject enterprises, 38 are from poor families and have an average annual income of CNY13,078 per person. During construction the CSPs will provide 20 temporary jobs of 2-4 months for the poor and during operation 3 poor farmers will get stable employment opportunities. For the overall Project about 114 poor farmers are expected to benefit during construction and about 30 during operation

(iii) Poor households will benefit from participation in community contracting for breeding and the supply of livestock. Wantong CSP currently has contracts for cattle-breeding with 1,900 poor rural households in 2 towns of Lvliang mountain area and this earns each household about CNY3,000/year. For the overall Project about 11,000 poor households are expected to benefit from livestock contracting.

(iv) Improved energy situation and protection of the ecological environment since the poor tend to rely more than the non-poor on coal, wood, and straw as their energy source. About 10,000 poor households are expected to benefit.

(v) Improved living environment since the treatment of livestock manure and agro-industrial waste will reduce the pollution of surrounding air, water and soil. Health risks will be reduced for the neighboring farmers, in particular by about 5,200 poor households.

4.5.2 Land Acquisition and Resettlement

No land acquisition or resettlement is planned for the core subprojects as all have been confirmed to have sufficient land available for the proposed subprojects. The provincial offices have indicated that no land acquisition or resettlement is required for the non-core subprojects but this will need to be confirmed during project implementation. Similarly land acquisition and resettlement will need to be considered during planning of the demonstration centralized plants.

4.5.3 Ethnic Minorities

There are 55 ethnic minorities in project provinces but they number only 4.54 million persons or about 2.86% of the population of the provinces. Other than in Heilongjiang Province, where they number 2 million and account for 5.26% of the population, the proportion of minorities is very small. Ethnic minorities in Henan Province account for only 1.36% of the population, with Hui accounting for 86% of the minority population. Ethnic minorities in the other provinces account for between 0.27% of the population of Jiangxi to 0.68% in Shandong.

None of the 154 proposed subprojects are located in the minority autonomous areas and there are no ethnic minority communities located in the nearby communities. Consequently there is not anticipated to be any significant impact on ethnic minorities.

4.6 Environmental Impact Assessment

4.6.1 Introduction

The purpose of this section is to summarize the results of Initial Environmental Examination (IEE) for the Integrated Renewable Biomass Energy Development Project (thereafter the Project). In view of the fact that the Project is a sector loan, this study is based on the proposed subprojects, and has followed the requirements for environmental assessment of sector loans stipulated in the ADB Environmental Policy (2002)[119] and Environmental Assessment Guidelines (2003)[120].

Detailed project description and its settings can be found in the section on the proposed project and relevant appendices. Detailed analyses can be found in the Summary Initial Environmental Examination (SIEE) and the Initial Environmental Examinations (IEEs) of the six sample subprojects as appendices to this Final Report.

4.6.2 Environmental Assessment of Sector Impacts

The impact of the Project is to reduce pollution from animal waste through the production of biogas energy and fertilizer by products in the targeted farms and agro-processing operations. The Project will build new or replace old bio-gas generation facilities and biogas fed electric generation facilities in the 154 selected operations. The Project will improve the ecological impact of agriculture, promote renewable energy, and address the overarching goals of poverty reduction and environmental sustainability.

The sector loan project covers six provinces that include Heilongjiang, Henan, Jiangsu, Jiangxi, Shandong and Shanxi. It includes a total of 154 subprojects sites, of which the total capacity of the farms and agro-processing operations are: 1,457,684 pigs, 88,180 diary cows, 40,100 beef cattle, 2,666,600 chickens, 4,760,000 ducks, and 1.97 mn tons of agro-processing wastes. The total gas generation capacity and fertilizer generation capacity are 98.04 million m^3 and 0.89 million tons per annum, respectively. A summary of the subprojects is provided as follows (see Table 32 and Table26)**.**

Table 32: Summary of subproject conditions

		Heilongjiang	Henan	Jiangsu	Jiangxi	Shandong	Shanxi	Total
Subprojects and Outputs by Province								
No. of Subprojects		14	40	12	51	23	14	154
Waste Treatment (mn t/yr)		0.96	2.93	0.67	0.73	2.60	1.50	9.4
Biogas Production (mn m^3)		11.02	25.28	9.59	10.85	23.96	17.33	98.04
Electric Power Generation (million kWh/yr)		9.26	34.9	14.39	11.32	30.22	22.28	122.37
Organic Fertilizers for Eco-farming (million t/yr)		0.46	1.37	0.64	0.63	1.63	0.47	5.21
Animal Farms and Agroprocessing Operations covered under the Project at each Province								
Pig	No. of Farms	7	30	7	47	6	9	106
	No. of Pigs	53,000	664,60	98,500	272,294	119,000	151,450	1,457,684
Diary	No. of Farms	5	6	4	1	4	0	20
	No. of Cows	36,000	8,380	20,200	3,000	10,600	0	88,780
Cattle	No. of Farms	2	1	0	0	4	2	9
	No. of Cattle	14,000	1,500	0	0	16,000	8,600	40,100
Chicken	No. of Farms	0	5	1	1	2	4	13
	No. of Chickens	0	880,000	360,000	131,600	500,000	795,000	2.6 mn
Duck	No. of Farms	0	0	0	0	9	0	9
	No. of Ducks	0	0	0	0	4,760,000	0	4.7 mn
No of Agroprocessing		2	0	1	2	5	1	11

[119] *Environmental Policy* (2002), Asian Development Bank, Manila, Philippines.

[120] *Environmental Assessment Guidelines* (2003), ADB, Manila, Philippines.

The Project activities deal with the use of the solid and liquid wastes from these animal and agro-processing operations, totaling 9.50 million t/yr, as feedstock to produce 98.04 million m^3/yr of biogas with anaerobic fermentation technologies. About 14.30 million m^3/yr of the biogas will be transmitted to the local village gas grids, 6.17 million m^3/yr for heating, and the remaining 77.55 million m^3/yr will be used to generate 122.37 million kWh/yr of electric power. The subprojects will also produce a total of 4.32 million t/yr of liquid organic fertilizers and 0.89 million t/yr of solid organic fertilizers for eco-farming. Four types of anaerobic digestion technologies are used under the Project. They include USR (Upflow Sludge Reactor), CSTR (Continuous Stirred Tank Reactor), UASB (Upflow Anaerobic Sludge Blanket Reactor) and HCF (High-Concentration Flow Reactor). There will be no increase in the capacity of animal farming and agro processing operations under the Project. Therefore this environmental impact assessment is dealing with the environmental impacts derived from the construction and operations of the facilities that the Project will deliver.

4.6.2.1 Contribution to National Strategy

PRC Government plans call for the accelerated development of medium and large sized biogas plants (MLBGPs) on large-scale livestock farms as well as household biogas in rural areas. The 2020 national target is to develop 10,000 MLBGPs in the agricultural sector and another 6,000 AD plants at industrial sewage treatment plants, with an annual biogas yield of 14 billion m^3 and electric power generation of 3 million kilowatt. By building 154 MLBGPs, the Project will contribute to rural renewable energy production, support the circular economy and zero-waste approach, in order to achieve a higher economic and socioeconomic sustainability in the animal farming sector and contribute to rural poverty reduction.

4.6.2.2 Renewable Energy for Rural Communities

According to estimates under the ADB-sponsored study on the national strategy for rural renewable biomass energy development[121], household energy consumption by residents in rural China will range from 280 to 358 million tce by 2020 representing an annual increase of 1.88% to 3.44%. Among the high quality energy resources, the proportion of biogas is expected to increase between 3.9% to 11.4%, pelletized fuel by 3.9% to 9.5%, and electricity by 7.6% to 8.4%. This Project will produce a total of 98.04 million m^3/yr of biogas with anaerobic fermentation technologies. About 14.30 million m^3/yr of the biogas will be transmitted to the local gas grids, 6.17 million m^3/yr for heating and the remaining 77.55 million m^3/yr will be used to generate 122.37 million kWh/yr of electric power which will be transmitted to local power grids. Most of the end-users of the newly available energy will be rural enterprises, public institutions and residents who are situated adjacent to the gas and power grids. The Project will therefore contribute to the country's drive to provide renewable, cleaner energy to rural communities, and help promote rural public health, socioeconomic development and the building of the "New Socialist Countryside".

4.6.2.3 Reduction in Non-Point Source Pollution

Pollution loadings from non-point sources (NPS) have grown to become a major source of pollution in the PRC[122]. NPS pollution from livestock breeding generally results from the inadequate management and treatment of solid and liquid animal wastes. The main pollutants include oxygen-consuming organic compounds, nitrogen, phosphorus and pathogenic microorganisms. The major environmental impacts include eutrophication caused

[121] ADB. 2008. *TA No. 4810-PRC: Preparing National Strategy for Rural Biomass Renewable Energy Development, Final Report*. Asian Development Bank, Manila, Philippines.

