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Report No: PAD 920

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED LOAN

IN THE AMOUNT OF US$71.5 MILLION

TO THE

PEOPLE'S REPUBLIC OF CHINA

FOR A

HEBEI RURAL RENEWABLE ENERGY DEVELOPMENT PROJECT

February 11, 2015

Environment & Natural Resources Global Practice
East Asia and Pacific Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective June 1, 2014)

Currency Unit	=	Renminbi (RMB), Yuan (Y)
RMB 6.10	=	US$1
US$ 0.16	=	RMB 1

FISCAL YEAR
January 1 – December 31

ABBREVIATIONS AND ACRONYMS

CDM	Clean Development Mechanism
CFB	County Finance Bureau
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CPS	Country Partnership Strategy
CQS	Consultants Qualifications Selection
CSTR	Continuous Stirred Tank Reactor
DA	Designated Account
DC	Direct Contracting
EA	Environmental Assessment
ECOP	Environmental Code of Practice
EIRR	Economic Internal Rate of Return
EMF	Environmental Management Framework
EMP	Environmental Management Plan
FIRR	Financial Internal Rate of Return
FM	Financial Management
FMM	Financial Management Manual
FSR	Feasibility Study Report
FYP	Five-Year Plan
GHG	Greenhouse Gas
GIZ	Gesellschaft fur International Zusammenarbeit
HPAO	Hebei Provincial Audit Office
HPFD	Hebei Provincial Finance Department
HSF	High Solids Fermentation
IBRD	International Bank for Reconstruction and Development
IC	Individual Consultant Selection
ICB	International Competitive Bidding
ICR	Implementation Completion and Results Report
M&E	Monitoring and Evaluation
MOF	Ministry of Finance
NCB	National Competitive Bidding
NDRC	National Development and Reform Commission
O&M	Operations and Maintenance
OP/BP	Operational Policy and Business Procedure
ORAF	Operational Risk Assessment Framework
PAD	Project Appraisal Document
PDO	Project Development Objective
PIU	Project Implementation Units
PLG	Project Leading Group
PM	Procurement Manual
PPMO	Provincial Project Management Office
RAP	Resettlement Action Plan
RMB	Renminbi
RPF	Resettlement Policy Framework
QBS	Quality-Based Selection
QCBS	Quality- and Cost-Based Selection
SA	Social Assessment
SAM	Subproject Appraisal Manual
SCADA	Supervisory Control and Data Acquisition
SIL	Specific Investment Loan
SSS	Single Source Selection
TA	Technical Assistance
TS	Total Solids
VPF	Vertical Plug Flow

IFR	Interim Financial Report	VSL	Variable Spread Loan
ISP	Implementation Support Plan		
LIBOR	London Interbank Offered Rate		

Regional Vice President:	Axel van Trotsenburg, EAPVP
Country Director:	Bert Hofman, EACCF
Senior Global Practice Director:	Paula Caballero, GENDR
Global Practice Director:	Bilal H. Rahill, GENDR
Practice Manager:	Iain Shuker, GENDR
Task Team Leader:	Jin Liu, GENDR

CHINA
HEBEI RURAL RENEWABLE ENERGY DEVELOPMENT PROJECT

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PAD DATA SHEET

China

Hebei Rural Renewable Energy Development Project (P132873)

PROJECT APPRAISAL DOCUMENT

EAST ASIA AND PACIFIC

GENDR

Report No.: PAD920

Basic Information		
Project ID P132873	EA Category B - Partial Assessment	Team Leader Jin Liu
Lending Instrument Investment Project Financing	Fragile and/or Capacity Constraints [ ] Financial Intermediaries [ ] Series of Projects [ ]	
Project Implementation Start Date 01-August-2014	Project Implementation End Date 31-Dec-2020	
Expected Effectiveness Date 30-June-2015	Expected Closing Date 31-Dec-2020	
Joint IFC No		

Practice Manager/Manager	Senior Global Practice Director	Country Director	Regional Vice President
Iain G. Shuker	Paula Caballero	Bert Hofman	Axel van Trotsenburg

Borrower: People's Republic of China					
Responsible Agency: Hebei Provincial Agriculture Department					
Contact:	Wang Xiangxue		Title:	Project Management Office Director	
Telephone No.:	86-311-67661793		Email:	wb-hebei2012@163.com	

Project Financing Data(in USD Million)					
[X]	Loan	[ ]	IDA Grant	[ ]	Guarantee
[ ]	Credit	[ ]	Grant	[ ]	Other

Total Project Cost:	150.78	Total Bank Financing:	71.50
Financing Gap:	0.00		

Financing Source	**Amount**
Borrower	79.28
International Bank for Reconstruction and Development	71.50
Total	150.78

Expected Disbursements (in USD Million)

Fiscal Year	2016	2017	2018	2019	2020	2021	--	--	--	--
Annual	10.00	12.00	15.00	15.00	12.00	7.50	--	--	--	--
Cumulative	10.00	22.00	37.00	52.00	64.00	71.50	--	--	--	--

Institutional Data

Practice Area / Cross Cutting Solution Area

Environment & Natural Resources

Cross Cutting Areas

[X] Climate Change

[ ] Fragile, Conflict & Violence

[ ] Gender

[ ] Jobs

[ ] Public Private Partnership

Sectors / Climate Change

Sector (Maximum 5 and total % must equal 100)

Major Sector	Sector	%	Adaptation Co-benefits %	Mitigation Co-benefits %
Energy and mining	Other Renewable Energy	50		100
Agriculture, fishing, and forestry	General agriculture, fishing and forestry sector	50		100
Total		100		

☐ I certify that there is no Adaptation and Mitigation Climate Change Co-benefits information

applicable to this project.

Themes

Theme (Maximum 5 and total % must equal 100)

Major theme	Theme	%
Rural development	Rural services and infrastructure	50
Environment and natural resources management	Climate change	50
Total		100

Project Development Objective(s)

The Project Development Objective (PDO) is to demonstrate sustainable biogas production and utilization to reduce environmental pollution and supply clean energy in rural areas of Hebei Province.

Components

Component Name	**Cost (USD Millions)**
Large-scale biogas facilities management and renewable energy supply	134.33
Technical support, project management and monitoring	5.80

Compliance

Policy

Does the project depart from the CAS in content or in other significant respects?	Yes [ ] No [X]
Does the project require any waivers of Bank policies?	Yes [ ] No [X]
Have these been approved by Bank management?	Yes [ ] No [ ]
Is approval for any policy waiver sought from the Board?	Yes [ ] No [ ]
Does the project meet the Regional criteria for readiness for implementation?	Yes [X] No [ ]

Safeguard Policies Triggered by the Project	**Yes**	**No**
Environmental Assessment OP/BP 4.01	**X**	
Natural Habitats OP/BP 4.04		**X**
Forests OP/BP 4.36		**X**
Pest Management OP 4.09		**X**
Physical Cultural Resources OP/BP 4.11		**X**
Indigenous Peoples OP/BP 4.10		**X**

Involuntary Resettlement OP/BP 4.12	**X**	
Safety of Dams OP/BP 4.37		**X**
Projects on International Waterways OP/BP 7.50		**X**
Projects in Disputed Areas OP/BP 7.60		**X**

Legal Covenants

Name	Recurrent	Due Date	Frequency
Institutional arrangements, Section I (A) of Schedule of Project Agreement	**X**		CONTINUOUS

Description of Covenant

Hebei Province to maintain the Project Leading Group and the Project Management Office in a satisfactory manner throughout Project implementation.

Name	Recurrent	Due Date	Frequency
Project Implementation Plan, Section I (c) of Schedule of Project Agreement	**X**		CONTINUOUS

Description of Covenant

Hebei Province to comply with the Project Implementation Plan.

Name	Recurrent	Due Date	Frequency
Additional RAPs, Section I (E) 4 of Schedule of Project Agreement	**X**		CONTINUOUS

Description of Covenant

Hebei Province to have satisfactory Additional Resettlement Plans prepared, adopted, and disclosed for subproject adjustments and any new activities identified under the project framework during the project implementation.

Name	Recurrent	Due Date	Frequency
Independent safeguards monitoring and evaluation, Section I (E) 7 of Schedule of Project Agreement	**X**		CONTINUOUS

Description of Covenant

Hebei Province to have independent monitoring and evaluation of the implementation of Project safeguards instruments carried out and semi-annual reports submitted to the Bank.

Conditions

Source Of Fund	Name	Type
IBRD withdrawal, Section IV (B) 1 (b) of	Subsidiary Agreement	Withdrawal

Schedule 2 of Loan Agreement		

Description of Condition

Hebei Province to provide evidence that all the Subsidiary Agreements have been duly executed on behalf of Hebei Province and the respective PIU, and are binding and enforceable upon the respective parties thereto in accordance with their terms.

Team Composition

Bank Staff

Name	Title	Specialization	Unit
Tijen Arin	Senior Environmental Economist	Senior Environmental Economist	GENDR
Xieli Bai	Program Assistant	Program Assistant	EACCF
Junxue Chu	Senior Finance Officer	Senior Finance Officer	CTRLN
Sameena Dost	Senior Counsel	Legal	LEGES
Yiren Feng	Senior Environmental Specialist	Senior Environmental Specialist	GENDR
Haixia Li	Senior Financial Management Specialist	Senior Financial Management Specialist	GGODR
Jin Liu	Senior Rural Development Specialist	Team Lead	GENDR
Yunlong Liu	Procurement Specialist	Procurement Specialist	GGODR
Aristeidis I. Panou	Counsel	Counsel	LEGOP
Ximing Peng	Senior Energy Specialist	Senior Energy Specialist	GEEDR
Nuyi Tao	Senior Carbon Finance Specialist	Senior Carbon Finance Specialist	GCCCF
Zhuo Yu	Finance Officer	Finance Officer	CTRLN
Meixiang Zhou	Social Development Specialist	Social Development Specialist	GSURR

Non Bank Staff

Name	Title	City
Henrik Hamrssen	Senior Biogas Engineer	Goettingen
Lars Hyttel	Senior Renewable Energy Specialist	Copenhagen
Xueming Liu	Senior Economist	Rome (FAO/CP)

Locations

Country	First Administrative Division	Location	Planned	Actual	Comments
China	Hebei	Hebei Province		**X**	

I. STRATEGIC CONTEXT

A. COUNTRY CONTEXT

1. China's economy has experienced remarkable growth over the past several decades. This growth, however, has been accompanied by an increase in social and environmental challenges. For example, while intensive agricultural farming and expansion of livestock production in rural areas are considered as a viable means to create rural incomes, employment, and a secure food supply, the agricultural sector's rapid development poses a threat to the local environment and public health. Every year, around 690 million tons of collectable crop residues are produced as byproducts of farming and most are used by households as fuel or burned in open fields. This causes significant indoor and outdoor air pollution. Other serious pollution results from livestock manure: every year livestock farms in rural areas produce around 840 million tons of livestock manure and the discharge of livestock waste is affecting surface and ground water quality. In addition, coal is still the main source of household energy for China's rural residents, accounting for around 60% of energy used for cooking and heating. The use of coal causes serious air pollution and health problems.

2. That air pollution remains a serious problem in the country is evidenced by the results of China's 2013 air quality monitoring study. According to the 2013 monitoring results, only 3 of the 74 (prefectural-level) cities that are implementing new air quality standards were able to reach the new standards; on average, cities were only able to reach the standards for 221 days in 2013 (60.5% of the year). Areas with more severe pollution included China's central areas, Yangtze River Delta and Pearl River Delta, in particular the areas in Hebei Province, Tianjin and Beijing municipalities.

3. China's government agencies are paying considerable attention to pollution reduction in the rural areas by promoting better management of crop and livestock wastes. The government is also aiming to increase rural areas' access to clean energy (to replace fossil energy), as one of the top priorities of the country's national rural development strategy.

4. The national agricultural development 12th Five-year Plan (FYP) for the period 2011-2015 sets out detailed strategies to address rural pollution. The plan promotes ecological and organic agriculture and encourages effective use of rural waste (such as crop residues and livestock manure) by developing biogas facilities and other rural renewable energies, to both reduce pollution and provide clean energy to rural residents. Over the last two decades, strong governmental policies and subsidies have been adopted to support China's biogas sector in an effort to reduce pollution from rural waste, promote circular and low-carbon economy, and extend clean energy supply and service system to rural areas. China's 12th FYP for Economic and Social Development emphasizes that energy supply for rural residents is an important part of public utilities.

5. According to this FYP, by 2015 around 55 million rural households should be able to access biogas, with around 3 million households accessing it from concentrated large-scale biomass facilities. By the end of the planning period, biogas digesters (as waste treatment facilities) should have been built at around 50% of the total livestock farms. The biogas program is expected to not only improve local rural environment but also contribute to fulfilling the government's energy development strategy of increasing the share of non-fossil fuels in primary

energy from 8 percent in 2011 to 15 percent by 2020, as well as its commitment to reduce carbon intensity by 40-45 percent from 2005 to 2020.

B. SECTORAL AND INSTITUTIONAL CONTEXT

6. Hebei, as one of China's leading agricultural provinces, is endowed with abundant resources for agricultural biomass and has a large production of livestock. The negative environmental impacts of the intensive farming and concentrated livestock production in Hebei basically reflect the overall situation in China, with Hebei experiencing even heavier pollution as a result of its rapid agricultural growth. Each year, around 61.8 million tons of crop residues are generated through its production of wheat, corn and cotton. Around two thirds of the crop wastes are used as fertilizer (incorporated in the cropland) and as animal feed. The remainder is mainly burned in open fields or used as fuel for household cooking and heating, causing indoor and outdoor air pollution. In addition, each year around 30.7 million tons of livestock wastes from concentrated livestock farms is not treated appropriately, causing water pollution and increasing exposure of diseases in the province's rural areas.

7. Hebei's limited access to clean energy in the rural areas further contributes to serious air pollution. There are around 50 million rural residents in the province, which means 54.5% of its total population lives in the rural areas. Use of rural energy has been increasing by about 4% annually over the last decade. Few natural gas supply pipelines, however, reach the province's rural areas and access to clean energy there is very limited. The rural households largely use coal, crop residues, and wood-fuel for individual household cooking and heating, which in 2011 accounted for about 48%, 22%, and 12% respectively of total energy used by rural households. This fuel use results in heavy indoor pollution and serious health problems and also contributes to outdoor air pollution. According to the air quality monitoring results, Hebei Province has the worst air quality of all China's provinces, having both the heaviest and the longest duration of haze. Of China's ten most polluted cities, more than 50% are in Hebei. In 2013, the number of days that air quality standards were met was below 40% in Hebei.

8. Reducing pollution is one of the top priorities for the government of Hebei and biogas utilization is considered an effective approach to address both rural pollution and lack of access to clean energy in the rural areas. Over the last five years, with the support of national subsidy programs for biogas development, hundreds of medium and large-sized biogas digesters and millions of household-based biogas digesters have been installed in the province. Developing biogas programs continues to be one of the key development goals outlined in the 12th FYP (2011-2015) of the Hebei Rural Development Strategy. Despite these developments, large quantities of crop and livestock wastes are not treated appropriately and local communities still experience environmental challenges. In addition, lack of clean energy services in the rural areas is considered to be a matter of inequity in the provision of public services. The government considers itself responsible for increasing access to clean energy to meet the basic livelihood needs of households in the rural areas. The project will support Hebei provincial government to achieve the objectives of its 12th FYP, for which around 400 large-scale biogas facilities should be developed during the period from 2011 to 2015, to improve environmental conditions and increasing access to renewable energy in rural areas.

9. China's success with biogas technology has been mainly with its household-based biogas program. However, due to China's rapid rural and urban integration process, much of the farm

labor has been migrating to cities and the household-based biogas programs have become constrained, making their replication more difficult. At the same time, however, the development of large-scale biogas programs[1]has become increasingly important for rural development. Those large-scale biogas programs have a potential for extensive replication, but a number of barriers are still preventing their effective operation. These barriers relate to technology, operational skills, financial viability, and availability of quality technical services. As a result, many of the large-scale biogas facilities are currently suffering from low productivity and poor operation and have yet to prove long-term operational stability. To address these challenges, the Chinese government is seeking the Bank's support to develop and demonstrate best practice models of large scale biogas programs, to provide guidance and experience to sustainable biogas program management in China.

C. HIGHER LEVEL OBJECTIVES TO WHICH THE PROJECT CONTRIBUTES

10. The project is consistent with the Bank's Country Partnership Strategy (CPS, 67566-CN) for China (2013-2016). Overall, the project will help improve rural environmental and living conditions by making proper use of rural wastes to generate clean energy in rural areas. The project objective is in line with the CPS, which calls for supporting greener growth with a focus on demonstrating sustainable agricultural and livestock practices to generate local and global environmental benefits, including better ways to integrate biogas in farming, improved livestock waste management, and the adoption of cleaner and more efficient household energy solutions in rural areas. The project will contribute to balance development between urban and rural areas in reducing pollution and supplying energy to address the needs of vulnerable groups, which is aligned with the World Bank's twin goals of eliminating extreme poverty and boosting shared prosperity.

