

PROJECT BRIEF

1. IDENTIFIERS

PROJECT NUMBER:	1105
PROJECT NAME:	Peoples' Republic of China: Efficient Utilization of Agricultural Wastes Project
DURATION:	5 years
IMPLEMENTING AGENCY:	World Bank
EXECUTING AGENCY:	Asian Development Bank (ADB)
NATIONAL EXECUTING AGENCY:	Ministry of Agriculture (MOA), PRC
NATIONAL IMPLEMENTING AGENCIES:	Provincial Departments of Agriculture (DOA) and Departments of Finance (DOF)
REQUESTING COUNTRY:	People's Republic of China (PRC)
ELIGIBILITY:	China ratified the UNFCCC on January 5, 1993
GEF FOCAL AREA(S):	Climate Change
GEF PROGRAMMING FRAMEWORK:	Operational Program No.6: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs

2. SUMMARY. The Project promotes the reduction of GHG emissions in China by expanding the use of small and medium scale biomass-based renewable energy technologies (BIORETS) in rural agricultural areas. These BIORETS, using integrated farming system models and gasification systems, will significantly replace coal, straw, and firewood currently used for household fuel and reduce open field burning of crop residues. Through the elimination of barriers (see para 30 of RRP), approximately 15,600 small scale and 42 medium BioRET systems will be implemented, involving about 34,080 households in four interior provinces. The Project will promote cleaner, more efficient energy use with concurrent ecological and human health benefits. It will also improve and expand agricultural and livestock production, introduce information dissemination programs, and improve marketing, financing and management practices. Once completed, the Project will result in an annual reduction of about 78,338 tons of CO₂ emissions and will have set the stage for the further expansion and adoption of similar BIORETS in other provinces of China.

3. COSTS AND FINANCING (US\$ MILLION)

GEF:	6.4
CO-FINANCING:	
ADB:	33.1
Government/Beneficiaries	<u>37.8</u>
TOTAL PROJECT COSTS:	77.3

**PRC: EFFICIENT UTILIZATION OF AGRICULTURAL WASTES PROJECT¹
RESPONSE TO GEF PROJECT REVIEW CRITERIA
(COVER NOTE)**

I. COUNTRY OWNERSHIP

A. Country Eligibility

1. The People's Republic of China (PRC) ratified the FCCC on 5 January 1993.

B. Country Drivenness

2. PRC has experienced rapid economic growth, industrialization and urbanization over the past two decades. A key component of this success has been and will continue to be reliable and ample energy production heavily dependent on coal. However, a serious consequence of this heavy dependence on coal is that China now accounts for about 10 percent of global greenhouse gas (GHG) emissions and is the world's second largest producer of carbon dioxide (CO₂) emissions. If China's high rate of economic development continues to be supported by current levels of coal-supplied power generation, its share of global CO₂ emissions will exceed those of the United States by 2020.²

3. The extensive use of coal has obvious adverse ecological and human health impacts on the environment at all levels (globally, nationally, locally and the household). GHG emissions (measured in CO₂ equivalent) impacts on the rural agricultural sector can include (i) worsening soil erosion; (ii) increasing loss of fertile soil and decreasing soil humidity; (iii) rising temperatures that can result in the earlier arrival and longer duration of insect pests and weeds; and (iv) changes in precipitation levels. The projected outcome means lower crop yields and increased crop losses, and therefore (i) less agricultural products of poorer quality for sale; and (ii) less grain and grass for livestock, leading to livestock of lower quality and lower livestock production. With fewer and lower quality crops and livestock to sell while facing continuing declines in farm productivity, farm incomes will decrease. Consequently, addressing GHG emissions becomes a fundamental concern to this sector.

4. In rural areas, a large part of the coal consumption could easily be substituted by biomass using the large amount of crop residues and animal wastes. In 1999, the amount of straw and stalk available after harvesting was over 600 million tons. Of this amount, more than half is available for renewable energy (after deducting for forage, raw material for paper production, and fertilizer). As the basis for biomass fuel, this remaining straw and stalk could easily be one of the basic elements in sustainable development for a country as densely populated as China. The utilization of biomass technology is well known in China, where biomass units have been built for both rural energy production and waste management. Biogas productivity from small-scale biomass digesters has increased slowly since the mid-1980s, and today there are about 7.5 million household digesters. Much of this increase was due to government grants and subsidies, which have substantially been eliminated.³ Lessons learned from past biomass technology adoption included: (i) need to integrate biogas production into the

¹ The summary (Response to GEF Project Review Criteria) presented in this section is based on the attached ADB's appraisal document called Report and Recommendation of the President (RRP).

² World Bank, 1994. *China: Issues and Options in Greenhouse Gas Emissions Control*.

³ Many of the earlier units have been abandoned due to outdated technology, inadequate technical and service personnel support, lack of spare parts and accessories in rural areas.

existing farming system to ensure viability; (ii) need to ensure availability of service infrastructure including easy access to spare parts and service technicians for operation and maintenance (O&M); (iii) appropriate incentives to encourage biogas production; and (iv) need to strengthen technical and institutional capacity. Recently, more emphasis has been given to the concept of integrating farming with a biogas digester along with incentives for continued operation. The integration aims to combine environmental and economic benefits within a rural farming system that provides biogas for cooking, heating, and lighting for farm households and increases in agriculture and livestock productivity (see para 22 of RRP).

5. In addition to CO₂ emissions from coal, rural agriculture is a major source of GHG emissions.⁴ These emissions include methane (CH₄) from the livestock sector and crop residues, and nitrogen oxide (N₂O) produced from fertilizers and field burning of crop residues. These emissions are predominantly due to poor farming practices and inefficient use of biomass resources (e.g., wood from forests, crop straw, organic wastes from animals and humans). About 100 million tons of crop residues are burnt in open fields every year. With the increase of agricultural production and the shift from traditional to commercial energy use by rural consumers, the quantity of unused crop residues has progressively increased. Enteric fermentation from livestock waste, a significant source of methane, is also on the increase. If the current practices continue unabated, GHG emissions will continue to increase (see paras 9 to 12 of RRP).

6. In the Ninth Five-Year Plan (NFP), relevant guiding principles include adhering to the Government's policy on environmental protection, pursuing the strategy of sustainable development, carrying out planning, implementation and development in terms of environmental protection, and the integration of economic, social and environmental benefits. The NFP also put a high priority on sustained and stable agricultural growth and the rural economy. The "China Trans-Century Green Project", part of the NFP, spans 15 years through 2010. Some project principles include combating environmental pollution and ecological destruction and improve environmental protection, considering environmental, social and economic benefits, and instituting the polluter pays for the pollution.⁵ In March 2001, the Government unveiled China's first "green" five-year plan for economic development, emphasizing that a high priority will be given to the reduction of air pollutants.

7. Under PRC's Tenth Five-Year Plan (TFP), an incremental 300,000 households annually are expected to be users of biomass systems. There is also ample scope for expansion of producer gas. For example, more than 14,000 large-scale livestock breeding farms are now operating, but only five percent have installed biogas/sewage treatment systems. In recent years the Government has given biomass gasification technology a high priority, and by the end of 1999 there were more than 300 crop residue gasification systems providing producer gas to households living in nearby villages. Despite the fact that much of the demand for gasification systems stems from environmental considerations, the market potential of gasification systems is considerable. If one assumes that only one percent of the total amount of crop residues were replaced by producer gas over the next ten years, approximately 10,000 gasification systems would have to be installed, producing enough gas to serve six million households.

8. In 1992, the UN Conference on Environment and Development (the *Rio Declaration*) made sustainable development the goal and recommended that each nation create an agenda for the 21st century; thus China's Agenda 21 recognizes that a better environment is essential

⁴ For a detailed account of GHG emissions in PRC, see ADB/GEF/UNDP. Asia Least-cost Greenhouse Gas Abatement Strategy – People's Republic of China. (ALGGAS) Oct. 1998. Table 1-1, p.5.

⁵ UNEP Jointly funded website <www.svr1-pek.unep.net> *State of the Environment, China '97*.

for improving the quality of life of the population, attracting foreign investment, and achieving sustainable growth and development, and that the spread of environmental problems is a recognized constraint. The long-standing problems of population pressure and limited resource base have been exacerbated by the emergence of environmental problems associated with rapid economic growth and the legacy of inappropriate environmental and pricing policies.

9. As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), China has taken a responsible position to reduce its GHG emissions. In 1994 the State Council issued a *White Paper on Population, Environment, and Development in the 21st Century*, the country's first effort at addressing renewable energy. In addition to sections addressing sustainable energy production and sustainable agriculture, Agenda 21 also addresses protection of the atmosphere by controlling air pollution and acid rain.⁶ The *New and Renewable Energy Development Program (1996-2010)*, prepared jointly by the State Development Planning Commission (SDPC), the Ministry of Science and Technology (MOST), and the State Economic and Trade Commission (SETC) in 1995, commits the Government to renewable energy. Part of this program aims to improve the efficiency of renewable energy technology.⁷

10. The *Energy Conservation Law of China*⁸ outlines basic principles for energy conservation that includes technology applied to energy conservation (Articles 3 and 6) and the support of energy conservation projects (Article 33). The Law includes biomass in its definition of energy resources, and states that "... the people's government at various levels shall strengthen the support, development and utilization of biogas...energy." (Article 38). While the Law attempts to strengthen environmental law enforcement, compliance remains low due to economic development priorities.

C. Country Operational Focal Point

11. The National Operational Focal Point for GEF in the PRC is Mr. Yang Jinlin of the Ministry of Finance (MOF), who has endorsed the proposed Project. The letter of endorsement was signed on 27 June 2001 (see attachment C).

II. PROGRAM AND POLICY CONFORMITY

A. Program Designation

12. GEF's Operations Program (OP) No. 6 is the most appropriate OP to assist the Government in its endeavor to reduce GHG emissions through the use of biomass renewable energy systems (BIORETS). The proposal will contribute to the China World Bank-GEF Renewable Energy Partnership to develop policies and mechanisms for renewable energy development.

B. Program Conformity

13. GEF incremental funding would address key identified barriers (see para 30 of RRP) through market-based solutions, in the rural agricultural sector, through relevant market

⁶ UNESCAP. Virtual Conference, <www.unescap.org> Aug. 2000

⁷ World Bank. Project: CNPE46829.

⁸ Presidential Act of the People's Republic of China No. 90 (1 November 1997). The law came into effect on 1 January 1998. (Unofficial English translation from UNESCAP).

applications, and within the context of replicability and sustainability.⁹ The Project conforms to the Operational Program and with its status of implementation, as set out in the GEF Corporate Business Plan. The Project will contribute towards extensive adoption of BIORETS which would significantly lead to reduction of GHG and environment improvement in a least cost approach. Also, the Project would provide the demonstration effect on positive environmental impact and health benefits to global, regional, and household inhabitants.

C. Identified Key Barriers and Proposed Interventions

14. The key barriers that restrict the promotion and expansion of BIORETS (see paras 29 and 30 of RRP) and the proposed interventions (activities) are given below:

1. Barrier 1. Lack of a Replicable Financing Model and Shortage of Available Capital and Credit in the Rural Areas

15. Although the adoption of biomass technologies is financially and economically viable, weak financial management capability and lack of a sustainable and replicable financing model have hampered the widespread adoption of biomass technologies in the rural sector. The expansion of BIORETS is also restricted because of shortage of longer-term credit facilities to enable rural households to adopt the biomass technologies. The commercial banks, such as the Agricultural Bank of China, Rural Credit Cooperatives, and other financial institutions, are unwilling to provide longer-term financing for large number of small borrowers in the rural sector. The relatively low incomes of the farmers makes it impossible to obtain credit from commercial sources. Medium-scale biomass systems, such as gasifiers, have low operating and maintenance costs compared to conventional alternatives, but these systems have high front-end costs. This poses a barrier to prospective investors such as township and village enterprises (TVEs), rural cooperatives or entrepreneurs, who do not have either collateral or access to long-term financing. The overall weak financial situation in the rural communities makes it difficult for them to obtain credits.

Activity 1. Overcoming the Financial Barrier (see para 71 of RRP):

- (i) assist the provincial finance bureaus to develop appropriate financing modality and mechanisms in order to overcome the shortage of capital and credit for small farmers and entrepreneurs who want to invest in BIORETS;
- (ii) assist to establish appropriate and sustainable financial lending and collection procedures at the provincial finance bureaus through institutional strengthening; and
- (iii) assist to develop a financial model for longer-term lending that is replicable by rural financial institutions such as Agricultural Bank of China and Rural Credit Cooperatives for expansion of BIORETS in other parts of the country.

⁹ GEF. GEF Operational Programs. June 1997. OP 6: §6.4, §6.7, §6.9, §6.10, §6.10(c), §6.10(g) and §6.12.

2. Barrier 2. Weak Institution and Inadequate Technical Expertise and a Lack of Viable Service Infrastructure and Personnel Along with Incentives for Continued Operation

16. Another major risk or barrier that hampered the widespread adoption of biomass technologies in the rural sector is the technically weak institutions and inadequate technical staff to cater for the need of the rural sector in adopting biomass technologies. Qualified technical staff needed to promote and support BIORETS expansion are in short supply. There are an inadequate number of biomass energy system designers, contractors, O&M technicians, and extension staff to rapidly promote and expand the use of biomass technologies. This inhibits the expansion of BIORETS. Other factors include the lack of reliable maintenance programs and supply of spare parts, good managers, and environmental programs. Access to the latest technologies and technical links are not readily available, inhibiting the ability to incorporate advanced technologies, such as in biomass gasification plants. High project preparation cost restricts expansion because investors are reluctant to proceed with these activities without the assurance of financing. Technical support is required to help potential investors to prepare feasibility studies, designs, cost estimates, and develop business plans in order to secure financing. Weak or inadequate service infrastructure and personnel along with incentives for continued operation is an associated barrier for widespread adoption of biomass technology. To ensure sustainable operation of small and medium scale BIORETS, it is necessary to develop and promote a viable and effective private service sector to provide spare parts, O&M service, and to help the biogas operators to improve their technology as newer and more efficient techniques become available.

Activity 2. Overcoming the Institutional, Technical Barrier, and Service Infrastructure Barrier (see para 73 of RRP):

a. Institutional Strengthening

- (i) assist to establish sound management support to overcome deficiencies in design, costs, financial planning, quality assurance, environmental monitoring, and technical supervision;
- (ii) assist to formulate a biomass energy program and action plan aimed at expanding the program nationwide;
- (iii) assist State Environment Protection Administration (SEPA) and Ministry of Agriculture (MOA) to address the government's policy to promote and expand biomass technologies and legal framework activities through national level steering committees and close liaison with other on-going renewable energy programs with various donors;
- (iv) assist to develop a market approach to expand biomass technology adoption country-wide; and
- (v) assist in institutional strengthening and capacity building for both the public and private sectors so they are better prepared to expand the biomass renewable energy program elsewhere in China.

b. Technical Capability Improvement

- (i) assist to introduce improved technologies to increase the efficiency of biomass systems that have been developed inside and outside of China;
- (ii) provide fellowships to universities and biomass technology research institutes to carry out further research and development programs to improve biomass models; particularly for the gasifiers;
- (iii) provide funds for short-term training for government officials in order that they understand new developments and problems in the biomass sector in other economies;
- (iv) assist to develop, install, and train personnel in environmental measurements and monitoring programs in order to provide a sound database to both SEPA and MOA; and assist SEPA to develop additional environmental standards and policies applicable to the renewable energy sector for biomass development.

c. Service Infrastructure Development

- (i) assist to strengthen service infrastructure and provide incentives to personnel and technicians to provide effective O&M service to biogas operators;
- (ii) provide training to local biogas and gasification contractors to improve their technical capability in construction and operational maintenance service; and
- (iii) assist in planning Project locations to ensure concentration of biogas units, biogas plants or biomass gasification plants so as to develop and promote a viable and effective private sector to provide the spare parts, O&M service and to help these service provider to improve their technical capability.

3. Barrier 3. Inadequate and Poor Rural Infrastructure for Effective Biomass Technology Promotion and Expansion.

17. Poor access to remote villages in rural areas hampered efficient extension of technical services and availability of spare parts and accessories for effective O&M of biogas digesters. It will also cause higher damage to farm produce during transportation, particularly during the wet season. Overcoming this barrier in rural areas will result in quicker and frequent access by technical staff to expand biomass technology as well as to reduce farm produce damage during transportation. This will result in higher farm incomes for better O&M of biogas digesters.

Activity 3. Overcoming Poor Farm Access Barrier (see para 74 of RRP):

- (i) assist to identify areas of poor rural infrastructure links to main roads leading to urban market; and
- (ii) assist to rehabilitate farmers-selected farm-to-market roads to provide better access in remote areas.

4. Barrier 4. Lack of Sound Environmental Programs for (i) Developing a Reliable Data Base and Social Monitoring; and (ii) a Lack of Public Awareness and Information

18. The national Government adopted comprehensive policy framework and strategies to mitigate environment degradation but implementation at provincial level is poor due to weak environmental capability at the local level. There is great need for assistance to help in developing environmental programs and assisting environment policy implementation, particularly those related to combating GHG emissions. There is also lack of sound environmental program for developing reliable database and for social monitoring of environmental conditions to highlight the positive impact of biomass technologies on environment and human health. Local government officials, in particular the decision-makers from local planning commissions, finance bureaus and agricultural bureaus, as well as farmers and potential investors, lacked information about the implications and use of renewable energy systems and thus are unable to make practical decisions on an investment. They also lack knowledge of the overall environmental and human health concerns and possible benefits that are directly related to biomass energy systems.

Activity 4. Overcoming Environment Institutional Weakness in Policy Implementation and Lack of Public Awareness, and Information (see para 75 of RRP):

- (i) assist the provincial government to develop framework for effective implementation of national policy on environment protection, particularly those related to biomass technologies;
- (ii) provide environmental facilities to rural townships to generate key data and information to highlight the results for public awareness, education, and training so that public and political support is forthcoming for the promotion and expansion of biomass technologies in the rural areas. The provision of environment facilities is an integral part of activity 4 which will serve as an important demonstration effect to (i) enhance promotion and expansion of biomass technology adoption as well as to help provincial governments to develop and adopt appropriate incentives and policies to ensure efficient implementation of environmental measures; and (ii) enhance environmental data gathering in rural areas to generate information for public education, raising public awareness, exhibitions, training of farmers and government officials, public campaigns and other activities that will lead to wider adoption of BIORETS in other provinces.
- (iii) assist in preparing and disseminating public awareness material and advise local communities and industry on the latest available technical options, costs, economic benefits, and financial risks;
- (iv) assist to organize public information campaigns, seminars, study tours, and media presentations in order to share the information on the advances and benefits of biomass systems;

- (v) assist to develop sound marketing and advertising campaigns, set up trade fairs, and other similar means, in order to expand the interest in biomass systems; and
- (vi) assist to develop an information campaign on the environmental and health benefits; and assist in developing training programs for government, private sector, and farmers.

5. Barrier 5. The Lack of Confidence for Government to Provide Adequate Assistance to the Poor Resulting in the Inability of Large Number of Disadvantaged and Poor Households to Participate in Biomass Development

19. Disadvantaged and poor households have been unable to participate in the renewable energy program, even though they are important partners to meet the Government's overall environmental objectives, as well as improving the quality of their lives. The Government has successfully reduced the number of disadvantaged and poor households living below the poverty line. However, millions of poor people are still in need of assistance. Poorer households have special and extraordinary problems that inhibit them from participating in biomass technology adoption projects due to a lack of capital, inadequate education and technical capabilities, and thus continue to remain in poverty. The Government, through the Poverty Alleviation Office, is currently spending about \$1.5 million in the four Project provinces to help the poor to adopt the biomass technologies. The assistance is mainly providing cash subsidies in the construction of biogas digesters. Such assistance is ineffective in helping the poor to adopt biomass technologies to increase their income. The Government lacks the confidence to expand its budget to assist larger number of poor to adopt the BIORETS.

Activity 5. Overcoming the Lack of Confidence of the Poverty Alleviation Office in the Merits of BIORETS for Poverty Alleviation (see para 76 of RRP):

- (i) An improved biomass development approach will be introduced to demonstrate its feasibility as well as positive impact in helping the poor to adopt BIORETS. The improved approach will involve a package of special training program and provision of basic BIORETS assistance to assist the poor. Basic biomass development facilities would be provided to supplement the initial capital requirements for the loans provided under activity 1 through the provincial finance bureaus to construct small-scale biomass systems. Providing support to the poor with an initial upfront grant of up to 25 percent of investment cost (in the form of basic biogas facilities) is important to enable them to qualify for the credit facilities (under activity 1). Successful implementation of this activity would serve as an important demonstration effect to convince those rural development agencies responsible to help the poor to continue the Project activities after its completion. For example, The Poverty Alleviation Office (with annual national budget of over \$600 million) is actively cooperating with this activity of the Project and would continue to replicate this activity to other non-project areas if this component is viable and successful. The implementation of this activity is divided into two phases. In phase 1 (year 1 to 3), GEF will provide assistance to about 15 percent of Project beneficiaries who are poor (about 2353 households). In phase 2, (year 4 to 5), the Poverty Alleviation Office will use its own resources to finance

another 2,597 poor households using similar approach. This would enable the Poverty Alleviation Office to gain confidence and to continue to adopt similar approach in other provinces.¹⁰

- (ii) assist to set-up, through Women's Associations, programs to help the disadvantaged and poor households to overcome their social stigmas and to train, inform, and assist them in the adoption and operation of small scale biomass technology; and
- (iii) assist to set up procedures to address social improvements in the villages as determined by the women's groups.

6. Barrier 6. Weak Project Implementation and Management Capacity

20. Executing agencies at the provincial level are weak in implementing project activities of relatively large scale in nature. This is especially in the field of biomass technology promotion and adoption where they lack experience for large scale implementation. They require technical support to develop appropriate models and approaches, and in strengthening biomass project implementation, and coordination. County and township level technicians need extensive training for effective biomass technology promotion and adoption. There is also a need to provide technical support (consulting services) to various provincial government agencies involving with the implementation of activities (i) to (vi) above to ensure Project success.

Activity 6. Overcoming Weak Project Implementation Capacity (see para 77 of RRP):

- (i) assist to establish better Project management and coordination in order to promote inter-sectoral cooperation between different ministries dealing with biomass technology and to supervise implementation of the interventions;
- (ii) provide technical support (consulting services) to help develop appropriate and sustainable models and approaches, and to strengthen Project institutional capacity. Assistance is provided in implementing activities (i) to (v) of the Project;
- (iii) provide management and implementation training to Project officials responsible to promote and assist rural households to adopt biomass technologies; and
- (iv) strengthen coordination among all levels of implementation agencies within and between provinces.

¹⁰ There are about 3 million poor households in the four Project provinces. Based on an average poverty percentage of the poor in the Project provinces (ranging from 12% to 18%) and discussions with MOA and Poverty Alleviation Office officials, about 15 percent of the Project beneficiaries (2,353 poor households) who are living below the poverty line will be selected to pilot test this biomass development approach during phase 1 of Project implementation (first 3 years). This is to be followed by phase 2 (year 4 to 5) of assisting 2,597 poor households by Poverty Alleviation Office. Successful outcome of this approach would enable the Government to replicate this activity in other areas.

D. Baseline Development Path

21. Since the 1970s, the Government has spent significant amounts of funding to develop biomass technologies which integrate into the existing farming systems. The use of biogas digesters and crop residue gasification technologies has become increasingly popular in recent years, particularly by small farmers in the inland provinces. However, the small and poorer farmers are facing constraints of obtaining credit to adopt the biomass technologies in their farming systems because rural financial institutions are reluctant to lend to them due to lack of collateral and large number of small loans involved. GEF support is important to remove the financial barrier as well as other institutional and technical barriers to enable large scale adoption of biomass technology. Without GEF support, the Project would not proceed as envisaged because the Government lacks the financial resources to expand the program as rapidly as required, having but eliminated grants for small-scale biomass projects. Most of the affected households and villages presently have no means to finance the investments even if they wanted to do so. Further replication of the technologies across the country will not happen unless barriers are removed.