[122] Yuan Zhibin. 2007. *Evolution of Water Pollution in the PRC and Policy Recommendations*, Institute of S&T Policies and Management Sciences, Chinese Academy of Sciences, Beijing, People's Republic of China, http://www.cas.cn/html/Dir/2007/08/06/15/10/70.htm

by organic and nutrient pollutants, pollution of groundwater by nitrates, and associated human health effects. In addition, fermented livestock manure can generate a significant amount of NH_3, H_2S, skatole, CH_4 and other hazardous gases which can be a risk to air quality, climate and human health. It is estimated that the COD, TN and TP runoffs from livestock breeding to water bodies totaled 6.9 million, 3.7 million and 0.3 million tons respectively in 2001[123]. In comparison, the COD discharges from industrial and residential pollution sources for 2001 amounted to 6.08 and 7.97 million tons respectively.

4.6.2.4 Ecological aspects of Eco-Farming

The excessive use of chemical fertilizers in the PRC has been recognized by many. A comprehensive assessment has revealed that the rate of uptake by plants for nitrogen is only 30% to 35%, phosphorus 10% to 20%, and potassium 35% to 50%; the remaining nutrients enter the environment (primarily surface water and ground water) through a number of pathways such as erosion, absorption, runoff and leaching[124.] The excessive use of chemical fertilizers can also degrade the soil texture and permeability[125]. Studies have shown that the use of biogas residues can reduce the use of pesticides by 77.5%, increase grain and fruit production by 10% to 20%, and increase quality of the agricultural products. The Project is estimated to produce 4.32 million tons of liquid organic fertilizers and 0.89 million tons of solid organic fertilizers. Assuming a recommended application rate of 25 to 50 t/ha/yr[126], the Project will be able to supply adequate organic fertilizers for 208,400 to 104,200 ha of farmland.

4.6.2.5 Air and Water Pollution Reductions and Public Health

In the PRC, large- and medium-sized livestock farms are located in areas with concentrated populations and in close proximity to waterways. About 25% to 40% of the large and medium-sized livestock farms in the PRC are located within 150 m of drinking water sources or residential areas, which poses a serious threat to public health[127]. For the PRC as a whole, 2% ~ 8% of feces from livestock farms goes to water bodies, and the figure goes up to 50% for liquid excreta. Anaerobic fermentation is estimated to reduce disease-causing pathogens and virus by 90.6% to 99.9%, COD by 87% to 90%, BOD by 88%, and TN and TP by 10% ~ 30%[128]. The anaerobic digestion technology used in the Project will therefore greatly reduce the risk of water-borne and infectious diseases for animals and local residents. The use of clean energy such as biogas and electric power will also reduce outdoor and indoor air pollution for local communities. The total coal saved as a result of the production of 108.4 million m^3/yr of biogas from the Project will amount to 216,800 t/yr. Therefore, the total annual emission reduction resulting from the Project will be 235 tons of SO_2, 369 tons of NOx and 255 tons of total soild particles (TSP). The health benefits of the emission

[123] ADB. 2004. *Study on Control and Management of Rural Non-Point Source Pollution, TA No. 3891-PRC, Draft Final Report*. Prepared by China Green International Consulting Co. for Asian Development Bank, Manila, Philippines.

[124] Tang Lian, et al. 2003. Effect of agriculture non-point source pollution on groundwater pollution and control measures. *Research of Soil and Water Conservation*, Vol. 10, No. 4, pp. 212-214.

[125] Zhang Qichun and Wang Guanghuo. 2006. Effect of chemical fertilizer on structure of soil humus. *Acta Pedologica Sinica*, Vol. 43, No. 4, pp. 617-623. Wei Yu and Su Yang. 2007. Types, status and consequences of rural environmental pollution in China. *Progress in China S&T*, No. 19 (2007).

[126] Wong, W J, et al. 1999. Utilization of a manure compost for organic farming in Hong Kong. *Bioresource Technology*, Vol. 7, No. 1, pp. 43-36.

[127] SEPA. 2002. *Status and Prospect of Disposal and Utilization of Animal Wastes in Concentrated Livestock Operations in China*. Published for the State Environmental Protection Administration by the China Environmental Science Press, Beijing, China.

[128] Zhu Wanbin, et al. 2007. On the contribution of ecological agriculture to reduction of non-point source pollution in China. *Chinese Agricultural Science Bulletin*, Vol. 23, No. 10, pp. 184-187. Liu Jianmin and Chen Yucheng. 2005. Biogas technology for control and prevention of multiple non-point source pollution in agriculture. *China Biogas*, Vol. 24, No. 4, pp. 40-42.

reductions are difficult to quantify as they depend on population density and distribution and a variety of other factors, but the health and social economic benefits are believed to be significant.

4.6.2.6 Climate Change

The climate change benefits from this Project have been estimated by calculating the greenhouse gas (GHG) emissions for with-and-without-biogas-production scenarios. The Project as a whole will produce 108.4 million m^3/yr of biogas. Assuming one cubic meter of biogas would generate the same quantity of CO_2 reduction, the total GHG reduction benefits from the Project will amount to 1.21 million t/yr of CO_2 equivalent.

4.6.2.7 Socioeconomic Assessment

The economic benefits of a household-based biogas digester with a production capacity of 300 m^3/yr of biogas, including savings from reduced use of commercial fuels, savings from reduced use chemical fertilizers and pesticides and increased sales as a result of improved quantity and quality of agricultural products, are estimated to be CNY 2,000/yr[129]. Assuming a levy of CNY 2 per m^3, the Project would result in a saving of CNY 19.01 million per annum in pollution levies. Assuming a CER price of $12/t of CO_2 equivalent, the reduction by the Project of 1.21 million t/yr of CO_2 equivalent would generate an additional economic benefit of $14.52 million per annum for the participating enterprises. Therefore, the total annual economic benefits are estimated at CNY 771.71 or US$112.99 million[130].

4.6.3 Summary of IEEs for Sample Subprojects

The following sections provide a summary of the IEEs for the six sample subprojects. The selection of the sample subprojects has been based on a number of considerations. Firstly, at least one subproject for each type of major operations, including swine, cow and cattle, chicken, duck and agro-processing. In this regard, the Jiangsu Weiwei subproject deals with cow breeding, Shanxi Jiyuan with corn processing, Zhaozhou Jinli with swine breeding, Zouping Zhongkang with duck breeding, Henan Huimin with chicken and swine breeding, and Jiangxi Jinmu with swine breeding and organic farming. Second, one subproject for each province to ensure full geographic coverage. Thirdly, the largest operation within the confines of the above two parameters.

4.6.3.1 Description of the Sample Subprojects

IEEs have been prepared for six sample subprojects. These sample subprojects include: Jiangsu Weiwei Nongmu Co., Jiangsu Province, Shanxi Jiyuan Corn Enterprises Group, Shanxi Province, Zhaozhou Jinli Shengsheng Swine Breeding Co., Heilongjiang Province, Zouping Zhongkang Foods Co., Shandong Province, Henan Huimin Poultry Co., Henan Province and the Jiangxi Jinmu Swine Development Co.

4.6.3.2 Core-subprojects, description of the Environmental situation

***Jiangsu Weiwei Nongmu Co., Jiangsu Province*:** The subproject is situated in 2.5 km south of Zhangji Town, Tongshan County. Zhangji Town has a population of 68,000. The region has an annual mean temperature of 14^0C and annual precipitation of 853 mm, and frost free period of 216 days. There is no surface water in the county except for an irrigation ditch whose water quality is compliance with the *Irrigation Water Quality Standards* (GB5084-92). The overall air quality in the Project area meets Class II of PRC *Ambient Air*

[129] Wu Wenliang. 2005. The Chinese ecological agriculture: development strategies, typical models and technologies. *Proceedings of the Fifth Conference of the Science Council of Asia on Bioscience and Biotechnology for Sustainable Development: Future of Asian Economy*, May 11-13, Hanoi, Vietnam.

[130] Given the inherent difficulty in quantification, water pollution reduction benefits and health benefits are not included.

Quality Standards (GB3095-1996). There are no protected animal and plant species and cultural sites in the region.

Shanxi Jiyuan Corn Enterprises Group, Shanxi Province: The subproject is located in Dingxiang County in the loess plateau. The county has an annual mean temperature is 8-10^{0}C, annual precipitation of 397 mm and frost free period of 150 days. Rural population accounts for 85.8% of the total population of 209,200, and corn accounts for 86.25% of total grain production. Lutuo River is the main water body; the water quality is below Class IV. The air quality can meet Class II of PRC *Ambient Air Quality Standards* (GB3095-1996). There are neither nature reserves nor historic sites.