11. The Bank's main value added will be its rigor and experience in the analysis of the technical feasibility and financial sustainability of the investments in biogas production and utilization. This will fully support the client in establishing and managing large-scale biogas facilities with sound technologies and sustainable operation. It will also support building Hebei sectoral capacity in biogas program management by bringing national and international best practice into the project design, implementation and monitoring and evaluation, as well as streamlining its biogas program management by developing and adopting standardized biogas program operations. The development of large-scale biogas facilities is currently at the early stages in China. The interventions from the Bank will help address the technical, financial and operational challenges that large-scale biogas programs established earlier are facing and demonstrate an efficient, standardized and sustainable approach for biogas production and utilization in rural areas.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

12. The Project Development Objective (PDO) is to demonstrate sustainable biogas production and utilization to reduce environmental pollution and supply clean energy in rural

[1] Large-scale biogas facilities have a daily production capacity above 1,000 m^3.

areas of Hebei Province.

B. PROJECT BENEFICIARIES

13. Key project beneficiaries include (a) targeted rural 96,100 households who will benefit from the increased access to the clean and easy-to-use biogas under the project; (b) rural residents who will benefit from the environmental improvements in the project areas in six counties/cities; (c) the project implementation units (PIUs), who will benefit from the technical support and international experience in adopting improved technologies; and (d) Hebei provincial and project county governments, who will be supported in achieving their targets for pollution reductions and increases in renewable energy supply in the rural areas.

C. PDO LEVEL RESULTS INDICATORS

14. Progress towards the achievement of the project objective will be monitored and measured against the following indicators: (a) amount of project-supplied biogas used by the end users; (b) carbon dioxide (CO_2) emission reduction by the project; and (c) numbers of rural household residents who can access biogas supply under the project (see Annex 1).

III. PROJECT DESCRIPTION

A. PROJECT COMPONENTS

15. The project includes two components.

Component 1: Large-scale biogas facilities management and renewable energy supply (Total Base Cost: US$134.33 million)

16. Under this component the national and international best practice in developing large-scale biogas facilities will be introduced and demonstrated. Six biogas facilities will be installed and operated in Hebei, as six investment subprojects, to effectively convert agricultural wastes (specifically crop residues and livestock manure) to biogas and to provide stable clean energy to local rural residents. The subprojects are located in six project counties, namely Anping, Yutian, Zunhua, Linzhang, Chengde, and Laoting counties.

17. It is expected that annually the project will produce around 42 million m^3 of biogas, and around 221,700 tons of crop residues and 241,600 tons of livestock manure will be appropriately treated as feedstock for biogas production. The biogas will be provided to around 96,100 rural households mainly for cooking energy, which will reduce around 58,780 tons of CO_2 emission annually by replacing coal. The remaining biogas, after supplying the targeted rural households, will be upgraded to vehicle fuel. An estimated 7 million m^3 of compressed biogas (equivalent to and conventionally known as "CNG") will be produced annually, which will be used to support public transportation in the project counties.

Component 2: Technical support, project management and monitoring (Total Base Cost: US$ 5.8 million)

18. This component will support technical services, training, monitoring and evaluation, and project management. Specifically, (a) an expert team will be contracted by PPMO to provide technical assistance for project implementation; (b) for each subproject a sample laboratory will be established for stabilizing day-to-day biogas facilities operation by analyzing and controlling fermenting conditions of biogas digesters and testing biogas and slurry; (c) a monitoring system will be established both at subprojects level to monitor their individual biogas system operation and at provincial level to monitor overall project biogas system operation, project performance and its impacts; (d) around 1,800 person-day training will be arranged for project technical and management staff at provincial and county levels, in particular for the local technical staff at the PIUs to obtain the skills in operating subprojects; and (e) biogas digester operation manual and digestate application manual will be developed to guide biogas program management in Hebei.

B. PROJECT FINANCING

Lending Instrument

19. The selected project lending instrument is Investment Project Financing (IPF). It will be on flexible IBRD terms, with a LIBOR-based U.S. dollar denominated Variable Spread Loan (VSL), with level repayment of principal following a schedule linked to commitments and final maturity of 25 years including a 6 year grace period.

Project Cost and Financing

20. The total financing required for the project is around US$ 150.78 million, of which, US$ 71.5 million (47%) will be financed by IBRD and US$ 79.28 million be provided as counterpart funds by Hebei provincial government and project entities. Project cost by components is summarized in the table below:

Table 1: Project Cost and Financing

Project Components	Project cost (US$ million)	IBRD Financing (US$ million)	IBRD Financing
1. Large-scale biogas facilities management and renewable energy supply in rural areas	134.33	63.96	48%
2. Technical support, project management and monitoring	5.80	2.24	39%
Total Baseline Costs	**140.13**	**66.20**	**47%**
Physical contingencies	5.35	0.00	0%
Total Project Costs	**145.48**	**66.20**	**46%**
Interest During Implementation	4.74	4.74	100%
Front-End Fees	0.18	0.18	100%

Commitment Fees	0.38	0.38	100%
Total Financing Required	**150.78**	**71.50**	**47%**

IV. IMPLEMENTATION

A. INSTITUTIONAL AND IMPLEMENTATION ARRANGEMENTS

21. Project Leading Group (PLG): The management structure of the project has been set up. A PLG has been established at the provincial level to provide overall leadership, policy guidance and coordination for the project preparation and implementation. The PLG is headed by a vice-governor of the provincial government and consists of members from key line departments, such as the Hebei Provincial Finance Department, the Provincial Development and Reform Commission, and the Agriculture Department. The PLG will oversee the overall project implementation and ensure inter-agency coordination.

22. Provincial Project Management Office (PPMO): In addition to the PLG, a PPMO has been established at Hebei Provincial Agriculture Department, which have overall responsibility for the project preparation and implementation, including day to day project management, implementation supervision, annual work and budget planning, fund withdrawal and reimbursement, reporting of financial and physical progress, and the provision of technical support and guidance to the PIUs. The PPMO, assisted by an expert team, will also support the project's technical services, training and dissemination, and monitoring and evaluation, in particular the quality control of biogas production and distribution, and the monitoring of project performance, outcomes and impacts. Additional technical support will be provided by the Hebei Rural New Energy Technology Extension Station, where the provincial level monitoring system will be established.

23. Project Implementing Units (PIUs): Biogas production and distribution will be implemented by the subproject companies, namely PIUs. The PIUs will borrow the Bank loan through on-lending arrangements from the participating county finance bureaus or directly from Hebei Provincial Finance Department for one provincial level company. PIUs will be responsible for implementing their own subprojects within the overall project framework. Supported and coordinated by the PPMO, they are responsible for the operational design of the biogas facilities, financial management including disbursement of the Bank loan, procurement of equipment and civil work, biogas facilities establishment, operation, and gas distribution, as well as monitoring of their on-going operations.

24. Adequate staff have been assigned to the PPMO and PIUs for project design and implementation including the implementation of social and environmental safeguards, procurement and financial management. The project's operational arrangements, in particular the roles and responsibilities of the relevant government agencies and PIUs have been clearly defined in the Project Implementation Plan. The full institutional structure is detailed in Annex 3.

B. RESULTS MONITORING AND EVALUATION

25. Project M&E includes the following four aspects: (a) monitoring project implementation

progress, including physical and financial progress; (b) monitoring the quality and performance of biogas facility installation and operation, biogas distribution, and the efficiency of technical and institutional supporting systems; (c) monitoring and evaluating the intermediate outcomes and the achievement of the PDO as described in the Results Framework; and (d) monitoring and assessing the environmental and social impacts of project activities. Both the PPMO and the PIUs will be responsible for project monitoring and evaluation, while PIUs are also responsible for keeping track of all planned and completed activities under the project, as well as planned and completed expenditures.

26. Contracted by PPMO, the professional consulting institutions/expert teams will conduct the project performance and impact monitoring (once a year), as well as the safety monitoring of the biogas production and distribution system (twice a year); the environmental and social impact monitoring will be conducted by contracted third part professional institutions; and all subprojects will be required to use an automatic control system (Supervisory Control and Data Acquisition, or SCADA). Data gathered by the individual systems will be analyzed in the field as well as automatically transmitted to the central monitoring system for further analysis by an expert team to optimize performance.

27. A detailed project monitoring and evaluation plan, acceptable to the Bank, has been developed by the PPMO. Project progress and outcomes will be checked and recorded regularly by the PIUs. Each half year, on June 30 and December 31, the PIUs will submit semi-annual progress reports to the PPMO. The PPMO will then prepare and submit a consolidated provincial semi-annual progress report to the Bank, by February 28 and August 31 of each year.

C. SUSTAINABILITY

28. The project is aligned with the ongoing efforts of the Chinese government of reducing pollution and increasing access to clean energy in rural areas. Likelihood of project sustainability is high, given the strong commitment of Hebei provincial and project county governments to achieve their goal of biogas and rural clean energy development. Project sustainability will also largely depend on the successful adoption of sound technical designs and standardized management and monitoring systems, as well as the rigor and experience in the analysis of the project's technical feasibility and financial sustainability. The applied technologies are selected through thorough studies and assessments combining the international expertise and locally proven technologies, and are based on the specific conditions of the sites identified, which helps to mitigate technically related risks. In addition, the establishment of an adequate technical and monitoring system, along with an increase in institutional capacity for biogas management, will help ensure the long-term stable operation of the biogas facilities and distribution of clean energy to rural residents. It is expected that successful operational models and experience will be developed during project implementation and will be available for scaling up to other parts of Hebei Province and China.

V. KEY RISKS AND MITIGATION MEASURES

A. RISK RATINGS SUMMARY TABLE

Risk Category	Rating
Stakeholder Risk	Moderate
Implementing Agency Risk	
Capacity	Moderate
Governance	Low
Project Risk	
Design	Moderate
Social and Environmental	Moderate
Program and Donor	Low
Delivery Monitoring and Sustainability	Substantial
Overall Implementation Risk	**Substantial**

B. OVERALL RISK RATING EXPLANATION

29. The overall risk of the project is rated as substantial. Risks and associated mitigation measures are presented in the Operational Risk Assessment Framework (ORAF) in Annex 4. The main risks are associated with the long-term operation and sustainability. While large-scale biogas programs are very successful in a number of developed countries like Germany and Denmark, many of the existing biogas facilities in China do not perform well during their operation period. This has resulted from inappropriate technical design, insufficient investments, and lack of technical services and monitoring systems. It is generally recognized that successful and sustainable biogas development can only be achieved with state-of-the-art technologies and reliable technical services and monitoring systems.

30. During the project preparation, both the Bank task team and client were fully aware of the challenges. With the Bank's coordination, a Sino-German expert team has introduced sustainable biogas technologies and management experience that have proved successful in Germany and other countries. In addition, several top international and national experts were hired by the Bank to help the client with the technical design and O&M arrangements. Experience from the Bank and other institutions has been incorporated into the project design and the risks of the project design have been largely addressed by adopting only proven technologies in combination with a well-designed technical support system. Even though the measures to tackle the risk on long-term biogas production and utilization have been incorporated in the project design, it is important to strictly implement the technical design including the mitigation measures to avoid or reduce the identified risks, which will be critical to the successful achievement of the PDO and sustainability.

31. The main risk management/mitigation measures include *inter alia*:

(a) *Introduction of international and national experience and lessons learned.* In particular experience related to setting appropriate technical criteria and addressing technical difficulties with crop-feedstock type biogas programs has been introduced to the project design.

(b) *Identification of the project's key technical challenges and risks related to long-term operational viability, along with the ways to address those challenges.* Supported by

the Bank financed Scaling up Access to Clean and Efficient Cooking Stoves program, two studies have been conducted for this project. The first was an assessment of existing biogas operations to diagnose technological and operational risks and suggest sound technical and operation models for promoting long-term sustainable management. The second study analyzed the rural residential heating, cooking and other clean energy demands; and the competitive alternatives of energy supply (such as coal and natural gas) in the project areas as well as in Hebei Province, to better link biogas production to local demand.

(c) *Continuous implementation support by the Bank.* Frequent short missions have been and will continue to be used to review the implementation of project design and provide specific recommendations to address any issues arising during the project implementation in a timely manner.

(d) *Standardization of the project's technical design and management.* Standardization, such as set eligibility criteria and rigorous selection procedures for participating entities and technical standards for biogas productions and distribution, can help ensure that the project staff correctly adopt the project's technical measures and build the institutional capacity to quickly diagnose and address any challenges during project preparation and implementation.

(e) *Development of a well-designed monitoring and evaluation (M&E) system.* The *M&E* system, which has been developed during project preparation, will promote the on-site monitoring of biogas facility operations and distribution systems, as well as support monitoring of overall project progress, quality, and impacts. The system will also help build the institutional capacity for Hebei sectoral biogas program management.

(f) *Provision of intensive technical assistance and training to the project implementation agencies and entities*. An expert team which includes international and national specialists has provided intensive technical support to the project design. An expert team with national and international experience will be also hired during project implementation to provide technical assistance and training to the project entities. The increased institutional capacity on biogas management will ensure the long-term stable operation of the biogas production and utilization.

VI. APPRAISAL SUMMARY

A. ECONOMIC AND FINANCIAL ANALYSIS

Economic Analysis

32. A cost-benefit analysis has been conducted for the six investment subprojects, using the "with/without project" comparison. The economic costs include total investment costs of biogas production facilities, pipelines, and their operation and maintenance (O&M). The major benefits included in the analysis are: (a) incremental production of biogas, CNG and organic fertilizers (depending on specific outputs of each subproject); (b) cost savings from the replacement of fossil fuel by biogas and other fuels; and (c) environmental benefits due to emission reduction.

The economic internal rate of return (EIRR) of each subproject has been estimated on the basis of the incremental costs and benefits identified. The analysis adopts conservative assumptions for output market demands and prices (coupled with major output sales contract and input procurement arrangements in place to mitigate future market risks). The results of the analysis show that the EIRRs of the six subprojects range between 16-23%, exceeding the 12% economic discount rate that is normally applied to Bank financed projects in China. The subprojects are therefore economically viable and robust.

Financial Analysis

33. Financial analysis has been carried out at the subproject level, with financial viability of each subproject measured with the financial internal rate of return (FIRR). The analysis of each investment subproject is based on the latest feasibility studies prepared by the local consulting firms (all with Class A accreditation from National Development and Reform Commission). Without government subsidies, the FIRRs for the six investment subprojects range from 4.7-7.7%, which means that the subprojects are not financially viable. With government subsidies (on average 25% of investment costs depending on the number of household beneficiaries of each subproject), however, the FIRRs will increase to 8.2-11.4%, justifying the government support to ensure the financial attractiveness for the participating enterprises. The project, however, is sensitive to changes in feedstock and biogas prices. Mitigation measures have been included in the project design to reduce these risks.

34. Finally, a corporate financial analysis, covering historical and future financial projections, has been conducted for each company involved in the various subprojects. Based on the key financial statements (balance sheet, income, and sources and use of funds), the companies' financial performances are sound and the cash flows generated by the operations will be more than adequate to service the Bank loan proceeds (see Annex 6).

B. TECHNICAL

35. To ensure the efficiency and quality of the biogas facilities, the biogas subprojects are designed and will be operated according to domestic and international best practice. In collaboration with the German Gesellschaft fur International Zusammenarbeit (GIZ), which has rich experience in international biogas program management, and supported by the China Clean Stove Initiative, the issues and risks of biogas operations have been thoroughly assessed and experiences (including that with cutting-edge technologies) have been integrated into the project. Key technical design approaches include (but are not limited to):

(a) Assessments of local conditions of feedstock supply and user demand. The local conditions of the project areas have been thoroughly assessed with regard to their suitability for large-scale biogas programs. In particular, attention has been paid to (i) feedstock potential and supply; (ii) biogas end users and biogas distributions; and (iii) demand for digestate/bio-fertilizer. Assessments of the local conditions have included an appropriate geospatial mapping of feedstock resources, identifying potential locations and setting capacities of bio-digesters, and estimating potential biogas demand from end users for each subproject. Selection of the six subprojects has been based on these assessments.

(b) Use of most appropriate technologies adapted to local conditions. Nationally and internationally available technologies were assessed to determine the most appropriate biogas technologies to be used for the project. The following three technologies are introduced to the subprojects: (i) vertical plug flow (VPF); (ii) continuous stirred tank reactor (CSTR); and (iii) high solids fermentation/solid state percolation technology (HSF/SSP).