E. Global Environmental Benefits and Alternative Development Path (see paras 119 to 122 of RRP)

22. The potential global environmental benefits will be the direct carbon emission reduction of about 78,338 tons/year and 1,226,000 tons over the lifetime of the BioRET systems through the implementation of about 15,600 small and 42 medium scale biomass renewable energy systems. There will be additional substantial indirect and multiple benefits including increased employment opportunities. Health benefits are expected to stem from cleaner cooking conditions, while the switch to biogas or producer (biomass) gas will save considerable time for end users compared with previous practices, particularly benefiting women. Households can expect fuel savings of up to \$79 per year. In the case of households adopting the northern biomass model (Type 1), annual incomes are expected to increase by over \$485 for traditional farmers moving to full adoption of the system. For households adopting the southern biomass model (Type 2), annual incomes are expected to increase by over \$1,724 when the citrus orchards come to full bearing in year 10. Financial returns from the medium-scale biomass plants are expected to be about 15 percent although added income from livestock production will add substantially to this. Owners of gasification plants can expect to obtain financial returns of about 14 percent.

23. Activity 1 (under the Funding for Renewable Energy Generation and Eco-Environment Development component, para 71 of RRP) is designed to overcome the financial barrier in the rural areas. Whilst the feasibility study indicates that the adoption of biomass technology is financially viable and would generate significant benefits including reduction of GHG emissions, there are inherent major risks associated with lack of suitable financial modality to provide longer-term credit to those in the rural sector who want to adopt the technology, and the need to strengthen institutional capability in financial management and credit provision functions. This activity will overcome the financial barrier. The activity will assist to establish and strengthen lending and collection procedures at the provincial finance bureaus to facilitate the provision of credits to BIORETS investors who want to invest in the biomass technologies. A financial model will be developed for longer-term lending. This is currently lacking in the rural areas. Successful implementation of this activity would serve as an important demonstration effect to convince the rural financial institutions like the Agricultural Bank of China and Rural Credit Cooperatives to participate in further biogas development and financing. The provincial governments have already committed a major share of the long-term finance under the Project (together with the

beneficiaries, they contributed about 50 percent of the investment cost) and it is their policy to encourage the rural financial institutions to play a major role to provide credits to small farmers. The financial model will be appropriate and replicable for adoption in other provinces of PRC ensuring sustainability and replicability.

24. Activity 2 (under Improve Mechanisms for Transferring Biomass Technology component, para 73 of RRP) is designed to overcome the weak institution and technical barrier and its associated constraints of inadequate technical experts to promote the adoption of biomass technologies. Qualified technical staff to promote and support biomass systems are in short supply in PRC. This inhibits the adoption and expansion of biomass technologies. The activity will assist in introducing improved technologies to increase the efficiency of the BIORETS. Under this activity, fellowships will be provided to universities and research institutes to further carry out research and development programs to improve the biomass technologies. Extensive training will be provided to extension staff to promote the adoption of the biomass technologies in rural areas. Technical support and assistance will be provided to support potential investors to acquire new biomass technologies, as well as helping them to prepare feasibility studies and develop business plans to secure financing. This activity will also help to build up a service infrastructure and strengthen the service sector to ensure the sustainability of biomass technologies adoption. Significant consulting services will be provided to help to devise incentives for service operators to ensure continued operation.

25. Activity 3 (under the Rehabilitate Farmers-Selected Farm-to-Market Facilities component, para 74 of RRP) will assist the rural farm households to overcome the constraints of transporting the incremental and better quality farm produce to urban markets. This will result in shorter time for the goods to reach the market and incur less transport damage to their goods, and hence enable them to fetch higher prices. It translates to higher farm incomes and provides the farmer with extra money to better operate and maintain the biogas digesters and to improve on them to ensure long term sustainability of biomass technologies. This will also allow easier access by technical staff and to obtain spare parts and accessories necessary for the O&M of the biogas digesters and will further enhance the adoption of biomass renewable energy systems in the country.

26. Activity 4 (under Improve Environment Policy Implementation and Awareness component, para 75 of RRP) is designed to assist and develop framework and programs to assist provincial governments to effectively implement national environment policy, particularly those relating to biomass technology development and adoption, as well as to raise public awareness, to educate, and to train government officials on the importance of clean environment and its impact on public health in order to promote of BIORETS in PRC. The activity will provide environmental facilities to rural township governments to generate quality environmental data and information to assist in overcoming barriers relating to lack of public awareness and information on how the adoption of biomass technologies would improve the environment and its impact on human health. It will assist in public education, training of government officials, and in preparing and disseminating public awareness material and advise local communities and industry on the latest available technical options, costs, economic benefits, and financial risks. It will also organize public information campaigns on environmental and health benefits, and assist in developing training programs relating to biomass renewable energy systems and environment improvement. Support to this activity is crucial as it would provide an important demonstration effect for further enhancing the promotion of and expansion of biomass technology development and adoption.

27. Activity 5 (under the Pilot Poverty-Focused Approaches to Biomass Development component, para 76 of RRP) is designed to introduce an improved and innovative biomass

development approach to demonstrate its feasibility and positive impact so that the Poverty Alleviation Office will adopt this improved approach in their effort to expand their assistance to the poor to adopt BIORET and improve their incomes. The disadvantaged and poor farm households have low technical capability and inadequate financial resources that inhibit them to participate in the adoption of biomass technologies. They also lack the initial capital seed money to avail of the credit facility provided by the Project. This activity aims to develop a poverty-focused approach to assist this group of disadvantaged and poor households to adopt biomass technology. It will involve a package of special training program and BIORET assistance to assist the poor. The activity will carefully organize and select the needy ones who are enthusiastic in adopting the biomass technology. Basic biogas generating facilities such as digesters, pigpens, and other farm fixtures will initially be provided to enable them to qualify for the Project credit facilities provided under activity 1. This will supplement the poor farmers' contribution to the investment to cover the initial capital requirements. The activity will also provide training programs specially designed for the disadvantaged and poor households to upgrade their technical capability to enable them to adopt the biomass technology in a sustainable manner. It will also assist to establish procedures to address social improvements in the villages. A two-phase approach in implementation will be adopted. In phase 1 (year 1 to 3), GEF will finance about 2,353 poor households. In phase 2, (year 4 to 5), the Poverty Alleviation Office will finance another 2,597 poor households (see also para 19). Successful implementation of this poverty-focused approach could serve as an important demonstration effect to convince the Poverty Alleviation Office to adopt such a viable and sustainable model for helping the poor to integrate the biomass technology into the existing farming operation in other provinces.

28. Activity 6 (under the Improved Implementation and Capacity Development component, para 77 of RRP) is designed to overcome the weak technical and implementation capability barrier. This is vital to ensure effective and efficient promotion and dissemination of biomass technologies to rural households thus helping to rapidly expand the adoption of biomass technologies. It will establish sound management system to overcome deficiencies in financial planning and budgeting, quality assurances, environmental monitoring, and technical supervision. It will also lead to better Project management and coordination in order to promote inter-sectoral cooperation in the adoption of biomass technologies. The activity will provide technical support (consulting services) to all Project activities (1 to 5) and assist to formulate a biomass energy program/action plan and develop a market approach to promote and expand the biomass renewable energy nationwide. Under this activity, major focus will be on capacity development to enhance and promote biomass renewable energy systems to other parts of the country.

F. Replicability and Sustainability

29. Replicability and sustainability of the biomass renewable energy systems nationwide will be better secured with the eventual outcome that there will be a very significant reduction in GHG emissions throughout the country. The Project design took into consideration of the lessons learned in the past decades of biomass technology development and adoption in PRC. The Project design will "glue" together all elements of biomass technology adoption incorporating existing farm production system, along with strengthening the institutions, technical capability, developing marketing facilities, promoting viable private service sector, and providing incentives and train service personnel for continued operation. The Project will require targeted research, institutional strengthening and capacity building, environmental monitoring, and technical expertise. Addressing the barriers will eventually reduce the costs of the biomass systems and improve the cost-effectiveness thus resulting in sustainability and replication. Health benefits are also derived throughout the region through cleaner air and water (i.e.,

reductions in point and non-point source pollution). An added benefit is the contribution that a healthier household makes to society in general. Rural households will realize increased annual and disposable income as a result of increased worker productivity and increased agricultural and livestock production. An increase in disposable income means increased spending locally and throughout the region as a result of the multiplier effect. Water quality improvements will be especially enhanced through wastewater treatments, and better farming practices including the use of organic fertilizers, reduced fertilizer applications, and improved disposal of animal wastes. The proposed biomass systems will reduce point and non-point sources of water pollution.

30. The Project's potential for replicability in other parts of China is excellent as it is a grass roots approach and is fully supported at all levels of Government. The Project constitutes a bottom-up approach within the overall policy framework that is envisaged to be developed by the Government under its Partnership Program for Renewable Energy Development. Addressing the various barriers and institutional strengthening will facilitate replicability since it will serve as an important demonstration effect and will create the required institutional, policy, and technical conditions to enable the mobilization of funds for the development of additional investments and wide expansion of the program. Within the Project, numerous replication activities have been included. These activities, among others, include study tours to neighboring provinces, training for government officials (including officials from the Ministry of Agriculture), seminars, workshops, exchange of technical visits and information with other non-project provinces, field days, media campaigns, exhibitions and other dissemination activities that will promote and expand the biomass technology information into other non-project provinces. The Ministry of Agriculture at the national level will also organize exchange programs between officials of various provinces in China to learn from each other on the latest development of biomass technologies resulting from Project investment.

31. Sustainability within the environmental context is also developed through the Project because renewable energy reduces the reliance on fossil fuel (coal) and biomass (firewood). A reduction in the use of these two fuels means reduced GHG emissions, and improvements in the forest sector has the added benefit of improving a natural emissions sink. The biomass system produces organic fertilizer, that has the effect of soil improvements, reductions in point and non-point pollution (by not using inorganic fertilizer) and improved agricultural outputs. Livestock are raised in more sanitary conditions by eliminating their waste through the biomass digester and enteric emissions are reduced, with the result of healthier livestock reaching the marketplace. Human health is improved, reducing the amount of time lost to sick days, increasing the household social structure, and improving the ability of household members to work and attend school.

32. Successful implementation of this Project will provide the demonstration effect for further enhancing the sustainability of Project with respect to:

- (i) long-term finance for small farmers – Activity 1 will develop an appropriate financing model in the finance bureaus for adoption by rural financial institutions like Agricultural Bank of China and Rural Credit Cooperatives. The provincial governments have already provided a major share of the long-term finance under the Project. At the completion of this Project (after exhaustion of ADB line of credit), the provincial governments and the rural financial institutions will adopt the financing model that is successfully implemented under the Project to ensure sustainable financial support to small farmers who need assistance to adopt the biomass technologies. Replicability of Project finance is thus ensured;

- (ii) appropriate and effective environment programs and implementation: Environment awareness is currently very poor in rural areas. Activity 4 will generate quality environment data and information that would serve as an important demonstration effect for the government to promote public awareness on environment protection in the rural areas and solicit political support to alleviate environmental pollution with regional significance. It will help to raise public awareness, train the government officials, and provide the necessary data to formulate programs for effective implementation of national government environment policy contributing to sustainable development of biomass technology development; and
- (iii) involvement of disadvantaged and poor small farmers: The Project area has about 3 million poor. This is a significant proportion and sustainable development of biomass technology in rural areas must involve poor small farmers. The pilot poverty-focused component of the Project (activity 5) will develop the most appropriate approach to enable the poor to participate in the Project and move out of poverty trap eventually. Successful implementation of this component will serve as a key demonstration effect for the Poverty Alleviation Office to continue this approach with its own fund after Project Completion, thus ensuring sustainability and replicability of Project activities in other parts of the country.

G. Public Involvement

33. From the time when MOA proposed the Project for ADB funding in 1999, there have been extensive consultations with all levels of stakeholders. In the four Project provinces, MOA held meetings with senior officials at all levels of government down to the municipalities and counties. Officials from the provincial Rural Energy Offices held extensive discussions with Village Committees who in turn held public consultations with villagers. During Project preparation, public consultation included 43 public meetings, 63 in-depth interviews, 11 participatory rural appraisals, and 150 household interviews. Village meetings were held with focus groups such as: Village People Committee, community leaders, elders, women representatives, and youth association to collect broad-based opinions on the Project. In depth interviews were done to understand socioeconomic, poverty, and environmental implications of the Project. Particular attention was given to foster the participation of villagers, in particular women, in all the steps of Project preparation. Public involvement in the Project is assured as the Government is committed to the expansion of the small-medium scale biomass systems nationwide (see para 101 of RRP).

H. Private Sector Development

34. The Project will be instrumental in promoting private sector investments in biomass and gasification plants, additional integrated farming, and anaerobic waste treatment systems. Under the Project, options for attracting private investors and non-government investment funds will be undertaken to facilitate the mobilization of such financing. In addition, competitive bidding procedures will be developed to attract potential biomass and gasification technology developers who may be interested to invest at already identified potential investment sites. Private sector contractors, including universities and NGOs, will be invited to participate in the construction, training, and research and development programs. A program will be developed to promote and develop a viable private service sector along with incentives and personnel training to ensure continued operation of biomass technology in every county so that sustainability of

Project benefits is ensured. Currently, the number of biogas units in each country is relatively small (existing greenhouse with biodigesters are mainly invested by farmers with their own resources) averaging less than 10 in each village. This will not support a viable private sector service operator. The Project would support the establishment of another 10 or more units in those villages that have already developed the greenhouses with digesters and this will support the establishment of at least one viable private sector service unit. About 15,600 small scale biogas units will be established in 145 villages under the Project. It is anticipated that these biogas units will support viable operation of about 300 private service units in the Project areas.

I. Project Monitoring and Performance Evaluation

35. Monitoring and evaluation function is a key aspect of Project design. The Project will be monitored and evaluated using ADB procedures. ADB will undertake this activity in cooperation with the GEF focal point in the MOF and other PRC agencies. ADB's extensive experience in administering projects will be drawn upon to ensure that all project activities are carefully recorded, documented, and accounted for. Data will be collected on the key performance indicators, and results of the monitoring and evaluation surveys will be used to implement changes to the Project, if necessary and for future reference in the development of similar projects. Annual progress reports will be prepared and discussed with the national PMO, the Executing Agencies, and Project staff. For the technical assistance, the progress of the various barrier removal and institutional strengthening activities will be discussed during annual reviews with the Executing Agencies and consultants, to undertake the necessary activity to improve and maximize Project impact and implementation.

36. The PMO and Provincial financial bureaus will maintain records of all expenditures and prepare consolidated Project accounts. They will ensure that auditors acceptable to ADB audit the accounts annually. The audited reports will be submitted to ADB through the PMO not later than one year after the end of the fiscal year. The PMO will submit consolidated semi-annual progress reports for the Project to ADB within three months at the end of each semester. These reports will include (i) physical and financial accomplishments, (ii) problems encountered or anticipated and action taken and (iii) a work plan for the following six months. Towards Project completion, the PMO will prepare and submit to ADB a draft project completion report summarizing the implementation record, including the achievement of objectives and targets, and a critical evaluation of implementation experience.

37. The Project Management Office (PMO), in coordination with Project Implementation Offices (PIOs), will establish a Project Performance Management System (PPMS) at both the PMO and PIOs to monitor and assess Project performance and impact. Consulting services provided under Activity 6 will assist the PMO to formulate and establish an effective PPMS from the commencement of the Project. ADB missions will also be fielded at regular intervals to monitor the progress of the Project. At commencement, ADB will field an inception mission to finalize all aspects of Project implementation and fine tune on all Project performance indicators. Annual review mission will be fielded to provide supervision and administration of the Project and resolve issues arising during implementation. A mid-term review mission will be fielded at year 3 of implementation to undertake a comprehensive assessment and review of the Project. Details of Project monitoring and performance evaluation are further elaborated in paras 92 to 94 of the RRP.

III. FINANCING

A. Budget and Incremental Cost

38. No GEF financing under PDF (blocks A, B, and C) has been requested for Project preparation. It is envisioned that GEF will provide grant financing of about \$6.4 million to finance activities as described in Section II E.

39. The total baseline cost of the Project is \$65.4 million. The total Project cost is \$77.3 million including total incremental cost of \$6.4 million. The detailed costs are given in the Section IV of the RRP. An incremental cost assessment, including incremental cost matrix, is attached in this cover note (see Attachment A).

B. Financial Modality

1. Sources

40. Of the total cost of \$77.3 million (including contingencies, interest and other charges, project preparatory technical assistance cost), ADB will provide a loan of \$33.1 million from ordinary capital resources (OCR). The loan amount will finance 91 percent of the total foreign exchange cost of the Project. The provincial governments contribute \$23.6 million, GEF \$6.4 million, and the beneficiaries \$14.2 million. The local counterpart currency requirements will be provided by the four participating provincial, municipal, county and township governments through annual budgets, and by the Project beneficiaries, including the enterprises. Loan funds repaid prior to ADB maturity date will be revolved by the relevant municipal and county finance bureaus for further financing type I and Type II farmer investors, particularly the disadvantage and the poor farmers. A summary of the financing plan is given in Table 1.

Table 1: Project Financing Plan
(\$ million)

Source	Foreign Exchange	Local Currency	Total Cost	Percent
ADB	33.12	0.00	33.12	43
Local Governments	1.10	22.49	23.59	31
Beneficiaries	0.00	14.20	14.20	18
GEF	2.05	4.31	6.36	8
Total	36.27	41.00	77.27	100

IV. INSTITUTIONAL COORDINATION AND SUPPORT

A. Core Commitments and Linkages

41. The ADB's Country Assistance Plan for the PRC is aimed at helping the country achieve economic growth in an efficient, equitable and sustainable manner. In the energy sector, ADB is placing special emphasis on the need to promote and encourage all rural household (particularly the poor) to extensively adopt biomass technology to enhance energy production efficiency, reduce GHG emissions, and reduce adverse environmental impacts. The bulk of population in China still live in the rural areas (over 70 percent) and promoting the rural sector to

adopt biomass technology will generate significant positive environmental impacts. ADB has provided grants of over \$7 million for a number of technical assistance projects to promote renewable energy development and reduce GHG emissions in PRC. The Project is the first ADB financed project for biomass renewable energy development in the rural sector of PRC.

B. Consultation and Coordination

42. During the Project's design, close consultations were held with the relevant Government agencies, UNDP, World Bank, and other bilateral donors to coordinate the proposed activities under the Project. Discussions were held with each of these agencies to understand their ongoing and planned activities to promote biomass renewable energy development in the PRC. Complementarity of the bottom-up approach of the Project activities in the four Project provinces with the activities of the GEF Strategic Partnership for Renewable Energy has been assured through the design of specific activities at the provincial, county, and township level to effectively remove those barriers for the biomass technology adoption. Close coordination has also been made with the State Development and Planning Commission (SDPC) which is the national coordinating agency for the Government's Partnership Program for Renewable Energy Development. During Project implementation, coordination of activities will be facilitated through the sharing of the findings and reports as well as regular meetings of ADB staff with UNDP, World Bank, and other donor agencies in PRC.

V. RESPONSIVENESS TO REVIEWS

A. Comments on Concept Paper

43. Comments made by the GEF Secretariat confirmed the country ownership, program conformity, and replicability and sustainability of the four biomass systems. Further support for these have been provided above.

44. The GEF Secretariat had suggested that non-grant financing modalities be considered such as contingent (equity) grants, contingent concessional loans, and partial risk or credit guarantees. The Project has been designed where all of the four biomass systems will be financed to qualified investors through the financial bureaus at the same rate as charged by ADB on OCR funds (or near market rates).

45. The GEF Secretariat wanted more clarification on the definition of an integrated enterprise farming system and required technology. The Project will finance four types of biomass systems; Type I and Type II are simple (Four-in-One Model and Three-in-One Model) that have been developed in the northern and southern parts of PRC. Type III is a typically located in medium scale livestock farm and Type IV is a crop residue gasification plant (gasifier). The GEF Secretariat wanted more information on how the Project would address the key barriers, how it fit into the overall strategic strategy issues of PRC on renewable energy, and what were the technical issues. Responses to these are shown below:

46. With respect to the identified key barriers, the Project would address the following:

- (i) Consultants will assist the MOA and SEPA to develop appropriate policies for the strategy of developing lost cost energy within the framework of the renewable energy policy.
- (ii) The Project is only for the private sector whereby potential investors will borrow the required capital from the provincial financial bureau and repay, over a to be

determined period, at market rates. No subsidies will be provided to investors. Foreign participation will be on the introduction of improved technologies, appropriate training (local and overseas), and consulting services.

- (iii) Tax incentives already exist on renewables. However, during implementation the EAs and consultants will prepare policies that will enhance the present situation.
- (iv) The Project will strengthen the provincial financial bureaus (and at other levels) through training and consulting services by establishing appropriate financing modalities and procedures during implementation.
- (v) The Project will review new and/or more modern technology and introduce, through research programs, the appropriate technology acceptable to PRC. The most changes are expected in the gasifiers and modest improvements in delivery of producer gas to households, improved efficiencies in the gasifiers, and improved operations of Type 1 and Type II biogas units.

47. With respect to strategic issues:

- (i) The Government has included the renewable energy program, using agricultural wastes, in the 10th Five-Year Plan.
- (ii) The barriers that have been identified occur at all levels. However, because the Project will be the responsibility of the four provinces, this will be the primary target area during implementation.
- (iii) No pilot large scale biomass plants will be constructed with grant funds.

48. With respect to technical questions:

- (i) An integrated farming system is widely known in PRC as the Four-in-One Model or the Three-in-One Model. These are simple systems that utilize agricultural wastes, primarily animal manure, to generate biogas for household use, and with the residual to be used as organic fertilizer. Green houses are also used in the northern model and capture of CO₂ for improved rates of production. Type III and Type IV models are the gasifier using straw and medium scale livestock feed lots (about 200 animals). The producer gas from Type III and Type IV will be used in local communities and is piped under pressure short distances from the unit. The producer gas is primarily used for personal home use. It is true that the systems to be constructed are relatively simple but there is substantial room to improve the technology and to improve the efficiency of the systems. Research and overseas tours will assist in improving all aspects of the present technology in particular for the gasifiers. Improved seals, valves, piping, handling of tar and other toxic wastes, will be addressed during the Project. Results will be used elsewhere to expand the countrywide program. Technology improvements are possible for all four types through appropriate locally funded research and development programs and through higher technology available overseas in Europe and the USA. Improvements in seals, valves, disposal of tar and toxic gases, and operational techniques are required to make the systems safer and more reliable as well as more efficient. All of these will be addressed during Project implementation.

49. With respect to processing of subloans to potential investors:

- (i) The Project offices will assist the investors in the application process, design process, and setting up an appropriate repayment schedule. The provincial financial bureau will be responsible for the subloans to each investor and also for collection of payments. Feasibility studies would only be required for Type III and Type IV biomass units as these are more complicated, larger subloans, and would require an EIA prior to implementation. Type I and Type II are simple and standard designs and costs have already been substantially developed by the Government. Forty-two counties have been selected to participate in the Project. These were selected during the feasibility study of the Project, through discussions and commitment of each county, commitment of counterpart funds, and willingness of the potential investors to borrow and to participate in the Project.

50. There are a number of concerns that may interfere in the expansion of the renewable energy program including expansion of the national electric grid and gas line. However, in the near future, there is an incredibly large market and PRC will need to produce household gas through simple and low cost technology as well as improving the environment and reduction of GHG emissions. The Project will assist the Government in both of these goals.

51. The major constraint is the lack of capital in the rural areas. During the Project, funds will be available for longer repayment periods thus providing the incentive for investors to borrow. Project offices with the assistance of consultants will establish appropriate procedures for planning, design, packing subloans, and repayment procedures.