Zhaozhou Jinli Shengsheng Swine Breeding Co. Ltd., Heilongjiang Province: The subproject is situated in Zhaozhou County. The county has 1.83 million mu of farmland and 0.85 million mu of grassland. It has an annual mean temperature of 4.3^{0}C and annual precipitation of 462.8 mm. There is no much surface water in the county; the Songhuang River is located 50 km away. The air quality in the subproject area meets Class II of PRC *Ambient Air Quality Standards* (GB3095-1996). There are no protected animal and plant species and cultural sites in the subproject area.

Zouping Zhongkang Foods Co., Shandong Province: The subproject is situated in Zouping County which has an annual mean temperature at 13 ^{0}C and annual mean precipitation at 633 mm. The county has a population of 709,570. Crop production is the leading sector in the area, animal husbandry is also developed. The water quality of the three main rivers is below than V level. The air quality meets Class II of PRC *Ambient Air Quality Standards* (GB3095-1996). There are no protected animals and plants.

Henan Huimin Poultry Co., Henan Province: The subproject is situated in 2 km west of Shangtun Town, Sui County. The county has a population of 0.807 million. Crop production is the leading sector in the area, animal husbandry is well developed. The Huiji River has a water quality is between Class IV and Class V. The air quality meets Class II of PRC *Ambient Air Quality Standards* (GB3095-1996). There are no protected animal and plant species and cultural sites in the subproject area.

Jiangxi Jinmu Swine Development Co., Jiangxi Province: The subproject is located in Jinxi County which has an annual mean temperature of 17.9^{0}C and annual mean precipitation of 1,867 mm. The county has a population of 280,000. The water quality of the Fu River meets the Class II water standards, and the air quality meets Class II of PRC *Ambient Air Quality Standards* (GB3095-1996). There are no protected animal and plant species and cultural sites in the subproject area.

4.6.3.3 Site Considerations

Multiple candidate sites were identified and analyzed for each of the sample subproject. The following factors were considered for the site selection: i) occupation of less land; ii) safe and sanitary distance to sensitive areas, including residences and residential areas, schools, hospitals, and business and office districts; iii) avoidance of runoff to surface water; iv) avoidance of penetration of leachate to groundwater aquifers; and v) adequate farmland for use of biogas residues to minimize non-point source pollution.

4.6.3.4 Potential Environmental Impacts during Construction and Mitigation Measures

For all subprojects, the construction of biogas digesters and associated facilities and infrastructure will require the removal of vegetation and excavation. The excavated earth will be used for road building and landscaping, and no external disposal is needed. Water and soil retaining weirs will be used to avoid soil erosion. Measures such as water spraying and

truck covers will be adopted so as to suppress the generation of dust. In view of the relatively long distance from sensitive areas and with the use of low-noise machinery, the noise pollution will be minimal. Solid wastes from construction activities will be collected by local sanitation bureaus for disposal in landfill sites. The wastewater from construction activities and from construction workers will not contain toxic substances and will be used for site spraying and landscaping. The environmental impacts during construction will be temporary and localized, and judged to be insignificant.

The major potential adverse environmental impacts during the operation phase are anticipated to include the following: (i) odour; (ii) water pollution; (iii) noise; and (iv) safety. The potential impacts and mitigation measures are summarized as follows.

(i) **Odour:** Odour is expected three major sources, including manure and waste transportation, manure and waste storage, and application of biogas residues as organic fertilizers. Of the sample subprojects, the biogas digesters will be built adjacent to the livestock and agro-processing operations, and as such the transportation of livestock manure and agro-processing wastes will be confined within the farms and plants. Sealed and covered vehicles will be used to prevent leakage during transportation. The livestock manure and agro-processing wastes will be dumped directly into the biogas digesters; no storage will be necessary. The anaerobic digestion process will remove over 90% of the odour. The field application of the biogas residues will be scheduled to avoid windy days, such that the odour will not be blown too far. Although unavoidable, the odour, with the recommended mitigation measures, can be minimized to an acceptable level.

(ii) **Water Pollution:** Water pollution will come mainly from surface runoff when the biogas residues are applied as organic fertilizers in the field. According to calculations, there is adequate farmland in the sample subproject areas so the application rate will not exceed the recommended 25 to 50 t/ha/yr. In the meantime, the application of biogas slurry and solids in the field will take consideration weather conditions and crop growth status. It will be scheduled to avoid the rainstorm season. Moreover, burying instead of spreading will also reduce the amount of surface runoff. The application areas should also be as far as possible to water bodies. With these mitigation measures, the pollution impact on the water environment will be insignificant.

(iii) **Noise:** Noise pollution comes mainly from the mechanical facilities at the highest level of 100 dB(A) (electric power generator). In view of the long distance sensitive areas (e.g., residential areas, schools, hospitals, etc.), the noise impacts on local communities will be minimal. However, noise pollution may also affect animals. To mitigate this impact, it is recommended that low-noise equipment will be selected, and insulation of power houses will be adopted. With the implementation of the mitigation measures, the noise impacts on people and animals will be minor.

(iv) **Safety and GHG Emissions:** Risk exists on the leakage of methane and complementary facilities as a fire and explosive hazard, and as a source of GHG emissions The mitigation measures are to: i) strictly obey the *Guideline on Operation, Maintenance and Safety of Biogas Systems for Livestock and Poultry Farms* (NY/T1221-2006) proclaimed by Ministry of Agriculture; ii) develop and implement operational safety procedures for biogas facilities; iii) provide safety training by biogas system safety experts to operational and management staff; iv) install safety apparatus, including water sealing and constant pressure equipment; v) provide fire prevention and extinguishing facilities; and vi) develop and implement emergency procedures for leakage, fire and explosion, and conduct

periodic drills. With the implementation of the proposed mitigation measures, the risk can be reduced into the minimum.

4.6.3.5 Public Consultations

For each subproject, key government stakeholders and environmental experts have been consulted throughout the domestic EIA process. A questionnaire survey of local residents numbered between 50 and 200 was carried out by the EIA institute. The comments and suggestions received from the survey covered odour prevention and control, water pollution prevention and control, safety and sanitation, implementation of mitigation measures and operational supervision by the local Environmental Protection Bureau EPB, and employment opportunities for local communities. The stakeholder comments and suggestions have been incorporated into the EIA reports. The stakeholder consultation exercises will continue during the Project implementation in accordance with ADB's and PRC's procedures and guidelines. The results of the consultations will be included in the semi-annual progress reports to be prepared by the EA, with assistance from the implementation consultancy, and submitted to the ADB and the Government.

4.6.3.6 Institutional Arrangements and Environmental Monitoring Program

For each subproject, the municipal EPB has been involved in the planning stage and is the responsible agency for reviewing and approving the domestic EIA report in accordance with the PRC *EIA Law* of 2003 and relevant regulations. As per PRC regulatory requirements[131], the municipal EPB will conduct an audit of the environmental protection facilities upon completion of construction, and will issue an approval certificate if the environmental facilities meet the design criteria, or else issue an order for corrective action. The Enterprise will be responsible for implementing the mitigation measures. Regular compliance monitoring will be conducted by the Municipal Environmental Monitoring Center under the delegation of the municipal EPB.

MOA as the EA will have the overall accountability for all subprojects for ensuring the compliance with the PRC environmental laws and regulations as well as the provisions of the *Environmental Assessment Guidelines* of the ADB. Each Enterprise will be responsible for implementing the specific mitigation measures as contained in the Environmental Management Plan (EMP) of the particular subproject. Within the Enterprise, a safety and environment protection section will recruit three environmental staff and they will be responsible for ensuring implementation of the mitigation measures in the EMP and corrective actions, and coordinating for environmental audit and monitoring.

The EA will be supported by the implementation consultancy to be retained through competitive bidding. The implementation consultancy will include a domestic environmental expert and an international counterpart. It will: i) advise the EA, IAs and Enterprises on ADB environmental safeguards requirements and PRC environmental laws and regulations; ii) provide training to the EA, IAs and Enterprises on environmental management and environmental monitoring; iii) assist the EA and IAs in overseeing the implementation of the EMP and environmental monitoring program; and iv) assist the EA, IAs and Enterprises in meeting the environmental reporting requirements of the ADB and PRC.