The CSTR digester technology is a mature technology for the intended feedstock with wide long term experience in numerous domestic and international applications; The VPF technology is a mature technology in China, but the size and load capacity of the existing plants cannot exceed certain thresholds. Therefore, for risk mitigation purpose the size of each single digester tank and the volumetric yield rate/gas productivity is restricted under the project; The SSP technology is a mature technology mainly with references in European countries and the experience has been gained with similar practice. A pilot SSP program was conducted in China since more than 4 years, which shows that this technology suits the local conditions well. A trial test with the intended materials will be conducted during the detailed project design stage to further confirm the most appropriate technical parameters.

(c) Capacity building for long-term biogas facility operation and maintenance. To ensure successful and stable long-term biogas facility operation, the project also focuses on building sectoral capacity by establishing and improving technical services, monitoring systems, and training and dissemination programs. The project will help standardize biogas management and build up the biogas services and monitoring systems in the project areas.

(d) Biogas distribution. The produced biogas will be mainly sold to households as cooking fuel. For nearby communities (approximately within a 3km radius), the biogas will be distributed through dedicated pipelines, and for more distant communities, the gas will be compressed (either partially or fully upgraded) and transported by tankers to gate stations at the villages and other concentrated rural residential areas or buildings. Any remaining biogas will be used by the subprojects directly to meet other needs of the PIUs or be upgraded to CNG and sold as vehicle fuel. To purify the biogas to CNG, the project proposes various technologies including high pressure water scrubbing technology, pressure swing adsorption technology, and membrane technology, which are all mature technologies. The CNG will be sold by PIUs' own filling stations being set up or will be sold directly to markets.

(e) Digestate application. The digestate generated from the sub-projects will be largely used as organic fertilizer on nearby farmlands and orchards, or processed to become marketable bio-fertilizer and sold to more broad areas.

C. FINANCIAL MANAGEMENT

36. PPMO is responsible for the overall coordination during the preparation and implementation stages as well as the day-to-day project management and operation. The Bank loan proceeds, including overseeing the Designated Account (DA), will be managed by Hebei Provincial Finance Department (HPFD).

37. A financial management capacity assessment for the PPMO and six PIUs was conducted by the Bank. Actions to strengthen the project's financial management capacity and measures to mitigate financial management (FM) risks have been agreed with the PPMO and relevant PIUs. Under the project, only HPFD has previous Bank-financed project experience. The PPMO and six PIUs are new to the Bank operations. Five of the six PIUs are small or medium size private companies, with three of them established 3-4 years ago. To address the risk of lack of knowledge in managing Bank-financed projects and less mature financial processes and controls, the following financial management arrangements have been made by the PPMO and PIUs: (a) PPMO has hired a qualified and experienced financial specialist to closely collaborate with HPFB and project auditors on the review, supervision and FM oversight of the project and liaison with PIUs; (b) PPMO has developed a project financial management manual (FMM) to standardize project FM and disbursement procedures; (c) all PIUs have developed or supplemented their financial management procedures, systems and processes to support project financial management; and (d) HPFD will provide tailored disbursement training and guidelines to PPMO and PIUs and also assist PPMO in the preparation of the project's financial reports, the Bank Withdrawal Applications and review payment supporting documents during the project implementation.

38. The FM assessment concluded that the PPMO and PIU financial staff are qualified but will benefit from continuous capacity building. It also concluded that with the implementation of the remaining proposed actions, the financial management arrangements will satisfy the Bank's requirements under OP/BP 10.00. Annex 3 of the PAD provides additional information on financial management.

D. PROCUREMENT

39. The PPMO and the PIUs will be responsible for the procurement and contract management of specific contracts under the project. The PPMO with active participation of PIUs as well as with the support of a qualified procurement agent will however be responsible for organizing the procurement and coordination and communications with the Bank. It will further be responsible for obtaining the required domestic approvals and submitting procurement documents to the Bank for review. The PIUs will be responsible for their subproject execution respectively, including preparation of procurement plan, providing technical inputs for procurement documents, as well as being accountable for contract management with oversight of the PPMO to ensure compliance and consistency with the procedures and processes used under the project.

40. Although the procurement staff at the PPMO and PIUs have experience with procurement under the national and local procurement laws and regulations, most are not familiar with Bank procurement policies and procedures. This may lead to possible delays and non-compliance with the Bank procurement policies and procedures, which has been identified by the procurement capacity and risk assessment as a key risk. Another risk is potentially the numbers of implementing agencies scattered in different locations which may present a challenge in supervision and coordination by the PPMO. To mitigate these risks, the following measures have been agreed on with the PPMO: (a) a qualified procurement agent with the required procurement experience and knowledge for the projects financed by the Bank or other multilateral financial institutions will be hired by the PPMO no later than project effectiveness;

(b) a procurement manual acceptable to the Bank was prepared to guide procurement cycle management under the project; (c) the Bank will continue to provide just-in-time guidance and implementation support; and (d) continuous and targeted training and capacity building will be provided for PPMO and PIU staff involved in procurement during the project implementation.

41. A draft procurement plan, prepared by PPMO, has been reviewed and agreed by the Bank. This plan will be updated in agreement with the Bank annually or as required to reflect actual project implementation needs. Further details on procurement are provided in Annex 3.

E. SOCIAL (INCLUDING SAFEGUARDS)

42. The project will have significant positive social impacts on local farmers according to a social assessment (SA) conducted in the proposed areas for the project during project preparation. The SA confirmed that the project will bring significant benefits to rural residents by increasing access to clean and easy-to-use energy, improving rural waste management, and reducing pollution. Negative social impacts mainly include the land acquisition for the construction of the biogas facilities and CNG stations as well as temporary land use for the pipe network. The Bank OP 4.12 involuntary resettlement policy is triggered and the social issues identified by the SA are reflected in the project design and measures to address the social concerns are incorporated.

43. Involuntary Resettlement (OP/BP 4.12). Three of the six subprojects (Laoting, Linzhang, and Chengde) need to acquire a total of 215 mu (about 15 ha) of land for the construction of the three biogas facilities. The total number of people affected by the land acquisition will be 203 in 45 households. The remaining three subprojects (Yutian, Zunhua, and Anping) have existing land available for their biogas facilities. Additional land acquisition during project implementation might be needed for setting four proposed CNG stations and the temporary land occupation for the biogas pipeline network installation. As a result, the Bank safeguards policy OP/BP 4.12 is triggered. According to the SA, no other social safeguards policies are triggered under the project.

44. For each of the three subprojects involving land acquisition, a Resettlement Action Plan (RAP) has been prepared, along with a consolidated RAP. The RAPs cover comprehensive mitigation measures, grievance redress mechanisms, monitoring and evaluation, institutional arrangements, and capacity building plans. They will be strictly implemented in accordance with the Chinese laws and regulations and with the Bank OP/BP4.12 policy. The RAP implementation will be regularly monitored both internally and externally throughout the project implementation period. The PPMO will monitor the land acquisition progress during project implementation and, as necessary, cause relevant authorities to take remedial action. In addition, a Resettlement Policy Framework (RPF) has been prepared to guide the potential land acquisition that might be identified during project implementation, as the exact land needs in terms of specific locations, routes, and sizes for the biogas supply pipe networks, CNG station sets, could not be determined by project appraisal. In case any land acquisitions are needed for the above activities, additional RAPs will be prepared and implemented according to the RPF. The additional RAPs are requested to be submitted to PPMO and Bank for review and approval.

45. During project preparation, public consultations and a project information dissemination campaign, involving several rounds of communications, were undertaken. A professional

consulting institute hired by the PPMO conducted the social assessment, along with intensive community consultations through interviews and consultation meetings. In addition, the PPMO and an expert team consulted all affected organizations and enterprises in each of the project counties. Information and alternative options for the project design (including the design of civil works and proposed locations), along with options for biogas operation and distribution were shared with the public and key stakeholders. In addition, willingness to use biogas was also surveyed during the consultation process. The visited households expressed their interest, enthusiasm and support for the project and fully understood the potential risks and opportunities associated with it.

46. Gender mainstreaming. Women play an important role in the agricultural and livestock sector in rural China. Gender equality was promoted in the public consultation process and project design during the project preparation. Those efforts were reflected by equal access to the participation in the consultation process by men and women. More specifically, women participating in consultation meetings and interviews accounted for more than 35% of the total number of farmers consulted; target trainings on biogas use and safety measures, and other capacity building aspects will be provided to both men and women during project implementation; and the approaches to equal compensation and job opportunity for men and women have been included in the project design and the relevant monitoring arrangements have been specified in the project overall monitoring plan. The project will continue to reflect gender dimensions during its implementation and the monitoring results will be included in the project progress report and completion report.

F. ENVIRONMENT (INCLUDING SAFEGUARDS)

47. Environmental Assessment (OP/BP 4.01). The project is classified as a Category B project as per Bank policy OP/BP 4.01 Environmental Assessment. The project will significantly improve rural environmental and living conditions by converting livestock manure and crop residues into biogas for rural resident cooking fuel. In addition, replacing coal with biogas will also reduce greenhouse gas (GHG) emissions and improve the health conditions of households. An Environmental Management Plan (EMP), analyzing potential adverse environmental impacts of the project, has been prepared in accordance with domestic and Bank requirements. It shows that the environmental impacts identified and assessed are deemed measurable and manageable. These relate mainly to the construction and operation of the biogas facilities, such as waste and dust caused by small civil works, the construction of the biogas pipeline and feedstock transportation. Impacts are not expected to be significant due to the small scale of the civil works and the non-sensitive nature of the locations. To enhance long-term environmental benefits of the project, mitigation measures for the adverse impacts have been integrated into the project design, construction and operational plans. These measures are incorporated in the EMP. With implementation of the proposed mitigation measures, the potential adverse impacts will be avoided or mitigated to an acceptable level.

48. An Environmental Management Framework (EMF) has been prepared as part of the EMP to guide the environmental assessment for any additional activities necessitated during the project implementation. The EMF clearly defines objectives, procedures, institutional framework, and implementation arrangements for identifying and managing potential environmental impacts from the biogas facilities. It includes the implementation of agreed

actions, supervision, and evaluation. It also addresses the mechanisms for public participation and redress of possible grievances, and includes the specific screening tool.

49. **Safeguard Documents Disclosure**. In accordance with the Bank disclosure policy, prior to project appraisal, the latest safeguards documents, including the EMP, the SA report and RAPs, were made available on May 15, 2014 at the PPMO, the agricultural bureaus of participating counties, and the PIUs. In addition, the documents were disclosed on the website of the Hebei Agriculture Department at http://www.he.xinhuanet.com/zfwq/xny. All safeguard documents were also disclosed at the World Bank InfoShop. (SA & RPF on June 9, 2014; initial EMP & RAP on June 9, 2014 and their subsequent versions on June 16, 2014).

ANNEX 1: RESULTS FRAMEWORK AND MONITORING

China: Hebei Rural Renewable Energy Development Project

Results Framework

Project Development Objectives

PDO Statement

The Project Development Objective (PDO) is to demonstrate sustainable biogas production and utilization to reduce environmental pollution and supply clean energy in rural areas of Hebei Province.

These results are at	Project Level

Project Development Objective Indicators

Indicator Name	**Baseline (2014)**	**2015**	**2016**	**2017**	**2018**	**2019**	**End Target (2020)**
1. Stable biogas production and supply by the project: Amount of project-supplied biogas used by end users (Million m3/year)	0	0	0	9	27	42	42
2. Reduction of pollution in rural areas: CO^2 emission reduction by the project (Ton/year)	0	0	0	29390	58780	58781	58781
3. Increased biogas access to rural residents: Number of rural resident households who can access biogas supply under the project (Number/ year)	0	0	0	28000	70500	96100	96100

Intermediate Results Indicators							
Indicator Name	**Baseline (2014)**	**2015**	**2016**	**2017**	**2018**	**2019**	**End Target (2020)**
Component One: Large-scale biogas facilities management and renewable energy supply							
1. Generation Capacity of Renewable Energy (Million m^3/year) - (Core)	0	0	0	9	27	42	42
3. Biogas distribution system established: (a)Length of main pipeline installed (Cumulative kilometer) (b) Gas gate-stations established (Cumulative number)	 0 0	 114 8	 230 22	 290 41	 320 45	 320 45	 320 45
3. Crop residues treated by the project (Ton/year)	0	0	0	39170	165900	221700	221700
4. Livestock manure treated by the project (Ton/year)	0	0	0	93265	176030	241600	241600
5. CNG produced by the project (Million m^3/year)	0	0	0	2	5	7	7
Component Two: Technical support, project management, and monitoring							
1. Client days of training provided (Cumulative person-day) - (Core)	0	330	790	1280	1600	1760	1800
2. Number of laboratories built at biogas plant level (Cumulative number)	0	0	6	6	6	6	6
3. M&E system put into operation	No	Yes	Yes	Yes	Yes	Yes	Yes
4. Number of guidelines and regulations prepared and put into use (Cumulative number)	0	1	2	2	2	2	2

Indicator Description

Project Development Objective Indicators				
Indicator Name	**Description (indicator definition etc.)**	**Frequency**	**Data Source / Methodology**	**Responsibility for Data Collection**
1. Stable biogas production and supply by the project	Amount of project-supplied biogas used by final users (Million m3 /year)	Annually	M&E report	PMO
2. Reduction of pollution in rural areas	CO2 emission reduction by the project (Ton/year)	Annually	M&E report	PMO
3. Increased biogas access to rural residents	Number of rural resident households who can access biogas supply under the project (Number/year)	Annually	M&E report	PMO
Intermediate Results Indicators				
Indicator Name	**Description (indicator definition etc.)**	**Frequency**	**Data Source / Methodology**	**Responsibility for Data Collection**
Component One: Large-scale biogas facilities management and renewable energy supply				
1. Generation Capacity of Renewable Energy	Capacity of biogas production constructed under the project (Million m^3/year)	Semi-annually	Implementation progress reports	PMO
2. Biogas distribution system established	Length of main pipeline installed for biogas distribution to rural residents (Cumulative Kilometer)	Semi-annually	Implementation progress reports	PMO
	Gas gate- stations established for biogas distributions to rural residents who live in the areas relatively far from biogas facilities (Cumulative Number)	Semi-annually	Implementation progress reports	PMO
3. Crop residue treated by the project	Amount of crop residue used as feedstock for biogas production (Ton/year)	Semi-annually	Implementation progress reports	PMO
4. Livestock manure treated by the project	Amount of livestock manure treated by biogas digesters to product biogas	Semi-annually	Implementation progress reports	PMO

	(Ton/year)			
5. CNG produced by the project	Amount of CNG produced for vehicle fuel by the project (Ton/year)	Semi-annually	Implementation progress reports	PMO
Component Two: Technical support, project management, and monitoring				
1. Client days of training provided	Person. Day of project technical and management staff who received training provided by the project (Cumulative number)	Semi-annually	Implementation progress reports	PMO
2. Number of laboratories built at biogas plant level	One simple laboratory established at each subproject to monitor the performance of biogas facility (Cumulative number)	Semi-annually	Implementation progress reports	PMO
3. M&E system put into operation	M&E system established and put into operation at provincial and subproject levels to monitor the project implementation and impacts	Semi-annually	Implementation reports	PMO
4. Number of guidelines and regulations prepared	Development of a manual to guide biogas digester operation and a manual for digestate application (Cumulative number)	Semi-annually	Implementation progress reports	PMO

ANNEX 2: DETAILED PROJECT DESCRIPTION

China: Hebei Rural Renewable Energy Development Project

A. Project Areas and Design Approach

1. Project Development Objective (PDO): The PDO is to demonstrate sustainable biogas production and utilization to reduce environmental pollution and supply clean energy in rural areas of Hebei Province.

2. Project Areas: Project areas are located in six counties within Hebei province, which include Anping, Yutian, Zunhua, Linzhang, Chengde, and Laoting counties.

B. Project Technical Design Details

3. The project consists of two components, including large-scale biogas facilities management and renewable energy supply (Component 1), and technical support, project management, and monitoring (Component 2).

Component 1: Large-scale biogas facilities management and renewable energy supply (Total Base Cost: US$ 134.33 million)

4. Under this component, the national and international best practice in developing large-scale biogas facilities will be demonstrated. Six biogas facilities will be installed and operated in Hebei to effectively convert agricultural wastes (specifically, crop residues and livestock manure) to biogas, to provide stable clean energy to local rural residents. It is expected that annually the project will produce around 42 million m^3 of biogas with around 221,700 tons of crop residues and 241,600 tons of livestock manure appropriately treated as feedstock for biogas production. The biogas will be provided to around 96,100 rural residents (households) mainly as cooking energy, which will reduce around 58,780 tons of CO_2 emissions annually by replacing coal burning. The remaining biogas, after supplying the target rural residents, will be upgraded and used as vehicle fuel. An estimated around 7 million m^3 of compressed biogas (equivalent to and conventionally known as "CNG") will be produced annually to support public transportation in the project counties.