52. Lessons learned in earlier interventions regarding services/activities/ modalities needed to address constraints hampering introduction of renewable energy based energy supplies and their incremental costs; identify and involve all interested domestic and international partners in planning and delivery of relevant services:

- (i) these have been determined in the Project design. Counterpart funds have been provided by the various government levels and potential investors have stated their desire to participate in the Project without subsidized market rates.
- (ii) larger financial institutions, such as the Agricultural Bank of China, are uncertain in participating as they are not sure of the BIORETS' viability and they do not want to handle thousands of small subloans. The provincial financial bureaus have experience in dealing with small farmers, investors, and in lending and collection procedures. The appropriate procedures will be strengthened during the Project.
- (iii) the Project will establish sound monitoring and evaluation procedures as well as indicators from the start of the Project.

B. STAP Comments on Project Document

53. Comments made by STAP Consultant is given in Attachment B. Basically, the comments are very positive. One issue raised is to ensure sustainable technical service to biogas operators. The Project design has provided special technical and management support (activities I to VI) to strengthen service infrastructure and personnel along with incentives for continued operation of the biogas digesters, especially among the small farm households.

Another issue raised is the need to ensure that new technologies and materials are available to improve efficiencies of the biomass technology. This aspect is important and the Project design has adequately provided assistance for significant technical support as well as funding (fellowships, etc.) for research and development of biomass technology. This will ensure the availability of newer technologies and materials for biomass technology adoption.

C. PRC Endorsement

54. The endorsement letter from the Government is given in Attachment C.

GEF Incremental Cost Analysis

A. Broad Development Goal

1. The overall development objective of the Project is the improvement of environment through provision or generation of biogas to meet the needs of rural households at the lowest possible cost. At the same time, the adoption of biomass technologies will bring about higher farm productivity and incomes which will further stimulate the adoption of biomass technologies to improve the environment nationwide.

B. Baseline

2. The baseline consists of what the Government and ADB would do without GEF support. Under the baseline, a number of barriers to adoption of biomass technologies exist in PRC. Without these barriers being removed through the Project, the biomass technologies adoption by the rural households will remain poor and underdeveloped as witnessed in the last three decades of biomass technologies promotion by the Government. Although the Government undertook numerous programs in the past to encourage the adoption of biomass technologies to generate biogas for environment improvement, the achievement so far has been dismay due to a number of barriers confronting the adoption of biomass technologies in the rural areas. The Tenth Five-Year Plan (2001-2006) is making further efforts to promote biomass technologies, and through this Project, the Government will attempt to eliminate the barriers to biomass technologies. GEF support in this Project is essential towards achieving the long-term development goal of the Project (see Project Framework – Appendix 1 of RRP).

C. Global Environment Objectives

3. The global environmental objective of the Project is the reduction of GHG emissions (about 78,338 tons of CO₂) by removing major barriers to the development of biomass renewable energy system through construction of about 15,600 small biogas digesters and 42 medium scale biogas plants. This will assist in reducing the quantity of fossil fuel (especially coal) consumption, reducing firewood collection from forest, reducing the quantity of straw and other crop residues being burnt in the field, and reducing the need to use chemicals in farming activities, etc. thus significantly reducing GHG emissions and other environmental degradations. The Project has been designed to be consistent with GEF Operational Program No. 6 on “Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementing Costs.”

D. GEF Alternative

4. The Project’s GEF programming approach is twofold and concurrent:
- (i) the removal of barriers to enable the biomass-based renewable energy systems to be implemented on a commercial basis; and
 - (ii) the support provided through technical assistance, training, education, basic facilities for the disadvantaged and poor, research, capacity development, improved financing modality and marketing, thus reducing implementation costs that are a result of a lack of applied experience, initial low volume markets, and dispersed geographic sites.

5. By addressing the barriers, replicability and sustainability of the biomass renewable energy systems nationwide will be better secured with the eventual outcome that there will be a significant reduction in GHG emissions throughout the country and an improved environment. The Project significantly promotes the adoption of biomass renewable energy system by removing barriers and this is to be achieved in the least costly manner.

6. Activity 1 (under the Funding for Renewable Energy Generation and Eco-Environment Development component) is designed to overcome the financial barriers in the rural areas. Although the biomass technology is financially viable and would generate significant positive environment benefits, there exists a financial barrier in the rural sector which prevented its widespread adoption by rural households. This financial barrier must be removed. This activity will assist the provincial finance bureaus to develop financing model and mechanisms to overcome the financial modality weakness and to provide credits to small farmers. The activity will also assist to establish financial management and collection procedures at the provincial finance bureaus to facilitate the provision of credits to rural farm households who want to invest the biomass technologies for renewable energy (biogas) generation.

7. Activity 2 (under the Improve Mechanisms for Transferring Biomass Technology component) is designed to overcome the technical barrier and its associated constraints of inadequate technical experts throughout the country to significantly promote the adoption of biomass technologies. It will assist in introducing improved technologies to increase the efficiency of the biomass systems that have been developed within and outside PRC. Under this activity, technical support will be provided to strengthen the institutions and technical expertise in all aspects of biomass technology adoption. To ensure the sustainability of Project, special training will be provided to develop and strengthen the service infrastructure and increase service personnel along with incentives for continued operation. Service personnel and contractors will be trained and assisted to set up an effective service sector. To strengthen technology development, fellowships will be provided to universities and research institutes to further carry out research and development programs to improve the biomass technologies. Extensive training will be provided to extension staff to promote the adoption of the biomass technologies in rural areas. Technical support and assistance will also be provided to support potential investors to acquire new biomass technologies, as well as helping them to prepare feasibility studies and develop business plans to secure financing.

8. Activity 3 (under the Rehabilitate Farmer-Selected Farm-to-Market Roads component) will assist the rural farm households to overcome the constraints of transporting their incremental and higher quality produce to urban markets. This will result in shorter time for the goods to reach the market and incur less transport damage to their goods, and hence enabled them to fetch higher prices. It translates to higher farm incomes and provides the farmer with extra money to better operate and maintain the biogas digesters. This will also allow easier access by service personnel and technical staff to bring to them new improved biomass technologies to ensure sustainability, and will further enhance the adoption of biomass renewable energy systems in the country.

9. Activity 4 (under the Improve Environment Policy Implementation and Awareness component) is designed to assist and develop framework and programs to assist the provincial governments to effectively implement national environment policy, particularly those relating to biomass technology development and adoption. Consulting services are provided to develop and strengthen environment policy implementation and awareness as well as to determine appropriate incentives for environment policy compliance. Technical staff will be trained in environmental measurements and monitoring programs in order to provide a sound data base to raise public awareness and to develop additional environmental standards and policies to enhance wider promotion of BIORETS in PRC. The activity will also assist in overcoming the

barrier relating to lack of education, public awareness, training, and information on how the adoption of biomass technologies would improve the environment and its impact on human health. It will assist in preparing and disseminating public awareness material and advise local communities and industry on the latest available technical options, costs, economic benefits, and financial risks. It will also organize public information campaigns on environmental and health benefits, and assist in developing training programs relating to biomass renewable energy systems and environment improvement.

10. Activity 5 (under the Pilot Poverty-Focused Approaches to Biomass Technology Development component) is designed to raise the level of confidence for Government to adopt an appropriate model to overcome the inability of large numbers of rural-based disadvantaged and poor farm households (about 3 million in Project areas) to participate in the adoption of biomass technology. The disadvantaged and poor farm households have low technical capability and inadequate financial resources that inhibit them to participate in the adoption of biomass technologies. The activity will introduce an improved and innovative approach and to demonstrate its feasibility as well positive impact in poverty alleviation through the merits of BIORETS. The approach will involve a package of special training and provision of basic biogas generation facilities such as digester and pigpen to enable the disadvantaged and poor households to participate in the Project activities. The assistance will supplement farmers' contribution to the investment to cover initial capital requirement to construct the small scale biomass system integrating with the existing farming practice. The activity will also provide training programs specially designed for the disadvantages and poor groups of beneficiaries. It will also assist to establish procedures to address social improvements in the villages. This activity will be implemented in two places. Phase 1 (year 1 to 3) will involve the financing of 2,353 poor households by GEF. Government commitment is demonstrated by its own financing of another 2,597 poor households in phase 2 (year 4 to 5). Successful outcome of this pilot approach will enable the Government to replicate the activity to other provinces.

11. Activity 6 (under the Improve Project Implementation and Capacity Development component) is designed to overcome the weak institutional barrier and improve the Project implementation capability. It will establish sound management system to overcome deficiencies in financial planning and budgeting, quality assurances, environmental monitoring, and technical supervision. It will also lead to better Project management and coordination in order to promote inter-sectoral cooperation in the adoption of biomass technologies. The activity will assist to formulate a biomass energy program/action plan and to develop a market approach to promote and expand the biomass renewable energy nationwide. Under this activity, major focus will be on capacity development to enhance and promote biomass renewable energy systems to other parts of the country.

E. Incremental Cost Matrix

12. The total Project cost amounts to \$77.27 million. GEF will contribute a total of \$6.36 million on grant basis. ADB financing is \$33.12 million. Equity contribution from beneficiaries is \$14.20 million equivalent. Counterpart fund from the Government (including 4 provincial governments) is \$23.59 million equivalent. The incremental costs have been discussed and agreed with the Government and the matrix is given below. Supporting cost tables are given in Tables A.1 and A.2 of the incremental cost matrix attachment.

Incremental Cost Matrix

Activity	Baseline ^a	Alternative	Increment
Activity 1. Funding for Renewable Energy Development and Eco-Environment	<p>One major barrier to development and promotion of biomass renewable energy is the lack of credit and suitable financing modality available to rural farm households. Commercial banks provide short-term credit but they are uncertain on the viability of biomass system to enable them to extend them to longer-term credit to large numbers of small farm households. Based on a feasibility study, ADB, the Government, and beneficiaries provide funding for the construction of about 15,600 units of small scale and 42 units of medium scale biomass systems.</p> <p>Cost: \$56,642,300</p>	<p>The financial bureaus in the four provinces will be provided with investment funding for onlend to the beneficiaries. At the same time, technical support will be provided to assist in developing an appropriate financing model and mechanism to channel credit fund to beneficiaries. The financial model developed would be suitable for longer-term lending that can be replicated to other parts of the country. Capacity development to the relevant finance bureaus will be provided.</p> <p>Cost: \$56, 642,300</p>	<p>Development of a viable financing mechanism for lending to small rural farm households, capacity development and skill training in the Project provinces to establish an efficient financial system for the promotion of biomass renewable energy systems. Technical support is needed to overcome the barrier. Consulting services is provided. The cost to this increment will be provided in Activity 6.</p> <p>Cost: \$0.0 (GEF)</p>
Activity 2. Introduce Improved Mechanisms for Transferring Biomass Technology	<p>In the Project areas, the technical capability to promote biomass technologies is weak and there is inadequate technical staff to undertake the assignment. Qualified technical staff needed to promote and support biomass systems are in short supply. This inhibits the expansion of biomass systems. Research and development will need to be funded.</p> <p>Cost: \$143,300</p>	<p>Technical support is required to strengthen the technical capacity and enhance capacity development. Skills training for designers, contractors, service personnel, and extension staff would be provided. Further research and development projects will need to be funded. Household farmers and medium scale enterprises will be given extensive technical support in all aspects of biomass technology adoption.</p> <p>Cost: \$1,237,200</p>	<p>GEF support is required to provide training, research for biomass systems improvement and promotion, and strengthen the institutional technical capacity for biomass technologies promotion and develop least cost options.</p> <p>Cost: \$1,093,900 (GEF)</p>
Activity 3. Rehabilitate Farmer-Selected Farm-to-Market Facilities	<p>Roads and bridges exist in Project areas but many need rehabilitation for easy access especially during wet season. As a consequence, poor extension services and damages to farm produce are main constraints. Farm-to-market facilities will be improved.</p> <p>Cost: \$1,195,100</p>	<p>Civil works and labor are required to rehabilitate the farmers selected access roads for easy. This would assist to promote and extend biomass technologies to the less accessible areas.</p> <p>Cost: \$1,195,100</p>	<p>None.</p> <p>Cost: \$0.0 (GEF)</p>
Activity 4. Environment Policy Implementation and Awareness	<p>Environment policy implementation is weak in the province. Poor public awareness, weak political support, and people's ignorance to protect and improve environment. There is also few environmental monitoring equipment available to monitor and disseminate information on environment.</p>	<p>Develop framework and programs to implement national environment policy. Create public awareness and political support, establish systems to measure and monitor emissions of GHG and the environmental contaminants, and conduct environmental monitoring and impact assessments.</p>	<p>Capacity building, developing environment framework and programs, environment management, provision of environmental equipment, technical support, and training are all part of a parcel to be provided to enhance public awareness, education, and training to encourage</p>

Activity	Baseline ^a	Alternative	Increment
	Cost: \$1,173,300	Environmental monitoring and measuring equipment will need to be provided to generate quality data and information in rural areas. Special environmental training program will be provided for technical staff, information days, and other activities will campaigns, seminars, field be organized to highlight the positive impact of biomass technologies on environment improvement. Cost: \$1,962,400	greater BIORETS adoption and to improve environment. GEF support is crucial for the success and sustainability of this activity. Cost: \$789,100 (GEF)
Activity 5. Develop Pilot Poverty-Focused Approaches to Biomass Technology Development	Disadvantaged households in the Project areas faced many constraints in participating the Project activities of biomass technology adoption. They have no access to credits and have weak technical capacity to adopt biomass technologies. Through the Poverty Alleviation Office, the Government is providing only financial assistance (about \$1.5 million) in the four Project provinces on BIORETS activities. However, Government's effort to help the poor is constrained by lack of appropriate approach to enable large number of the poor to participate in biomass technology adoption and improving their income. Cost: \$1,542,000	There is a need to introduce improved approach for community mobilization of disadvantaged households, train disadvantaged poor farmers to adopt biomass technologies, establish effective social and poverty monitoring system, and provide basic biomass technology facilities to assist the disadvantaged and poor farmers to adopt the biomass technologies. Support to this group of poor and disadvantaged farmers is important as they constituted about 26 percent of Project beneficiaries. Cost: \$3,279,800	GEF support is to introduce an improved and innovative approach and to demonstrate its feasibility and positive impact so that the Poverty Alleviation Office could adopt this approach to help large number of disadvantaged and poor rural farmers to adopt biomass technology. The assistance would provide basic biogas generation facilities to the disadvantaged and poor farmers to adopt the biomass technology. The pilot scheme will also provide special technical support and training upgrade the poor farmers' capability in adopting the biomass technologies. Success of this poverty-focused approach is important as it would serve as a model for Poverty Alleviation Office to adopt the model for massive promotion of biomass renewable energy to replicate the model to other poor farmers. Cost: \$1,737,800 (GEF)
Activity 6. Improving Implementation and Capacity Development	Weak institutional capacity is a major barrier for effective promotion of biomass energy system. There is great need to improve the Project management capability and strengthening the management system.	Introduce management skills, establish Project monitoring and management effectiveness, provide technical support and management training, and Project management and implementation support.	Technical support, institutional strengthening, information dissemination, marketing skills, and technical and management training to extension staff, Project management officials, contractors, biogas system designers, farmers, investors, and others. GEF support is needed to provide

Activity	Baseline ^a	Alternative	Increment
	Cost: \$4,734,600	Cost: \$7,476,600	consulting services to strengthen all agencies and institutions involved in Project implementation. Technical support is provided for Activity 1 to 5 above. Cost: \$2,742,000 (GEF)
Total Project Costs	\$65,430,600	\$71,793,400^b	\$6,362,800
Global Environmental Benefits	Biomass gas system and sustainable integrated farming remains undeveloped. Baseline 78,338 tons of carbon/year emitted from equivalent fossil fuel energy generation systems for heating and power.	Biomass systems and integrated farming are widely adopted and replicated due to information dissemination campaigns and marketing efforts. Financial, institutional, information, market, and technical skill barriers are removed. Assume 100 % of the energy generated will replace fossil fuels, alternative carbon emission = 0 tons of carbon emissions per year.	GHG emission reduction is fully obtained. Direct carbon emission reduction of 78,338 tons/year and over 1 million tons over the lifetime of the biomass-based renewable energy systems.
Domestic Benefits	Local and regional air pollution from burning coal and biomass on-field as well as indoor pollution is getting worse. Liquid wastes are discharged without treatment into waterways thus polluting the environment.	Significant air pollution reduction in the project provinces. Pollution from liquid effluents from livestock and households is reduced. Market for biomass gas and integrated farming grows through demonstrations under the project. Environmental regulations and policies are enforced.	Public health will benefit from better air quality and environmental conditions, obtained by the removal of the barriers that allow for the implementation of a large number of biogas units. Acid rain will be mitigated. Water supplies will meet a higher standard (surface and groundwater).
Summary of Costs	ADB: \$33,118,100 Government: \$23,591,900 Beneficiaries: \$14,198,900	Total Project Cost: \$77,271,700	Total Incremental Cost: \$6,362,800 (GEF)

^a The baseline comprises ADB and Government activities. Alternative includes baseline as well as incremental barrier removal activities to be financed by GEF.

^b Excluding interest charges and project preparatory cost totaling \$5,478,400.

**Independent Technical Review of the
Proposed Efficient Utilization of Agricultural Waste Project
by STAP Consultant Dr. Hu Tao and Response to STAP Review**

1 Basic review of the Project

1. General speaking, it's an excellent Project with great innovativeness. It's the first time in China to have such an integrated Project related to climate change, rural development, poverty alleviation, rural environmental protection as well as other wide significances. Hopefully, the following comments and suggestions would be helpful to improve the Project design better.

1.1 Scientific and technical soundness of the Project

2. Type 1 and 2 technologies could be traced back to thousand years ago in China's history. The farmers in history used to integrate fertilizer, feeding materials and fuel together by a biogas digester. Technically these are indigent technologies of China and shouldn't have any problems. Only two issues should be paid attentions:

- Technical services should be provided for farmers after establishment of the biogas digestion pond. Otherwise, some of them may loss their functions due to careless maintenance and operation by uneducated farmers.
- Some new technologies and new materials could be used to improve the efficiencies of the technologies, such as a pump for the biogas digestion pond, high quality plastic for biogas pipeline, high quality glass with the function of absorbing solar energy for greenhouse, special boiler or cooking machine for biogas to improve its energy efficiency, a simple CPU to control the biogas pond etc.

3. For type 3, for China it maybe a new technology, but it's definitely not a new technology for other developed countries. For example, there is a very good system in the Netherlands and Denmark to produce biogas in pig farms. Even in Shanghai Jiaotong University, they also have developed the technology many years ago for pig farms in Shanghai City. So, the type 3 technology is the soundest technology, which can easily transfer to the 4 Project provinces.

4. For type 4, it just came out in recent decades in the world. Some other countries, such as Brazil, are also developing the system. China has made a lot of efforts on R&D of the technology. It's the time to apply for the R&D results. The technology also should be sound.

1.2 Identification of the global environmental benefits and/or drawbacks of the Project of the Project

5. The global environmental benefits of the Project, as described in the proposal, mainly are reduction of GHG emissions. However, the other two global issues I want to add here.

6. Biodiversity protection is another global benefit of the Project. Type 1, 2 and 4 technologies are all related to biogas production that could be used for cooking in households. If no such Project, one of the alternatives for households is to get fuel woods wherever they could

get - it will result in deforestation or degrade the forest. The consequence of it is to threaten wildlife in forests.

7. The fuel woods collection also results in desertification, although it has not been listed into the 4 focal areas of GEF so far. Desertification is one the consequence of deforestation. Desertification is becoming another global issue. The dust clouds could move to North America from China and Mongolia.

8. In summary, the Project not only results in significant carbon reduction, but also brings about substantial biodiversity protection, reforestation as well as anti-desertification.

1.3 How the Project fits within the context of the goals of the GEF, as well as its operational strategies, program priorities. GEF Council guidance and the provisions of the relevant conventions

9. The Project targets on the C reduction and is related to biodiversity as well as desertification, which are the goals of GEF.

10. The Project, as described in the proposal, is to directly focus on OP6 promoting and adoption of renewable energy by removing barriers and reducing implementation costs.

11. At the same time, I think the Project is also strongly linked to “integrated ecosystem management”, which was just issued recently as its OP12 of GEF. Because the Project is not only limited to reduce GHGs by promoting renewable energy but also has contributions to protecting biodiversity and combating desertification by ecosystem design. Type 1 and 2 as well as partly 3 and 4 are actually the artificial ecosystems to reach both economy and environmental targets.

12. As OP12 of GEF is currently being promoted in China, especially in western part of China. It might a good idea to set up the linkage to OP12 program in China.

1.4 Regional context

13. The places selected in the Project represent different types of national situations in China. Jiangxi and Hubei are two of rice production bases; Henan and Shanxi are two of wheat production bases. Beside, Shanxi is also the main coal production base. The situations in other provinces with rice or wheat are quite similar to these 4 Project provinces. Thus, the Project could demonstrate to other non-Project provinces that how to utilize the agriculture wastes by sound environmental ways. After the Project successfully implemented as demonstration of rural energy, it's easy for other provinces to follow up.

1.5 Replicability of the Project (added value for the global environmental beyond the Project itself)

14. The Project has not only the global benefits but also local economy benefits, environmental benefits and social benefits, as described in the proposal. It's really a win-win Project.

15. If there is a place with technical, economic and social similarities of the Project, the Project could be replicable there. Actually there are many places in China and the world that replicate the Project. So, the Project could be expanded to other provinces of China, especially

in the poor remote and mountain areas where they need more renewable energy. The Project also could be followed by other developing countries that have similar conditions with China, such as India, and Africa countries.

1.6 Sustainability of the Project

16. It is very important to continue the technologies practices after the ADB/GEF funded Project. Fortunately there are many channels existing now. Here the most important domestic programs at national level, which are related to the Project, are listed below.

- Ecological Agriculture County by MOA
- Greed food program by MOA
- Micro-financing by Poverty alleviation by PA Office of State Council and MOA
- Ecological Demonstration Area by SEPA
- Trans-century program by SEPA
- Sustainable Development strategy by SDPC/MOST
- 9th and 10th five year plan by SDPC
- New and renewable energy development by SETC
- Green accounting by State Statistics Bureau

17. WB/GEF and the Chinese government are also making a program “China Renewable energy scale-up program (CRESP).” There are also some bilateral cooperation Projects related to new and renewable issue. It also would be helpful to have some contacts with these organizations.

2 Special review of the Project for GEF

2.1 Linkages to other focal areas

18. There are 4 focal areas of GEF: global warming, biodiversity loss, Ozone layer depletion, and international waters. Desertification has been discussed for some time if it should be put into the focal areas of GEF.

19. For this Project, it is directly focusing on GHGs emission by promoting renewable energy. It also has indirect linkages with Biodiversity and Desertification. In the Project, the Type 1, 2 and 4 technologies are mainly concentrate on biogas/methane production that could be used for cooking, heating and lighting in rural areas. Without the Project, the traditional way for fuel energy in rural areas is to get fuel woods from forests. Cutting tress would result in deforestation or degrade the forest. The consequence is to threaten wildlife in forests and resulting in desertification. For example, in the area of the national panda reserve, poor farmers collect fuel woods around the area for cooking. It threatens the bamboo forest there and has a negative impact on panda – the most sensitive animal as an alive fossil. The traditional Chinese herbs medicines are getting less and nation-widely due to the deforestation.

20. The Project has no linkages with Ozone and international waters issues.

2.2 Linkages to other program and action plans at regional or sub-regional level

21. The Project has many linkages with other programs at both regional level, sub-regional level and national level.

22. At GEF level, it's linked to the following programs:

- Capacity building for the rapid commercialization of renewable energy
- Energy conservation and pollution control in Township and Village Enterprises industries
- Issues and Options in Greenhouse Gas Emissions control
- Renewable energy development

23. At national level, it's linked to the following programs:

- Sustainable Development strategy and Agenda 21 of China by SDPC/MOST
- The five year plan for economy and social development by SDPC
- Ecological Agriculture County by MOA
- Greed food program by MOA and Organic food by SEPA
- Micro-financing by Poverty alleviation by PA Office of State Council and MOA
- Ecological Demonstration Area by SEPA
- Trans-century program by SEPA
- New and renewable energy development by SETC
- Green accounting by State Statistics Bureau
- Bilateral environment and energy cooperation with other countries by MOFTEC/MOST

24. The Project also has several linkages with World Bank and Asian Development Bank.

2.3 Other beneficial or damaging environmental effects

25. The Project can gain other national environmental benefits, beside for the benefits of protecting biodiversity and combating desertification mentioned above.