4.6.3.7 Findings and Conclusion

The findings from the IEEs of the sample subprojects have shown that the subprojects will produce multiple environmental and social benefits that include, among other things, cleaner energy for rural communities, organic fertilizers for eco-farming, reduced non-point source water pollution, reduced odour annoyance to local communities, reduced sanitation and

[131] *Management Guideline on Acceptance Review and Approval of Construction Projects upon Completion*, SEPA, 2001.

public health risk, reduced emission of GHGs, and promotion of rural socioeconomic development. Possible adverse environmental impacts during construction and operation of subproject facilities, including soil erosion, surface runoff and foul odour from application of biogas residues, noise, and fire and explosion hazards, will be expected. Mitigation measures, institutional arrangements, environmental monitoring and adjustment mechanisms, capacity building for EA and IAs, and public consultations have been proposed. The residual adverse environmental impacts are assessed to be insignificant. A Summary Environmental Impact Assessment (SEIA) is, therefore, not required.

4.6.4 Environmental Criteria for Subproject Selection

As a sector loan, the Project has an evolving scope. The Final Report is prepared on the basis on 154 subprojects[132]. The number of subprojects will be revised as the project preparation moves along and during project implementation. The PPTA Consultants have prepared a list of environmental criteria for the selection of subprojects. The environmental criteria have been used for the subproject screening and selection throughout the PPTA. They will be used for further subproject screening and selection.

The environmental criteria include the following: (i) regulatory restrictions; (ii) safe distance from sensitive objects; (iii) sensitivity of local environment; (iv) carrying capacity of local farmland; and v) environmental commitment of the enterprise. A more detailed description of the environmental criteria is provided in the Environmental Assessment and Review Framework as appendix to the SIEE. These criteria will be applied when the environmental assessment and review is conducted.

First, regulatory restrictions refer to environmentally-sensitive areas – such as drinking water supply protection sources, cultural and tourist areas, nature reserves and populated areas – where concentrated livestock breeding operation are prohibited by law[133]. Second, in the PRC, no national regulations exist on the minimum distance to sensitive areas, such as isolated residences, residential communities, schools, hospitals, office districts, business areas and tourist spots. In reference to Canadian[134], American[135] and Zhejiang provincial[136] standards, the PPTA Consultants proposes 100 m to isolated, occupied residence, 500 m to afore-mentioned sensitive areas, and 1,000 to 2,000 m to the sensitive areas downwind. If manure transport and storage is well covered, the distance can be reduced. Third, the environmental impact assessments will include an assessment of the available farmland in the subproject area and of the total carrying capacity of the farmland for biogas residues[137], to avoid non-point source pollution. Finally, the existing environmental performance of the enterprise and its willingness should be taken into consideration in the EIA.

[132] Sinoc. 2008. *Draft Final Report, Preparing the Integrated Renewable Biomass Energy Development Project*. Submitted to Asian Development by Sinoc Investment Consulting Co., Ltd., Beijing, People's Republic of China.

[133] SEPA. 2001. *Management Guideline on Pollution Prevention and Control of Livestock Husbandry*. State Environmental Protection Administration, Beijing, China.

[134] Province of British Columbia. 1978. *Odour Control on Swine Farms*. Order No. 361-800-01, Ministry of Agriculture and Food, Vancouver, British Columbia, Canada.

[135] State of North Carolina. 2008. *Rule 15A.NCAC.02D.1808, Evaluation of New or Modified Swine Farms*. Proposed for adoption to address the requirements of Session Law 2007-523, s.1(a) which includes the requirement for new or modified swine farms to "substantially eliminate the emission of odor that is detectable beyond the boundaries of the parcel or tract of land on which the swine farm is located."

[136] Province of British Columbia. 1978. *Odour Control on Swine Farms*. Order No. 361-800-01, Ministry of Agriculture and Food, Vancouver, British Columbia, Canada.

[137] According to previous studies, the threshold level for farmland application of livestock manure is 25 to 50 t/ha/a. The actual amount depends on a variety of factors, including climatic conditions and soil properties. See, for example, Gao Ding, et al. 2006. Release of pollutants from livestock manure in China and recommended strategies for pollution prevention. *Geographical Research*, Vol. 25, No. 2, pp. 311-319.

4.6.5 Environmental Assessment and Review Framework

The PRC has a formal environmental impact assessment and review process. The 2003 Environmental Impact Assessment Law[138] requires all construction projects to undergo environmental impact assessment, review and approval before the proposed projects can proceed. Other important regulations and standards with relevance to environmental impact assessment of livestock breeding operations include the following:

[138] People's Congress. 2003. *Environmental Impact Assessment Law*. Beijing, People's Republic of China. For the first time, the Law also require the assessment of plans and programs. Another important feature is the requirement for involving the general public in the EIA process.

Regulations/Standards	Summary
Environmental Quality Standards for Livestock and Poultry Farms (NY/T 388-1999), Ministry of Agriculture	It stipulates the air and ecological environmental standards within as *well* as drinking water standards for livestock and poultry farms.
Guideline on Pollution Control for Livestock and Poultry Farms (2001), Ministry of Environmental Protection	It specifies the sitting restrictions, environmental impact assessment requirements and the pollution control requirements for livestock and poultry farms.
Discharge Standards of Pollutants for Livestock and Poultry Breeding (GB 18596-2001), Ministry of Environmental Protection	It stipulates the daily unit discharges of wastewater by volume and by season from livestock and poultry breeding operations and the concentrations of 8 pollutants (BOD, COD, SS, NH_3-N, TP, coliform counts, ascarid eggs and foul odour).
Criteria for Evaluating Environmental Quality of Livestock and Poultry Farms (GB/T 19525.2-2004), Ministry of Agriculture	It specifies the procedures, methodologies, contents and requirements for environmental quality assessment of proposed new construction, modification and expansion of a livestock and poultry farm. The standards are for use of environmental quality assessment and environmental impact assessment of scale livestock and poultry farms.
Standards for Irrigation Water Quality (GB 5084-2005), Ministry of Agriculture	It contains 27 parameters, including 16 basic control parameters that apply to irrigation with surface water and treated wastewater from livestock and agroprocessing industries, and 11 supplementary parameters that can be imposed by EPBs at the county level or above.
Animal Husbandry Law (2006), National People's Congress	Chapter IV, Article 39 (4) requires livestock breeding farms and districts to use wastes for biogas production or to install other forms of sanitary disposal facilities.
	Chapter IV, Article 40 prohibits livestock breeding farms and districts to be built in environmentally sensitive areas.
	Chapter IV, Article 46 requires all livestock breeding farms and districts to ensure that the waste utilization or sanitary disposal facilities will operate properly; violators will be prosecuted; and the State supports waste utilization and sanitary disposal.
Environmental Quality and Sanitary Control Requirement for Livestock and Poultry Farms (NY/T 1167-2006), Ministry of Agriculture	It stipulates: (i) the indicators for livestock and poultry farms on ecological environmental quality and sanitation, air environmental quality, soil environmental quality and sanitation, and drinking water quality and sanitation; and (ii) environmental quality and sanitation control measures for livestock and poultry farms.
Technical Requirements for Non-Hazardous Treatment of Animal Manure (NY/T 1168-2006) Ministry of Agriculture	It stipulates the technical requirements for the site selection, layout, treatment technologies, epidemiological control parameters, and pollution monitoring and control for concentrated animal breeding farms, districts and manure-processing facilities.
Technical Criteria for Controlling Environmental Pollution of Livestock and Poultry Farms (NY/T 1169-2006), Ministry of Agriculture	It stipulates: (i) livestock and poultry farm site selection, internal layout, and pollution control facilities; (ii) basic technological requirements for control livestock and poultry farm pollution from foul odour, manure, wastewater, disease-vector microorganisms, disease-control drugs and dead animal bodies; and (iii) technical requirements for environmental pollution monitoring of livestock and poultry farms.
Technical Specifications for Operation, Maintenance and Safety of Biogas Plants in Scale Animal and Poultry Farms (NY/T 1221-2006), MOA	It contains technical specifications for the operation, maintenance and safety of the various components and processes of a biogas plant for a concentrated animal or poultry operation.
Criteria for Design of Biogas Plant for Scale Livestock and Poultry Farms (NY/T 1222-2006), MOA	It specifies the scope, principles and parameters for the design of biogas plant for scale livestock and poultry farms, covering site selection, internal layout, production processes and residual utilization.