5. The digestate generated from the subprojects, a by-product of the biogas production, will be used as organic fertilizer. The project is expected to produce about 91,900 tons of solid bio-fertilizer and around 100,200 ton of liquid bio-fertilizer per year, which will be used mainly on the croplands, orchards and vegetable lands in the vicinity of the plants. The remaining part will be sold to other counties.

6. Component 1 will finance all civil works and equipment for the biogas production facilities, the gas distribution and supply systems including CNG filling stations and digestate fertilizer processing. The procurement contracts were packaged by separating goods and works

that will be either financed by the Bank or by the counterpart funding to simplify the procurement process, which are detailed in PIP.

7. Subprojects: During project preparation, PPMO developed a subproject appraisal manual to guide the subproject assessment and selection. It outlines the selection criteria for subprojects. In line with this Manual, six subprojects, involving six biogas facilities with sizes between 8,500 to 31,700 m³/day (m^3/d) biogas productions, have been identified and prepared. The subprojects, named Anping, Yutian, Zunhua, Linzhang, Chengde, and Laoting Subprojects, are expected to produce around 42 million tons of biogas annually.

8. An overview of the subproject characteristics is presented as the Table 2-1. The details are referred to the subproject feasibility study reports (FSRs) and project implementation plan (PIP).

Table 2-1: Subproject Characteristics

	Name (short)	Capacity (Gas production)	Feedstock (for digestion)	Digestion technology	Digester size
1	**Anping**	31,700 m³/d	Manure (+ 15% straw)	CSTR	6 x 4,700 m³
2	**Yutian**	21,000 m³/d	Manure	CSTR	6 x 3,200 m³
3	**Zunhua**	24,000 m³/d	62% manure + 38% straw	SSP	16 x 1,100 m³
4	**Linzhang**	8,500 m³/d	Straw (+ some manure for C/N balancing)	VPF	4 x 2,500 m³
5	**Chengde**	16,200 m³/d	Straw (+ some manure for C/N balancing)	VPF	8 x 2,500 m³
6	**Laoting (1 main station and 4 substations**	27,100 m³/d	Straw (+ some manure for C/N balancing)	VPF	8 x 2,500 m³ 6 x 1,150 m³ 2 x 1,550 m³

9. Applied technologies: The feedstock for the biogas digestion facilities will consist of animal manure from the concentrated livestock farms as well as crop residues from local farmlands. The technology for large-scale biogas facilities using animal manure as the feedstock is mature in China and other counties. The technology for biogas facilities using straw as the feedstock has been developed and used in China for many years. It is a proven technology, however, the process for using crop residues, such as corn stalk (which contains stems, leaves, husks, and partial cob cores) involves relatively difficult feedstock pre-treatment and straw digestion, and the successful experience with those processes in large scale biogas production is limited.

10. During project preparation, a thorough assessment has been made for the available biogas technologies with focus on addressing the difficulties related to the use of straw as a feedstock.

The studies on the specific areas included feedstock collection and transportation, feedstock storage (considering that straw and other crop residues can only be collected seasonally), and the needs for pretreatment and longer fermentation times (because of the crop residue's high content in lignocellulosis) were conducted. Based on the assessments, three biogas technologies have been selected for the project and the relevant technical standards have been established to reduce operation risks and ensure project performed on an international level. The biogas technologies are detailed as follows:

(a) *Continuous Stirred Tank Reactor Technology (CSTR).* With this method, all feedstock is mixed and injected into the digester; the contents are completely mixed. Total solids (TS) in the digester should be between 5 and 10%, depending on the type of substrate. The CSTR is a well-known and internationally proven technology, which is mainly used for biogas operations with animal manure as the feedstock. It is recommended for subprojects with either mainly manure as substrate, or with a mixed substrate with a large portion of animal waste. Two subprojects, Yutian and Anping, have selected CSTR.

(b) *Vertical Plug Flow Technology (VPF).* VPF, named for its use of a vertical cylinder, is a Chinese technology specifically developed for straw feedstock. A mixture of chopped straw and recycled liquid is sprayed onto the surface where a floating "plug" forms without mixing. The solids content is high and the solids retention time is comparably long (>60d), sufficient for straw degradation. Digested material is discharged at the bottom of the reactor, which is expected to be difficult if digesters are too large (channeling/bridging). Because of this, based on the successful experience, smaller-size digesters ($\leq$2500 m^3/d) are recommended for the subprojects that will mainly use straw as substrate. From an international point of view, VPF is an innovative technology internationally with a huge potential for scaling up for crop waste treatment. The experience and lessons learned from current similar operations in China as well as other countries have been taken into account, and key technical perimeters and requests have been set for the biogas facility design, operation and monitoring. Three subprojects, Linzhang, Chengde, and Laoting, have selected VPF.

(c) *Solid State Percolation Technology (SSP).* The solid state fermenter facility consists of several garage type chambers, which are operated in batch mode. The feedstock needs to be a stackable and porous material. It is inoculated with recycled digested material, loaded into the garages, and percolated with liquid. One batch takes approximately 20–30 days to digest. As the garage digesters are operated in a staggered mode, the total gas production is fairly constant. The solid state percolation technology was developed in Europe mainly for treatment of municipal and rural wastes. The technology is mature with the advantage of use of a broad range of feedstock. A pilot SSP biogas program has been implemented in China for four years, which shows that this technology fits well with the local conditions. One subproject, Zunhua, has selected SSP.

11. A Sino-German expert team as well as Bank experts reviewed the above proposed technologies and consider that these technologies—CSTR, VPF, and SSP—are appropriate for the project.

12. Feedstock supply: Hebei, as one of China's leading agricultural provinces, is endowed with abundant resources for agricultural production and has a large production of livestock. The province includes around 6.3 million ha of agricultural land and each year around 61.8 million tons of crop residues are produced, representing a huge amount of potential feedstock for biogas facilities. In addition, Hebei's more than 2,000 concentrated livestock farms each year produce around 30.7 million tons of livestock waste that is not treated properly, causing serious pollution in the rural areas. This livestock waste can also serve to provide large quantities of feedstock for biogas production in the province. The overall assessment of the potential feedstock supply in Hebei indicated that the large amount of livestock manure and crop residues across the province need to be treated appropriately, which provide huge potential resources/feedstock to biogas production.

13. Feedstock for the subprojects. For each of the subprojects, comprehensive assessments of the potential feedstock were conducted, which include the surveys undertaken in 580 villages (107 townships) in the areas around the subproject sites, both within the "core area" (a five-kilometer (km) radius around the plant location) and within the "outer area" (the area within a radius of 20 km).

(a) According to the surveys, animal manure from the PIUs' own livestock farms will be sufficient. This relates to the Anping, Yutian, and Zunhua subprojects and they each year produce a total of 341,600 tons of pig, chicken, and cattle manure, which is 1.4 times of the demand of 261,400 tons of livestock manure. For each subproject, the amount of animal manure from the PIU own livestock farm is expected to be 1.1 to 1.9 times the demand, which indicated that there is also sufficient feedstock for each of the three subprojects.

(b) A survey on accessible straw resources around the six subproject sites also indicates that the available corn straw within the core area is more than enough after taking into account the alternative uses of the crop residue (for example for livestock forage and crops kept in the field to improve soil fertility). According to the surveys, the available crop straw of 621,000 tons (calculation basis straw with 15% moisture) within the core area exceeds the needed amount of 229,400 tons for the project. For the single subproject the core area provides approximately 1.5 to 14 times the demand. All feedstock for the subprojects will be collected within a radius of 5km, which exceeds the threshold of 75% of required feedstock provided within the core area. In addition, the area within a 20 km radius (radiation area) was also investigated and the availability of crop straw is also high, providing as much as 6-25 times of the demand from the subprojects. This sufficient feedstock supply also results from the necessary biogas facility adjustments that were made under the project preparation. Laoting, for example, split its one biogas facility site into five separate sites to match the supply of substrate resources and locate the biogas facilities close to the end users.

14. Straw for the subprojects will be largely procured with the help of a system of free agents who will collect the straw from the farmers and transport it to the sites, or be directly collected by the PIUs. As the price of the feedstock is crucial for the project revenue, several measures have been taken to secure a feedstock supply at a stable price. Some of the PIUs, such as those in

Anping and Laoting, will use a cooperative system for straw procurement, for example by providing harvesting services in exchange for the straw. In those locations, the majority of biogas users live in the areas surrounding the biogas facilities and the PIUs will also be providing the households with biogas and digestate fertilizer at stable prices. Taking advantage of this potential "win-win" situation, the PIUs were able to sign agreements with the farmers on the amount and stable prices of the crop residue supplied to the PIU. Finally, by collecting the majority of crop residue within the core area, transportation costs are reduced, which also contributes to lower feedstock collection costs.

15. Storage and pretreatment: Straw is a seasonal feedstock, which requires storage from harvest over the whole year. Intermediate storage of the feedstock during the year is done partially by the free agents, partially on the site of the biogas plants. The number of storage sites ranges from 2 large sites (Chengde) to 40 small sites (Linzhang), based on considerations of economical transport, agent diversification to fire safety. Straw is a resilient feedstock and the material needs proper pretreatment or sufficient retention time to release its full biogas potential. The subprojects are considering the ensilaging of green straw/silage (with around 70% water content) to simultaneously address storage and pretreatment. During ensilaging, complex carbohydrates are degraded to alcohols and acids, while the energy content will be nearly completely retained as long as best practices are applied. Storage of manure is not necessary as the manure will be available all year round; manure storage will even be avoided to minimize energy losses.

16. Digestate handling/fertilizer production: A biogas facility not only supplies energy, its digested substrate is also a valuable soil fertilizer that is rich in nitrogen, phosphorus, potassium, and micronutrients. Compared to raw animal manure, digestate has improved fertilizer efficiency due to its higher homogeneity and nutrient availability. The use of this bio-fertilizer instead of chemical fertilizer will generally improve the quality of the soil and agricultural products. The sale of this digestate fertilizer will generate incomes to contribute to a sustainable biogas operation and avoid secondary pollution that might be caused by the digestate.

17. Because the use of specific fertilizers should depend on soil nutrition conditions, assessments were carried out by the PIUs and design institutions to determine the fertilizer needs of various crops on the farmlands around the biogas facilities. In addition, consultations were carried out to understand the local farmers' willingness to use the digestate fertilizer and at what price to secure the bulk sale of digestate fertilizer to the local farmers. Any digestate fertilizer not sold will be further packaged and sold to the market through fertilizer wholesalers. The digestate fertilizer demand analysis has been reviewed by the Bank team. It includes an estimate of the demand for fertilizer, a price comparison with other fertilizers and estimates of the distance over which the fertilizer will have to be transported and etc. According to the project design, around 91,200 ton solid and around 100,200 ton liquid digestate fertilizer will be produced from the subprojects annually, which will constitute around 25% of the fertilizer demand in the areas around those biogas facilities (most within the five-km and some in the twenty-km radius). Purchase (or similar) agreements have been signed between the six PIUs and households/communities, as well as with wholesalers. The industry standard (NY525-2012) for organic fertilizer will be followed to ensure key quality requirements for organic fertilizer (e.g., acceptable levels of organic matter, heavy metal, moisture content, pH level, and total coliform)

will be met.

18. Biogas distribution and utilization: The main utilization for the biogas is the distribution of purified (with particulate matter and hydrogen sulfide removed) biogas to households in the nearby communities and concentrated rural resident buildings. The biogas will be used mostly for cooking purposes—to replace coal, straw, and wood fuel—with the majority of households living within a 5 km radius. Like most rural areas, the project areas don't have a national gas grid (either currently or in the foreseen further), which means gas will be distributed to the households via a dedicated micro-grid; the installation and maintenance of the grid is part of the subprojects' scope. After the gas is purified (to meet requirements for rural household use), some biogas facilities will deliver the gas directly to the households through low-pressure pipelines (mainly for housing areas within a 3 km radius). For longer distances, gas (after upgrading) will be pressurized and transported by cylinders to village gas gate stations that have pressure reduction units. In response to feedback from household consultations, a government subsidy will be not only provided for main gas pipe installation, but also cover the cost of branch pipe extending to each household as well as the cost for gas stove and gas meter sets to reduce the initial installation costs for gas users.

19. Stable gas supply. To ensure the stable and sufficient gas provided to the end users, the conservative approaches were taken for the biogas facility design. Experience from other countries with developed biogas facilities shows that an availability of 90%, equaling approximately 8000 hour/year at full capacity, is a realistic and conservative assumption. It is also the standardized request for biogas production set in China. To minimize the overall project risk, a maximum capacity utilization of 8000 full capacity hours per year is used as a basis for design. In addition, other measures are also taken to address the fluctuation of gas use and any other unexpected impacts to whole processes of biogas productions: (a) securing sufficient supply of feedstock within the core areas (a five km radius around the biogas felicities) for any additional potential needs; (b) using conservative technical perimeters for biogas productivity estimation. For instance, the gas production potential of feedstock is set as less than 400 m^3/t (TS), however the tests show that it is around 420 to 450 m^3/t; and (c)) installing sufficient gas storage, with around 50% of daily gas production capacity, to adjust the gas use change. As part of the biogas will be used to support PIUs' own use, the alternative uses for biogas will also accommodate the fluctuations in household gas demand and ensure a stable gas distribution to the rural residents.

20. Any biogas not distributed to the local communities can still be used, and various options have been explored for the use of this surplus biogas. Three subprojects (Laoting, Anping and Zunhua) will upgrade the surplus biogas by removing carbon dioxide and thus produce biomethane/ compressed bio-methane (CNG). Assisted by the expert team, the PIUs have adopted various technologies including high pressure water scrubbing, pressure swing adsorption, and membrane technology, which are all considered to be mature technologies. The subproject companies will also use part of the biogas to meet their own energy needs, for example, for livestock production, operation of the biogas facilities and digestate fertilizer production.

21. Biogas end users: For each subproject, assessments of the biogas end users in the areas

around the biogas facilities have been conducted and the assessment reports have been reviewed by the Bank team. The reports indicate that the markets for the proposed products (biogas and CNG) are promising. Supported by the expert team and design institutions, the PIUs have conducted surveys of biogas demand by visiting each of the potential user villages and rural residential buildings to find out the potential users' willingness to use biogas, the price they are willing to pay, any technical support they might need, and any concerns they might have. According to the survey, the majority of households, as well as the real estate developers of the concentrated rural residential buildings, are willing to use the biogas.

22. According to the surveys, the rural households located around the six subprojects currently largely use coal, crop residue, and wood-fuel for individual household cooking and heating, on average accounting for about 44.9%, 24.1%, and 14.5% of total household energy needs respectively. The main reasons for households' willingness to use biogas are its competitive price and the fact that it is clean and easy to use. More than 95% of visited farmers said they are looking forward to using clean energy to replace coal, which will greatly reduce indoor pollution. The surveys also indicated that the natural gas grid is not currently available in the project areas, nor will it be in the foreseen future. Although LNG (liquefied natural gas) is available on the local market, it is more expensive than biogas. While cooking expenses for one household using biogas will be around 440-500 Yuan per year (based on current market prices of 2.0 to 2.3 Yuan/m^3, which are also the proposed prices of the subprojects), the same expenses using LNG will be around 700-950 Yuan per year (based on the current LNG price of around 7.8 Yuan/kg).

23. The surveys and consultations confirmed that the target biogas users of the subprojects are located in about 160 villages and 10 rural residential buildings, together covering about 96,100 households. Biogas supply agreements have been signed by the PIUs and the biogas users. Additional detail about biogas distribution is included in the FSRs, including information on the distribution of biogas end users (household numbers and distances from the villages to the biogas plants); the biogas distribution design (pipelines or other methods, such as canisters); required technical services and management; the consultation process with end users; agreements on price setting; and signed biogas use contracts.

24. Because three of the six subprojects (Anping, Laoting, and Zunhua) have been designed to produce CNG, a CNG demand analysis was also carried out. The analysis evaluated the local government's clean transportation and CNG development strategies and plans (to determine the potential market), as well as government commitments to the project on CNG supply authorization. In addition, assessments were made on the gap between CNG supply and demand. A price comparison indicated that CNG prices are competitive compared to natural gas, which is a potential competitor to CNG on the local market for consumption by vehicles. Moreover, prices of natural gas are even increasing due to the huge gap between its supply and the demand in the project areas as well as in Hebei. From 2009 to 2013, the price of natural gas for transportation in Hebei has increased by 30% to 50% and further increases are expected in the future. The CNG will be sold by PIUs' own filling stations which will be set as second stage of the project or be sold directly to markets.