26. Reduction of wastewater pressure on water bodies is one of the local environmental benefits. If no such a Project to deal with crop straws by type 1, 2 and 4 technologies, one of the ways dealing with the crop straws for farmers is to develop a small size paper mill to produce pulp and paper. The wastewater from the small size paper mills is extremely bad for water quality in water bodies. It happened to Henan Province – one of the Project provinces - in Huaihe River several years ago. So, the Project actually could contribute to reduce the wastewater pressure on water bodies.

27. The Project can also contribute to improve air quality. Because if no such a Project to deal with crop straws by type 1, 2 and 4 technologies, one of the ways dealing with the crop straws for farmers is just to burn the straws in the open field. It's hard to regulate the farms, although SEPA and MOA have issued several regulations to control the situation. For example, due to the bad air quality by straws burning in the open field, the Shijiazhuang airport had to close down for over 48 hours two years ago, which is just located about several hundred kilometers away from Henan and Shanxi Provinces.

28. Of course, the Project also could improve the indoor air quality for households, especially for women's health. It has been mentioned in the proposal.

29. The above local environmental benefits, by terminology of GEF, should be called ancillary benefit or secondary benefit or co-benefit. It means when a Project targets on GHGs reduction, the Project also gains local environmental benefit.

30. General speaking, the Project can achieve the following environmental benefits:

- Local water benefit
- Local air ambient benefit
- Local indoor benefit
- Biodiversity
- Soil erosion
- Wind erosion
- Land degradation

2.4 Degree of involvement of stakeholder in the Project

31. There are many stakeholders involved in the Project at different degrees and scales:

- ADB: loan lender for the Project
- GEF: grant provider of Project for global environmental benefits
- MOA: playing a role as coordinator for 4 provinces
- MOF: playing a role as national focal point
- The 4 provinces: the Project implementing organizers
- SEPA: taking the environmental responsibility at national level
- PA office, MOST/SDPC, SETC, MOFTEC: all related to the sustainability of Project
- Country governments: playing a key role of organizing the farmers to implement the Project, but they are more interested in profits and reputations than environment
- Peasants/farmers/owners of gasification/pig farms: playing a critical role of the Project implementation, who are profits/benefits-driven.

32. For different stakeholders, they play different roles and have their own niches in the Project system. The most difficult, critical and sensitive stakeholders for the Project implementation, I think, are the county governments and Peasants/farmers/owners of gasification/pig farms. They are the real implementers. To keep their interests is the key to carry out the Project.

2.5 Capacity building aspects

33. The Project would definitely helpful for capacity building of the 4 provinces as well as MOA, SEPA etc in the following aspects except for the contents mentioned in the Project proposal:

- To learn how to manage the Project, especial at the county level. The local county Projects normally have very low efficiency and corruption problems.
- To learn how to value the environment and integrate environment value into economy.
- To strengthen the environmental management in rural area. So far, environmental management in rural area is very weak, few staff, little budget, and less equipped.

34. Personally I think the capacity building contribution is even more important than the financing support from ADB/GEF. China could find money to support the Project but don't have capability to manage the Project.

2.6 Innovativeness of the Project.

35. I found several innovativeness contained in the design of the Project:

- Integration: it's the first time in China to have such an integrated Project combining GHGs emission, local environmental benefits, poverty alleviation, employment, and local economy development as well as other social aspects.
- Promotion: there are several existing programs in China related to rural renewable energy issue. This Project could help the ministries and provinces related to the Project to promote the renewable energy.
- Marketing for the indigent renewable energy technology of China: as mentioned at the beginning, biogas digester is an indigent technology in China. How could we let it work widely and practice them under new modern market economy? The Project is trying to overcome the barriers to develop them.
- Paying higher attentions on rural energy: the rural energy as well as related climate change issue is not paid higher attention by China's authorities due to its current energy proportion in the whole energy structure. However, it's one of the most fast growing energy consumption sectors because of such a huge base of nearly 1 billion populations in rural area. The success of Project would change the priority of rural energy in China.

3 Critical points

3.1 The proposal's global priority in the area of the Chinese climate change mitigation under OP6

36. The highest priority of climate change for China is energy efficiency improving and energy saving. In the area of OP6, China's priority is mainly in industry sector, such as the new wind farms development, solar promotion, biogas in factors. The rural energy is paid attention but not as high as it should be. As mentioned above, the rural energy as well as related climate change issue takes up a small proportion in the whole energy structure. However, it's one of the most fast growing energy consumption sectors because of its huge base of nearly 1 billion populations in rural area. This Project strengthens the priority of rural energy in China.

3.2 It's cost-effectiveness in achieving climate change / OP6 objectives

37. It seems the proposed Project has demonstrated that the Project results will be achieved by the mot least cost manners in achieving carbon reduction targets. In order to further demonstrate its cost-effectiveness, it might be appropriate for the Project to derive the indices of cost-effectiveness for carbon reduction under different scenarios.

38. It would be clearer to have an estimation of the ratios of cost-effectiveness for different technologies of using agriculture waste related to the Project. According the values of result, the ratios could be ranked. Obviously, the highest vale of ratio is most cost-effective one. Based on the estimation results, it also could be done a comparison analysis between the Project proposed technologies and the others.

3.3 The adequacy of Project design

39. The Project has been designed well. Still I have several points to add for comments and suggestions:

- Financial and Economic feasibility

40. According to the proposal, the FIRR of Project seem high. Based on my own experiences in China's rural area, personally I think the FIRR may not be that high, at least for the involvement of disadvantaged households it shouldn't be as high as the figures mentioned in the Project proposal.

41. Normally, for environmental Projects, they have good environmental benefits, but may or may not have good economic benefits. It really depends the economic conditions, such as geographic locations, ability of accession to energy market, environmental regulations and enforcement. For those ecological agriculture models that have good economic benefits (for example, IRR is higher than 6%, the lending rate of banks), market would drive the commercial banks, farmers, wholesale and retailers to be automatically involved into the process by market force without government's intervention. Government bodies just help them to solve the loan financial problems to promote the Projects, as Chinese government is going this Project. For those ecological agriculture models that have not good economic benefits (for example, the IRR is less than 5%), market would work too. No commercial banks would like to lend the loans to farmers and no wholesale and retailers would be involved into the process to earn money, if there is still without government intervention.

- Policy reform

42. Following discussion on the financial and economic feasibility of the Project, government intervention and policy reform could change the economic conditions to let the Project financially feasible. That also means policy reform could increase the IRR of Project for the farmers.

43. For example, in China farmers should pay a so-called special agriculture product tax when selling the products. Here special agriculture product means non-crop or non-grain products, such as vegetables type 1 and fruits in type 2. However, this tax is a barrier to develop ecological agriculture and implement the Project. If this tax policy could be reformed, it would be very helpful for implementing the Project as well as developing the renewable energy.

44. The core of policy reforming is to internalize the environmental cost of behaves by farmers in rural areas.

- Coal price as well as other alternative energy price

45. To develop the renewable energy in rural area, there is a big strong competitor – coal (and maybe some other alternative energies). If the coal cheaper enough, why should farmers to develop the technology 1, 2, 3 and 4 to use biogas under market mechanism? For example, in Dazu County, Chongqing City, the local farmers only at mountain regions use biogas but the farmers around plain town areas.

46. Coal price as well as the other alternative energy prices is the critical factor that should be ignored in the Project design.

- China's accession to WTO

47. China's accession to WTO will change China's economy structure and energy structure by trading and FDI. These will change energy price, crop production and labor price, which are key factors for the Project. It's necessary to have a risk analysis of these factors to the Project.

3.4 The feasibility of implementation and operation and maintenance

- Technical feasibility

48. The four types technologies should be sound enough, especially for type 3. For other types, it also should be feasible and it would be better if adapting some new technologies and providing technical services.

- Economic and Financial feasibility

49. The FIRR's are high enough based on the Project proposal. Thus, it also should be no problem in the aspects of economic and financial feasibilities. For a few of households, it would be a problem when they couldn't get enough benefits expected by them, unless they could be supported by reformed government policies.

- Management feasibility

50. Based on the experiences of ADB and WB Projects in China, management feasibility should not be a problem.

51. There is only a small issue I noticed and need to pay attention on it. I found there are no any budgets for central government organizations in this Project. Will they do the work free? If they will be paid by central government, where are the budgets? If they could combine their daily work with the Project together, how much energy they will use on this Project without an earmarked budget? Will they charge the 4 provinces a small proportion as service fee?

52. General speaking, the feasibility of implementation, operation and maintenance should be adequate for the Project.

4 Response to STAP Review

4.1 Major Comments

53. The STAP Review given above is very positive and encouraging. One issue raised is to ensure sustainable technical service to biogas operators. The Project design has provided special technical and management support (activities I to VI) to strengthen service infrastructure and personnel along with incentives for continued operation of the biogas digesters, especially among the small farm households. Another issue raised is the need to ensure that new technologies and materials are available to improve efficiencies of the biomass technology. This aspect is important and the Project design has adequately provided assistance for significant technical support as well as funding (fellowships, etc.) for research and development of biomass technology. This will ensure the availability of newer technologies and materials for biomass technology adoption.

4.2 Minor Issues

54. In paras 11 and 12 (Section 1.3), the Review states that the Project is also strongly linked to “integrated ecosystem management” which is related to OP 12 of GEF. This is true as the overall benefits will not only result in reduction of GHG but also contribute to eco-farming development and protecting the biodiversity.

55. The Review also commented that the Project has significant and good prospective for replication in other parts of China. Replication activities included in the Project design are study tours, demonstrations farms, exchange visits to other provinces, exchange programs to be formulated by Ministry of Agriculture for nationwide implementation, technical, and scientific seminars and workshops on BIORETS, etc.

56. Para 32 of the Review suggested that there is a need to maintain the interest of the implementers (such as government officials, farmers, and entrepreneurs). This is an important issue to sustain the BIORETS development. The Project has provided budget to local universities and research institutes to sustain technical research activities and continue to improve the BIORETS technologies leading to higher productivity and income. Research fellowships are also given to postgraduate students and researchers for this purpose.

57. Para 40 of STAP Review indicated that the FIRR of the Project seemed high. In the Project FIRR analysis, the FIRRs for Type I to Type IV investments are respectively 16.3%, 15.1%, 14.5%, and 12.0%. For the Project as a whole, it is 15.1%. Such an FIRR could be high in the 1980s but with the advancements in biomass technologies in 1990s, these FIRRs are appropriate and correct.

58. Para 45 of STAP Review queried that if coal is cheap, why should farmers want to invest in Type 1, 2, 3, and 4 technologies to produce biogas. The Project is not simply investing in Type 1, 2, 3, and 4 technologies to produce biogas, it is an integrated approach combining biogas with farm production. Thus, biogas price is not the only element that determine farmer’s decision to invest. The increase in farm productivity by using organic fertilizers from the digesters, by using greenhouse to grow crops throughout the year, cleaner environment through the use of biogas for cooking and lighting, etc. These elements of benefits outweigh the cheaper coal or alternative energy prices.

59. As for para 50 comment, it is confirmed that the Central Government provides counterpart budget through the Ministry of Agriculture, provincial governments, and the agencies such as the Poverty Alleviation Office and SEPA.

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MOF

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June 27, 2001

Mr. Nassim Ahmad
GEF Facilitator, OESD
Asian Development Bank
Fax: (632) 636-12195

China: Endorsement Letter for GEF Project

**Removing Barriers to the Expansion of Biomass-Based
Renewable Energy Technology Systems Utilizing Agricultural Wastes**

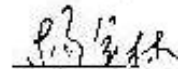
This is to advise you that Ministry of Finance, as the GEF Focal Point for China, would like to endorse the captioned project to be submitted by ADB for GEF support.

This project reflects the priority of the Chinese government in its energy conservation. It has a positive linkage to the poverty reduction with full consideration of reducing GHG emission through a well-designed integrated farming model.

I believe that the project would not only benefit the local people but also has great contribution to global environmental improvement. With the efforts of all participants, I am hoping to see this project be a great success.

Best regards.

Sincerely yours,



(Jinlin Yang)

Operational Focal Point for China

ASIAN DEVELOPMENT BANK

PRC: XXXXX

**REPORT AND RECOMMENDATION
OF THE
PRESIDENT
TO THE
BOARD OF DIRECTORS
ON A PROPOSED LOAN
TO THE
PEOPLE'S REPUBLIC OF CHINA
FOR THE
EFFICIENT UTILIZATION OF AGRICULTURAL WASTES PROJECT**

October 2001

CURRENCY EQUIVALENTS

(as of 1 July 2001)

Currency Unit	–	Yuan (Y)
Y1.00	=	\$0.12
\$1.00	=	Y8.27

The exchange rate of the Yuan is determined under a floating exchange rate system. In this report, a rate of \$1.00 = Y8.27, the rate prevailing at the time of appraisal of the Project, has been used.

ABBREVIATIONS

ADB	–	Asian Development Bank
CO ₂	–	Carbon Dioxide
DDP	–	Department of Development Planning
DRER	–	Department of Research, Education and Rural Environment
EIA	–	Environment Impact Assessment
FECC	–	Foreign Economic Cooperation Center
GEF	–	Global Environmental Facility
GHG	–	global greenhouse gas
IREDP	–	Integrated Rural Energy Development
MMS	–	mandated market share
NGO	–	nongovernment organization
PPMS	–	Project Performance Management System
PRC	–	People's Republic of China
PV	–	photovoltaic
SEPA	–	State Environment Protection Administration
SO ₂	–	sulphur dioxide
TFP	–	Tenth Five-Year Plan
TSP	–	total suspended particulates
TVE	–	township and village enterprise

WEIGHTS AND MEASURES

gw	–	gigawatts
ha	–	hectare
km ²	–	square kilometer
m ³	–	cubic meter
mu	–	15 mu equivalent to 1 ha
mw	–	megawatts
tce	–	total coal equivalent
t	–	metric ton

NOTES

- (i) The fiscal year (FY) of the Government ends on 31 December.
- (ii) In this report, "\$" refers to US dollars.

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LOAN AND PROJECT SUMMARY

Borrower	People's Republic of China (PRC)
Project Description	<p>The Project will overcome barriers and constraints leading to widespread promotion and adoption of biomass-based renewable energy systems. It will improve the environment and promote economic growth in rural areas of Jiangxi, Hubei, Henan, and Shanxi Provinces. The Project will provide funding support to small household farms through the development of an integrated farm production system by expanding vegetable and fruit production and establishing on-farm biogas digesters and biomass gasification plants to generate clean renewable energy. Agricultural wastes from both crops and animals will fuel the biogas digesters and biomass gasification plants. These activities will reduce greenhouse emissions, improve environment, increase household incomes and reduce poverty in the rural areas. Technical support and training will be provided to promote and improve biomass technology and to establish adequate service infrastructure to ensure sustainability and biomass system development in the rural areas. Special efforts will be taken to ensure poor and disadvantaged farmers and women participate in all aspects of Project activities.</p>
Classification	<p>Poverty Intervention: (PI)</p> <p>Proportion of poor among the Project beneficiaries will be about 26 percent which is higher than the estimated 12 percent poor for the overall population in PRC.</p> <p>Thematic: Environment Protection</p> <p>Environmental benefits of the Project will include reduction of CO₂, SO₂ emissions; non-point pollution from intensive livestock production; decrease exploitation of forests for fuelwood. Benefits also include improvement in health of the rural population and increase forest and vegetative coverage of non-productive lands with fruit trees.</p>
Environmental Assessment	Category B. An Initial Environment Examination (IEE) was undertaken and the summary initial environmental evaluation (SIEE) was prepared.
Rationale	<p>There are opportunities to improve PRC's environment through promotion and adoption of sustainable biomass technology for efficient utilization of agricultural wastes to generate cleaner biomass energy. This will also lead to improved natural resource management at the farm level generating benefits for the rural households, the environment, and the economy. At present, large quantities of agricultural wastes are disposed off inappropriately (e.g., burning of large quantity of crop residues in the open field or discharge of animal wastes polluting streams and groundwater). This is not only harmful for the environment, but constitutes a loss of potential energy and nutrient resources that could add value to integrated farming systems, reduce farm input costs, and provide opportunities for integrated pest management and organic farming techniques. Development of a clean energy source like biogas</p>

digesters would reduce dependence in poor households on coal and firewood for heating and cooking, promoting better living environment, improved health from reduced air pollution, and less stress on forest resources. An integrated agricultural production system with biomass technology has proven to be an effective means to generate cleaner renewable energy for environment improvement as well as to improve the quantity and quality of farm outputs. However, biomass technology is facing numerous constraints and barriers for mass adoption, particularly in rural areas. These barriers include shortage of credit facilities, weak institution and technical expertise, inadequate service infrastructure, lack of environmental awareness, and few policy incentives. Farmers are facing constraints in obtaining access to credit for the adoption of biomass-based renewable energy systems to integrate with the existing farming practice. Current interest rates in PRC are set at levels below market rates, creating excess demand within which rural investments have received a low priority. As a consequence, farmers can not access longer term loans with the grace period necessary for rural capital investments that require time to generate a positive cash flow. The commercial financial institutions and banks are not certain on the viability of biogas system and do not provide longer-term credit to large number of small farmers. This Project will overcome major constraints and barriers. It represents a major effort to promote renewable energy generation to improve the environment, enhance the quality and quantity of agricultural production, and improve the health and income of rural farmers. It will also serve as a demonstration Project showing its feasibility and profitability through the adoption of biomass technology as well as promoting private entrepreneurs to participate in larger scale biomass technology for biogas production. Private sector service technicians and facilities will be enhanced to ensure sustainability of the biogas technology adoption.

Objective and Scope

The Project's objectives are to improve the environment and to promote economic growth to improve welfare and living conditions of rural households by generating cleaner biomass energy and increasing agricultural productivity through efficient utilization of agricultural wastes. The Project has six components:

- I. **Funding for Renewable Energy Generation and Eco-Environment Development:** This component will develop a viable and sustainable and replicable financing model and organize and provide credit through subloans to rural households as well as to medium scale enterprises for the adoption of biomass-based renewable energy systems integrated with existing farming practices. The biomass technology will produce cleaner biogas for cooking and lighting as well as to improve and increase farm produce. The component will ensure efficient management of Project loans for rehabilitating and constructing 15,600 units of small scale farms incorporating with biogas digesters and 42 units of medium scale biogas and gasification plants.

- II. **Improve Mechanisms for Transferring Biomass Technology:** This component will address technical barriers for biomass technology adoption through provision of training to biogas contractors and technicians as well as Project beneficiaries to acquire biomass technology for biogas production. The component will also help to strengthen private service sector for operation and maintenance (O&M) of farmers biogas digesters, including access to spare parts, to ensure sustainability of biomass technology adoption. Workshops, study tours, and fellowships will be provided to help in the transfer of biomass technology. Project officials and private sector businesses will be trained in key aspects of biomass systems including provision of extension services, establishment of effective service and marketing industries, development of pricing policy for Project outputs and O&M that integrate biomass technology adoption with farming system operation to ensure sustainability and replicability.
- III. **Rehabilitate Farmers Selected Farm-to-Market Facilities:** This component will rehabilitate rural roads and bridges to link the agricultural production areas to the urban markets. It will help to increase access to markets, provide extension of services and O&M, reduce transportation costs, and lessen damage to vegetable outputs faced by small and poor farmers in the disadvantaged areas. The farm-to-market facilities will strengthen service infrastructure and provide better and easier access of technical specialists and provision of spare parts necessary for the sustainable O&M of biogas digesters and gasification plants.
- IV. **Improve Environment Policy Implementation and Awareness:** This component will help to remove the institutional barriers to promote and expand biomass technology adoption for environment improvement and public awareness. It will provide technical support to assist the four provincial governments in removing barriers for environment improvement as well as to provide environment monitoring facilities to assure high environment standards for air, water, soil, and other elements and to highlight beneficial environment impact. The Project will focus on four environment support elements: (i) creating a receptive environment through the application of a comprehensive public awareness campaign on the Project goals and activities; (ii) monitoring the impact of the Project on the environment to highlight positive impacts from cleaner energy source; (iii) enabling the farmers to become green food producers associated with biomass technology adoption; and (iv) facilitating biomass technology adoption by small poor farmers and private businesses.

- V. **Pilot Poverty-Focused Approaches for Biomass Development:** This component will remove constraints to participation by large numbers of poor farmers in rural areas. There are significant numbers of poor living in rural areas. The poor use coal and firewood that contribute to significant environment degradation and greenhouse gas emissions. This component will provide specially designed training programs and biomass development assistance to the poor to enable them to adopt the integrated agricultural production with biomass system for cleaner energy production. It will serve as a demonstration model for government agencies (such as Poverty Alleviation Office) to replicate in larger scale for further poverty reduction in other rural areas.
- VI. **Improve Project Implementation and Capacity Development:** This component will provide consulting services to strengthen technical support and coordination, and to improve the capability of the implementation agencies. It will strengthen their institutional capacity to manage and supervise Project activities which are essential to ensure sustainability and replicability of biomass technology adoption.

Cost Estimates The total Project cost is estimated at \$77.3 million equivalent, of which \$36.3 million is the foreign exchange cost and \$41.0 million equivalent is the local cost.

Financing Plan (\$ million)

Source	Foreign Exchange	Local Currency	Total	Percent
ADB	33.12	0.00	33.12	43
National and Provincial Governments	1.10	22.49	23.59	31
Beneficiaries	0.00	14.20	14.20	18
GEF	2.05	4.31	6.36	8
Total	36.27	41.00	77.27	100

Loan Amount And Terms A loan of \$33.1 million from ADB's ordinary capital resources will be provided under ADB's LIBOR-based lending facility. The loan will have a 25-year term, including a grace period of 5 years, an interest rate determined in accordance with ADB's LIBOR-based fixed lending facility, a commitment fee of 0.75 percent per annum, a front-end fee of 1.0 percent, conversion options that may be exercised in accordance with the terms of the loan agreement, the loan regulations, and ADB's Conversion Guidelines, and such other terms and conditions set forth in the draft loan agreement. GEF is envisaged to provide a grant of \$6.4 million to finance consulting services for Project implementation and the assistance for barrier removal and institutional strengthening. The GEF grant will be administered by ADB.