The environmental assessment and review procedure in relation to the subprojects involves a number of interrelated sequential steps as follows:

i) The Enterprise registers the subproject with the Municipal EPB by submitting the Project Proposal.
ii) The Municipal EPB will determine the class of EIA report (i.e., an EIS, TEIR or EIRF) and the review and approval authority. The EPB may require a thematic study or studies such as groundwater aquifer impact, for any issue of concern. In most cases of the subprojects under this particular Project, a TEIR will be required and the Municipal EPB will be the responsible review and approval authority.
iii) The Enterprise will contract an MEP-certified EIA institute to prepare the EIA report, according to the template designed by MEP.
iv) The Municipal EPB will organize a panel review of the EIA report once it received. The panel review will recommend the acceptance or rejection of the EIA report, or often provide comments for revision.
v) Once the final draft is received, the Municipal EPB will render a decision on whether or not the project is accepted or rejected.
vi) If the EIA report is accepted by the Municipal EPB, the Enterprise can proceed with construction, including the implementation of the mitigation measures as proposed in the EIA report.
vii) The Municipal EPB will conduct an environmental audit within three months of test operation, and may recommend corrective measures if deficiencies are discovered.
viii) The Municipal EPB also carries out regular (usually quarterly) compliance monitoring of the discharges and emissions of the plant. If violations are found, the plant will be ordered to take corrective actions; repeated violators will be ordered to shut down.

These procedures have synchronized both PRC and ADB regulatory and policy requirements. When ADB and PRC requirements differ, the more stringent is applied. For example, the PRC requirement for a simplified EMP will be adopted, whereas ADB has no specific requirement for an EMP. ADB requirement for public consultation and SIEE web posting will be adopted, whereas neither is required in the PRC. A detailed procedural roadmap for environmental impact assessment can be found in the SIEE and in Figure 10.

The implementation consulting services, to be engaged with loan proceeds, will cover the environmental assessment and review responsibilities. The Implementation Consultants will provide advice to the EA, IAs and Enterprises on, and will monitor and supervise, the environmental assessment and review of the non-sample subprojects. The monitoring results will be included in the project progress and monitoring reports to be submitted by the EA to the ADB. The Government will take timely corrective action on any non-compliance.

The Framework also includes the authorities and responsibilities of the domestic institutions and ADB departments involved in the environmental assessment and review process, procedural issues and actions, and staff requirements and budget. It is estimated that the environmental assessment and review will require 1,847 months of staffing inputs, with an indicative budget of $872,000. A detailed breakdown of the budget can be found in the SIEE (Appendix 12).

On the basis of the review of the IEEs for the six sample subprojects, it is concluded that the Project as a whole and the subprojects will fully meet ADB's environmental and social safeguard policy requirements, if the recommended environmental assessment and review is followed.

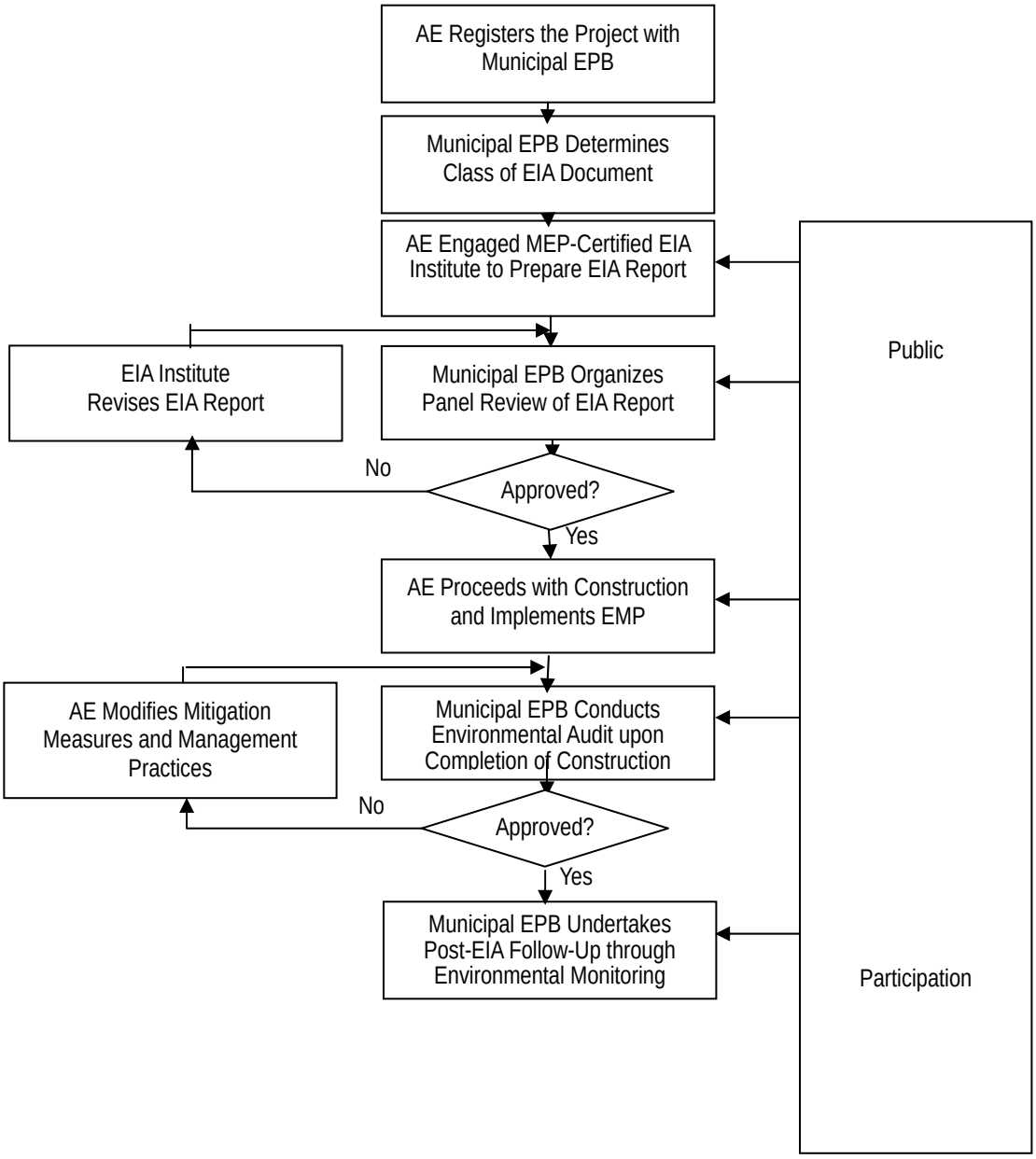

Figure 10: Procedural Framework for Environmental Assessment and Review.

4.6.5.1 PRC's Environmental Assessment and Review Process

The Project will comply with the formal environmental impact assessment and review process of the PRC. The 2003 *Environmental Impact Assessment Law*[139] requires all construction projects to undergo environmental impact assessment, review and approval before the proposed projects can proceed. An overview of the other relevant key important laws, regulations, guidelines and standards governing environmental impact assessment, and the siting and waste management of livestock breeding operations are included in the SIEE.

[139] People's Congress. 2003. *Environmental Impact Assessment Law*. Beijing, People's Republic of China.

A number of ministerial guidelines[140] have defined the classes of the EIA documents and the jurisdictional division of responsibilities for the review and approval of EIA documents for construction projects. The ministerial guidelines also define the requirement for the class of EIA document in accordance to the scale, investment, and environmental sensitivity of each of the 92 types of construction projects. The three classes of EIA documents include comprehensive environmental impact statement (EIS), or tabular environmental impact report (TEIR) or environmental impact registration form (EIRF). An EIS will be required if a construction project is expected to produce significant adverse impacts on the environment. A TEIR is required if the proposed project is expected to produce similar adverse environmental impacts but to a lesser extent. In 2006, SEPA issued an interim guideline on public participation in the EIA of a proposed project for which an EIS is required[141].

In the PRC, there is a stringent process for qualifying EIA institutes into Class A or Class B[142]. An EIA institute with a Class A certificate in a particular sector or sectors can prepare EISs for that particular sector or sectors. A 2001 ministerial guideline issued by SEPA requires an environmental protection audit upon completion of a project for which an EIS or TEIR is required[143].

4.6.5.2 Specific Environmental Assessment and Review Procedures

Authorities and Responsibilities

The authorities and responsibilities for the environmental assessment and review of the subprojects are summarized in Table 33. In accordance with EIA law and regulations of the PRC, the required EIA report for the subprojects under the Project is a TEIR that can be prepared by an EIA institute with a Class B certificate, and the responsible authority for approval and review of the EIA report is the municipal environmental protection bureau (EPB).

Environmental Criteria of Subproject Selection

As a sector loan, the Project has an evolving scope. The number of subprojects has changed from about 200 at the PPTA Inception, to about 150 in the final report. It is anticipated that the number of subprojects may further be updated and revised as the project preparation moves along and during project implementation.

A list of environmental criteria for the selection of subprojects has been prepared and already applied for the core subprojects. The environmental criteria to be used for further subproject screening and selection include: regulatory restrictions, safe distance from sensitive objects, sensitivity of local environment, carrying capacity of local farmland; and environmental commitment of the enterprise. The PMO and TIOs will be responsible for using the criteria to screen and select subprojects. The process will be similar to that used during the project preparation phase, i.e., a subproject will be examined against the criteria. Subprojects that can not meet the criteria will be removed from the list.