25. Criteria for subprojects selection: Specific criteria were developed for subproject

selection including eligibility of the participating entities and have been included in PIP. These criteria guided the subproject identification and assessment during the project preparation and may be continued used for any necessary adjustments during the project implementation. All the selected subprojects meet these criteria. The eligibility criteria for the subproject selection are the following.

(a) The participating entities should be located in Hebei province and be a leader in the renewable energy business or rural waste management business.

(b) The participating entities should have a business scope that includes the production and sale of biomass energy or renewable energy.

(c) A corporate financial analysis should be conducted for each proposed participating entity, covering at least three years of financial statements and a ten-year projection, with the results confirming that the proposed entity: (i) has been profitable for three consecutive years; (ii) has strong solvency with a debt service coverage ratio of 150% or above after the grace period; and (iii) has the ability to provide counterpart funding.

(d) The proposed subproject should meet the standards for the financial analysis with a FIRR for the subproject above 8 percent (with government subsidy).

(e) The proposed subproject should have strong backing by its shareholders, who support the investments, and a sound organizational structure with a strong professional team and technical and managerial capacity.

(f) The proposed subproject should meet a set of overall technical conditions and parameters set by PIP.

26. The technical requirements also set for the project design during the project preparation and the biogas plant designs ware consistent with the relevant criteria. Table 2-2 lists the key biogas plant performance criteria and requirements that subprojects must adhere to:

Table 2-2: Biogas Plant Performance Criteria

(a) : Biogas Plant Performance Criteria for CSTR and VPS

NO	Parameter	Unit	Project requires
1	**Silage straw pretreatment parameters**		
1.1	Moisture content	%	≥65
1.2	Density	kg/m^3	≥500
1.3	Straw particle size	mm	≤10
2	**Fermentation parameters**		

NO	Parameter	Unit	Project requires
2.1	Fermentation temperature	˚C	Medium or high temperatures, but at the set temperature does not exceed plus or minus 2 ˚C
2.2	Hydraulic retention time	Day	With manure as raw materials 20 days; straw as raw material 40 days (silage)
2.3	Corn stalks gas production [1)]	$m^3t^{2)}$ .TS	≤400（Under standard conditions, the yellow straw storage is not recommended as a raw material）
2.4	The volume of gas production rate	$m^3/m^3.d$	1.0（Raw manure） 0.8（Silage）
2.5	VPF Fermenter return flow		Slurry circulation return loop should be controlled at 5-10 times the volume of straw
2.6	Monomer volume fermenter	m^3	≤2500 (Only VPF process fermenter)
2.7	Recommended N ratio		20-30
3	**Biogas project Operation**		
3.1	Annual operating time	h/a	8000
3.2	Automatic control		Mandatory
3.3	Fire protection requirements		Straw biogas project area> 3000m3, it is desirable to set fire ring road, fire road shall comply with the provisions of GB50016.
3.4	On-site laboratory		Necessary / required to cooperate with the central laboratory
3.5	On-site monitoring system		Mandatory / networking with provincial monitoring center
3.6	Biogas utilization	%	>95
3.7	The amount of household biogas	m^3/d	0.6
3.8	Gas torch		Necessary

(b) : Biogas Plant Performance Criteria for SSP

No	Parameter	Unit	Project requirements
1	**Silage straw pretreatment parameters**		
1.1	Straw particle size	mm	40-50
2	**Fermentation Tank Parameters**		
2.1	Fermentation temperature	^oC	Medium or high temperatures, but at the set temperature does not exceed plus or minus 2 ˚C
2.2	Hydraulic retention time	d	The total residence time fermentation materials: ≥55 days
2.3	Feed concentration of dry matter	%	≥25
2.4	Volumetric Biogas Yield Rate (Digester productivity)	$m^3/m^3 \cdot d$	≥1

2.5	Digester Single Volume	m^3	≤1200
3. Biogas Plant： Operation requirements with table 1 - biogas engineering			

Component 2 – Technical support, project management, and monitoring (Total Base Cost: US$ 5.8 million)

27. Component 2 includes technical services, training and extension, monitoring and evaluation, as well as project management provided by the PPMO. An expert team will be contracted to provide technical assistance during project implementation.

28. Existing biogas projects in China are largely lack of monitoring systems and ongoing technical and scientific support by dedicated institutions over the lifetime of the project, both of which are key factors behind the poor operation of biogas programs. The project will strengthen biogas technical service support, training programs and establish a monitoring system. Through the support, the project will build institutional capacity for long-term biogas program operations. The component will finance consulting services for technical assistance and monitoring activities; equipment procurement for monitoring system set at provincial and PIU levels and laboratory set-up at the PIU levels; project management; and domestic and overseas training and study tours.

29. Technical Support: Technical support under Component 2 includes:

(a) Technical assistance to the project implementation. National and international consultancy services in variety of technical and operational aspects of biogas production and distribution as well as monitoring and evaluation will be contracted by the PPMO to provide technical assistance (TA) to the project implementation. The Bank team reviewed the detailed TA arrangements. The terms of references for the consulting services will be prepared before the project launch by PPMO.

(b) *Setting-up of subproject level based laboratories*. The laboratories will be used to monitor the performance of biogas facilities by analyzing fermenting conditions and testing biogas and slurry. The local laboratories will be set up to be able to do the basic analyses like solids content, fermenting conditions (volatile fatty acids, buffer capacity), biogas and its slurry compositions. More specialized analyses shall be contracted to external professional laboratories. The expert team will support these laboratories to develop analyses programs and methods suited for the monitoring and survey biogas processes and products.

(c) *Training programs for project management and biogas facility operation.* The PPMO will organize trainings for the project technical and management staff at both provincial and PIU levels to ensure project designs will be implemented appropriately and the biogas facilities will be operated in a sustainable way. The trainings will in particular focus on enabling local technicians (staff) of PIUs to obtain the skills to handle subproject operations and appropriately and safely maintain the biogas distribution system. A training plan has been prepared by PPMO and reviewed by the Bank. Around 1,800 person-day domestic trainings

will be provided by the project in the aspects of biogas production and distribution, safety measures for biogas production and utilization, procurement, finance management, implementation of environmental and social safeguards, project monitoring and evaluation. Around 60 person-day international trainings have been also planned to learn biogas management experiences from other countries. In addition, the trainings for biogas users will be provided by the PIUs during the biogas facility operation period.

(d) *Development of manuals for biogas digester operation and digestate application.* The PPMO will contract with expert teams to prepare a biogas digester operation manual and a digestate application manual. The biogas digester operation manual will provide technical guidance on biogas system operation and standardize the biogas system management. The manual for digestate application will include guidance on how to effectively apply the bio-fertilizer to various types of soil and crops to replace chemical fertilizers and improve soil conditions and crop yield and quality. The manuals will be updated on a regular basis to include new findings and experiences from the project and make the best use of them.

30. Project Monitoring and Evaluation: The project's monitoring system includes a central monitoring platform at the provincial level (including a data collection and assessment centre) and monitoring systems at each of the subproject sites to monitor the operations of the individual biogas facilities as well as overall project performance and impacts. The overall system will consolidate experiences and results from the subprojects to benefit the entire project. The monitoring system focuses on monitoring biogas facility operation as well as project performance:

(a) *Data monitoring:* All subprojects will be required to use high quality instrumentation and an automatic control system (Supervisory Control and Data Acquisition, or SCADA). Data gathered by the systems will be analyzed in the field as well as automatically transmitted to the central monitoring system, where they will be available for in-depth inspection by an expert team, in a simple and cost effective way, to optimize performance. The central support and supervision team will be responsible for reviewing and evaluating biogas facility operations based on collected data and provide benchmarking and advice on possible actions at early stages to deal with operation imbalances. As part of the data monitoring, substrate and digestate, flow rate, and the quality of the produced biogas will be regularly monitored to assess plant performance and identify areas for improvement.

(b) *Project performance monitoring:* The project monitoring and evaluation system will not only monitor biogas facility operations, but also monitor project progress, performance, and impacts, which cover, among others: (i) the implementation of the project technical design under the subprojects; (ii) the implementation of safeguard policies; (iii) the implementation of training and technical assistance; and (iv) the project performance and impacts. Contracted by PPMO, the professional consulting institutions/expert teams will conduct the project performance and impacts monitoring (once a year), as well as the safety monitoring of the biogas production and

distribution system (twice a year) during the project implementation period. The monitoring to project environmental and social impacts will be also conducted by contracted third part professional institutions. A project monitoring plan has been developed by the PPMO and reviewed by the Bank.

ANNEX 3: IMPLEMENTATION ARRANGEMENTS

China: Hebei Rural Renewable Energy Development Project

Project Institutional and Implementation Arrangements

1. The management structure of the project has been set up. The project implementation arrangements, in particular the role and responsibilities of government agencies and project implementation units have been clearly defined and assessed by the Bank.

2. Project Leading Group. A Project Leading Group (PLG), headed by the vice-governor and consisting of members from key line departments such as the Hebei provincial Finance Department, Development and Reform Commission, and Agriculture Department, has been established at the provincial level to provide overall guidance and coordination during project preparation and implementation. The PLG will oversee overall project progress and performance. The PLG will also ensure inter-agency coordination, particularly on seeking joint solutions for any issues occurred during project implementation.

3. Provincial PMO. A Provincial Project Management Office (PPMO) has been established, which has overall responsibilities for the project preparation and implementation including day-to-day supervision and project monitoring and evaluation, as well as for providing technical support to the PIUs. The PPMO will also prepare annual working and budget plans; organize trainings for PPMO and PIU staff; supervise the PIUs' implementation of the project technical design, social and environmental policies, and financial management; and organize and coordinate PIU procurement processes. The PPMO will monitor overall project implementation and impacts.

4. The PPMO is located within the Hebei Provincial Agricultural Department and is staffed by personnel with expertise in biogas technologies and operation, environmental and social management, financial and procurement management, and training and monitoring. The PPMO will also coordinate with an expert team, which will provide technical assistance to the project through technical services, training and dissemination. Additional technical support will be provided by the Hebei Rural New Energy Technology Extension Station, where the provincial-level monitoring system will be established.

5. Project Implementation Unit (PIU). Biogas production and distribution will be implemented by the subproject companies as the PIUs. The PIUs will implement the individual subprojects under the overall project framework, with technical support, supervision and coordination provided by the PPMO. The specific responsibilities of the PIUs include subproject level procurement, financial management, biogas facilities establishment and operation, distribution of biogas and other products, provision of services and trainings to the end users, implementation of social and environmental management plans, as well as subproject level monitoring and reporting.

6. In line with the subproject assessment manual, six subprojects have been identified under the project. The subprojects will be implemented by six companies: Hebei Yufeng Jingan Livestock Farming Co., Ltd; Yutian Yiheyuan, Ecological Agriculture Co., Ltd; Hebei Meikeduo Food (Group) Co., Ltd; Hebei Runze Zhimin, Agricultural Science and Technology Co., Ltd; Hebei Green Energy Ecological Environmental S&T Co. Ltd; and Hebei Construction and Energy Investment Co., Ltd. The subproject companies are national and provincial dragonhead agro-industrial companies with primary business in raising and selling livestock; organic fertilizer production, grains processing; energy including rural renewable energy such as biogas production; as well as biogas system design and engineering construction, and technical services provision. They all have the business scope in the production and sale of biomass energy or renewable energy.

7. The companies, as the PIUs, will receive around 25% of subsidized funding from the provincial government and provide their own equity of around 25% of the total investment as counterpart funding. The PIUs will borrow the Bank loan through an on-lending arrangement with the participating county Finance Bureaus, with the PIUs ultimately bearing the project risk and the obligations of loan repayment. The Bank has assessed the financial capacity of the PIUs (including profitability, operational efficiency and solvency, liquidity, and growth and stability) and concluded that the selected companies have profitable core businesses, efficient operations, and sound financing structures. Supported by strong cash flows and stable business, they are in a proper position to implement the project.

8. Project Implementation Plan (PIP). A PIP with 11 annexes has been prepared to guide the project agencies and PIUs implementing the project. It includes detailed project technical design and standards, activities under each component, institutional and management arrangements including the aspects of financial management and disbursement, procurement, social and environmental safeguards, project monitoring and evaluation and etc. All the project activities will be carried out according to the PIP. PIP is written in Chinese and English and is made available to all the staff involved in the implementation of the project.

Financial Management, Disbursements and Procurement

Financial Management

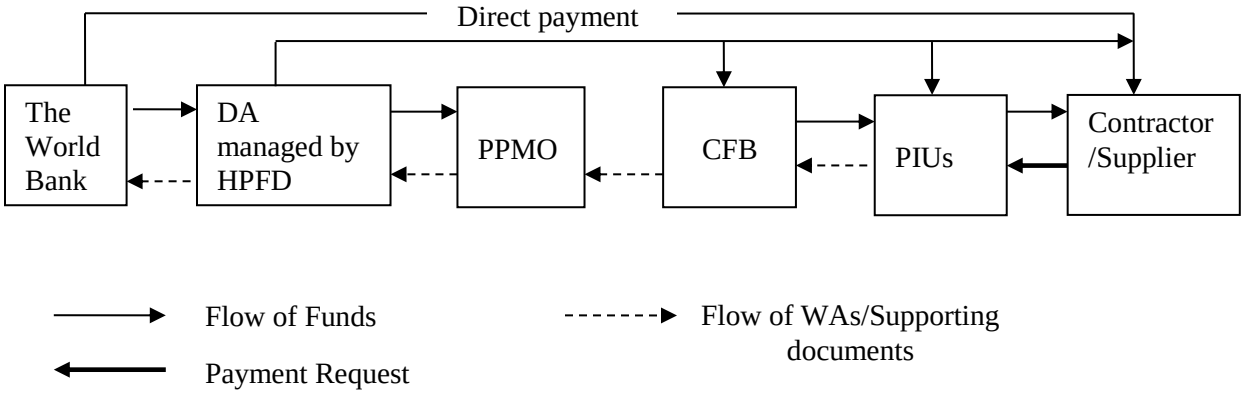
9. Overall, the residual financial management risk after mitigating measure for the project is assessed as Substantial.

10. Funding sources for the project include the Bank loan and counterpart funds. The Bank Loan Agreement will be signed between the Bank and the People's Republic of China through its Ministry of Finance (MOF), and on-lending agreements for the Bank loan will be signed between MOF and the Hebei Provincial Government through Hebei Provincial Finance Department (HPFD), then between HPFD and county government through the county finance bureaus (CFB), and finally between CFB and PIUs. As an exception, the Bank Loan will be on-lent to the Hebei Construction and Energy Investment Co., Ltd directly from HPFD. The Bank loan will be on-lent on the same terms and conditions as received from the Bank.

11. Budget. An overall project work and budget plan, including financing sources, has been prepared by the PPMO. In the government's budget and accounting system, expenditures will be executed when counterpart funding is transferred to the project. The project budget and project expenditures will be recorded in a project accounting system(s). Budget variance analysis will be conducted regularly by the PIUs providing periodic information on project execution progress thus enabling timely corrective actions.

12. Budget for counterpart funds from the provincial level, accounting for around 50% of total counterpart funds, has been committed by the Hebei provincial government, which was secured from the National Rural Bio-gas Support Program. Through increasing the PIUs' registered capital by the amount of total self-raised counterpart funds by PIUs, the other 50% of total counterpart funds from the PIUs are also secured. Before project appraisal, more than half of PIUs' counterpart funding has been in place and the remaining has been committed and will be arranged during project implementation according to the project annual implementation plan.

13. Flow of Funds. Bank loan proceeds will flow from the Bank into a project designated account (DA) to be set up at and managed by the HPFD. The PIUs will pay contractors and suppliers and then request reimbursement from the DA through withdrawal applications. The PIUs will prepare reimbursement request and other supporting documents to request reimbursement of expenditures and submit them through CFB for PPMO review and then for approval and verification by HPFD. HPFD will transfer the reimbursement through CFB to the PIUs or directly to contractors/suppliers. For Hebei Construction and Energy Investment Co., Ltd., its reimbursement request for Bank loan financing will only go through the review and approval of PPMO and HPFD, and HPFD will directly transfer the reimbursement to it or its contractors or suppliers. The flow of funds and WA's/supporting documents are as follows:



14. Accounting and Reporting. The PPMO and each PIU will establish a separate account for the project activities within their existing accounting system, either manual or computerized, in accordance with Circular #13: "Accounting Regulations for the Bank-financed Projects" issued in January 2000 by MOF. The PPMO and each PIU will manage, monitor, and maintain project accounting records for the activities they execute. Original supporting documents for project activities will be retained by the PPMO and each PIU respectively. The PPMO and each PIU will prepare their own stand-alone project financial statements, which will then be consolidated by the PPMO and submitted to the Bank for review and comment on a regular

basis. The interim unaudited project financial statements should be consolidated, prepared and furnished to the Bank by the PPMO no later than 60 days following each semester (due dates will be August 31 and February 28), in form and substance satisfactory to the Bank.