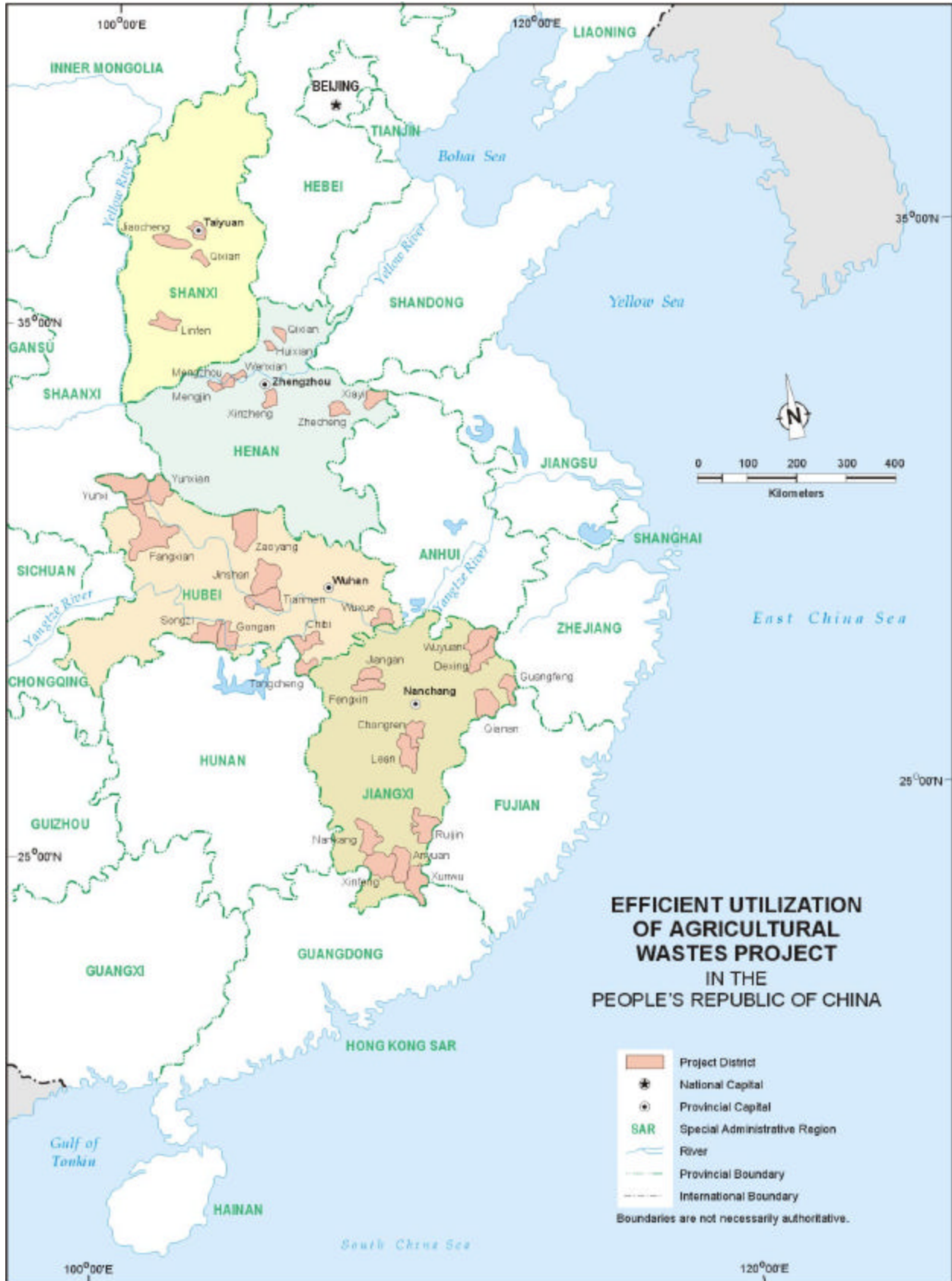
Allocation and Lending Terms	The Ministry of Finance will relend the ADB loan under the same terms and conditions to the four provincial governments of Jiangxi, Hubei, Henan, and Shanxi. The provincial Finance Departments will onlend the funds to municipal and county finance bureaus under the same terms and conditions. End users (farmers and private enterprises) will receive loan funds from the relevant finance bureaus at an interest rate not less than commercial bank rates, under repayment terms based on profitability and cash-flow projections.
Period of Utilization	Until 30 June 2007
Executing Agency	Ministry of Agriculture (MOA) through its Foreign Economic Cooperation Center (FECC) at the national level, and the provincial governments of Henan, Hubei, Jiangxi, and Shanxi, through their Department of Agriculture at the provincial level.
Implementing Agencies	The Project Management Office (PMO) at MOA, the Project Implementation Offices (PIO) of Jiangxi, Hubei, Henan and Shanxi will implement the Project in conjunction with relevant technical agencies in the municipal, county and township levels. The PMO Director will have the overall responsibility for Project implementation.
Implementation Arrangements	A National Project Coordination Committee based at PMO in Beijing will provide guidance to the four Project provinces on all aspects of policies, implementation, and resolving issues beyond the control of provincial governments. At the national level, the PMO is established at FECC for overall Project management, coordination, training, and other implementation and monitoring activities. At the provincial level, a Provincial Leading Group is established to provide guidance on field level implementation, review and approve plans, source counterpart funding, inter-sectoral coordination, and assist in solving implementation issues at the field level. A Project Implementation Office (PIO) is established at the Provincial Department of Agriculture in each province to oversee the activities of Project Implementation Units (PIUs) is established at municipal or county agriculture bureaus to supervise and implement subproject activities in conjunction with relevant technical agencies and NGOs.
Procurement	Goods and services financed by ADB loan and GEF grant will be procured in accordance with ADB's <i>Guidelines for Procurement</i> . Each contract estimated to cost \$100,000 or more, but less than \$500,000, will be awarded through international shopping (IS). Contracts for less than \$100,000 will be by direct purchase. Civil works contracts are relatively small relating to construction of greenhouses and biogas digesters which may be carried out through force account, or through contracts awarded to village teams or farm contractors where suitable.

**Estimated
Project
Completion Date**

31 December 2006

**Project Benefits
and Beneficiaries**

The Project will result in positive environmental impacts (globally, nationally, and locally) and will benefit about 34,080 households living in about 150 villages; either as operators in the case of the smaller biogas digesters incorporated within farming systems or as consumers of gas from medium scale biogas and gasification plants. The potential global environmental benefits will be the carbon dioxide emission reduction of about 78,338 tons per annum and over a million tons over the lifetime of the biomass-based renewable energy systems. Health benefits are expected to result from cleaner cooking conditions using biogas or producer gas. The need to collect firewood from forests will be eliminated thus relieving significant pressure on forest regeneration. The incomes of about 9,000 poor farm households will be lifted above poverty line. There will be substantial indirect and multiplier benefits for others, including increased employment opportunities. Annual incomes for households adopting the integrated farming biomass system which incorporate biogas digesters are expected to increase by Y4,013 (\$485) for traditional farmers moving to full adoption of the type I system. Households adopting the southern small-scale farming system type II (3 in 1 orchard system) will achieve a higher incremental annual income of Y14,254 (\$1,724) when their citrus orchards come to full production at about year 10. Financial returns from medium-scale biogas plants (type III) are expected to be about 15.9 percent. Owners of gasification plants (type IV) should achieve returns of about 13.8 percent on their investment. The EIRR for the Project as a whole is 18.2 percent. About 26 percent of the beneficiaries or 9,000 households will be from the low-income groups. They will be provided with a special support to make it possible to eliminate socio-economic barriers that currently would prevent them from adopting the integrated biomass with farming system. The Project will produce an annual incremental output of about 882 tons of greenhouse vegetables which are all organic production, about 209,280 tons of citrus fruits, and 289,780 heads of pigs. The Project will utilize over a million tons of agricultural wastes per year which would otherwise contaminate the soil and river/water systems, and provide over 600,000 tons of sludge and effluent as farm organic fertilizer.



I. THE PROPOSAL

1. I submit for your approval the following Report and Recommendation on a proposed loan to the People's Republic of China (PRC); and the proposed administration by the Asian Development Bank (ADB) of a grant from the Global Environment Facility (GEF) for the Efficient Utilization of Agricultural Wastes Project.

II. INTRODUCTION

2. Moving into the new millennium, the Government of People's Republic of China (PRC) is facing the daunting task of increasing agricultural productivity and reversing the environmental degradation caused by decades of agricultural intensification. Increasing rural productivity to bring about both food security and poverty reduction in rural areas is a critical issue for PRC, which feeds 22 percent of the world's population on 7 percent of world's arable land. Few opportunities exist in PRC for expanding arable land. Increased farm productivity remains the key to meeting future demand. Associated with the need to significantly raise farm productivity is the need to reduce the rural-urban income gap through an intensive developmental effort to increase rural incomes thereby reducing poverty, particularly in the interior provinces.

3. The Government faces serious challenges in achieving high economic growth to alleviate poverty and in reversing the environmental degradation caused by rapid industrialization and agricultural intensification. Arable land in PRC is diminishing and new innovations are needed to bring about greater agricultural productivity to meet future demands. A number of poorer and mountainous inland provinces with limited arable land are promoting the use of greenhouses to intensify crop production and using biomass technologies to convert agricultural waste to provide clean energy and organic fertilizers. In 1999, the Government requested ADB to fund its first Efficient Utilization of Agricultural Wastes Project covering four inland provinces. A Feasibility study was carried out in July-December 2000 under an ADB project preparatory technical assistance.¹ The study examined resource availability and technical and economical feasibility of converting agricultural wastes (such as household wastes, crop straw, and other crop and animal wastes) into a clean source of energy for lighting, heating and cooking through integration into the farmers' agriculture production system of the farmers. The study also examined the feasibility of reducing chemical fertilizer usage in farm production to be replaced by organic fertilizer derived from the effluent of the biogas digesters. This would help improve soil nutrients, reduce input costs, and increase productivity. Following completion of the Project preparation and feasibility study in January 2001, a Fact-Finding Mission visited PRC in February 2001 to refine the Project design and discuss various Project issues with the national and provincial governments of Jiangxi, Hubei, Henan, and Shanxi. An Appraisal Mission conducted from 25 May to 16 June 2001² finalized the details of various Project components. The linkages between the policies, institutional framework, goal, purpose, outputs and physical investments of the Project are described in the Project Framework (Appendix 1). The Project's primary objective is the environment protection.

¹ TA 3370-PRC: *Efficient Utilization of Agricultural Wastes Project*, for \$703,000, approved on 26 December 1999.

² The Appraisal Mission comprised Y.L. Yee, Senior Project Economist/Mission Leader, Peng Xiaohua (Senior Counsel), Sujan Emma Yang (Senior Financial Management Specialist), J. Yang (Program Officer), Sununtar Setboonsarng (Poverty Specialist), Dingding Tang (Environment Specialist), and Jerome F. Sison (Staff Consultant).

III. BACKGROUND

A. Sector Description

1. The Agriculture and Rural Sector

4. Agriculture plays a major role in the economic development of PRC. It provides an important source of income directly or indirectly for about 240 million rural families that account for about 64 percent of the country's total population. The sector accounted for about 16 percent of PRC's gross domestic product in 2000. About 95 million hectares (ha) of PRC's land area of 960 million ha are cultivated. Until 1998, about half a million ha of arable land were annually converted from agriculture to industrial, infrastructure, and housing use. With ADB assistance, the Government amended the Land Administration Law in 1998 (para 61) to protect arable land and limit conversion to other uses to 160,000 ha per year, with an equivalent amount of degraded land converted to agricultural use. The pressure on land has resulted in farmers adopting various innovative and intensive ways of increasing farm productivity through a combination of intensive labor, chemicals, small machinery, irrigation, greenhouses, and other intensive and controlled production environments. Intensive farming has enabled the rural sector to meet the basic food requirements of the people but the challenges ahead for further productivity increases will require innovative solutions.

5. The economic reform programs that started in the late 1970s provided a good model to enable the rural sector to become more efficient and progressive. The most important aspect of the agriculture sector's reform program was the replacement of the commune system with a household contract responsibility system whereby plots of collectively owned land were subdivided and allocated to individual households for farm production. The households supplied the State with mandatory production quotas at fixed prices, with output above the quota allowed to be sold at market prices. Over the years, this household responsibility system has been gradually revised, including a gradual increase in State procurement prices, enlargement of farm plots, and extending fixed-term household contracts. Economic reforms also encouraged the establishment of township and village enterprises (TVE), which are now an important part of the industrial structure and a major source of nonfarm employment for the off-season surplus rural labor.

6. The reforms in the rural sector in the last two decades have resulted in an increase in agricultural productivity, increased agricultural production, improved terms of trade in agriculture, generated on-farm and off-farm employment, and promoted significant growth in agricultural output. During the initial years of reform, particularly in late 1970s and early 1980s, agricultural output grew at about 8.8 percent per annum. This growth slowed to about 3.8 percent in the early 1990s but in recent years, it has increased to about 4.6 percent per annum, well in excess of population growth of less than 1 percent. Livestock, fisheries and horticulture subsectors achieved the fastest growth rate of up to 10 percent per annum. The crop subsector, such as food grains, registered a lower rate of growth of about 1.7 percent per annum in the 1990s.

7. Whilst the reforms of the rural sector have resulted in significant increased output and higher incomes, the disparity between urban and rural income has grown. Early years of reform in the agriculture sector resulted in rural incomes increasing significantly and the ratio of urban to rural incomes fell from 2.3 in 1980 to 1.7 in 1984. From the mid 1980s, however, the urban-rural income disparity reversed its trend. The ratio increased to 2.8 in 2000, when the average per capita urban income was Y6,280 compared with Y2,253 in rural areas. The widening gap

between urban and rural incomes has provided opportunities and incentives for migration from rural to urban areas. About 100 million rural residents have migrated to the urban areas since the commencement of the reform process.

8. Another feature of PRC's development is that rapid growth during the last two decades has not been shared equally among the regions. The coastal regions have grown faster than the interior provinces. Interior regions have been disadvantaged by their relatively poorer access to investment funds, weak institutional capabilities, inadequate infrastructure and market linkages, and degraded environment. The interior provinces are also disadvantaged by relatively slower implementation of economic reforms, weaker institutional capacity and limited financial resources.

9. Rapid growth in per capita income has resulted in significant demand for meat products to satisfy the needs of the increasingly affluent urban population. This has resulted in rapid expansion of livestock production, particularly chicken and pig production. Total meat production in PRC increased from 25 million tons in 1990 to 61 million tons in 2000 and is expected to increase to over 100 million tons by 2010 as income and population increase. Livestock production has become an important component of rural farming systems. In 2000, there were about 200,000 TVEs and small private farms involved in livestock production. The number of medium to large-scale commercial pig production farms has increased significantly from less than 5,000 in the 1970s to over 16,000 in 2000. The amount of waste water discharged from each animal is about 20 liters per day. The effluent discharge from these pig farms is well in excess of a billion ton a year and less than 5 percent of this animal waste is being treated. Most of the wastes are discharged untreated into nearby rivers, lakes or other water bodies causing serious environmental and groundwater pollution. Output from pig production is forecast to increase by about 8 percent per year and pig wastes could increase to about 5 billion tons by 2010. Reducing the potential for groundwater contamination and other environmental problems resulting from livestock sector expansion is a challenging task. In the grain crops production, total grain production is expected to increase from about 407 million tons to about 499 million tons by 2005, or 23 percent increase in a decade. Such an increase in grains production will generate large quantities of straw that is normally burnt in the field under current farming practices, leading to further environmental degradation such as CO₂ release and haze.

2. The Environment Sector

10. As a consequence of rapid economic growth since the late 1970s, obsolete industrial technology, inappropriate pricing, and a lack of market based instruments to encourage environmentally friendly behavior, PRC is now faced with serious environmental problems. Severe air and water pollution and land degradation affect crop production and human health. The economic costs of environmental pollution in PRC were estimated to be about Y98.6 billion or about 4 percent of GDP in 1998.³ Air pollution accounted for about 59 percent of the total losses, with water pollution and solid waste accounting for the remaining 36 percent and 5 percent respectively. PRC relies heavily on coal as its primary fuel for industrial production, power generation, and commercial and residential applications such as heating and cooking. Because of this heavy dependence on coal, PRC now accounts for about a tenth of total global greenhouse gas (GHG) emissions and is the world's second largest producer of carbon dioxide (CO₂). The use of coal has resulted in the emission of high levels of sulfur dioxide (SO₂) and

³ Xia Guang, (1988). "An Estimate of the Economic Consequences of Environmental Pollution in China." Research Paper of Policy Research Center for Environment and Economy, State Environmental Protection Administration (SEPA).

total suspended particulates (TSP). In most PRC cities, air pollution exceeds environmental standards by several times. The high level of air pollution in densely populated cities of PRC causes severe health problems, particularly those related to respiratory illnesses. The economic losses due to high air pollution in PRC are difficult to estimate but the value could be very significant. For example, chronic pulmonary diseases linked to exposure to TSP are a leading cause of death among PRC urban residents.

11. The extensive use of coal has adverse ecological and human health impacts on the environment at all levels (globally, nationally, locally and the household). GHG emissions (measured in CO₂ equivalent) impacts on the rural sector in severe cases could include (i) worsening soil erosion; (ii) increasing loss of fertile soil and decreasing soil humidity; (iii) rising temperatures that can result in the earlier arrival and longer duration of insect pests and weeds; and (iv) changes in precipitation levels. These impacts mean lower crop yields and increased crop losses, and therefore (i) less agricultural products of poorer quality for sale; and (ii) less grain and grass for livestock, leading to livestock of lower quality and lower livestock production. With fewer and lower quality crops and livestock to sell while facing continuing declines in farm productivity, farm incomes will decrease. The resulting adverse impacts on the rural farm household will be severe, both economically and socially, particularly when taking into account that rural household income 2000 is only about 36 percent of urban household income. The rural agricultural sector is the keystone of the national economy. It provides food for the country's large population. About 64 percent of the total population or about 760 million people live in rural areas. Consequently, addressing GHG emissions is a fundamental for the economy.

12. In addition to CO₂ emissions from coal, rural agriculture is a major source of GHG emissions.⁴ These emissions include methane (CH₄) from the livestock sector and crop residues, and nitrogen oxide (N₂O) produced from fertilizers and field burning of crop residues. These emissions are predominantly due to poor farming practices and inefficient use of biomass resources (e.g., wood from forests, crop straw, organic wastes from animals and humans). About 100 million tons of crop residues are burnt in open fields every year. With the increase of agricultural production and the shift from traditional to commercial energy use by rural consumers, the quantity of unused crop residues has progressively increased. Enteric fermentation from livestock waste, a significant source of methane, is also on the increase. If the current practices to continue unabated, GHG emissions will continue increasing.

13. There are many causes for the high environmental pollution in PRC. The major one is the inefficiency in the utilization of energy, raw materials, liquid and solid wastes, and other resources in the production of goods and services. Another factor is the past practice of locating industrial enterprises in urban centers, and inadequate and inappropriate regulatory measures and pricing policies that did not provide adequate incentives for conservation and environment-friendly behavior or punitive measures for polluting the environment. Other factors are the use of obsolete technology, inadequate knowledge of available cleaner technology, low levels of environmental awareness, poor enterprise management, and the pursuit of profits without regard to the environment. The economic growth in PRC will continue to be rapid for the foreseeable future. This will result in further expansion of energy and raw material usage. Environment quality would further deteriorate unless production technologies and management standards are improved and alternative cleaner energy sources such as renewable energy from biomass, wind, water, and solar are promoted and increased throughout PRC.

⁴ For details, see ADB/GEF/UNDP. Asia Least-cost Greenhouse Gas Abatement Strategy – People's Republic of China. (ALGGAS) Oct. 1998. Table 1-1, p.5.

14. Since the early 1990s, the Government enacted a series of laws and regulations to strengthen environmental management. The State Environmental Protection Administration (SEPA) and other Government agencies were strengthened for more effective monitoring and implementation of environmental regulations. This, coupled with the growing awareness of environmental concerns among the civil society, has shown some positive results. The Government has created a conducive policy to improve environmental management involving command-and-control measures requiring enterprises to adopt appropriate technologies for efficient resource use and reduced pollution, and provided economic incentives for environment-friendly production processes. Some of the command-and-control measures included Environment Impact Assessments (EIAs), adoption of low-polluting environmental technologies, centralized waste treatment, adoption of technologies for renewable energy generation, and treatment of agricultural wastes. Many economic incentive policies and market-based instruments have also been implemented, including adjusting prices to create incentives for conservation, a pollution levy system, taxes on polluting inputs, tax rebates for environment-friendly measures adopted by enterprises, and a system of standards and permits for pollution monitoring and control. Although numerous environment control and incentive measures are in place, local governments below the provincial level do not always enforce these rules and regulations due to lack of funds and incentives and a perceived negative impact on the local economy. Thus, significant investment and stricter enforcement of the regulatory and monitoring functions are needed to resolve the environmental problems in PRC.

15. In response to the 1992 Earth Summit, PRC was the first developing country to adopt an Agenda 21 Program to integrate economic and social development by improving the efficiency of energy utilization, introducing environment-friendly technologies, and managing toxic and hazardous wastes. The Government is responding seriously to global environmental problems such as climate change. PRC has adopted the principles of “protection, conservation and rational use of resources and giving equal importance to exploitation and conservation... as well as the policy that whoever exploits the resources must conserve, whoever damages the resources must restore, whoever uses must compensate”.⁵ In response to PRC’s programs to develop the economy and protect the environment, ADB provided technical assistance to develop methodologies to (i) evaluate greenhouse gas emissions and outline options for policy implementation,⁶ (ii) evaluate possible options for more efficient capture and use of coalbed methane gas⁷ (iii) develop strategies to minimize SO₂ emissions that cause acid rain,⁸ and (iv) participate in regional activities relating to global warming and transboundary environmental cooperation in Northeast Asia.⁹

16. Another major initiative adopted by the PRC Government is the trading of pollution permits. This is an emerging market-based instrument that is receiving increasing attention for air quality management in the PRC. It provides opportunities for polluters to buy or sell permits for air emissions and effluent discharges to achieve compliance with environmental standards and to meet the legal and regulatory requirements. Such a market-based instrument plays an

⁵ Ministry of Agriculture, *Agriculture Action Plan for China’s Agenda 21*, p. 41.

⁶ TA 1690-PRC: *National Response Strategy for Global Climate Change*, for \$600,000, approved on 10 April 1992.

⁷ TA 3081-PRC: *Coalbed Methane Demonstration Project*, FOR \$600,000, approved on 1 October 1998.

⁸ TA 5528-REG: *Acid Rain and Emission Reduction in Asia*, for \$450,000, approved on 16 April 1993; and TA 5792-REG: *I Acid Rain and Emission Reduction in Asia, Phase II, I* for \$600,000, approved on 3 September 1996.

⁹ TA 5592-REG: *A Study of a Least-Cost Greenhouse Gas Abatement Strategy in Asia*, for \$8,237,000, approved on 4 August 1994; with supplementary TAs for \$492,000, approved on 10 September 1996, and for \$133,363, approved on 9 June 1998; TA 5695-REG: *Environment Cooperation in Northeast Asia*, for \$495,000, approved 1 August 1996; and TA 5865-REG: *Transboundary Environmental Cooperation in Northeast Asia*, for \$350,000, approved on 13 October 1999.

important role in helping the Government to improve the efficiency of pollution control and to provide incentives for improving the environment. The ADB is actively participating in promoting pollution permit trading in the Shanxi province.¹⁰

3. Renewable Energy Development

17. PRC is the second largest energy user in the world behind the USA. The dominant source of energy in PRC is derived from coal, which accounts for about 68 percent of total commercial energy production, followed by oil (21 percent), hydropower (8 percent), and natural gas (3 percent). Energy is a major source of greenhouse emissions and PRC accounts for about 10 percent of global greenhouse emissions from energy use. PRC's share will continue to grow as rapid rates of economic growth continue well into the next decade.

18. Renewable energy is an important component of PRC's long-term energy strategy for rural development. PRC's primary energy needs are still dependent on coal, even though the use of oil and natural gas has increased in recent years. The use of renewable energy technologies offers an environmentally sound source of energy, especially in the rural and remote areas. PRC's current renewable energy resources comprise small-scale hydropower, wind, biomass, solar and geothermal energy and are mostly used in rural areas. Renewable energy constitutes a major element of PRC's national development strategy. However, compared with the available potential, the PRC's renewable energy program is relatively small. By 2005, about 5 percent of the country's total energy consumption will come from renewable sources. Small-scale hydropower has been developed to commercial levels for decentralized rural use and currently totals about 18 gigawatts (GW). The installed capacity of wind-based power generation is about 350 megawatts (MW), solar photovoltaic (PV) energy about 40 MW, and geothermal energy about 30 MW. Biogas power systems currently account for only about 100 MW and are mainly used for cooking and some lighting and heating by individual farm household. Biogas is mainly produced by small scale individual farm households for their own use. In the case of large pig farms, medium scale biogas plants are constructed to produce biogas from the pig manure and the biogas are connected to pig farm employees' house or sold to nearby rural households. Biomass, i.e. fuel wood and crop residues, accounts for nearly a quarter of the country's energy supply, and about three quarters of energy consumed by rural households. PRC's total rural energy consumption in 1999 was about 600 million tons coal equivalent (TCE) with crop residue (mainly straw) accounting for about 18 percent and firewood 15 percent. As a result, deforestation is prevalent in some areas, contributing to soil erosion and flooding. The Government is addressing this problem by promoting efficient use of fuelwood, improving natural resource management, promoting afforestation, and providing rural households with access to electricity.