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[140] SEPA. 2002. *List of Classified Management of Construction Projects for Environmental Protection*. State Environmental Protection Administration Order No. 14, 12 October 2002, Beijing, People's Republic of China. SEPA. 2002. *Guideline on Jurisdictional Division of Responsibilities for Review and Approval of EIA Documents*. State Environmental Protection Administration Order No. 15, 1 November 2002, effective 1 January 2003, Beijing, People's Republic of China. SEPA. 2004. *Notice on Strengthening Jurisdictional Division of Responsibilities for Review and Approval of EIA Documents*. State Environmental Protection Administration Official Document No. (2004) 164, 2 December 2004, Beijing, People's Republic of China.

[141] SEPA. 2006. *Interim Guideline on Public Participation in EIA*. State Environmental Protection Administration, Beijing, People's Republic of China.

[142] SEPA. 2005. *Guideline on Certification of EIA Institutes for Construction Projects*. State Environmental Protection Administration, Beijing, People's Republic of China.

[143] SEPA. 2001. *Guideline on Environmental Audit upon Completion of a Construction Project*. State Environmental Protection Administration, Beijing, People's Republic of China.

Table 33: EIA Authorities and Responsibilities

Institution	Responsibilities / Authorities
Executing Agency (MoA)	• Supervise the IA to ensure compliance with PRC and ADB environmental assessment requirements • Supervise and monitor the implementation of the EMP • Provide regular environmental reporting to ADB
Implementing Agencies (Provincial TIOs)	• Overall responsibility for complying with PRC and ADB environmental assessment requirements • Identify and contract MEP-certified EIA institute to prepare the EIA report • Submit necessary documentation to the Municipal EPB • Implements the EMP
EIA Institute	• Prepare TOR for EIA and submit for review and approval by the Municipal EPB • Prepare the EIA report in accordance with PRC laws, regulations and standards and ADB environmental assessment requirements • Conduct public consultations throughout the EIA process • Revise the EIA report on the basis of comments of the EIA review panel
Municipal EPB	• Review and approve the TOR for the EIA • Organize a panel to review the EIA report • Conduct the environmental audit upon project completion • Delegate the Municipal Environmental Monitoring Station to undertake regular compliance environmental monitoring • Order modifications and impose fines and penalties for violations
Suppliers and Contractors	• Supply environmental protection equipment • Design and construct environmental protection facilities in accordance with the EMP
Implementation Consultancy	• Provide training to EA, IA, and suppliers and contractors • Conduct independent monitoring of the implementation of the EMP • Assist the EA with environmental reporting to ADB and Municipal EPB
ADB	• Undertake review of IEEs for non-sample subprojects • Conduct regular review missions during Project implementation

National guidelines[144] specify that concentrated livestock raising operations are not permissible in the following areas: i) important ecological function zones, drinking water supply protection sources, scenic areas, tourist areas, forest parks, cultural and historical relics protection areas, and core and buffer zones of nature reserves; ii) populated areas, including urban residential areas, cultural and educational and scientific research areas, medical areas; and iii) areas under special protection by law. Each and every proposed biogas subproject shall comply with this regulatory restriction. Moreover, the existing livestock operation for which the biogas subproject is proposed should also give full consideration to this regulatory restriction, as such an operation could be outlawed in the future.

In the PRC, no national regulations exist on the minimum distance to sensitive areas, such as isolated residences, residential communities, schools, hospitals, office districts, business areas and tourist spots. Based on international experiences[145], the Project will ensure minimum distances of 100 m to isolated, occupied residence, 500 m to afore-mentioned sensitive areas, and 1,000 to 2,000 m to the sensitive areas downwind. If manure transport and storage is well covered, the distance can be reduced.

[144] SEPA. 2001. *Management Guideline on Pollution Prevention and Control of Livestock Husbandry*. State Environmental Protection Administration, Beijing, China.

[145] Mainly Canada and the United States.

The afore-mentioned restricted and sensitive areas aside, there are other areas with environmental sensitivity that require special attention. The category of areas includes those upstream of watershed or a groundwater aquifer used as a centralized urban or decentralized rural water supply source. The determination of the environmental sensitivity of a subproject rests with the local EPB. When a subproject is determined by the local EPB to be environmentally sensitive, the EIA report will be upgraded to an EIS. If any of the subprojects receives this determination, the EIA report will be submitted to the ADB for review. Construction shall not commence until approval is granted by the local EPB and ADB.

The environmental assessments will include a rapid assessment of the available farmland in the subproject area and of the total carrying capacity of the farmland for biogas residues. Environmental pollution can occur if the application of livestock manure is excessive. According to previous studies in the PRC, a safe threshold level is reported to be between 25 and 50 t/ha[146]. If this threshold is exceeded, some of the manure risks to be washed or leached away as non-point source pollution, also depending on the different climatic zones. If excess is expected, alternative options should be recommended.

Future environmental compliance depends, to a large extent, on the demonstrated awareness and commitment of the candidate agro-enterprises. These factors will be taken into consideration in the environmental impact assessment.

4.6.5.3 Procedures for Environmental Assessment of Subprojects

The environmental assessment and review procedures in relation to the remaining subprojects are depicted in Figure 10. The relevant procedural issues and actions for environmental assessment and review of the subprojects are summarized in Table 34. These procedures have synchronized both PRC and ADB regulatory and policy requirements. When ADB and PRC requirements differ, the more stringent is applied. For example, the PRC requirement for a simplified EMP will be adopted, whereas ADB has no specific requirement for an EMP. ADB requirement for public consultation and SIEE web posting will be adopted, whereas neither is required in the PRC.

4.6.6 Conformity to ADB's Environmental and Social Safeguard Policies

The Project is classified as a Category B project according to ADB's environmental policy and sector loan procedures will be applied. A SIEE report has been prepared summarizing the findings of 6 core subprojects and disclosed on the ADB website. A due-diligence review has been carried out to assess the quality and completeness of 12 Chinese EA reports and to document experiences regarding the process to be applied for the remaining sub-project. It was concluded that the Project as a whole and the subprojects will fully meet ADB's environmental and social safeguard policy requirements. The applied Chinese EIA system complies with the ADB environmental policy in many aspects, including the preparation of a simplified EMP, the environmental audit upon project completion, and regular quarterly compliance monitoring.

The PRC regulations do not have provisions for public participation for a project for which a TEIR is required. This gap has been filled for the sample core subprojects by requiring additional public consultations to be conducted. All remaining subprojects will also be required conduct public consultations.

[146] Gao Ding, et al. 2006. Release of pollutants from livestock manure in China and recommended strategies for pollution prevention. *Geographical Research*, Vol. 25, No. 2, pp. 311-319.

Table 34: EIA Procedural Issues and Actions

Procedural Issue	Action
Environmental classification (if necessary)	• ADB has classified this Project as Category B for a sector loan, requiring: i) SIEE for the overall Project; ii) IEEs for sample subprojects; and iii) an environmental assessment and review framework for the non-sample subprojects. • According to PRC regulations, a TEIR is required for each subproject.
Specific of free limits[147] as appropriate	• Not applicable
Preparation of initial environmental examinations (IEEs)	• According to PRC regulations, a TEIR will be prepared by an EIA institute with a Class B certificate for each of the subprojects. • According to ADB policy requirements, the environmental assessment of all subprojects will be undertaken, on the basis on the environmental assessment and review framework agreed upon at the time of appraisal.
Requirements for environmental management plans	• According to PRC regulations, a simplified EMP, entailing formulation of environmental protection measures and evaluation of their effectiveness, will be prepared for each subproject. • According to ADB policy, there is no specific requirement for an EMP.
Requirements for public consultation and information disclosure	• According to PRC regulations, no information disclosure and public consultation is required for projects for which a TEIR is submitted. • According to ADB policy, public consultation is conducted but to a lesser extent than for a Category A project; the SIEE will be posted on ADB website after loan approval.
Review of environmental assessment reports by government environmental agencies	• According to PRC regulatory requirements, the EIA reports of the subprojects will be reviewed and approved by the respective municipal EPBs.
Review of environmental assessment by ADB regional departments and RSDD as necessary	• According to ADB policy, the project team is responsible for ADB's environmental assessment process, and environment specialists in EARD will review the sample EA reports. Quality assurance of projects and programs is undertaken by the project team, without formal peer review being done through the environment committee for a Category B project.
Monitoring environmental performance – reporting on environmental assessment activities	• According to PRC regulations, an environmental audit will be conducted upon completion. Regular quarterly compliance monitoring will be carried out by the Municipal Environmental Monitoring Center under delegation from the Municipal EPB. The Municipal EPB also makes unannounced inspections. • According to ADB policy, the EA will submit semi-annual environmental monitoring reports to the ADB. Two environmental monitors (international and domestic each) will form part of the implementation consultancy. The environmental monitors will conduct site inspections and assist the EA in preparing semi-annual environmental monitoring reports.