15. Internal Control. The related accounting policies, procedures, and regulations have been issued by MOF to uniformly align with the financial management and disbursement requirements for all Bank financed projects. A project financial management manual (FMM) has been prepared, describing financial management policies, requirements, and procedures. The FMM will be used to guide the project's financial management and disbursement process.

16. Auditing. The Hebei Provincial Audit Office (HPAO)has been identified as the auditor for the project. Annual audit reports of project financial statements will be issued by HPAO and submitted to the Bank within 6 months after the end of each calendar year. According to the agreement reached with MOF and China National Audit Office, the audit report and audited financial statements will be made publicly available in both the Bank and HPAO's official websites. This requirement is stipulated in the loan agreement.

Disbursements

17. Four disbursement methods: advance, reimbursement, direct payment and special commitment are available for the project. The primary Bank disbursement method will be advances to the DA. Supporting documents required for Bank disbursement under different disbursement methods are described in the Disbursement Letter.

18. One segregated DA in US dollar will be opened at a commercial bank acceptable to the Bank and will be managed by HPFD. The ceiling of the DA will be determined and documented in the Disbursement Letter. HPFD will be directly responsible for the management, maintenance and reconciliation of the DA.

19. The Bank loan proceeds will be disbursed against eligible expenditures (taxes inclusive) as in the following table:

Table 3-1: IBRD Disbursement Methods

Expenditure Category	**IBRD Loan (US $)**	
	Allocated Amount	**Percentage of Expenditure to be financed**
(1) Goods and Works for Component 1	63,964,000	100
(2) Goods, works, non-consulting services, consulting services and training for Component 2	2,240,000	100
(3) Front-end fee	178,750	
(4) Commitment Charge and Interest during Implementation	5,117,250	
Total	**71,500,000**	

20. Retroactive financing of up to US$ 10 million will be available for eligible expenditures incurred on and after August 1, 2014 for the implementation of goods, civil work, non-consulting services, and consultant services as well as training programs.

Procurement

21. Institutional Arrangements. The PPMO and PIUs will be responsible for procurement and contract management of specific contracts under the project. The PPMO will be responsible for organizing procurement under component 2 as well as the overall coordination and communications with the Bank including requests for no objection. Procurement of works, goods, and non-consulting and consulting services contracts under the subprojects of component 1 will be carried out by the PPMO and respective PIUs together with the active support and guidance from a qualified procurement agent and under the close coordination and supervision of the PPMO. The PIUs with leadership of PPMO and support of procurement agent will be responsible for (a) preparing the procurement plan for their subprojects (along with updates), bidding documents, and requests for proposals; (b) organizing the bidding/selection process; (c) procurement cycle management and contract management; and (d) obtaining the required domestic approvals through the PPMO. The PPMO will consolidate the procurement plans prepared by the PIUs and carry out compliance reviews of procurement conducted by the PIUs.

22. Procurement risk assessment and mitigation measures. The procurement staff at the PPMO and PIUs do not have prior experience or knowledge about Bank procurement policies and procedures. However, most of them are familiar with local procurement procedures under the domestic laws and regulations. The key risks concerning procurement under the project are: (a) delays and non-compliance with Bank procurement guidelines due to either unfamiliarity with specific Bank procurement policies and procedures or a tendency to comply with local procedures when they conflict with Bank procurement guidelines; (b) weak capacity of the procurement staff in procurement cycle management and contract management, due to a lack of understanding of the Bank's procurement compliance requirements; and (c) the potentially large number of PIUs, which may present a challenge for the supervision and coordination by the PPMO.

23. To mitigate these risks, the following actions have been agreed with the PPMO: (a) hiring by the PPMO of a procurement agent with experience in procurement under Bank-financed projects (or projects financed by other International Finance Institutions) to support and guide the procurement work (completed); (b) provision of training to the procurement staff on the Bank's procurement policies, methods and procedures, as well as the use of standard bidding/proposal documents and evaluation principles; (c) preparation of a procurement manual (PM) to guide project implementation (the PM has prepared and reviewed by the Bank); (d) just-in-time procurement support by the Bank's procurement specialist; (e) annual field procurement supervision missions to review procurement actions where needed; and (f) hiring by the PPMO of an additional staff member with good English communication skills (oral and writing) and Bank procurement knowledge (completed). Considering the potential procurement risks as well as the above mitigation measures, which have been taken during the project preparation and will

be continued during project implementation to strengthen the procurement capacities of the PPMO and the PIUs, the overall procurement risk for the project is assessed as Moderate.

24. Procurement policies and guidelines. Procurement for the project will be carried out in accordance with the World Bank's "Guidelines: Procurement of Goods, Works, and Non-Consulting Services under IBRD Loans and IDA Credits & Grants by World Bank Borrowers" dated January 2011, and "Guidelines: Selection and Employment of Consultants under IBRD Loans and IDA Credits & Grants by World Bank Borrowers" dated January 2011, and the provisions stipulated in the legal agreements. National Competitive Bidding (NCB) will be carried out in accordance with the "Law on Tendering and Bidding of the People's Republic of China" promulgated by Order of the President of the People's Republic of China on August 30, 1999 subject to the modifications stipulated in the Legal Agreement in order to ensure broad consistency with the Bank's Procurement Guidelines and relevant procurement policies.

(a) *Procurement of goods and works.* The bulk of project funds will finance the construction, supply and installation of the large-scale biogas facilities, the supply and installation of a monitoring network, and the equipment for setting-up subproject-based laboratories. Procurement will be done by using the Bank's Standard Bidding Document for all International Competitive Bidding (ICB) contracts and National Model Bidding Documents agreed with or satisfactory to the Bank for all National Competitive Bidding. Further details are provided in the procurement plan.

(b) *Selection of consultants*. The Bank loan will finance various consulting services contracts for technical assistance, including technical services for project implementation, development of manuals for biogas digester operation and biogas digestate application, and capacity building for the PPMO and the PIUs. The Bank's Standard Request for Proposals shall be used for all consulting assignments with firms. Short lists of consultants (firms) for services estimated to cost less than US$ 500,000 equivalent per contract may be composed entirely of national consultants in accordance with the provisions of paragraph 2.7 of the Consultant Guidelines.

25. Procurement plan. A project procurement plan has been reviewed and agreed by the Bank. It will also be available in the project's database, on the Bank's external website, and at the PPMO and PIUs. The procurement plan will be updated annually or as required and in agreement with the Bank to reflect actual project implementation needs and improvements in institutional capacity.

26. Procurement methods and Bank prior reviews. The thresholds for procurement methods and Bank prior review indicated in Table 3-2 will be followed for project procurement implementation. Specific prior review requirements will be indicated in the project procurement plan. In addition to the prior review carried out from the Bank offices, Bank procurement supervision missions will visit the field to carry out procurement supervision or post-review of procurement activities at least once every 12 months. The post review sampling ratio will be a minimum of one out of 15 contracts.

Table 3-2: Thresholds for Procurement Methods and Prior Review

Expenditure Category	Contract Value Threshold (US$)	Procurement Method	Prior Review Threshold (US$)
1. Works, Turnkey and Supply & Installation of Plant and Equipment	≥40,000,000	ICB	First NCB contract by each PIU irrespective of value and all contracts ≥ USD 15 million
	<40,000,000	NCB	
	<200,000	Shopping	None
2. Goods and Non-Consulting Services	≥10,000,000	ICB	First NCB contract by each PIU irrespective of value and all contracts ≥USD 3 million
	<10,000,000	NCB	
	<100,000	Shopping	None
		Direct Contracting	All DC contracts regardless of value
3. Consultant services	≥300,000	QCBS/QBS	First Contract for each selection method and all contracts ≥USD 1 million
	<300,000	CQS	
		Individual Consultants	Only in exceptional cases
		Single Source Selection (Firm)	≥USD100,000
		Single Source Selection (Individual)	≥USD 50,000

Notes: ICB: International Competitive Bidding
NCB: National Competitive Bidding
DC: Direct Contracting
QBS: Quality-Based Selection
QCBS: Quality- and Cost-Based Selection
CQS: Selection Based on the Consultants' Qualifications
SSS: Single Source Selection
IC: Individual Consultant selection procedure
NA: Not Applicable

27. Advance contracting/retroactive financing. The initial procurement plan for the project will identify any contracts that will be procured in advance of the signing of the loan agreement. All such contracts will be subject to prior review by the Bank.

Environmental and Social (including safeguards)

Environment

28. Environmental Assessment (OP 4.01). The project is classified as a Category B project based on the type, location, sensitivity, and scale, as well as the nature and magnitude of project activities and their potential environmental impacts. The environmental impacts that have been identified and assessed are deemed measureable and manageable. An EMP, including an Environmental Code of Practice (ECOP) and Environmental Management Framework (EMF),

was prepared by the Hebei Jingmiao Environmental Consulting Ltd Co. The EMP was prepared in accordance with domestic and Bank requirements and covers the project area of influence.

29. The project is designed to demonstrate biogas production and utilization to reduce pollution and supply clean energy in rural areas. The project will help improve the rural environmental and living conditions. Converting livestock manure to biogas will reduce land and water pollution; collecting and using crop residues as feedstock for biogas facilities will largely reduce indoor and outdoor air pollution, which are currently caused by burning crop wastes in open areas and directly using them as households' cooking fuel. Replacing coal by biogas will also significantly reduce greenhouse gas (GHG) emissions. In addition, the project will provide digestate fertilizer, which is rich in nitrogen, phosphorus, potassium, and micronutrients, to replace the use of chemical fertilizers, which will improve the quality of the soil nutrient availability and agricultural product quality. Some negative short-term construction and long-term operational impacts may result from project implementation. During the construction period of project financed facilities, small civil works will lead to limited negative impacts on ambient air, water, and acoustic environments and create solid waste. These negative impacts will be small in size, short-term, temporary and site-specific. During the operation phase of the facilities, long-term impacts will exist, including the disposal of livestock waste, the need for wastewater treatment, and other impacts associated with the operation and maintenance of biogas facilities and distribution pipelines.

30. To enhance the positive and long-term environmental benefits of the project, mitigation measures have been integrated into the project design, construction, and operation phases. The potential adverse environmental and social impacts are thoroughly addressed by the EMP report, which also lists preventive and mitigation measures. Bank review concluded that these adverse environmental and social impacts can be adequately avoided, minimized and mitigated with good management practice and mitigation measures, as developed in the EMP. All mitigation measures related to contractors will be included in the bidding documents and the corresponding contracts.

31. During the feasibility study phase, the environmental assessment team worked closely with the PPMO, PIUs and project designers to compare and evaluate alternatives. The EMP identified, evaluated, and compared various options for plant locations, pipeline alignments, and technological processes, and optimal alternatives were selected based on the avoidance of social and environmental impacts (or for having the least adverse impacts), as well as technology and financial considerations for least cost solutions. A "no project" scenario was also considered.

32. The EMP includes an ECOP to address generic impacts and measures from small construction activities; the ECOP will also be included as part of the project implementation plan (PIP). ECOP is prepared based on national norms, practices proven in other Bank-financed projects, and the practice recommended in the Environmental Health and Safety Guidelines of the World Bank Group. The ECOP specifies the environmental management issues during the entire project cycle including, but not limited to, construction dust management, air pollution control, noise impact control, water pollution control, waste management, public and workers' health and safety, chance finding procedure for physical cultural resources, as well as

consultation for environmental aspects. It further includes the reporting and supervision arrangements for the implementation phase of the project.

33. Risk analysis and management. The potential risks associated with the biogas facilities and gas pipelines have been identified as fire and explosion. A parallel safety assessment has been prepared as part of the project preparation to cope with these potential risks. The relevant institutional arrangements, mitigation measures and management system, emergency planning and response, as well as training and monitoring plans have been arranged.

34. The EMF has been prepared as an annex to the EMP with clearly defined objectives, procedures, an institutional framework, and implementation arrangements for identifying and managing potential environmental impacts from the biogas facilities. It includes the implementation of agreed actions, supervision, and evaluation. It also addresses mechanisms for public participation and redress of possible grievances, and includes the specific screening tool. The EMF will be used for guiding the environmental assessment for potential CNG station set and any adjustments necessary during project implementation. In the case of any new activities identified during the project implementation, the potential environmental impacts will be screened and the additional EA will be undertaken according to the EMF.

35. Environmental management responsibilities will be built into the relevant divisions of the overall project management structure, with dedicated management staff to ensure effective EMP implementation. The trainings will be provided by the PPMO and expert team to project management and technical staff, and contractors, prior to and during biogas facility construction and operation period.

36. Environmental Monitoring. A detailed environmental monitoring program was prepared and incorporated into the EMP. It includes the environmental acceptance monitoring, which specifies the environmental monitoring arrangements required during the project operational phase, including parameters those should be monitored, such as air quality, wastewater, solid waste and noise. The monitoring program has been budgeted with adequate funding allocated.

Social

37. Social Assessment. The social assessment (SA) was conducted by a very experienced social development specialist team. Led by the project SA team, an extensive project information dissemination and consultation campaign was conducted, along with intensive socio-economic survey fieldwork in the areas where land acquisition is needed. Within 12 selected sample villages of the 6 project counties: (a) 33 meetings were held with the farmers affected by land acquisition, with the potential biogas users, and with the crop residue suppliers; 330 farmers (around 35% of which were women) attended the meetings; (b) 768 people from the villages were interviewed, while another 800 local households filled out questionnaires. In addition, 26 meetings with other stakeholders, including local governmental agencies and PIUs, were also held. The SA identified that the project will bring significant benefits to rural residents by increasing access to clean energy for cooking, thus replacing the use of coal and reducing pollution from livestock manure and the burning of crop residue in open areas or direct use of it

as cooking fuel. The visited households expressed their interests, enthusiasm, and support for the project and fully understood the potential risks and opportunities associated with it.

38. The SA also identified the negative impacts of the project for local households, which mainly includes the need for some land acquisition for the construction of the biogas facilities. The team therefore concludes that the Bank OP/BP4.12 policy is triggered. The social issues identified by the SA, along with appropriate mitigation measures, have been incorporated in the project design. In addition, the project design has incorporated countermeasures to address the concerns raised during the consultancies, such as putting in place safety measures for biogas use, providing subsidies for gas use facility installation, and arranging adequate training for rural residents on biogas use and equipment maintenance, among others.

39. Involuntary Resettlement (OP/BP4.12). Three of the six subprojects (Laoting, Linzhang, and Chengde) need to acquire altogether 215 mu (about 15 ha) land for construction of their biogas facilities. The total numbers of affected people will be 203 in 45 households due to the land acquisition. The remaining three subprojects (Yutian, Zunhua, and Anping) have existing land available for the construction of the facilities. For each of the three subprojects involving land acquisition, a Resettlement Action Plan (RAP) has been prepared, along with a consolidated RAP. The RAPs will be strictly implemented, following the Chinese government laws and regulations and complying with the Bank OP/BP4.12 policy. The RAP implementation will be regularly monitored, both internally and externally, throughout the project implementation period.

40. A Resettlement Policy Framework (RPF) has also been prepared to guide any potential land acquisition during project implementation, as a small volume of extra land needs could not be determined during the project preparation period in terms of specific locations, routes, and sizes for biogas supply pipe networks and the proposed four CNG station sets. The RPFs set comprehensive mitigation measures, grievance redress mechanisms, monitoring and evaluation methods, institutional arrangements, and capacity building plans. In the case of any new activities identified during the project implementation, the potential social impacts will be screened and the additional RAPs will be prepared and implemented according to the RPF if any land acquisitions are needed. The new RAPs are requested to be submitted to PPMO and Bank for review and approval.

41. Institutional arrangements and capacity building have been reflected in the project preparation process and are defined in the RAPs. The PPMO will take overall responsibility for coordinating and overseeing the implementation of the RAPs. While each PIU will take its respective responsibility for the implementation of the RAP for its own subproject, including implementing the resettlement plan, monitoring the implementation of the mitigation measures together with related local authorities and stakeholders, and promoting good practice in resettlement and social development, the PPMO will monitor overall land acquisition activities and other action plans set in the SA report, and, as necessary, take remedial action. The PIUs will also contract an external consulting institute for independent monitoring and evaluation of the implementation of the project RAPs (including the RPF) at the project sites. Dedicated social staff at the PPMO and each of PIUs have been assigned to coordinate the social safeguards work together with related local government departments in charge of local land requisition.