19. The rapid changes in household energy production, poor farming practices, and the underutilization of biomass surpluses exacerbates the problem of GHG emissions. Individually and in the aggregate, these activities contribute to air pollution which has adverse consequences on the environment and human health. Forested lands are reduced as a result of being used as a source of firewood and from clearing for new development. Current farming practices that include a reliance on inorganic fertilizers, inappropriate fertilizer applications, and uncontrolled discharges into rivers also represent serious threats to the regional environment.

20. To reduce continued reliance on coal as a source of energy, particularly in the rural areas, and to address the environmental problems associated with the energy sector, in 1995

¹⁰ TA 3325-PRC: *Shanxi Air Quality Improvement*, for \$700,000, approved on 7 December 1999.

the Government launched an important measure and adopted the New and Renewable Energy Development Program (1996-2010). This program aims at improving the efficiency of renewable energy technology applications, lowering production costs, enlarging the contribution of renewable energy to energy supply, and deriving environmental benefits by reducing air and water pollution.

21. The rural agricultural sector plays an important role in addressing GHG emissions. The implementation of biomass-based renewable energy technologies by rural farms and villages will have a direct impact on reducing GHG emissions. These rural farms and villages are: (i) improving and expanding agricultural and livestock production in the face of decreasing arable land, decreasing rural populations and increasing demand for quality farm products; (ii) increasing and redistributing rural incomes; (iii) improving rural health; and (iv) improving their household social conditions.

22. PRC has significant experience in developing biomass technology. The utilization of biomass technology is well known in PRC. Productivity from biomass digesters has increased by 50 percent since the mid-1980s. Since the 1960s, about 7.5 million biogas generation units have been built for energy production in rural areas. Many of the earlier units have been abandoned due to factors such as outdated technology, weak technical support and institutions for extension services, lack of service infrastructure and personnel and a phasing out of incentives for continued operation. In the less accessible rural areas, the lack of availability of spare parts for lighting and gas cookers was another major factor that limited the adoption and sustainability of biomass technology in the last three decades. The present situation of biogas technology development in rural areas is optimum for development intervention because (i) the Government is committed to institute policies and measures to protect the deteriorating environment in both the urban and rural areas; (ii) appropriate biomass technologies have improved significantly and suitable for small farmers' adoption; (iii) provincial governments commitment to promote and expand biomass technology adoption for production of green vegetables; (iv) improved service infrastructure making spare parts and accessories readily available; and (v) small farmers interest in adopting biomass technology to eliminate the use of coal and firewood and straw for heating and cooking and to produce higher quality green vegetables. The major lessons learned were the need (i) to integrate biomass technology with existing farming system to ensure viability; (ii) for effective service infrastructure and competent technicians to provide operation and maintenance services; (iii) for sufficient concentration of biogas units in one location covering a few nearby villages to ensure sufficient demand for service; and (v) to ensure effective extension services and competent technicians to assist continued biomass technology development. Since the mid 1990s, special emphasis was given to developing efficient biogas digesters integrated into the existing farming system for small farm households. The integration aims to combine environmental and economic benefits within a rural farming system that provide biogas for cooking, heating, and lighting for farm households and increase agriculture and livestock productivity. The development of biogas energy can use the availability of large amount of biomass resources in the rural areas. The biomass resources include processing residues and crop straw, organic wastes from livestock production, particularly chickens and pigs, and agro-industrial wastes. PRC produces over 10 billion tons of agricultural wastes per year. Inappropriate disposal contributes to environmental pollution through air and ground water pollution. For efficient utilization of agricultural wastes, projects must be designed to incorporate lessons learned from the past to overcome key barriers that restrict broader application of biogas technology development. The barriers for biomass technology adoption in the four Project provinces are discussed in para 30.

4. Agriculture and Renewable Energy Development in the Four Project Provinces

23. The middle and lower reaches of the Yellow River (Huanghe) and the Yangtze (Changjiang) River basins are the regions where PRC's agricultural civilization started 5,000-7,000 years ago. The four Project provinces, Jiangxi, Hubei, Henan and Shanxi provinces, represent a typical sample of PRC's oldest farming areas (see Map). With the Huai River as a demarcation (close to Latitude 32°), Jiangxi and Hubei provinces are located in the southern subtropical zone while Henan and Shanxi belong to the northern temperate zone. In the southern subtropical zone, agriculture is characterized by paddy rice while the northern provinces are characterized by wheat production. These two crops constitute the staple food for the people in the south and north respectively, and in many aspects determine the patterns of local farming systems and customs. Highlights of agriculture in each province are given in Table 1. Details are given in Appendix 2.

24. The use of renewable energy technologies offers an environmentally sound and least-cost option to replace coal, firewood, and straw in the rural and remote areas. Pilot programs encouraging rural households to adopt the biomass technology have shown highly satisfactory results. Biogas generation from small-scale digesters is becoming popular in the four Project provinces and more villagers have indicated their willingness during consultations with beneficiaries during Project preparation to adopt the technologies. The provincial governments are emphasizing the development of an integrated farming system incorporating biomass technologies to generate cleaner biogas for lighting and cooking and organic fertilizer for farming. Local governments are encouraging rural farm households to build biogas digesters integrated into their farming systems to reduce the need to use firewood, coal, and burning of crop straw in the field. These programs should improve the environment and raise farmers living conditions. Land used for biogas digester construction is normally exempted from tax.

25. Jiangxi Province has pioneered an integrated farming with a biomass system called the 3-in-1 model (see Supplementary Appendix A for details) incorporating pig-digester-orchard (alternatively the orchard can be substituted by either vegetables, cotton, or fish). This biomass technology is well accepted among farmers. During the early biomass technology development phase, the provincial government supported about 555,000 farm households or 8 percent of rural households to establish their own integrated farming with biomass system. The Government also supported 54 medium-scale biogas plants producing gas for 10,000 farm households. The provincial government is promoting the use of biomass technology to help improve the living standard of the farmers and to improve the environment by utilizing agricultural wastes and production of biogas as a cleaner energy source for the farmers.

26. Rural energy development in Hubei includes developing renewable energy in the form of biomass, solar, wind, geothermal, and mini-hydropower. The provincial government encourages the integration of biomass technologies with existing farming practice. The 3-in-1 model is also well accepted by farmers in Hubei.

27. Integrated farming systems incorporating biomass technology are actively being promoted in Henan. About 31,000 small farm households having constructed the 4-in-1 model (pig-greenhouse-digester-vegetables) with government support.

Table 1: Key Agriculture Features of the Four Project Provinces

	Hubei	Shanxi	Henan	Jiangxi
Population	60.3 million	33.0 million	92.6 million	41.4 million
Urban Population	20.0 million	10.2 million	18.2 million	8.9 million
Capital	Wuhan	Taiyuan	Zhengzhou	Nanchang
Nationalities	Han, Tujia, Hui, Manchu, Miao, and Mongolian	Han, Hui, Mongolian, and Manchu	Han, Hui, Mongolian, and Manchu	Han, Hui, Miao, She, and Yao
Area	185,900 km ²	156,300 km ²	167,000 km ²	166,900 km ²
Average Rural Income Per Capita	Y2,269 / year	Y1,906 / year	Y1,986 / year	Y2,135/ year
Climatic Features	Subtropical, humid, monsoon climate; frequent droughts and floods	Temperate, continental, monsoon climate; long, cold winters and mild summers	Spans the warm-temperate/semi-humid and subtropical/humid climates	Subtropical, humid, monsoon climate
Average Temperature	1 to 6 degrees centigrade in January, 24 to 30 degrees in July.	Minus 16 to minus 2 degrees centigrade in January, 19 - 28 degrees in July.	Minus 3 to plus 3-degrees centigrade in January, 24 - 29 degrees in July.	3 to 9 degrees centigrade in January, 27 to 31 degrees in July
Annual Average Rainfall	750-1,500 mm; high precipitation in the south-eastern and south-western mountains	350 - 700 mm; high precipitation in the southeast and low in the northwest	500 – 900 mm; high precipitation in the southern and northern mountains	1,200 - 1,900 mm; high precipitation in the northeast
Rivers	Yangtze River and its tributary the Hanshui River.	Fen River, a tributary of the Yellow River located on the eastern part of the Loess Plateau; the Yellow (Huanghe) River in the west and south,	Yellow and Huai Rivers	The Ganjiang-Poyang drainage system covers most of the province and empties into the Yangtze River.
Products	Rice, wheat, sorghum, millet, peanuts, sugar cane; cotton, ramie, freshwater products; peaches, oranges, chestnuts; silver fungus.	Wheat, corn, sorghum, millet, potatoes, soybeans, sesame, peanuts, tobacco; pears, dates, walnuts, persimmons;	Wheat, millet, sorghum, corn, rice, potatoes; peanuts, sesame, soybeans, sugar cane, rape, edible fungus; cotton, apples, peaches, grapes, walnuts, ginkgo, persimmons;	Rice, wheat, corn, potatoes, millet, rape, sugar cane, tea, peanuts, soybeans, sesame, cotton, lotus seeds, carp.
Administrative Divisions	1 autonomous prefecture, 25 cities, 51 counties, 2 autonomous counties, and 1 forest district.	8 prefectures, 6 cities, 118 counties, 437 towns, 1,402 townships and 32,371 administrative villages	18 cities and 111 counties	12 cities and 77 counties Poyang Lake, 3,583 km ² , PRC's largest fresh water lake

Source: Provincial Statistical Bureaus. 2000.

28. Biomass technology development in Shanxi has progressed steadily. The 4-in-1 model based on integration of biogas digester, greenhouses for vegetable and pig production was developed in Shanxi under the government promotion program. To eliminate the need to burn the wheat straw in the field, the government is also actively promoting the construction of biomass gasification plants utilizing straw for generating producer gas for cooking and lighting. Annual provincial straw production is 12 million tons of which about 4 million tons are not put to economic use. Despite the fact that Shanxi Province has extensive coal deposits, the government is encouraging the use of biomass gasification technology to improve its environment. To date, 6 biomass gasification plants have been constructed producing gas for about 3,600 rural households.

5. Barriers to the Expansion of Biomass Renewable Energy

29. The promotion and expansion of biomass technologies in rural areas face many barriers and constraints. The Project provincial governments lack the technical and financial resources to rapidly expand their biomass renewable energy programs. Most rural households have no means to finance the investment. With the availability of relatively cheap supplies of coal (which causes serious environment degradation and health problems), and the use of firewood (which causes destruction of forested areas), and no alternate means to utilize crop residues and animal wastes, farm households could continue to heat and cook as they presently do and will continue to burn crop residue in open fields. Consequently, GHG emissions from coal, firewood, animal wastes, and crop residue burning will continue. It is, therefore, important that the barriers to promotion and rapid adoption of biomass energy systems be identified and removed. The proposed Project aims to provide the means and resources to remove the barriers and develop sustainable and replicable models for further expansion to other provinces as the Project will be an important demonstration model for replication by other provinces.

30. The key barriers that restrict the promotion and expansion of biomass renewable energy in the four Project provinces are:

- (i) **Lack of a replicable financing model and shortage of available capital and credit in the rural areas:** The expansion of biomass renewable energy is restricted because there is no sustainable and replicable financing model. Longer-term credit facilities are not available to rural households for the adoption of biomass-based renewable energy systems. The rural commercial banks, such as the Agricultural Bank of China (ABC), Rural Credit Cooperatives, and other financial institutions, are uncertain about the viability of biogas technology and do not provide longer-term financing to small farmers. In addition, the relatively low incomes of small farmers makes it impossible for them to obtain credit from commercial sources. Medium-scale biomass systems, such as gasifiers, have low operating and maintenance costs compared to conventional alternatives, but these systems have high front-end costs. This poses a barrier to prospective investors such as village organizations, TVEs or entrepreneurs, who do not have either collateral, or access to long-term financing. The overall weak financial situation of the communities makes it difficult for them to obtain commercial loans offered by rural financial institutions.¹¹

¹¹ For a review of the financing system for rural energy development, see *Rural Energy Development Study in the People's Republic of China, April 1996*. ADB. TA 2100-PRC.

- (ii) **Weak institutional capacities, inadequate technical expertise, and a lack of viable service infrastructure along with incentives for continued operation:** Qualified technical staff needed to promote and support biomass energy expansion are in short supply. There are inadequate numbers of biomass energy system designers, contractors, maintenance technicians, and extension staff to rapidly promote and expand the use of biomass technologies. This inhibits the expansion of biomass systems. Other factors include lack of reliable maintenance programs, and supply of spare parts, good managers, and environmental measurement programs. Access to the modern technologies and technical links are not readily available, inhibiting the ability to incorporate advanced technologies, such as in biomass gasification plants. High project preparation cost restricts expansion because investors are reluctant to proceed with these activities without the assurance of financing. Technical support is required to help potential investors to prepare feasibility studies, designs, cost estimates, and develop business plans in order to secure financing. To ensure sustainable operation of individual biogas units, biogas plants, and biomass gasification plants, a viable and effective private service sector must be developed to provide spare parts, O&M services to the producer of biogas, and to help them to improve their technology as new techniques are available. Incentives such as concentration of a minimum number biogas units in one location to support a unit of service agency must be ensured, along with government policy to provide incentives for service personnel to earn adequate income for the provision of such services.
- (iii) **Inadequate and poor rural infrastructure for effective biomass technology:** Poor access to remote villages in rural areas hampered efficient extension of technical services and availability of spare parts and accessories for effective O&M of biogas digesters. It will also cause higher damage to farm produce during transportation, particularly during the wet season. Overcoming this barrier in rural areas will result in quicker and frequent access by technical staff to expand biomass technology as well as to reduce farm produce damage during transportation. This will result in higher farm incomes for better O&M of biogas digesters.
- (iv) **Lack of sound environmental programs for (a) developing a reliable data base and social monitoring; and (b) a lack of public awareness and information:** Without these types of programs, the capacity to ensure environmental improvement and assure the public is restricted when it comes to the need for better quality environment and food products (e.g., organic foods, 'green' foods, etc) are restricted. Environmental monitoring at the county level is poor due to inadequate equipment and manpower. The generation of quality environmental data and information could act as good demonstration effect to convince local governments to develop and frame appropriate environmental policies and protection measures. Local government officials, in particular the decision-makers from the planning commissions, finance and agricultural bureaus, as well as farmers and potential investors, lack information about the implications and use of biomass energy systems. Consequently, they are unable to make practical decisions on an investment. They also lack knowledge of the overall environmental and human health concerns and possible benefits that are directly related to biomass energy systems. Lack of environmental equipment to

generate quality environment data and information is the root cause for such barrier.

- (v) **The lack of confidence for Government to provide adequate assistance to the poor resulting in the inability of large number of disadvantaged and poor households to participate in biomass development:** Disadvantaged and poor households have been unable to participate in the renewable energy program, even though they are important partner to meet the Government's overall environmental objectives, as well as improve the quality of their lives. Millions of poor farmers are in need of assistance. Poorer households have very special and extraordinary problems that inhibit them from participating in income-generating projects. Major constraints include lack of capital, weak technical capability, and lack of education and training. Special assistance is needed to help this group of disadvantaged and poor farmers to adopt biomass technology. The Government's effort to help the poor is constrained by lack of appropriate approach to enable large number of the poor to participate in biomass development. Without an appropriate biomass development approach or model, the Government lacks the confidence to commit itself for larger scale assistance to enable the disadvantaged and poor rural households to participate in biomass technology development.
- (vi) **Weak implementation and management capacity:** Implementation agencies at local levels are weak and lack experience to implement large scale biomass technology projects. They require technical support to further strengthen their institutional capability and coordination functions.

B. Government Policies and Plans

1. Agriculture

31. The Tenth Five-Year Plan (TFP) (2001-2005) was approved by the National People's Congress on 15 March 2001. Under the TFP, efforts will be intensified to bring about stronger economic restructuring, sustain natural resources management, and preserve the environment. Strengthening agriculture production and marketing will be the major priority to achieve a sound economic foundation and improve the living standards of farmers. The TFP emphasized adopting an integrated system of farming with biomass technology to generate biogas and other renewable energy to improve the environment. In agriculture, TFP aims to (i) strengthen agriculture and improve productivity as the country's economic base to increase farmers' income; (ii) accelerate restructuring of agricultural production; (iii) promote reforms in rural areas to maintain the traditional system of stable, long-term land contracts and encourage provincial governments to further land reform; and (iv) deepen financial reform in rural areas and stimulate rural economy development.

32. The TFP gives high priority to the agriculture sector in order to maintain the momentum achieved in the Ninth Five-Year Plan. The Western Region Development Strategy gives high priority to the development of western and central provinces and to alleviate poverty in the less accessible areas. The medium-term sector strategies are designed to (i) increase food production to meet increasing demand resulting from the growth in population and income, and (ii) increase rural incomes and employment opportunities to reduce the widening rural-urban income disparities. Given the arable land constraints (currently at 0.1 ha per capita), the agriculture sector development strategy focuses on increasing farm productivity, developing the

underutilized and wasteland, diversifying crop production, increasing productivity and efficiency, and adopting integrated approaches to farming which are friendly to the environment. The strategy also seeks to increase value added for agricultural produce and to increase off-farm employment opportunities.

2. Poverty Reduction

33. The Government is committed to poverty reduction. PRC is one of the successful countries in reducing rural poverty. The number of people classified as absolutely poor declined from 125 million in 1985 to 32 million in 2000.¹² This success is based on broad-based pro-poor economic growth, investment in social and physical infrastructure development and promotion of good governance and policies to include the poor in mainstream development. Despite the remarkable success, PRC still accounts for around one fourth of the absolute poor in Asia. The majority of the rural poor live in the central and western provinces, mostly in areas with limited natural resources, poor agriculture land, and inadequate physical and social infrastructure. About 60 percent of the poor live in mountainous areas characterized by poor soil conditions and in areas suffering from drought and environmental degradation.

34. PRC's poverty reduction-related objectives, as expressed in the TFP and the Ten Year Poverty Reduction Strategy call for: (i) increasing the incomes of farmers; (ii) constructing infrastructure, particularly in the western region; (iii) fostering development-oriented poverty reduction, especially in the western, remote, and minority areas; (iv) developing industries for processing, storing, and transporting agricultural products; (v) developing small towns and cities to increase off-farm employment opportunities for the rural poor; (vi) increasing standards of living for the urban and rural poor in terms of housing, education, health, and environment; (vii) establishing a sound social security system (including support to those with medical, unemployment, pension, old-age, and disability needs) to combat urban poverty; (viii) strengthening urban infrastructure and reducing urban pollution; (ix) developing labor-intensive industries, especially in the service sector, to increase job opportunities; (x) offering incentives for people to start their own businesses; (xi) expanding job training and skills retraining to help people adapt better to a market-oriented employment system; (xii) increasing Government grants and credit for poverty reduction; (xiii) increasing microcredit programs for the poor; (xiv) deepening relations between wealthier and poorer areas under the East-West cooperation program; (xv) expanding the role of non-governmental organizations (NGOs) in delivering programs and services to the poor; (xvi) increasing the participation of the private sector in poverty reduction activities; and (xvii) enhancing cooperation with international organizations for poverty reduction planning and program implementation.

35. Since 1986, the State Council's Leading Group for Poverty has launched a number of poverty reduction programs. These programs are periodically revised to better respond to the challenges of poverty reduction. The poverty reduction program focused on 592 poverty counties across the nation. In June 2001, the new poverty reduction program for 2001 to 2010 was launched. The new program promotes decentralized implementation and bottom-up participatory need assessment of the poor at the village level to develop specific poverty reduction strategy for each area.

36. The strong Government commitment to reduce poverty is witnessed by the increased allocation of budgetary funds for poverty reduction. Since 1994, real annual Government

¹² These figures are based on the PRC Chinese poverty line, which is about \$0.66 per capita expenditure a day on a purchasing power parity (PPP) basis.

spending on poverty reduction has increased by 260 percent. In 2000, the budgeted funds for poverty reduction program totaled to Y26 billion (\$ 3.1 billion). In this new program, the Government is committed to increasing the budget by Y1 billion-Y5 billion (\$121 million to \$605 million) annually.

3. Energy

37. The Government's strategy in the energy sector is to reduce the growth of coal consumption and the environmental pollution that coal consumption causes. The Government has recognized the need to address the environmental problems associated with the heavy dependence of coal, and has reiterated its commitment to increase use of renewable energy as outlined in its Program on New and Renewable Energy Development in the PRC (1996-2010). The plan calls for promoting clean coal technologies for energy production and, where possible, substituting the use of coal energy with natural gas, hydropower, wind, solar, and biomass renewable energy. Concerted efforts are being made to improve energy management and to decrease the growth rate of energy consumption. The Government aims to develop renewable energy to (i) diversify power generation, (ii) accelerate rural development, (iii) develop sustainable resources, and (iv) derive environmental benefits.

38. In the TFP, the Government will accelerate renewable energy development through the use of market-based policy instruments. The Government will create a market for renewable energy through a mandated market share (MMS) policy. The key elements of the new policy are to: (i) create a MMS for renewable energy in the form of a legal requirement that some share of electricity comes from renewable energy, and (ii) introduce an instrument to share the incremental costs and benefits among the regions in PRC. The Government intends to gradually introduce a requirement that 5 percent of electricity supplied to consumers be generated from renewable energy sources. This will maintain the current share in the energy generation mix. About 18 GW of renewable energy capacity would need to be added by 2010 to achieve this target. To support development and implementation of the new renewable energy policy and to catalyze international financing, the Government has also initiated the development of a "Partnership for Renewable Energy" with support from the World Bank and Global Environmental Facility (GEF). The Partnership will provide an umbrella for all renewable energy activities within the country during the next decade. The Partnership will support the Government Renewable Energy Program during the 10th and 11th Five-Year Plans to create a mandated market and reduce costs for mature technologies such as wind-farm, small hydroelectricity and biomass. Maintaining the current share of five percent of renewable energy in power generation is being taken as the tentative goal for the purpose of preparation of the Governmental Program. Trading mechanisms, such as green certificate trading, are also contemplated to create competition and allow the selection of the lowest cost alternatives. In May 2001, a World Bank mission visited PRC to prepare the World Bank/GEF China Renewable Energy Scale-up Program (CRESP). The GEF Council approved the CRESP Project Brief in its May 2001 meeting and supports it with a grant of \$140 million. Under the CRESP, the World Bank would provide assistance to recommend revisions to current pricing policies, that are consistent with the PRC market economy and international best practice, as part of the CRESP preparation. The World Bank will help in preparing the voluntary "green electricity" scheme and the Government Strategic Partnership for Renewable Energy. The CRESP will be implemented in two phases: phase I will be the proposal for MMS and the introduction of pilot schemes. It will define the MMS policy, describe the pilot schemes and identify candidates for the pilot provinces. It will also propose a process for the introduction of the MMS in legislation or a State Council Decree, and carrying out workshops and other activities to increase awareness, consensus and confidence of all stakeholders on the proposed

MMS. Phase II will prepare policies that result in a proposal to the State Council for approval for implementation of pilot schemes. SDPC will propose new measures to State Council for inclusion in a decree to support renewable energy.

4. Environment

39. In the environmental sector, the Government's strategic objectives are to (i) control environment pollution, (ii) improve the quality of environment, particularly in major cities, (iii) reduce degradation of natural ecological systems, and (iv) integrate environmental planning with social and economic development. Major emphasis will be given to reducing air and water pollution in 52 major cities where pollution is most severe. The Government will pursue a strategy of sustainable development integrating environmental protection programs into national economic and social planning, and establishing an effective environmental regulatory framework and management systems in urban and rural areas.