References: i) Operations Manual, Operating Procedures: Environmental Considerations in Bank Operations, OM Section F1/OP, Issued on 25 September 2006, Asian Development Bank; and ii) EIA Law, regulations and guidelines of the PRC.

4.6.7 Staffing Requirements and Budget

The total estimated budget for environmental monitoring is $122,000 for the entire duration of the Project. The estimates of staffing requirements and budget by institution to ensure compliance with both PRC regulations and ADB policies are presented in the SIEE. Coordination, technical analysis and monitoring will be necessary for completing the environmental assessments, including the preparation of EIA reports, public consultations, environmental audit upon completion, regular environmental monitoring, implementation consultancy, reporting, and coordination and management.

[147] Free limit: A monetary limit above which sub loans require the Bank's prior approval.

4.7 CDM Impact

By including the Clean Development Mechanism (CDM) in the project implementation, greenhouse gas emissions can be reduced which can generate the carbon credits for trading. This will bring additional economic benefits to the project via reduction of greenhouse gases emission and/or replacement of fossil fuels by clean renewable energy (electricity and heat). Carbon trading market through CDM has been increasing over last few years[148]. The implementation of projects with involving the CDM projects will improve the project economic benefits due to the potential revenue from the sales of CERs based on an average price of US$ 10/tCO_{2e}. The situation for 2008 CER prices is: ~7 Euro for post-2012 vintages, 6-10 Euro for medium-risk forwards, 9-11 Euro for low-risk forwards, 10-12 Euro for registered projects, 13-14 Euro for issued CERs, 13.6 Euro Dec. 31, 2008 spot price on Reuters[149]. Table 35 lists the potential benefits, provided all projects have been implemented CDM.

It shall be pointed out that not all projects can be developed for CDM. Table 35 indicates the maximum potential of the projects by using existing methodologies and leaving out small projects. More detailed analysis shall be further conducted for the feasibility of projects for further development into CDM projects, see more 4.5.3 on the risk of CDM project.

Table 35: Potential Emission Reduction Estimation and Benefits and Sensitivity analysis, Summary of Six Provinces

Item	Henan	Heilongjiang	Shandong	Shanxi	Jiangsu	Jiangxi	Total
ER (tCO_{2e}/y)	448,635	8,925	130,433	129,157	108,298	183,960	1,009,408
% of total (%)	44.4%	0.9%	12.9%	12.8%	10.7%	18.2%	100.0%
Potential benefits US$ *	4,486,350	89,250	1,304,330	1,291,570	1,082,980	1,839,600	10,094,080
10 years pot. benefits US$ *	44,863,500	892,500	13,043,300	12,915,700	10,829,800	18,396,000	**100,940,800**
Sensitivity analysis of CER price							
if CER =5 $/$tCO_{2e}$							
Potential benefits US$	2,243,175	44,625	652,165	645,785	541,490	919,800	5,047,040
10 years pot. benefits US$	22,431,750	446,250	6,521,650	6,457,850	5,414,900	9,198,000	50,470,400
if CER =15 $/$tCO_{2e}$							
Potential benefits US$	6,729,525	133,875	1,956,495	1,937,355	1,624,470	2,759,400	15,141,120
10 years pot. benefits US$	67,295,250	1,338,750	19,564,950	19,373,550	16,244,700	27,594,000	151,411,200

Note: * CER price = US$ 10/tCO_{2e} (= EUR 7.5/tCO_{2e})
The Emissions Reduction Potential is made based on the input data from the long list provided by the provinces. The accurate estimation of the CERs needs to make the detailed evaluation of baseline and project activity. This shall be further investigated to finalize and revise the estimation of the emission reduction potential.

The potential of CER revenues based on existing methodologies over a crediting period of 10 years is estimated to be US$101 million (see Table 27). If the small projects and project which require new methodologies are included the total emission reduction (ER) may amount to more than US$120 million (see subproject Long List in Supplementary Appendix K1), which can be used as an environmental value in the economic analysis.

[148] CDM increased to 947 Mt and €12 bn in 2007 (up 68% in volume, 200% in value compared to 2006). CDM holds 35% of physical market and 29% financial market, Carbon Point, 2008

[149] GTZ Climate Protection Programme, a project carried out on behalf of the German Federal Ministry for Economic Cooperation and Development, www.gtz.de/climate

The determination of the inclusion of subproject for the consideration for further development will depend upon different of factors, among them, the most important are the applicability of CDM methodologies, the risk to develop new methodologies by the project owner, the volume of potential CERs, the reliability of applied technology and the capacity of the project owners to operate the projects according 'best practice' and to deal with CDM monitoring and administration. Detailed case studies shall be further carried out one by one to estimate the possibility of CDM implementation. This will be further covered in the CDM final report.

An uncertainty of CDM project implementation in the post Kyoto scenario after 2012. To discuss future commitments for industrialized countries under the Kyoto Protocol, the Conference of the Parties (COP) serving as the meeting of the Parties to the Kyoto Protocol established a working group in December 2005 called the Ad Hoc Working Group on Further Commitments for Annex 1 Parties. The working group is set to complete its work by the end of 2009 in Copenhagen. However, it is most likely that CDM will continue since both Annex 1 and non-Annex 1 countries are showing positive attitude for the Clean Development Mechanism.

4.8 Assumptions and Risks

The following issues might be risk for the Project implementation:

- *Governmental policy continues to reduce the pollutions from the agricultural wastes and renewable energy production in rural areas.* This will ensure the financial support of the government at the provincial level that is required to provide counterpart contributions. There is evidence however that some enterprises may not be able to ensure the availability of counterpart contributions of 50% of the investment. The Provincial Finance bureau however is providing the guarantee of the repayment of the ADB loan in the case where enterprises are not able to meet their loan repayments. In the course of the financial evaluation of the enterprises it was seen that only about 20% of the CSP enterprises would be able to pay back the ADB loan from their own financial capacity. Certain provinces have expressed the need to provide additional financial assistance by special governmental funds, or they will take the responsibility to pay back the loan. Binding arrangements could not be identified by the PTTA team.

- *Technical capacity* to plan, set up and operate state of the art biogas plants which are running as biogas power plants under CDM conditions. Even though the new China National Standards for biogas plant design and operation[150] are indicating the 'right direction' the Project will require capacity building of the IAs and project owners. There is still a risk that the agricultural biogas plants are seen as technical installations which require qualified operation and maintenance. The biogas plants in the Project, which according to EU definition are all large sized biogas plants and will need qualified staff to ensure maintenance and process control.

- *Financial implications of revenues.* The main sources of income are Energy (electricity, heat or biogas), eco-fertilizer sales and CERs. These are essential to operate the biogas plants under financially viable conditions Therefore biogas plants which do not convert biomass in to biogas effectively (that is at least 60% of the COD is used) and don't use the biogas efficiently (at least 90%) will not achieve the required economic conditions for viability over the expected lifetime of 20 years.

[150] NY/T1222-2006: Design Standards for Biogas Projects in Large Livestock and Poultry Breeding Farms, NY/T 1221-2006: Technical Standards for Operation, Maintenance and Safety of Biogas Projects in Large Livestock Animal Breeding and Poultry Farms

- *Project Proposals (Draft Feasibility Studies) of Core-subprojects and subprojects.* The CSP FSRs do not currently meet the requirements to be accepted by the ADB for implementation. This is mainly with respect to the technical concept and detail design. The final FSRs must take into consideration the Chinese National Standards and the implementation conditions provided by the PPTA team (see Appendix 4B and Supplementary Appendix H) to upgrade and further improve the project standard to state of the art. The financial implications of this additional investment has been taken into account during the financial analysis and accepted by most of the provinces. The subprojects must apply the same framework conditions.

- *Financial viability of the smaller subprojects* at the lower end of the range: The final CSPs do not include the smaller CSPs.The technical/financial analysis was conducted on CSPs in the higher end of the range (Figure 7: Specific Investment costs of 11CSPs and of 143 subprojects in CHY/t.yr feedstock treatment capacity related to the plant capacity in t/yr shows that the small projects are more costly (the specific investment cost per feedstock treatment capacity of smaller projects is up to 5 times higher). Even an economic analysis of smaller decentralized projects has shown the limits of their economic viability. The problem of operating them under financially viable conditions remains. To apply the centralized biogas project approach and/or co-feedstock utilization to increase the size of these plants appears to be the best solution.