42. Ethnic minority: Hebei Province has a minority population of 2.63 million, accounting for 3.9% of its total population. The ethnic minority groups mainly are Man, Hui, Mongolian, Zhuang, Korean, Miao, Tujia, Buyi, Yi, Yao and Bai. During project preparation, the social assessment was undertaken and found a small number of Hui and Man ethnic minority people live scattered among Han people in the subproject sites. Among them, only five Man people will be affected by the project in terms of land acquisition under the project. The people of those ethnic minority groups live mixed-in with the local majority population without significant ethnic characteristics. They speak Mandarin Chinese, have a life style similar to local majority Han people, and have been well integrated with the local majority Han people for a long time. They do not fit the definition of the Bank IP term. It is concluded that the Bank OP/BP 4.10 is not applicable to this project.

43. Gender aspect: Women play an important role in the agricultural and livestock sector in rural China. Gender equality was promoted in the public consultation process and project design during the project preparation. Those efforts were reflected by equal access to the participation in the consultation process by men and women. More specifically, women participating in consultation meetings and interviews accounted for more than 35% of the total number of farmers consulted; target trainings on biogas use and safety measures, and other capacity building aspects will be provided to both men and women during project implementation; and the approaches to equal compensation and job opportunity for men and women have been included in the project design and the relevant monitoring arrangements have been specified in the project overall monitoring plan. Some relevant indicators were set in the monitoring plan such as no less than 40% of trained biogas users and no less than 35% participating farmers for the continued consultation process during the project implementation will be women. The project will continue to reflect gender dimensions during its implementation and the monitoring results will be included in the project progress report and completion report.

Public Consultation and Information Disclosure

44. Public consultations, including expert consultations, questionnaires, symposia and interviews, were conducted with various stakeholders of the project for both environment and social assessment processes. All affected organizations and enterprises were consulted in each of the project counties by the PPMO and expert team. The consulted people included persons of different gender, different groups, and various socioeconomic and educational backgrounds and occupations. The majority of those consulted expressed strong support to the project. The EMP, RAP, and SA all have incorporated countermeasures to address the concerns raised during the consultancies, including measures related to the safety aspects of biogas use and training, the price of biogas, and emergency planning and response. In accordance with the Bank disclosure policy, prior to project appraisal, the safeguards documents, including the EMP, RAP, and SA report have been made available on May 15, 2014 at the PPMO, the PIUs, and the county agriculture bureaus of participating counties, as well as on the website of the Hebei Agriculture Department at http://www.he.xinhuanet.com/zfwq/xny. All safeguard documents were also disclosed at the World Bank InfoShop. (SA & RPF on June 9, 2014; initial EMP & RAP on June 9, 2014 and their subsequent versions on June 16, 2014).

Monitoring & Evaluation

45. The project's monitoring and evaluation (M&E) includes four aspects: (a) monitoring implementation progress; (b) monitoring the quality and performance of biogas facility operation as well as technical and support systems; (c) evaluating the achievement of the PDO; and (d) assessing environmental and social impacts. A detailed project M&E plan has been developed by the PPMO and was reviewed by the Bank.

46. The PPMO and PIUs will be responsible for the project monitoring and evaluation. The PIUs will monitor the operation of the biogas facility on a regular basis and also keep track of all planned and completed activities and expenditures. In addition, PIUs will contract with an independent third party to monitor the quality and construction of the biogas facilities. The PPMO will be responsible for monitoring overall project progress, its performance and impact. It will contract relevant institutes and expert team to conduct project technical surveys, as well as assess environmental and social impacts and achievement of the PDO. The Hebei Rural New Energy Technology Extension Station, where the project provincial level monitoring system will be set, will regularly monitor the biogas operation and extend their monitoring to other biogas programs in Hebei Province.

47. Every year on June 30 and December 31, the PIUs will submit semi-annual progress reports to the PPMO. The PPMO will consolidate these subproject reports into a semi-annual project report and furnish it to the Bank by February 28 and August 31 of each year, commencing on August 31, 2015. These reports will include an updated results monitoring table (Annex 1) indicating the progress made by the project towards achieving its outputs and impact indicators.

48. In addition to the semi-annual reports, the PPMO will submit the following reports to the Bank: (a) a project annual work and budget plan for the next calendar year by December 15 of each year, commencing on December 15, 2014; (b) a mid-term review report on November 30, 2017; and (c) a project ICR on December 31, 2020. The progress report for the implementation of the project monitoring plan should be part of the project semi-annual reports, as well as the mid-term review report and the ICR.

49. Dissemination. Given that the project focuses on bringing national and international best practice to the development of sustainable large-scale biogas production and utilization in Hebei, there are significant advantages to the rural energy sector in Hebei in ensuring that there is an explicit learning process and dissemination process in place under the project. The project will support: (a) the review of implementation experiences and dissemination of experience and lessons learned; and (b) the annual progress review meetings at the provincial level, which should include officials from other relevant institutions responsible for the biogas development and management. In addition, either the project mid-term review report or the project completion report should include a section on lessons learned for the project.

ANNEX 4: OPERATIONAL RISK ASSESSMENT FRAMEWORK (ORAF)

China: Hebei Rural Renewable Energy Development Project

<table>
<tr><th colspan="7">Project Stakeholder Risks</th></tr>
<tr><td>Stakeholder Risk</td><td>Rating</td><td colspan="5">Moderate</td></tr>
<tr><td rowspan="2">Risk Description:

Improving the rural environment by developing biogas and other renewable energy is a development priority for the Hebei government. Stakeholders at provincial and county levels are currently highly committed to this project by supporting the innovative project concept, providing counterpart funding, and putting in place the institutional arrangements for project preparation and implementation.

Interest in the project by participating biogas entities and households living in the villages and concentrated rural residential buildings in the project areas is very high, as the project will contribute to improving the local environment and living conditions, as well as provide clean energy for their cooking and heating.

The project’s potential risk is a disconnect between the project entities</td><td colspan="6">Risk Management:

No changes in political leadership or government support towards the project are expected. Overall stakeholder risk is relatively low.

Thorough stakeholder consultation have been carried out during project preparation to better understand more specific energy needs from rural households, as well as the social relationships and interactions between the project entities and surrounding village communities. Stakeholder consultation and participation were fully incorporated in the project design during project preparation and will continue during project implementation.</td></tr>
<tr><td>Resp: Both</td><td>Status: In Progress</td><td>Stage: Implementation</td><td>Recurrent: ☑</td><td>Due</td><td>Frequency: Yearly</td></tr>
</table>

and the communities they plan to serve, which can lead to a mismatch between the quantity and type of energy produced and the communities' needs.						

Implementing Agency (IA) Risks (including Fiduciary Risks)						
Capacity	Rating	Moderate				
Risk Description: The Hebei Provincial Rural New Energy Technical Extension Station (under the Hebei Agriculture Department) and its county offices, which are the project agencies, have adequate staff with the necessary expertise in managing government biogas programs. However, the PPMO and PIUs lack knowledge of international best practice and experience with long-term biogas operation. Also, as this is the first time for the PPMO and PIUs to implement a Bank project, staff are not familiar with the Bank financial and procurement management policies, and its safeguard policies.	**Risk Management:** The team has taken the approach of 'preparation support'—rather than focusing only on review and appraisal—and has provided more hands-on support through frequent short missions and intensive training during the project preparation. This approach will continue during project implementation. During the project preparation, intensive trainings have been provided to the project agencies on technical design, financial management, and procurement and safeguard policies. A Sino-German expert team was also established and has provided technical assistance to the project preparation. With the trainings and assistance provided by the Bank and expert team during project preparation and with a fully staffed PPMO and PIUs, the capacity of the project agencies has been greatly improved. During the project implementation, the capacity of technical services at each level will be further strengthened by undertaking technical support including training programs. To standardize project operation and ensure the quality control, a number of guidelines/requests, which were developed during the project preparation, will be implemented , such as technical criteria for biogas digester design and performance, procurement and financial management manuals, to guide the project management.					
	Resp: Both	Status: In Progress	Stage: Implementation	Recurrent: ☑	Due Date:	Frequency: Yearly
Governance	Rating	Low				
Risk Description: A strong overall governance framework is in place and the governance and decision making structures of the agriculture and energy sectors in China are	**Risk Management:** The task team is at present not aware of any cases of corruption regarding the implementation agency. Capacity of the implementing agencies to carry out this operation in a transparent and accountable manner is expected to be adequate for both provincial and county project government agencies. There is no main risk associated with this aspect.					

appropriate for the project. A high-level leading group is in place at the provincial level and will guide and oversee project preparation and implementation. In case the rules and responsibilities of the PPMO and PIUs are not clear, the project cannot be managed and monitored effectively.	Resp: Both	Status: In Progress	Stage: Implementation	Recurrent: ☑	Due Date:	Frequency: Yearly

Project Risks						
Design	Rating	Moderate				
Risk Description: Because the improved technical and operational models that will be introduced to the project design are new to the project agencies, some difficulties might be encountered during the project design and implementation phases. The client, for example, might not understand the best practices or how to adapt the international experience to local conditions.	**Risk Management:** Both the Bank task team and client are fully aware of the technical challenges. With the Bank's coordination, a Sino-German expert team has introduced sustainable biogas technologies and management experience that proved successful in Germany and other counties. In addition, several top international and national experts were hired by the Bank during project preparation to help the client with the technical design. Experience from the Bank and other institutions has been incorporated into the project design and the design risks have been largely addressed. The PPMO will continue to work with an expert team to provide technical assistance for the implementation of technical designs, technical services, and monitoring programs. The Bank team will also continue to provide relevant technical expertise during project implementation using national and international experts.					
	Resp: Both	Status: Completed	Stage: Implementation	Recurrent: ☑	Due Date:	Frequency: Yearly
Social and Environmental	Rating	Moderate				
Risk Description: Environment: The project is expected to bring significant positive environmental and social benefits to the selected rural areas; it is assigned as a B-category project. During project preparation, no significant	**Risk Management:** An Environmental Management Plan (EMP) has been prepared, including Environmental Codes of Practice (ECOP) to address negative environmental impacts from project activities. In addition, an Environmental Management Framework (EMF) was prepared and provided as an annex to the EMP, to guide any new activities that might be needed during the project implementation. A parallel safety assessment has also been conducted as part of the project preparation to cope with these potential risks on fire and explosion associated with the biogas plants and gas pipelines.					

environmental risks that will prevent achievement of the PDO have been identified. The adverse environmental impacts of this project will mainly relate to the construction and operation of the biogas facilities (such as waste and dust from small civil work), the construction of the biogas pipeline to nearby rural communities, feedstock transportation, as well as the potential risk on fire and explosion associated with the biogas plants and gas pipelines. Social: Based on a screening of project sites, it was determined that three of the six biogas sites do not need to acquire new land, as their civil works and project facilities can be built on existing plant compounds. The other three project sites will need to acquire additional land (about 15 hectare in total) for the project civil works. No house demolition will take place under the project. As a result, Bank policy OP/BP 4.12 is triggered. The EA and SA have been conducted and the mitigation measures have been incorporated to the project design. The risk is that the PPMO and PIUs have limited experience in implementing relevant safeguards action plans, such as the EMP and RAP.	A Resettlement Action Plan (RAP) has been prepared for each of the three subprojects requiring land acquisition, along with a consolidated RAP. A resettlement policy framework (RPF) is also attached to the consolidated RAP as its annex, to guide land acquisition as needed for any new activities that might be identified during the project implementation, or for the gas stations and temporary land use for biogas supply pipeline distribution, which will be identified during the project implementation. The PPMO will take a leading role in monitoring the implementation of relevant safeguards action plans. Appropriate measures to address the project's negative social and environmental impacts, as well as relevant training and monitoring arrangements have been incorporated in the project design as well as compliance with safeguard implementation.					
	Resp: Both	Status: In Progress	Stage: Implementation	Recurrent: ☑	Due Date:	Frequency: Yearly

<table>
<tr><td>Program and Donor</td><td>Rating</td><td colspan="5">Low</td></tr>
<tr><td rowspan="2">Risk Description:

Currently there are no similar donor projects in Hebei Province.</td><td colspan="6">Risk Management:

No actions needed.</td></tr>
<tr><td>Resp:</td><td>Status:</td><td>Stage:</td><td>Recurrent:</td><td>Due Date:</td><td>Frequency:</td></tr>
<tr><td>Delivery Monitoring and Sustainability</td><td>Rating</td><td colspan="5">Substantial</td></tr>
<tr><td rowspan="2">Risk Description:

Technical designs may not be fully adhered to during project implementation and the project progress might be delayed at its initial stage of implementation.</td><td colspan="6">Risk Management:

Specific trainings on the implementation of the technical design, monitoring plan, and technical services will be provided to project management staff and PIUs staff by the PPMO with support from its expert team to ensure that the project technical design will be strictly followed. In addition, the PPMO will closely monitor the implementation of the PIP and the subproject FSRs.

During project implementation, the Bank team will continue to provide strong technical support on aspects related to the long-term stable operation of the biogas facility and sound management of the biogas service system to ensure biogas can be provided to communities and rural residential areas in a sustainable manner. The Bank team will closely supervise and monitor the project implementation.</td></tr>
<tr><td>Resp: Both</td><td>Status: In Progress</td><td>Stage: Implementation</td><td>Recurrent: ☑</td><td>Due Date:</td><td>Frequency: Yearly</td></tr>
<tr><td colspan="7">Overall Risk:</td></tr>
<tr><td colspan="7">Implementation Risk Rating : Substantial</td></tr>
<tr><td colspan="7">Risk Description:

Due to the innovative nature of the project, implementing the technical design is crucial to the project success and sustainability. Therefore, the overall project risk at the implementation stage is rated as substantial. The project may take time to not only develop the biogas facility, but also to build up capacity, in particular putting in place technical services and monitoring system. This might cause slow disbursement during the initial stage of implementation. More importantly, the extensive technical assistance to long-term biogas facility operation has also been designed and the client committed to making efforts during its implementation to appropriately manage the risks. The Bank will also provide intensive support to the project implementation through supervision missions and day to day work.</td></tr>
</table>

ANNEX 5: IMPLEMENTATION SUPPORT PLAN

China: Hebei Rural Renewable Energy Development Project

Strategy and Approach for Implementation Support

1. An implementation support plan (ISP) has been developed for the project, taking into account the risks and risk management measures described in the ORAF (Annex 4). The ISP focuses on the management of the identified risks and supports project agencies to comply with Bank fiduciary and safeguard policies.

2. Technical Support. National and international biogas engineers and biomass program management experts have contributed to the design and preparation of the project and the technical risks at the design stage have been largely addressed during project preparation. The appropriate technical design for biogas digestion and plant operation, along with the setting of criteria and parameters to standardize the biogas facility operation have been introduced. The designs are intended to ensure that international and national best practices will be applied and the project will be operated sustainably. The Bank expert team will continue to provide extensive technical support to the implementation of the technical design, extension programs, and monitoring and evaluation. The Bank will also support the effective dissemination of project experiences and lessons learned.

3. Procurement. Procurement implementation support will be provided by Bank procurement specialists and will include: (a) the facilitation of a multi-stage training program targeting procurement staff at the PPMO and PIUs; (b) the review of procurement documents and provision of timely feedback on the results of prior reviews and post reviews; (c) a detailed guidance on Bank Procurement Guidelines to project procurement staff; and (d) the monitoring of procurement progress against the agreed Procurement Plan.

4. Financial Management. Project financial management will be reviewed and evaluated on a regular basis by the Bank's financial management specialist (FMS). The FMS will join Bank implementation support missions to review the implementation of the FMM. The FMS will also provide technical support to project implementing agencies and help with the timely resolution of potential financial management issues, as well as any issues identified by auditors. The FMS reviews will include the adequacy of the financial management arrangements in place, disbursement process, Bank loan on-lending arrangements, counterpart fund allocations, and document filing systems.

5. Environmental and Social Safeguards. Bank project environmental and social development experts will support the implementation of the EMP and RAP and provide guidance to project implementing agencies on issues that arise during project implementation. They will also help ensure that community and stakeholders consultations continue during project implementation.

Implementation Support Plan

6. Given the innovative project design, the first two years of project implementation will be crucial to the project's success. Intensive supervisions will be required in this period.

7. Several team members will be based in China Country Office in Beijing, allowing for a rapid and effective response to borrower's needs during implementation. In addition, Washington-based staff and international consultants will contribute their global expertise. Formal supervision and field visits covering all aspects of project implementation will be carried out semi-annually. These will be supplemented by ad hoc and need-based visits by small groups.