40. The Government recognizes the need for a balanced and integrated approach to environmental protection and has enacted a series of laws and regulations on pollution prevention and environmental protection to control and reduce the adverse impact of energy generation and industry production on the environment. The Government received considerable assistance from international donors to strengthen its institutional capacity for environmental impact assessments and formulate relevant and effective legislation on environment protection. The Government's environmental policies focus on resource pricing, enforcing regulations, implementing control measures, and developing least-cost energy-efficient manufacturing technologies.

41. In the TFP, the Government will continue to improve ecological conservation and strengthen environmental protection. To this end, the Government will continue to implement new natural forest protection projects on the upper reaches of the Yangtze River and in the upper and middle reaches of the Yellow River; control urban pollution by strengthening enforcement and introducing new and comprehensive regulatory measures to improve the environmental quality of large and medium-sized cities; protect the rural environment, especially from pollution caused by farm chemicals; and improve the environmental, meteorological and seismological monitoring systems to help prevent and reduce natural disasters.

C. External Assistance

42. World Bank and Japan Bank for International Cooperation (JBIC) are the major sources of external assistance to PRC. JBIC provided over \$20 billion assistance to PRC, mainly in infrastructure and environmental development. As of 30 June 2000, the World Bank financed about 234 projects with loans of about \$35 billion. Of these, 61 projects with loans totaling \$9.7 billion supported agricultural development, 31 projects with loans of \$6.3 billion were for energy sector development, and 17 projects with loans of \$2.4 billion were to help improve the environment. The World Bank is assisting the Government to formulate a Partnership with GEF to provide the Government with about \$100 million loans through its "China Renewable Energy Scale-up Program". In the development of renewable energy resources in PRC, World Bank's \$100 million renewable energy development project includes a wind-farm component, a solar photovoltaic (PV) component, and a technology improvement component.

43. ADB is another major international lender to PRC. As of December 2000, PRC received a total of 83 loans amounting to \$10.3 billion from ADB. In the agriculture and natural resources sector, ADB has provided 9 loans amounting to \$583.9 million. In the energy sector, 15 loans

amounting to \$1.8 billion were provided. A Wind Power Development Project loan of \$58 million was provided in November 2000 to assist PRC to develop renewable energy. A Renewable Energy Development technical assistance grant addressed barriers to commercial development of renewable energy through review of the policy and institutional framework, developing and evaluating prioritized investment programs for commercialization and identifying specific investment requirements for external financing.¹³

44. UNDP and GEF have also contributed to PRC's renewable energy development. GEF has financed two projects in Yunnan Province: (i) Energy Conservation Project - a \$22 million GEF grant, together with a World Bank loan of \$63 million and a European Commission grant of \$5 million aims to increase energy efficiency through the introduction, demonstration and dissemination of new energy conservation project financing concepts and market-oriented institutions; and (ii) the \$35 million Renewable Energy Project to develop and enhance the renewable energy sector. A World Bank loan of \$ 100 million was provided to support the grid-connected wind component. The "Wind Power Development Project"¹⁴ aims to reduce GHG emissions by accelerating the growth of large-scale grid-connected wind power development to replace current fossil fuel consumption in the provinces of Xinjiang, Liaoning, and Heilongjiang. "Capacity Building for the Rapid Commercialization of Renewable Energy" in PRC is another GEF project that aims to primarily address commercialized large-scale renewable energy technologies through market-based instruments. Direct beneficiaries of this project will be "Chinese professionals, policy makers, and businessmen who will be exposed to market-friendly mechanisms for the commercialization of renewable energy forms." The "Issues and Options in Greenhouse Gas Emissions Control" project had as its goals: generate information needed by policymakers for making good decisions on reducing GHG emissions; introduce efficient industrial boiler designs and controls; reduce residential and commercial coal use; and train the various professionals in skills needed to attain the previous three goals. The project took place from January 1992 through March 1994. The "China Renewable Energy Scale-up Program" or CRESPP (see para 38) will support the implementation of a national policy framework that would legally require a share of electricity to be met from renewable energy resources.

45. UNDP has a number of ongoing and pipeline programs to support the commercialization of renewable energy. These include: (i) ongoing *Resources Concessions for Sustainable Development of Renewable Energy* focusing on policy implementation with respect to wind energy; (ii) a pipeline project aims to develop a *National Energy Strategy and Plan*; identify energy-related issues/strategies; and set options for energy policy development; (iii) a proposed demonstration project to promote *Modernized Biomass Energy in Jilin Province*; (iv) a project to help strengthening the Chengdu Biogas Research and Training Centre; and (v) an ongoing *Capacity Building for the Rapid Commercialization of Renewable Energy Project*.

46. Bilateral assistance agencies focus on installing PV systems and developing grid-connected wind farms. Denmark, Germany and Spain are the main bilateral agencies providing assistance for wind-based renewable energy development. There is an ongoing cooperation project in Liaoning Province financed by Italy dealing with gasification technology. A protocol on Scientific and Technological Co-operation has been signed in June 2000. This covers scientific and technological activities providing support for exchange of PRC and Italian researchers. DFID of United Kingdom recently financed a renewable study entitled "Rural Energy in China—A Scoping Study" but has not made any commitment in the renewable energy sector for the next

¹³ TA 3056-PRC: Renewable Energy Development Project, for \$566,000, approved on 19 August 1998.

¹⁴ Project Number: CPR/00/G31.

few years. DFID emphasis is mainly on poverty reduction program and its program's poverty focus concentrates in the provinces of Yunnan, Sichuan and Ganzu.

D. Lessons Learned

47. Since PRC joined ADB in 1986, a number of projects in the agriculture, energy and environment sectors have been implemented and completed. Similarly, World Bank and other funding agencies have also completed many projects related to the proposed Project and valuable lessons have been learned. Most of these projects have addressed issues relating to promoting land reform, liberalizing markets, raising the level of crop production, increasing farm productivity, generating rural employment, reducing the rural-urban income gap and poverty, developing renewable energy, and protecting the environment. The report on assessment of ADB's Country Assistance Program in the PRC conducted in 1998¹⁵ highlighted that PRC has strong project implementation capacity, with most ADB assisted projects implemented efficiently and some completed ahead of schedule. There is a strong sense of project ownership at all levels and consequent commitment to their effective implementation. Factors contributing to many project successes included: (i) intensive project preparatory phase and rigorous screening to ensure appropriate technical, financial, economic viability as well as debt servicing capability; (ii) strong commitment and technical capability of executing agencies; (iii) appropriate project activities sequencing and suitable institutional arrangements for effective implementation; (iv) strong involvement of beneficiaries (individual households or village community groups) during project preparation; (v) effective interagency coordination; and (vi) strong performance monitoring. Another lesson learned is that project performance tends to be improved when technical assistance is provided to upgrade the capabilities of EAs and to hold seminars and workshops to familiarize project staff with ADB procurement and disbursement procedures as well as other project implementation and monitoring guidelines at the early stage of project implementation.

48. However, not all ADB funded projects have been successfully implemented. There are areas of weaknesses that need to be highlighted and the lessons learned. ADB's operations in the agriculture and rural sector over the period 1986-1999 had some poor performances. Less than satisfactory performance was noted in a project associated with state-owned agro-processing industries (the Hexian Pulp Mill project loan 937-PRC), involving inward looking state-owned entity which isolated itself in a rapidly changing sector that is increasingly exposed to international competition. Projects that promoted direct Government investment to provide incentives and regulatory functions and involving extensive individual private household and communities' participation in the production, harvesting and downstream processing have been more successful. These lessons have been considered and incorporated in the design of subsequent projects, including the proposed Project.

49. Two completed projects were postevaluated. The two postevaluation findings (Loan 937-PRC Hexian Pulp Mill and Loan 1055-PRC Agriculture Bank of China) showed contrasting performance results. The Hexian Pulp Mill Project was rated unsuccessful because of inappropriate technical design and mismatch between the project goal and the expected outputs. The project design failed to consider backward and forward linkages of pulp production and adequate consideration of raw material supply and pulp production to replace pulp imports in an economically viable way. The Mill was poorly designed and lacked capacity to achieve economies of scale. There was no proper assessment of market demand for the enterprise's

¹⁵ CAP: PRC 98026: Country Assistance Program Evaluation in the People's Republic of China, Doc. No. In. 29-99, circulated to the Board on 25 January 1999.

output, and no realistic business and financial plans that examine carefully the cash flow and debt equity issues. There was also insufficient in-depth analysis on risk factors relating to technical, commercial and financial issues facing the mill during implementation and operation. The people managing the mill were mostly bureaucrats as opposed to private investors risking their own capital. The evaluation demonstrates the need to carefully assess production targets, quality goals, and financial viability of an agroprocessing entity. The Agriculture Bank of China Project, however, was rated generally successful. The project was efficiently implemented and achieved its objectives as envisaged.

50. Despite some setbacks in the implementation of PRC projects, the lessons learned have showed that PRC has strong project implementation capability and ownership, but there is need to ensure that proper sector analysis is conducted to ensure the backward and forward linkages of the project are well understood and incorporated in the design, appropriate institutional arrangements and monitoring system set up at early phase of project commencement, strong involvement by private sector or community beneficiaries, strong Government and EA commitment, and provision of capacity building assistance. The proposed Project made a concerted effort to incorporate these elements of success into the design and implementation arrangements of the Project.

51. Several World Bank postcompletion reviews of agriculture projects have also been drawn upon for lessons learned to be applied in the Project design. The projects reviewed are multicomponent projects implemented in many counties and in more than one province, and are therefore similar to the proposed Project in design. The lessons learned in these multicomponent and multilocation projects included: (i) flexibility in project design to respond to site-specific technical problems and rapid market changes; and (ii) specific measures to ensure poverty reduction impacts by providing increased extension and support to farmers. The Project design has accordingly incorporated these lessons and experience. Various measures are taken to allow for Project activities to be implemented in four provinces in a flexible manner, and provision of extensive technical training, extension, and support to small farmers to enable them to increase productivity and income, and at the same time leading to improvement in the environment.

52. In the energy and environment sectors, the Country Assistance Program Evaluation for PRC conducted by OEO in 1998 concluded that the ADB Strategic objectives in these sectors are appropriate. ADB has played an effective role in assisting the PRC in the environment sector and has made advances in expanding its policies on social concerns. The loan projects addressing environmental problems in several major cities have been generally successful.

E. ADB's Country and Sectoral Strategy

53. In pursuit of ADB's overarching poverty reduction objective, the PRC current Country Operational Strategy¹⁶ was designed to (i) assist in improving the efficiency of the economy in a sustainable manner; (ii) help address poverty by promoting growth in the poorer interior provinces; and (iii) achieve balanced regional development to protect the environment and better manage the country's natural resources. The poverty reduction objectives of ADB, as expressed in its Poverty Reduction Strategy, include three pillars: (i) *pro-poor, sustainable economic growth*, in which growth is based on policies and programs that facilitate employment and income generation for the poor; (ii) social development, that can enable the poor to make full use of the opportunities to improve their living standard (*poverty interventions*), and

¹⁶ ADB's New Country Strategy and Program is under preparation.

programs directly addressing the severity of poverty (*core-poverty interventions*); and (iii) *good governance*, to ensure that the poor have better access to basic services and greater voice and participation in decisions affecting them.

54. For agriculture, the country operational strategy focuses on (i) increasing efficiency in agricultural production, processing, and marketing; (ii) reducing rural poverty and increasing rural income opportunities through cash crops and off-farm employment; (iii) improving management and development of soil, water, forest, and marine resources for sustainable development; (iv) supporting the transition of market economy through improved incentives for private sector investment and establishment of market information system; and (v) supporting enterprise reforms.

55. In the environment sector, the strategy focuses on (i) strengthening the legal policy and regulatory framework for sustainable environment management; (ii) supporting institutional building in environmental impact assessment (EIA) monitoring and enforcement; (iii) supporting the utilization of economic measures (taxes, charges, and fees), supply-side measures (integrated resource planning and fuel switching), and other measures (waste minimization and recycling) to protect and to ensure sustainable utilization of natural resources; (iv) promoting market-based pricing; (v) promoting the use of cleaner technologies for industrial production and power generation; and (vi) implementing and monitoring agro-industrial pollution mechanisms. Agricultural projects are designed to simultaneously address both the environmental concerns and crosscutting issues, particularly poverty reduction, beneficiaries welfare, and improving natural resources management. ADB's operations are designed to narrow the gap between rural and urban income opportunities by assisting in land reforms, improving agricultural production and productivity, providing better postharvest processing facilities, developing efficient market for agricultural goods, improving extension and research, and improving the environment. ADB's strategic thrust to reduce poverty in the poorer inland provinces is to help (i) promote market-based policy changes to attract more foreign and domestic investments; (ii) address rural infrastructure and institutional constraints; (iii) develop integrated agriculture and agrobased industries; (iv) develop transportation, communications, and marketing linkages between interior and coastal provinces; (v) locate developmental projects in poverty counties; and (vi) incorporate project component to minimize or reverse environmental pollution due to agricultural wastes. ADB's assistance to the agriculture sector will emphasize: (i) targeting the poor as the main beneficiaries; (ii) helping to remove the remaining pricing restriction/barriers to permit efficiency improvements in agriculture production, processing, and marketing; (iii) creating employment opportunities in off-farm economic activities; (iv) improving management, development, and rehabilitation of soil, marine, water, and forest resources for sustainable utilization and improving the environment; (v) modernizing agriculture by upgrading technology and developing and improving agricultural statistics and market information system; and (vi) expanding and modernizing key marketing facilities, and transport linkages to urban centers.

F. Policy Dialogue

1. Land Tenure Reforms

56. Land use and land tenure in the Project provinces are covered by the respective provincial regulations within the broad policy framework of the national government. ADB assisted PRC in drafting the Land Administration Law, which became effective on 1 January 1999. The law provides for a national land-use plan, which will stipulate the total amount of arable land to be put under protection. Every province, county and township will be assigned quotas of arable land for protection. The area of cultivated land should comprise 80 percent of

arable land. Any arable land that is required for urban or industrial expansion must be replaced by a similar area of unused degraded land (such as wetland, hilly or other marginal land) that should be reclaimed to become arable land. The local governments must develop plans to protect arable land. A national supervision and inspection system for land resources and land occupation is set up at the Ministry of Land and Resources for the implementation of the Land Administration Law. To help modify provincial land administration laws to be consistent with the 1998 amendments to the national law, ADB helped Sichuan Province to draft a model enabling provincial law, which could be adopted by other provinces. The Sichuan land law provided: (i) registration of land rights and issuance of certificates by which landholders can confirm their rights against intrusions by other landholders and claimants, and against arbitrary actions by State or local government agencies; (ii) local government is given responsibilities to prepare the overall land use plans; (iii) formulas for payments for rural land to be acquired for urban construction or other purposes should be based on the measurement of the productivity of the rural land being acquired, and full compensation for collective farm organizations and individual families; and (iv) citizen participation in the process of land use and planning and in the procedures for conversion of rural land to urban uses. Representatives from the four provinces attended a workshop that reviewed the model Sichuan Law. ADB funded a Land Use and Land Use Tenure Policy in Fujian Province (TA 2428-PRC).

57. Access to adequate land resources by rural farmers is an important factor in rural poverty reduction. Reform of the legal framework covering land use and land tenure is a vital step in reducing rural poverty. During Project processing, policy dialogue with the Project provinces were undertaken to highlight the importance of land use tenure and the recommendations of the ADB assisted Sichuan Province report were discussed. The Mission urged the respective provincial governments to consider the study and adopt the recommendations.

2. Promotion of Biogas Energy Development and Barriers Removal

58. The Government initiated the promotion of biogas energy development under the framework of the Seventh Five-Year Plan (1986-1990) which established the energy quality standards, standardized energy technologies, and strengthened institutional capacity in the development of biogas from agricultural wastes. The early experience led to the implementation of an Integrated Rural Energy Development Program (IREDP). IREDP demonstrated the feasibility of renewable energy technologies such as using biogas digesters and biomass gasification plants using low cost agricultural wastes.

59. Because of its potential to improve the environment through reduction in coal usage, increased utilization of agricultural wastes for biogas production and organic fertilizer production, ADB and other international agencies have actively engaged in policy dialogues with the Government to help in the promotion of biogas renewable energy development. In 1996, ADB financed a study entitled "Rural Energy Development Study" (TA 2100-PRC). Following this study, ADB engaged in active discussion with the Government which resulted in the preparation of an Efficient Utilization of Agricultural Wastes feasibility study (TA 3370-PRC). Policy dialogue undertaken during Project processing aimed at promoting larger scale biogas energy development in PRC. However, impediments for development of biomass renewable energy in the rural sector These barriers are inhibiting rapid adoption of biomass technologies (para 30).

60. During the TFP, the Government will introduce policies and mechanisms to promote the adoption of biomass technologies and the plan aims to achieve a target of 300,000 households

per year. The World Bank and GEF will assist the Government through the Partnership for Renewable Energy Development to develop policies and mechanisms for renewable energy development. The World Bank-GEF assistance for the partnership will not likely to be operational in 2001 and several more years will probably be required before appropriate regulatory and policy framework is established for renewable energy development. In the meantime, the Government will actively pursue the achievement of TFP targets of 300,000 rural households adopting biomass technologies. The Project supports the envisaged partnership by providing momentum for biomass energy systems adoption in rural areas during the transition period.

61. The barriers inhibiting biomass renewable energy development will be addressed in the Project provinces. As a result of the Mission's policy dialogue, a viable and sustainable financing modality will be developed so that rural households can access to longer-term credit. Steps will also be taken to strengthen institutional capacity, and overcome shortages of technical expertise. Weakness related to environment policy implementation and environmental management capacity will also be strengthened. The Project will develop approaches to enable large number of poor and disadvantaged rural households to adopt the biomass technologies. In view of the global, regional, and national benefits associated with the Project, ADB approached GEF for assistance in addressing these barriers and providing financial support for the environment policy implementation and public awareness activities. The Project, which will serve as a model for further replication in other parts of PRC, was accepted into the GEF formal pipeline in June 2000.

3. Environment Protection and Promotion of Clean Technologies

62. Efficient utilization of agricultural wastes for biomass energy generation will improve the rural environment and reduce GHG emissions. During Project Processing, the Mission's policy dialogue was designed to encourage the Government to actively promote a policy to adopt clean renewable energy especially in the rural areas. The use of biomass fuels can be a basic element in sustainable development for a densely populated country like PRC. In some northern areas of the country, forests near to agriculture lands have been cleared for firewood and the small farmers are now turning to less efficient fuels such as straw and dung for fuel and heating. Many rural households with higher than average incomes have increasingly switched to coal or Liquid Petroleum Gas (LPG). For most of the poorer farm households, biomass gas provides an appropriate and sustainable alternative.

63. PRC has experience in biomass technology. Biogas productivity from small-scale digesters has increased by 50 percent since the mid-1980s. Recently, more emphasis has been given to the concept of integrated farming with biomass systems, which aims to enhance farm productivity and improve the environment within a farming system.

64. The Mission emphasized to the Government that the market potential for biogas in PRC is considerable and that there is scope for expansion. For example, more than 14,000 large-scale livestock breeding farms exist in PRC; but only 5 percent have biogas/sewage treatment installations. In rural areas, huge amount of biomass residues are available for biomass gasification each year. However, most is burnt causing environmental air pollution and respiratory diseases. The Government should promote biomass gasification technology to reduce crop residue burning. Progress so far has been limited. By the end of 1999, there were only about 300 crop residue biomass gasification plants in PRC, each providing producer gas to about 600 rural households. The market potential of gasification systems is large. If only one percent of the total amount of crop residues were converted into producer gas by 2010,

approximately 10,000 gasification systems would have to be installed. The Project will provide funding to assist the Government to establish 28 units of gasification plants and strengthen institutional capability to provide technical support and extension services. The Government will ensure continued funding will be provided to support the development of gasification technology and to ensure future sustainability of gasification technology development.

IV. THE PROPOSED PROJECT

A. Rationale

65. The strategy for industrial growth and agricultural intensification adopted by PRC in the past decades had resulted in environment problems particularly in air and water pollution linked to rapid economic growth and industrialization. Coal is the dominant primary source of energy accounting for about 67 percent of total commercial energy production. The use of coal for energy production has resulted in high levels of air pollution causing major health problems, degenerating eco-systems, declining agricultural production, increasing emissions of greenhouse gases, and occurrences of acid rain. Total GHG emissions from all components of the agricultural sector account for 12 to 18 percent of the national total. These emissions are predominantly due to poor farming practices and inefficient use of biomass resources.

66. The rural environment has been degrading as a result of unsustainable forestry practices, exploitation of firewood for commercial and domestic use, production of excess biomass from rural farms and households, and intensive farming practices on degraded soils. These factors have led to increased air pollution from the burning crop residues, soil erosion, low farm productivity. Poverty has increased as natural resources are despoiled and depleted in the rural areas. Farm households have limited access to modern energy sources. The limited supply, high cost, and low quality of energy have become important limiting factors for rural economic development. Direct combustion of large amounts of coal, firewood, and crop residues is contributing to the deterioration of the environment. Coal is the dominant fuel source for most households in rural areas. From an environment point of view, the current practice in energy utilization and agricultural production in the rural areas have led to increased pollution. Poor farm households put enormous pressure on the forests for firewood. The surplus of biomass, primarily due to an increase in crop residues, has doubled from about 300 million tons in 1978 to over 600 million tons in 1999. Over 100 million tons of crop residues are burned each year in open fields contributing to high levels of air pollution as a result of the smoke. Air pollution contributes to respiratory illnesses.

67. Because of the lack of proper disposal of household and animal wastes (such as poultry and pig manure), a typical poor farm household is usually littered with decayed vegetables and fruits, animal manure, unhygienic latrines, and other household wastes. The situation is worse during the wet season when living conditions become filthy, causing health problems among the children and older people. A significant reduction of such environmental pollution and health problems could be achieved through adoption of biomass technologies utilizing agricultural wastes or biomass resources.

68. During the last three decades, the Government has spent significant amount of funding to develop biomass technologies which are integrated into the existing farming systems. The use of biogas digesters and crop residue gasification technologies has the potential to become increasingly, particularly among small farmers. However, the small and poorer farmers face constraints in obtaining credit to adopt the biomass technologies. Rural financial institutions are reluctant to lend to them due to lack of collateral and large number of small loans involved.

There is also lack of a suitable financial modality whereby rural farm households and enterprises could obtain longer-term credit to assist them in the adoption of biomass technology. Such financial barrier can be overcome with assistance to develop appropriate financial model and mechanisms for longer-term lending that could be replicable in other parts of PRC. Although the end users of the biomass technologies are private sector, there is a strong public sector interest and significant environmental benefits associated with the adoption of biomass technologies. The Government has made concerted effort to promote renewable biomass energy to improve environment, enhance the quality and quantity of agricultural production, and improve the health and income of small poor farmers. Four enthusiastic inland provinces (Jiangxi, Hubei, Henan and Shanxi) has been selected to implement the proposed Project. The four provinces were selected because they represent the inland provinces with distinct climatic ranges, have significant experience in developing and promoting biomass technologies, have large proportion of poor farmers living in marginal areas, and have expressed great enthusiasm to implement the Project. The Project will also have demonstration effect on other poorer and less innovative inland provinces by showing the feasibility and profitability of the adoption of biomass technologies as well as promoting private entrepreneurs' participation in the Project activities.

B. Objectives and Scope

1. Objectives

69. The long-term goal of the Project is to improve the environment, promote economic growth, and improve welfare and living conditions of rural households, particularly poor farmers. The immediate objectives are to demonstrate the economic viability of sustainable biomass technology and to enhance agricultural productivity and rural income. The objectives will be achieved by: (i) developing and enhancing sustainable biomass technology using agricultural wastes to generate cleaner energy; (ii) introducing improved mechanisms and strengthening institutional capacity for the adoption of biomass technology; (iii) improving rural marketing facilities; (iv) strengthening environmental policy implementation and public awareness; (v) assisting and facilitating the poor and disadvantaged group of farmers to adopt biomass technology; and (vi) promoting private sector participation. The Project framework depicted in Appendix 1 provides more details on the Project objectives and activities.