- *The equipment suppliers* are able to deliver reliable engineering quality and they are in the position to bear and provide plant performance guaranties, maintenance and costs guaranties, technical after sales services, training to the equipment users, spare part holding (to be requested in the tender documents) for reasonable and competitive costs.

- *'Turn key' procurement* is the recommended approach (see Appendix 4B) where plant-design, equipment supply and installation are under one contract. The capacity of the EAs, also the capacity and experience of the design institutes are sufficient to handle multiple contracts and to ensure that the links between civil works and good delivery and the implementation of various project lots without friction.

- *Centralized AD projects.* New logistical concepts are to be approached to make MLBPs developing sustainable and not only for pure large scale farms. Centralized AD projects are appropriate to process the manure from live stock animals raised by small to middle scale farms in certain regions. Business models have demonstrated that the centralized project approach can be developed to set up large scale, economically viable AD plants for China.

- *The grid companies* are supporting the sector under the provisions of the renewable energy law and buying the grid connected energy, but not only from large plants which can supply a surplus energy of more than 0.5 MW. For example the new German Renewable Energy Law[151] is now providing better electricity prices to small suppliers than to large ones. It can be shown that the production costs of electricity at small farms are higher than at large facilities (economy of scale).

- *Coordination of a multitask biogas sector.* This will be done to facilitate a business and operational environment for the sustainable implementation and operation of MLBPs. This will occur under a defined competitive political and technical framework conditions in a mature market to the benefit of the local and global environment.

[151] German Ministry for Environment, Erneuerbare-Energien-Gesetz, EEG 2009, German Renewable Energy Act (EEG), 2009, Gesetz zur Neuregelung des Rechts replaces Version 2004)

- *Eco-farming:* The theoretical value of slurry based eco-fertilizers (justified by NPK content, the organic matter, trace elements, the biocide effect), to arable soils is well known. The real cost savings through reduced need to purchase mineral fertilizer and pesticides are understood by the farmers. However it is not ensured that the farmers are willing to pay for biogas slurry from the BGPs. As such it has to be decided in an early stage of project development to invest in the required eco-fertilizer infrastructure. For fertilizer storage of the slurry during periods where the eco-fertilizer cannot be applied to the farmland), or invest into a wastewater treatment plants to process the liquid effluent up to effluent standards for discharge. The biogas slurry utilization varies from project site to project side, but most of the project proposals are all lacking a detailed eco-farming concept which clearly provides the basis for a sustainable slurry utilization and marketing.

- **Social risks:** Vulnerable groups, such as poor and women, may be excluded from employment during project construction and operation due to additional requirements such as the person should be in good health, be skilled at livestock raising and crop production, or have biogas technology, etc. Biogas supply is relatively popular but gas pipeline construction needs a large initial investment and ongoing maintenance costs. Although some enterprises plan to provide biogas free of charge, they may start charging after 1-2 years. The social benefits of Eco farming may be decreased through product market and production cost. For example, organic and green products are good for health but their price is high and market demand small. In addition organic fertilizer transportation and application needs more labor input than mineral fertilizer. Limited stimulation effect on industry development in poverty-stricken areas and unstable relations between farmers and enterprises could be an issue. Some enterprises may not be able to fulfill their commitment, such as reducing emissions.

CDM projects have potential risks that need to be carefully considered and handled as follows:

- CDM requires ongoing financial support to ensure the *financial viability of the project*s. However CDM awareness, knowledge, motivation and capacity to apply for CDM as a financial incentive is still quite low. This is a risk that CDM applications might be not successfully developed.

- For about 10% of the subprojects *new methodologies* are required. These will need to be developed by professional CDM consulting companies, or experts with equivalent sector experience and qualification. Although the official policies are highly supportive of CDM projects in China, the practical experience in the biogas sector is behind expectations[152] . The development of new methods and technologies for CDM may pose more risks. Such risks include the time needed for the development, registration and approval of new methodology

- *Technical risks* are related to t*he operation of t*he biogas plants. The failure of the plant or plant underperformance will result in no or low CERs generated from the projects. Thus the expected and required benefits will not be realized by the sale of CERs. A potential penalty could also occur depending on the contract of sales of CERs. s

[152] NDRC, GIC-AHK, Germany, CDM conference, Beijing, 2007

- *Management, M&O, monitoring:* A stricter monitoring methodology has to be applied for CDM projects. This requires reliable operation and continuous data recording in order to claim the CERs.

- *Policy and Regulation:* Uncertainty of post Kyoto negotiations may have negative impacts on the CDM carbon trading markets especially for the credits generated after 2012. It is expected that by the end of 2009 the post-Kyoto Scenario will be settled.

- *Institutional aspects:* if the bundle approach is applied to the implementation of small CDM projects, a central supporting framework will be necessary. This will require the central institutions to functions well through the whole period of CDM implementation.

5. Issues and Suggested Assurances

In addition to standard assurances, the Government, EA and the IAs will have to provide the following assurances, which will be incorporated into the Loan and Project Agreements.

(v) *Counterpart Financing.* The Government shall cause the EA and IAs to ensure that (a) all domestic financing necessary for the Project be provided in a timely manner, and (b) additional counterpart financing be provided in the event of any shortfall of funds or cost overruns to complete the Project. Each IA will ensure that adequate counterpart funds are made available in a timely manner for the concerned PIOs to implement planned Project activities, as well as maintenance and management of all Project assets.

(vi) *Land Acquisition and Resettlement.* Each IA will ensure that (a) no land acquisition is required for all the subprojects, and (b) no resettlement is required for all the subprojects.

(vii) *Environment.* Each IA will ensure that the facilities are constructed, maintained and operated in strict conformity to (a) all applicable national and local government environmental laws, regulations, and procedures; (b) ADB's Environmental Policy (2002) and guidelines; and (c) the environmental mitigation and monitoring measures set out in the relevant IEE or an Environmental Impact Assessment (EIA) for the Project. In case that any subproject is cited for a violation of any law, regulation, standard, or ordinance related to environmental protection within the reporting period, a certification from the environmental authorities concerned shall be included in the reports showing that the defect has been corrected or a corrective action plan has been accepted or approved.

(viii) *Environmental review of non-core subprojects.* The EA will ensure that all IAs will apply environmental safeguard screening procedures of non-core subprojects in compliance with the Environmental Assessment and Review Procedures (EARP). This requires adequate consultations and the establishment of an environmental management plan.

(ix) *Project Proposals (Draft Feasibility Studies) of Core-subprojects and subprojects.* The CSP FSRs have to be adapted and further developed to meet the technological standard (see Appendix 4B and Supplementary Appendix H) and have to be approved by the experts of the PMO. For the subprojects the appraisal of eligibility to be financed under the loan is task of the PMO TA under Project component 4.

(x) *Gender Development.* Each IA will follow ADB's Policy on Gender Development during implementation of the Project and take all necessary actions to encourage women living in the Project areas to participate in planning and implementing the Project.

(xi) *Project Management (PMO) and Project implementation Units (PIU).* The provincial governments and the FECC at the MOA in Beijing will establish a suitably staffed project office (project director, finance manager, qualified technical and administrative support staff,). Within 5 months of loan effectiveness, the provincial governments will have fully staffed the PIO and will ensure that the unit will remain fully staffed throughout the project implementation period in order to implement Project component 1. Project Management assistance and

consultant support is provided by Project component 4 and capacity building will be provided through Project component 3.

(xii) *'State of the art' Technology and 'best practice' operation of biogas plants.* In order to achieve the expected result to operate MLSBP sustainably in terms of environmental and economic conditions the design and operation has to follow the Chinese National Standards and the 'Guidelines for Technical Specification. This includes Performance, Implementation and Operation of Medium and Large Scale Biogas Plants (MLBGP) under the ADB Loan' (Appendix 4B), considering process and technology performance, safety and management standards, and managerial conditions.

(xiii) *Coordination of multitask tasks related to the biogas sector and standards for the quality of equipment, services and performances.* Qualified planning and provisions as proposed in Appendix 4B are mandatory parts of planning, tendering and supply contracts. These have to be considered by the design institutes/consultants and supported by the government to ensure the required state of the art to achieve subprojects that can be sustainably operated under the aspect of Energy production and CDM support. A national level technical biogas committee shall be established within 6 months of loan effectiveness under the NDRC Energy Bureau (or other institutions which have the capacity to attract the various stakeholders) to develop policy papers, guidelines, standards etc. to ensure the long term development of this sector under the support of required policies.

(xiv) *Monitoring of Project impact.* Each province will monitor and evaluate the project impacts and effects to ensure that the project facilities are managed and operated effectively and the anticipated social and environmental benefits take place.