8. Estimated inputs from different specialists at different stages of project implementation are outlined in table 5-1.

Table 5-1: Project Implementation Support Inputs Requirements

Time	Focus	Skills Needed	Resource Estimate
First twelve months	Overall project management and task leadership	Project management/task leadership	2 trips
	Project design implementation and technical support	Biogas engineer, biomass energy specialist	2 trips
	Financial management and procurement	FMS and procurement specialists	2 trips
	Safeguards implementation	Social and environmental specialists	2 trips
	Monitoring and evaluation	Monitoring specialist	2 trips
12-48 months	Team and project leadership	Project management/task leadership	2 trips/year
	Project design implementation and technical support	Biogas engineer, biomass energy specialist	2 trips/year
	Financial management and procurement	FMS and procurement specialists	1 or 2 trips/year
	Safeguards implementation	Social and environmental specialists	1 or 2 trips/year
	Monitoring and evaluation	Monitoring specialist	1 or 2 trips/year

Table 5-2: Skills Mix Required

Skills Needed	Number of Staff Week	Number of Trips	Comments
TTL/Project management	6 SWs annually	2 trips	Bank staff
Biogas engineer/Biomass energy specialist	6 SWs annually	2 trips	Bank staff and consultants
Procurement specialist	3-4 SWs annually	1-2 trips	Bank staff
Social development specialist	2-3 SWs annually	1-2 trips	Bank staff
Environment specialist	2-3 SWs annually	1-2 trips	Bank staff
Financial management specialist	2-3 SWs annually	1-2 trips	Bank staff
Monitoring & evaluation specialist	2-3 SWs annually	1-2 trips	Bank staff and consultants

ANNEX 6: ECONOMIC AND FINANCIAL ANALYSIS

China: Hebei Rural Renewable Energy Development Project

A. Rationale for public sector provision/financing

1. The rationale for public sector financing for the project is to cover the public goods that the biogas project will produce in terms of reduced air, water, and indoor pollution, climate change mitigation, and the provision of clean energy as a supplementary energy supply for rural residents. In particular, the Government considers that the provision of quality energy to rural residents is a public service to increase the equitable access of energy in rural areas to meet the basic livelihood needs of rural households, which is an important part of public unities to rebalance the current inequity in the provision of public services between urban and rural areas.

2. Although the Government considers the development of biogas programs as one of the best approaches to address rural environmental and clean energy issues, the investments in biogas program, like other biogas programs, are not financially viable (without the government subsidy), as indicated by the financial cash flow analysis. There are no financial institutions currently in China that venture into financing large scale biogas production because of its relatively low profitability and perceived high market risks. For this reason, the government has adopted its subsidy policy to financially attract enterprises to biogas production, through which to secure the public goods provision—environmental benefits and increased access to clean energy for rural households.

B. Economic Analyses of Each Investment Subproject

3. Cost benefit analyses have been conducted for the proposed six investment subprojects using the “with/without project” comparison. The "without project" (baseline) case is defined as “the status quo,” and the difference in carbon emissions between the "with" and "without project" cases is the basis for calculating the environmental benefits. The major assumptions and results of the analysis are summarized below:

(a) Project Costs: The economic costs include (a) total investment costs of biogas production facilities and pipeline grid, and their operation and maintenance (O&M) costs, which include raw material costs, electricity and water consumption, salary and regular equipment maintenance, overhaul and replacement costs. Taxes, duties and financing costs are excluded as they do not represent "real costs” to society as a whole. A conversion factor of 0.3 has been used to derive the economic price of straw/crop residues from financial prices, largely to account for the fact that more than 70% of crop waste is not treated and may be burned directly in field. For anything else, in line with the practice of recent Bank project analysis in China, the conversion factor is considered as 1.0 when estimating the economic costs from financial costs because the distortions in the exchange and wage rates in the overall costs are not significant enough to justify the use of shadow prices. The land cost is valued as its opportunity cost using market price.

(b) Project Benefits: The major quantifiable benefits in the analysis cover (a) incremental production of biogas, CNG and organic fertilizers, depending on specific outputs of each subproject, (b) cost savings from replacement of fossil fuel by biogas and CNG, and (c) environmental benefits due to emission reduction.

4. The valuation of the incremental production of biogas, CNG and organic fertilizers is measured by the sales revenue; while both cost savings from replacement of fossil fuel by biogas and CNG, and environmental benefits are based on the practice commonly used in Bank Clean Development Mechanism (CDM) projects (as an appendix on file). Calculation for cost savings and carbon emission reduction is done by subproject to account for the location specific fuel mix. Detailed calculations are included in the Subproject FSRs (on file). For the economic value of carbon emission reduction, 8 Euro (66.4 Yuan)/ton (used in approving CDM projects as the lowest price by the Chinese government) has been adopted by the analysis. This is very conservative compared with other estimations of the economic value of carbon reduction[2].

5. The subprojects will also generate a number of other benefits that are not readily quantifiable and therefore are not included in analysis. Those include but are not limited to (a) improved land fertility and prevention of land-fertility degradation due to the increased use of organic fertilizers; (b) health impact from reduction of coal/straw burning, which has harmful levels of toxins, such as fluoride, arsenic, selenium and mercury causing different forms of poisoning and disease; (c) job creation for local people; and (d) reduced water pollution of ground water.

6. The EIRR of each subproject has been estimated on the basis of the incremental costs and benefits identified. The analysis adopts conservative assumptions for output market demands and prices (coupled with major output sales and input procurement arrangements in place to mitigate the future market risks). As such, the results of the analysis show that the EIRRs of six subprojects range between 16-23%, exceeding the 12% economic discount rate that is normally applied to Bank projects in China (8% by NDRC norms). These subprojects are therefore economically viable and robust. A more detailed description of these six subprojects is provided in the subproject FRS.

Table 6-1: EIRR by Subproject

	Linzhang	Anping	Laoting	Chengde	Yutian	Zunhua
EIRR (%)	**21.12**	**19.51**	**21.70**	**16.15**	**15.79**	**22.54**

C. Financial Analysis

7. Financial analysis has been carried out: (a) at the subproject level, with financial soundness of each investment subproject measured by the financial internal rate of return (FIRR); and (b) for the households involved, using average cost saving per household to gauge

2 The carbon prices were assumed at $30/ton as in some recent Bank approved projects.

the financial incentives for their participation, in addition to the indoor pollution reduction and the convenience brought to the households in the use of cooking fuel. The analysis of each investment subproject is based on the latest feasibility studies prepared by the local consulting firms (all with Class A accreditation from NDRC).

8. Financial Analysis at Subproject Level: Financial analysis has been conducted for each subproject. Because in general realistic assumptions are the key to a reliable outcome, a conservative approach was adopted to ensure that revenues were not overestimated and costs and expenses not underestimated. The major assumptions about different parameters within the Financial Analysis are as follows:

(a) *Performance in year 1 of operation*: When the biogas plant starts operation after finalization of the construction, a full performance at 100% cannot be assumed. As with any biogas plant, the operator can only gradually load the feedstock to the full capacity of the biogas digester over 3-6 months; during this period, the operator has to closely monitor all key operating parameters (such as balance of nutrients/bacteria) and adjust the feedstock accordingly. In addition it will take another 3-6 months before the first batch of feedstock reaches its peak of biogas production. Because of this, it will take at least 6 months for the plant to reach stable and smooth digestion at full capacity. This means that in year 1 of operation, the capacity utilization needs to be estimated realistically in line with the technical feasibility and the demand analysis.

(b) *Depreciation:* Realistic assumptions about the depreciation of the biogas plant's assets were made. While the buildings and tanks are depreciated over 20 years, most of the other equipment are over 10 years. The depreciations are reflected within the costs for maintenance and replacement.

(c) *Lifetime:* A lifetime of 20 years (including the construction period) is expected for each subproject.

(d) *Tax:* Because taxes differ among the various counties involved, income tax and any others taxes/fees are explained and reflected within the cash flow model.

(e) *Government subsidies to the subproject:* As stated within the Financing Plan, the local government will provide a subsidy of about 25% of total investment costs to each subproject. As such, 25% of financing sources should be either directly deducted from the investment cost or considered as a cash-inflow in the cash flow analysis. Other subsidies that are provided by local governments in some counties (not in for all subprojects) are not included.

9. Based on the above, the FIRRs for the six investment subprojects vary between 4.77 and 7.68% (without government subsidies), indicating that they are not financially viable. With government subsidies (on average 25% of investment costs depending on the number of household beneficiaries of each subproject), the FIRRs are estimated to 8.18-11.42%, justifying the government support to ensure the financial attractiveness for the participating enterprises.

Table 6-2: FIRR by Subproject

	Linzhang	Anping	Laoting	Chengde	Yutian	Zunhua
FIRR (%) no subsidies	**5.23**	**6.93**	**6.41**	**6.86**	**7.68**	**4.77**
FIRR (%) with subsidies	**9.28**	**8.18**	**9.05**	**10.47**	**11.42**	**8.77**

10. *Cost saving per household.* In addition to the other benefits such as improved indoor air and more convenient access to cooking energy, the average savings per household for the subprojects range from 140-260 Yuan per year, depending on the energy mix under the "without-project" situation. This will also provide financial incentives for farmers' participation. The farmers will also gain additional benefits from the sale of corn straw to the biogas plant. As indicated by the baseline survey, large portions of the crop straw is currently being wasted without any economic value being realized.

11. Sensitivity Analysis: A sensitivity analysis has been conducted on the key factors that have a major impact on the subproject financial and economic availability. Those include: (a) the output prices; (b) the feedstock prices; and (c) the capacity utilization. The tentative results of a switching value test show that the viability of the subprojects is most sensitive to the output prices. A reduction in output prices of less than 5% reduction will lower the FIRRs to the discount rate (8%) for most of the subprojects, indicating that those subprojects are vulnerable to changes in output prices; similarly, they are also vulnerable to the under-utilization of the production facilities, with some 10% reduction of full capacity (defined as 8,000 hours of operations annually) bringing down the FIRRs to 8%.

12. These sensitivities notwithstanding, it should be noted that the EIRR and FIRR calculations have been based on conservative assumptions (low end values for output prices and high end values for inputs prices). In the case of biogas, the selling prices will be fixed for 5 years and energy prices (including CNG) in general are trending up in the longer run. Moreover, with the current priority given to environmental concerns, carbon prices are expected to increase too.

13. Furthermore, mitigation measures, including detailed market and demand analyses, have been incorporated into the project design to manage the market risks:

(a) *Biogas market assessment.* A biogas market assessment was conducted; the assessment also covered the design for biogas distribution by analyzing and documenting specific locations of users, as well as expected population trends in relevant villages.

(b) *CNG demand analysis.* A demand analysis (to assess the potential market) for CNG was also conducted, taking consideration of both the local government development plan for CNG use (to replace the use of fossil fuels mandatorily within a certain

period) and the relevant commitment from the government (including CNG supply authorization).

(c) *Feedstock supply analysis.* This analysis covered specific feedstock distribution locations, a price analysis, and collection arrangements. The cooperative structure to link biogas entities with farmers or straw producers, such as in Anping, will ensure a long-term stable feedstock supply. The feedstock supply contracts/agreements were reached between the project entities and the feedstock suppliers. Further, the amount of feedstock (straw) was surveyed.

(d) *Digestate Fertilizer utilization.* Most PIUs like Anping, Yutian, and Linzhang have established stable bio-fertilizer supply chains, with large portions of their biogas residue being used in their own and around agriculture lands. The rest can be further packaged to be sold on the broader market through a fertilizer wholesaler. The purchase agreements or similar agreements have been largely signed.

D. Financial Viability of Project Entities.

14. In addition to financial analysis at sub-project level, assessments of the financial capacity for each of 6 PIUs have been conducted, covering their whole operations, of which the Bank financed sub-projects are integral parts. The analyses at entity level included key aspects of their financial viability and performance. The conclusions are summarized as below:

(a) Profitability, operational efficiency, and solvency of the companies for the past 3 years (2010-2012) were reviewed to assessing whether the individual companies' existing businesses are healthy and profitable, and if they could potentially be burdensome to the equity requirement and loan repayment of the subproject. All existing enterprises had demonstrated their financial viability, with being profitable for three consecutive years and will not add burdens to the project implementation.

(b) Liquidity. The cash flow ratios of the companies were studied, in association with the on-going and other planned investment projects in the coming 10 years, to assess whether the companies will have positive cash flow to provide counterpart funding to the implementation of the subproject and repay the Loan. The financial assessment indicated that the six companies have profitable core businesses, efficient operation, and sound financing structure. Supported by strong cash flow and stable business, these companies are in a proper position to implement the project. The required counterpart funds have been secured from (i) cash flows from existing operations; (ii) increased paid-in capital (equity financing), and (iii) mortgage backed debt financing. All the six entities are projected to have satisfactory financial strength for the next decade to repay their debts as demonstrated with strong debt-to-equity ratio of lower than 50% (except the publicly listed Jiantou Energy Investment Company, see below for details); and debt service coverage ratio of more than 150%.

(c) Growth and Sustainability . With above profitability and liquidity, for each enterprise, the total assets and retained capital will be on a growing trend, reflecting the growth and sustainability of the operations.

15. Brief description of the participating companies is as follows:

(a) Hebei Yu Feng Jing An aquaculture Co., Ltd. The company, established in 2003, is a national leading agro-industrial company. Its primary business is to raise and sell breeding pigs and commodity pigs (around 200,000 per year). The total assets of the company were RMB 350 million in 2012. The company was profitable over past 3 years with cash balance of RMB 30 million at the end of 2012. The company has a reasonable debt-equity ratio and a good capacity for loan repayment in the short term and moderate long-term debt repayment ability with debt-to-equity ratio of lower than 48% and debt service coverage ratio of above 400%. As a livestock production enterprise, the company has stable raw material sources (livestock manure) for the project.

(b) Green Energy Ecological Environment S&T Company Ltd. Established in 2009, the company has a successful track record in biogas engineering design, system construction, relevant training and other technical services provision. Its main business also includes design and construction of other waste treatment plants, as well as bio-fertilizer production. The financial assessments for the company indicated that the company was profitability over past 3 years with revenue of RMB 84.8 million in 2012, and it presented a progressive growth trend. The company has a reasonable debt-equity ratio and a good capacity for loan repayment in the short term and moderate long-term debt repayment ability with debt-to-equity ratio of lower than 42% and debt service coverage ratio above 300%.

(c) Yutian Yiheyuan Ecological Company. Established in 2011, the company is a subsidiary of Beijing Jiuding Improved Livestock Production Company Ltd and all the project funding will be provided by the parent company. The primary business lines of Yutian Company are the production and sale of fattened pigs, breeding stock, and piglets; the provision of animal production technological services; and sale of pig manure. Financial statements indicate that the company has excellent profitability over the past years, with revenue of RMB 130 million in 2012. It presents a growing trend with significant competitiveness in the sector. The company has a reasonable debt-equity ratio and a good capacity for loan repayment in the short term and moderate long-term debt repayment ability with debt-to-equity ratio of less than 14% and debt service coverage ratio of more than 170%. As a livestock production enterprise, the company has stable raw material sources (livestock manure) for the project.

(d) Meikeduo Food Processing Group. Established in 2003, its main business includes chicken raising, animal feed production, and fruit processing. (Its annual sales include 20 million chickens, 200,000 ton animal feed, 10,000 tins of vegetables and fruit, and 4000 ton fruit nutlets). Profitability over the past three years was good with revenue of more than RMB 538 million in 2012. The company has a reasonable debt-equity ratio and a good capacity for loan repayment in the short term and good long-term debt

repayment ability with debt-to-equity ratio of less than 33%and debt service coverage ratio of above 150%. As a livestock production enterprise, the company has stable raw material supply (livestock manure) for the project.

(e) Hebei Jiantou Energy Investment Shareholding Company Ltd. Established in 1994, the company is publicly listed. Its primary business is thermal power generation and energy and hotel services, and its business has been expanded to rural renewable energy development including biogas program with strong technical support team. The profitability of the company over the past three years was stable with total revenue of RMB 6.03 billion in 2012. The company has a reasonable debt-equity ratio and a good capacity for loan repayment in the short term and long-term debt repayment ability with debt-to-equity ratio of less than 70%, trending down to 53% when Bank debt service begins in 2020. Considering this is large sized, publicly listed company, such debt-to-equity ratio is acceptable. Its debt service coverage ratio is projected to be above 275%. The company has both strong financing capacity and biogas program technical and management capacity.

(f) Hebei Runze Zhimin Agricultural S&T Company Ltd. The company was established in 2010 and its primary business is the production and sale of digestate-based organic fertilizers and of organic vegetables and grains. It presented a strong growing trend over past years with income balance of around RMB 5 million in 2012. Though the scope of this company is relatively small, to ensure that the provision of needed project counterpart funding of RMB 7.5 million annually (for two years with total RMB 15 million) by the company, additional RMB 15 million of capital has been registered by the company by May 2014 before project appraisal, as the project counterpart funding. The company has a reasonable debt-equity ratio and a good capacity for loan repayment in the short term and long-term debt repayment ability with debt-to-equity ratio of less than 28% and debt service coverage ratio of above 420%.

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