2. Scope

70. The Project scope comprises components that will address and remove various constraints and barriers leading to the adoption of biomass technologies in a least-cost manner. The Project will overcome the financial barrier by developing and establishing an appropriate financing modality and mechanism that will enable rural farm households to access to longer-term credit for the adoption of the biomass technology. The Project will provide support to overcome institutional and technical barriers through the provision of management and technical assistance to strengthen the concerned institutions to ensure Project sustainability and greater adoption of biomass technologies. The lack of public awareness, information, and marketing barriers will also be addressed through various publicity campaigns, seminars, and information dissemination activities. Finally, the Project will address the inability of disadvantaged and poor households through special training and provision of biogas adoption facilities. The Project has six components:

a. Component A: Funding for Renewable Energy Generation and Eco-Environment Development

71. This component will provide funding assistance to all Project beneficiaries for the development and adoption of biomass technology and develop an appropriate financing model and mechanism based at the provincial finance bureaus for extending longer-term credit to rural farm households. A sustainable and replicable financing model will overcome a key barrier, lack of access to credit, that prevents farm households from adopting biomass technologies¹⁷. Successful implementation of the Project will have a significant demonstration effect to attract financial institutions such as the Agricultural Bank of China and Rural Credit Cooperatives to gain confidence as commercial provider of credits for similar activities in PRC beyond the Project implementation phase. This line of approach is strongly supported by the national and provincial governments who have shown strong commitments to ensure successful implementation of the Project activities. The longer-term financing will allow the beneficiaries to construct:¹⁸

- (i) 4,700 units of greenhouse with small biogas digesters for Project farmers (type I technology). This is commonly referred to as the 4-in-1 model ecofarm. The four elements are: greenhouse, pigs in an integrated pigpen inside the greenhouse, vegetable crops, and the digester. The provision of greenhouses and digesters will enhance small farmers' productivity and improve their incomes. Digested fluids and sludge (manure and household wastes) from the pigs and household latrine provide the fuel for the underground digester to produce biogas for lighting and cooking and for greenhouse heating and CO₂ generation. Organic fertilizer is produced through the fermented effluent and sludge and is used as an input to improve greenhouse vegetables and farm production.
- (ii) 10,900 units of smaller scale orchard plantation development and biogas digester (type II technology). This is commonly referred to as the 3-in-1 model ecofarm. The three elements are pigs, orchard (1 hectare), and digester. The model can also use vegetables, cotton, fishponds or grain crops to substitute for the orchard farm. Manure from the pigs and household wastes provide the source of fuel for the digester to produce biogas. Fermented sludge and effluents are by-products and are used as organic fertilizer for the vegetable, farm or fish production. Most of type II units are located in the two southern provinces where there is high demand for fresh fruits in the nearby cities. Fresh citrus fruit from Project will be sold to nearby cities such as Guangzhou, Hong Kong and Shanghai where the market demand is high.
- (iii) 14 units of medium-scale biogas plants (type III technology). The biogas plants are located in a large commercial pig farm. Pig manure and other liquid wastes and sludge provide the fuel for the biogas plant. Each plant can supply up to 120 households and the central pig farm with biogas for lighting and cooking. Organic

¹⁷ Details of biomass technology are given in Supplementary Appendix A. In this Project, 4 types of biomass technology are adopted. Type I technology consists of a greenhouse, a digester (cement tank with inlets and outlets located underground below the greenhouse). A pigpen will be built above the digesters inside the greenhouse. Type II technology consists of an orchard farm, pigpen, and a digester below the pigpen. Type III technology is a biogas plant built within the pig farm utilizing pig manure as input for generating biogas. Anaerobic digester will be built to degrade the solid content of the sludge and generate biogas. Type IV technology consists of a conversion unit that converts crop residues into producer gas.

¹⁸ The figures given are indicative only as the actual number will depend on the actual demand during implementation.

manure, which is the by-product of the plant's effluent, will be sold to adjacent farms.

- (iv) 28 units of medium scale straw biomass gasification plants (type IV technology). The gasification plant is located in a farming village where there are abundant wheat or other grain straw which is normally burned in the field after harvesting the crop. The plant uses mostly crop residues to fuel producer gas production. The gas will be distributed to farm households for cooking, lighting, and heating. Each gasification plant can supply up to 600 farm households.

72. Details of each type of biomass technologies are given in Supplementary Appendix A.

b. Component B: Improve Mechanisms for Transferring Biomass Technology

73. This component will promote and expand biomass technology adoption through provision of training to biogas contractors, biogas technicians, beneficiary farmers, and medium scale plant operators. The contractors will be assisted so that the investments will be built to the standards expected. The contractors will develop a large network of private service professionals to conduct operation and maintenance (O&M) and repair work after the systems have been constructed. Farmers will be trained in O&M of their biogas digesters and on appropriate farming systems to be adopted in the greenhouse and in the orchards. Operators of medium scale biogas and biomass gasification plants will be provided with technical training to improve their skills in the O&M of the plants. To strengthen their experience in the efficient utilization of agriculture waste, management and strategies, Project staff will receive training to improve their technical expertise and extension skills. The training will take the form of workshops, study tours to neighboring provinces, group farm visits and on the job training. Local research fellowships on biomass energy system improvement, environmental protection and monitoring of biomass technologies. Promotion and expansion of biogas technology and renewable energy policy will also be provided. Consulting services will be provided to help the local government to develop and adopt appropriate policies and incentives to encourage biomass technology adoption in the rural areas. This component will integrate all elements of biomass technology adoption incorporating the existing farm production system along with strengthening the institutions, develop a viable private service sector and incentives for continued operation to ensure sustainability. The number of biogas units in each participating village will be significantly increased to support at least one or more private service units. It is expected that more than 300 viable private service units will be established in the Project areas.

c. Component C: Rehabilitate Farmers-Selected Farm-to-Market Facilities

74. This component will provide rural infrastructure to link the agricultural production areas to the existing road network. The Project will construct or rehabilitate about 60 km of rural access roads in the four participating provinces. The component will improve the ability of small farmers in the Project villages to develop, expand, and market their farm products by constructing, improving, or rehabilitating strategic access and farm-to-market roads, drainage systems, and bridges. This activity will result in higher farm incomes, marketing of better farm outputs and supply of inputs, easy access by extension officers to promote and enhance biomass technology adoption by the rural households, and easier access to obtain spare parts necessary for the O&M of the biogas digesters. Construction will be undertaken with cooperative effort of village's farm labor on volunteer basis while the local government provides

the material. The Project implementation agencies will organize the civil works. Road maintenance will be done by farm volunteer labor supervised by Village Committees. About 100 remote villages with small-scale biogas digesters will undertake this rural infrastructure activity. It will increase access to markets and facilitate O&M services, and reduce high transportation costs and produce damage, particularly in the more remote and disadvantaged areas.

d. Component D: Improve Environment Policy Implementation and Awareness

75. This component is designed to assist and develop environmental frameworks and programs to assist the provincial governments to effectively implement national environment policy, particularly those relating to biomass technology development and adoption. It will provide environment equipment, technical support, and training to improve environment policy implementation and awareness and to establish facilities and systems for environmental monitoring to assure higher environmental standards. This will assist to establish benchmark for environmental standards and to measure environment impacts resulting from Project activities to highlight the results for public awareness so that public and political support is forthcoming for the promotion and expansion of biomass technologies in the rural areas. Such a demonstration effect will also promote public awareness and solicit political support to alleviate environment pollution. The component will develop a communication strategy to educate the public to raise public awareness, establish a system of monitoring emissions of environmental contaminants through provision of monitoring equipment and training to farmers and government offices; public information campaigns and barrier removal targeting on: (i) facilitating implementation of a national renewable energy policy framework; (ii) developing a legal framework for private sector participation; (iii) improving tax incentives for renewable energy development; (iv) strengthening rural financial institutions; and (v) promoting technology for the manufacturing of biogas components.

e. Component E: Pilot Poverty Focused Approaches for Biomass Development

76. This component will introduce an improved and innovative biomass development approach specially designed to assist the disadvantaged and poor households. The component will develop appropriate community-based biogas energy programs targeted for the poor who would otherwise not be eligible to apply for Project credit facilities provided under component A. Initially, special training materials for adult semi-literate and extension services will be developed for this group of the beneficiaries.¹⁹ Women Associations at the village level will assist farmers to participate in the adoption of biomass technology through special training to upgrade their technical capability; and provide assistance to help them prepare subloan applications. To enable the poor to participate in the Project (i.e. to be eligible for Component A of the Project), they will be provided with basic biogas facilities such as biogas digester, pig pen and other equipment which form part of their own equity contribution, in addition to their labor, for application of Project financing to undertake the biogas production investment. A traditional household assistance model will be adopted to provide assistance to the poor families. It involves assigning a better-off and more experienced household to aid the disadvantaged and poor family on a one-to-one basis to provide technical assistance and support to enable the poor family to successfully adopt the biomass technology. Support to the poor and

¹⁹ The disadvantaged and poor farmer, as defined in the Project, is one who (i) has per capita income of less than Y1,000/year, (ii) has limited formal education; (iii) is dependent on coal, firewood, and crop straw for heating and cooking, (iv) lives under poor sanitary conditions; and (v) lives in less accessible villages.

disadvantaged farmers is important because they constitute about 3 million of rural population in the Project provinces and because they are the main users of polluting energy (coal and firewood). The Poverty Alleviation Office in PRC receives substantial budget from the national government (over \$600 million annually) and its rural county offices are actively involved in the Project implementation activities for this component. The component will be implemented in two phases. Phase 1 (year 1 to 3) involves the selection and provision of assistance to about 15 percent of Project beneficiaries who live below poverty line (about 2,353 households).²⁰ GEF fund will be used to introduce this improved approach in phase 1. In phase 2 (year 4 to 5), the Government, through its Poverty Alleviation Office, will continue to pilot test this approach using its own resources. Successful outcome of this component will enable the Poverty Alleviation Office to replicate the activity to other provinces.

f. Component F: Improve Project Implementation and Capacity Development

77. The component will provide consulting services to strengthen technical support coordination, improve the implementation capacity of the executing agencies, and strengthen their institutional capacity to manage and supervise Project implementation activities. The Project will involve the Foreign Economic Cooperation Center (FECC) within the Ministry of Agriculture (MOA), and the provincial governments of Jiangxi, Hubei, Henan and Shanxi as executing agencies. The Project county financial bureaus will serve as Project implementation agencies. The Project implementation capability at both the national and provincial levels will be strengthened through technical support, incremental staffing and provision of training to both the finance and technical personnel. Extensive training in financial management and credit provision will be provided to the staff of finance bureaus. Consulting services will be provided to strengthen the EAs institutional capacity to implement and monitor all Project activities. The executing agencies will be supported technically and financially to assume the coordination and monitoring evaluation functions both at the provincial and county levels.

C. Cost Estimates

78. The total cost of the Project is estimated at \$77.3 million including price and physical contingencies, interest during implementation, and other charges including front-end fees, taxes and duties. Of the total cost, about \$36.3 million or 47 percent is in foreign exchange cost and \$41.0 million equivalent or 53 percent in local currency cost. A summary of the cost estimates is given in Table 2 and details are given in Appendix 3. About 79 percent of total base cost will be spent on component (A) on renewable energy development and eco-environment and about 10 percent on component (F) on improving Project implementation and capacity development. Component (F) has larger than normal expenditure item due mainly to allocating all PMO consulting services (both international and domestic as given in para 90) under this component. In practice, the services of PMO consultants will be distributed among all components. The interest and other charges, totaling to about \$5.3 million, are calculated based on current LIBOR-based interest rate of 3.8 percent.

²⁰ There are about 3 million poor households in the four Project provinces. Based on an average poverty percentage of the poor in the Project provinces (ranging from 12% to 18%) and discussions with MOA and Poverty Alleviation Office officials, about 15 percent of the Project beneficiaries (2,353 poor households) who are living below the poverty line will be selected to pilot test this biomass development approach during phase 1 of Project implementation (first 3 years). This is to be followed by phase 2 (year 4 to 5) of assisting 2,597 poor households by Poverty Alleviation Office. Successful outcome of this approach would enable the Government to replicate this activity in other areas.

Table 2: Summary of Project Cost Estimates
(\$ million)

Item	Foreign Exchange	Local Currency	Total Cost
A. Base Cost			
1. Funding for Renewable Energy Development and Eco-environment	23.66	24.77	48.43
2. Improve Mechanism for Transferring Biogas Technology	0.27	0.77	1.04
3. Rehabilitate Farm-to-Market Facilities	0.24	0.78	1.02
4. Improve Environment Policy Implementation and Awareness	0.50	1.22	1.72
5. Pilot Poverty-Focused Approaches to Biomass Development	0.06	2.72	2.78
6. Improve Project Implementation and Capacity Development	1.64	4.86	6.50
Subtotal (A)	26.37	35.12	61.49
B. Contingencies^a			
1. Physical Contingencies	2.64	3.50	6.14
2. Price Contingency	1.78	2.38	4.16
Subtotal (B)	4.42	5.88	10.30
C. Interest Charges During Construction			
1. Front-end Fee	0.33	0.00	0.28
2. Commitment Fee	0.28	0.00	0.28
3. Interest Charges ^b	4.66	0.00	4.71
Subtotal (C)	5.27	0.00	5.27
D. TA Preparation Cost	0.21	0.00	0.21
Total	36.27	41.00	77.27

^a Physical contingency is assumed at 10 percent of base cost. Price contingency is calculated based on price escalation factor as a local currency: year 1 is 3 percent and year 2 onwards is 2 percent; foreign currency: year 1 onwards is 2.4 percent.

^b Interest charges are based on current LIBOR-based of 3.8 percent plus a spread of 0.6 percent.

D. Financing Plan

1. Sources

79. A summary of the financing plan is given in Table 3. Of the total cost of \$77.3 million, the Government has requested ADB to provide a loan of \$33.1 million (43 percent of total cost) from ordinary capital resources (OCR) to help finance the Project. The loan will finance 91 percent of the total foreign exchange cost of the Project. The loan will have a 25-year term, including a grace period of 5 years, an Interest rate determined in accordance with ADB's LIBOR-based lending facility, a commitment charge of 0.75 percent per annum, a front-end fee of one percent, conversion options that may be exercised in accordance with the terms of the draft loan agreement, the loan regulations and ADB's conversion guidelines, and such other terms and conditions set forth in the loan agreement. The provincial governments will contribute \$23.6 million and the beneficiaries \$14.2 million. The Global Environmental Facility (GEF) is envisaged to provide \$6.4 million on a grant basis.

Table 3: Financing Plan
(\$ million)

Source	Foreign Exchange	Local Currency	Total Cost	Percent
ADB	33.12	0.00	33.12	43
Local Governments	1.10	22.49	23.59	31
Beneficiaries	0.00	14.20	14.20	18
GEF ^a	2.05	4.31	6.36	8
Total	36.27	41.00	77.27	100

^a Details and components to be financed by GEF are given in Appendix 3, Table A3.3.

80. The local counterpart currency requirements will be provided by the participating provincial, municipal, county, and township governments through annual budgets, and by the Project beneficiaries, including the private enterprises. Loan funds repaid prior to ADB maturity date will be revolved by the relevant municipal and county finance bureaus for further financing type I and type II investments, particularly to the disadvantage and the poor farmers.

2. Relending and Onlending

81. PRC is the Borrower of the ADB loan. On behalf of the Borrower, MOF will enter into subsidiary loan agreement (SLA) with Jiangxi, Hubei, Henan, and Shanxi provincial governments. MOF will relend the proceeds of the ADB loan to the four provincial governments at the same rates and terms for financing component (A): Funding for Renewable Energy Generation and Eco-environment Development. The funds will be onlent to the municipal, county, and township finance bureaus at the same rates and terms as the ADB loan. The concerned finance bureaus (county and municipal level), in turn, will be responsible for channeling the loan proceeds and counterpart funds to the eligible enterprises, and to the eligible farmers through the township government finance bureaus. The ADB loan proceeds will be used to finance 50 percent of the cost of each subproject²¹. The government and the beneficiaries will contribute the balance of the investment cost which will blend into the ADB loan. The finance bureaus will be responsible for recovery of the loan proceeds, foreign exchange and interest rate variation risks for the small-scale borrowers (type I and II), and servicing the debt obligations of the Borrower. However, for the medium scale biogas and gasification plants (type III and IV), the subborrowers will bear the foreign exchange and interest rate variation risks.

82. Farmer and enterprise beneficiaries will enter into legally binding contracts with the relevant PIUs and the finance bureaus (county, municipal, or township) on terms and conditions of the investment loan. The onlending interest rates to the farmers and enterprises would be no less than the prevailing commercial bank rate for similar loans and terms. The repayment periods will be based on the projected cash flow and profitability of each type of investments. For the type I and II investment, the township will onlend to the farmers in local currency with repayment period of not more than 10 years and a grace period of not more than 5 years. For the type III and IV investments for the enterprises, the municipal or the county finance bureaus

²¹ Type I technology subproject cost ranges from \$2,000 in Henan to \$3,000 in Shanxi. Type II technology subproject cost ranges from \$2,250 in Hubei to \$3,000 in Henan. Type III biogas plant is estimated at \$235,784 per unit, and Type IV gasification plant costs about \$13,814 per unit.

will onlend the ADB loan funds in US dollars with repayment terms of 5 to 10 years, and a grace period of 3 to 5 years, depending on the projected cash flows and profitability of the investment subprojects.

83. The finance bureaus²² will review and appraise each subloan application and evaluate its merits based on criteria to be established by the Project. The subloan approach is demand-based and only the qualified applications will be approved. The eligibility criteria for all types of applicants are given in Appendix 4. Funds from ADB and the Government will be blended in a package based on onlending interest rate as described above. Beneficiary contributions can be in the form of labor, existing assets, and cash contribution.

E. Implementation Arrangements

1. Project Management

84. While the detailed implementation arrangements vary from one province to another, the Project will have the following organizational and management structure (see also Appendix 4). A National Project Coordination Committee (NPCC) which will serve as the policy-making body of the Project, will be established at MOA in Beijing to provide guidance to the four Project provinces on all aspects of policies, implementation, coordination, and resolving issues beyond the control of provincial governments. NPCC is comprised of a Vice Minister of MOA as the chairperson with senior directors from State Development and Planning Commission (SDPC), MOF, SEPA, and representatives of MOA in the Department of Development Planning (DDP), Department of Research, Education and Rural Environment (DRER), Poverty Alleviation Office, and FECC as members. At the National level, a Project Management Office (PMO) is established at the FECC for overall Project management, coordination, training, recruitment of consultants, and other implementation and monitoring activities. The PMO is the secretariat of NPCC and the PMO Director serves as the secretary for the NPCC. The functions of the PMO include: (i) supervising feasibility studies of subloans (medium scale biogas and biomass gasification plants, (ii) reviewing overall Project annual work programs and budgets, (iii) supervising procurement activities, (iv) coordinating and compiling Project progress reports submitted by PIOs, (v) developing monitoring indicators, establish monitoring system, and evaluating overall Project performance, (vi) recruiting and supervising consultants, and (vii) providing technical and management training including training provincial officials on the adoption of Project Performance Management System (PPMS).

85. The four provincial governments are the executing agencies of the Project. A Provincial Leading Group (PLG) is established at each province to oversee Project implementation, review and approve Project plans, source counterpart funding, inter-sectoral coordination, and providing guidance and advice to resolve field level Project implementation issues. The PLG is comprised of a Vice Governor as the Chairperson, with senior directors of the Department of Agriculture, Development Planning Commission, Department of Finance, Women Association, Bureau of Environment Protection, Audit and other relevant bureaus as members. Under the administrative control of the provincial Department of Agriculture, a Project Implementation Office (PIO) is established to manage and oversee Project implementation activities in each province. The duties of the PIO include (i) organizing and compiling all medium scale biogas and biomass gasification feasibility studies and investment plans of type I and II subprojects; (ii) drawing up annual work programs and budgets; (iii) applying approved selection criteria in

²² The capability of the finance bureaus to assess subloan applications in the four provinces was thoroughly reviewed and it was found that they have the experience and capability to undertake the tasks as required under the Project.

selecting subprojects of large scale biogas plants, (iv) reviewing and approving county PIUs work plan and verifying cost of the proposed subprojects; (v) supervising and managing procurement activities; (vi) supervising construction, inspection, and acceptance; (vii) monitoring physical and financial progress and setting up PPMS for results monitoring evaluation; (viii) coordinating and compiling progress reports submitted by PIUs; (ix) conducting, in coordination with the county and township implementation agencies, periodic socioeconomic surveys to monitor Project impacts; (x) preparing and submitting withdrawal applications to ADB. The PIOs also serve as the secretariat for the PLG. The PIOs is staffed with trained and qualified technical, financial, and management personnel and headed by a senior provincial government official as the PIO Director. To ensure strong financial management of the Project, a senior official from the provincial Department of Finance is appointed as the Deputy Director of the PIO to manage all financial aspects of the Project.

86. The municipal and county governments are the PIUs for field level Project activities. The PIUs are located at the Bureau of Agriculture and supported by local Bureaus of Livestock, Renewable Energy Offices, Poverty Alleviation Offices, and other relevant technical agencies. The municipal and county PIUs in turn work closely with the Township governments and village committees, and civil society organizations such as Women Associations, research institutes, universities, etc.

87. The Provincial Finance Bureaus (PFB) are responsible for management of the Project finances. The Project funds will be released from PFB to the municipal and county Finance Bureaus, in accordance with the recommendations of PIOs, and in turn disbursed to Project beneficiaries. The disbursement, repayment and other finance activities will be channeled through the relevant finance bureaus for the medium scale biogas and biomass gasification plants; and through township Finance Offices to the farmer beneficiaries or rural cooperatives (legal entity) in cases of small biogas investors.

2. Implementation Schedule

88. The Project will be implemented over a period of five years commencing in 2002 (see Appendix 5). In 2004, ADB and the Government will jointly undertake a comprehensive midterm review of the Project to assess the implementation status, review the project parameters, and take appropriate measures to further improve the implementation efficiency of the Project to ensure the achievement of Project objectives and the anticipated socioeconomic impacts.

3. Procurement

89. All goods and services to be financed by the ADB loan and GEF grants will be procured in accordance with the ADB *Guidelines for Procurement*. Most of loan funds will be used by subloan borrowers to construct small and medium scale biomass systems integrated with existing agriculture production. Procurement will be mainly for environment monitoring and training equipment. Most of this equipment is simple and available locally and will be procured by the respective provincial PMOs. Supply contracts for equipment and materials is estimated to cost less than \$500,000 and will be done by international shopping or local competitive bidding and those estimated to cost less than \$100,000 will be done by direct purchase. The civil works for rehabilitation of local farm roads and bridges are simple and the material will be provided by local governments and PIUs with volunteer labor from the local farmers. Other civil works associated with the provision of basic biogas facilities to the poor farmers are relatively small, they are unlikely to be of interest to foreign contractors and will be carried by force account basis. An indicative procurement package is given in Appendix 6.

4. Consulting Services

90. Consulting services will be required to assist the executing agencies, through the Project Management Office (PMO) and Project Implementation Offices (PIOs). All consulting services will be financed by the GEF grant. International consultants will be selected and engaged through a firm in accordance with ADB's *Guidelines on the Use of Consultants*. For domestic consultants, they will be recruited on individual basis through arrangements satisfactory to ADB. The consultants will assist the Government to address key barriers that are contributing to lack of wide spread dissemination and expansion of biomass renewable energy systems. Both international and domestic consultants will be engaged to develop synchronized programs to help in removing the barriers and oversee the implementation of selected activities, assist to set up institutional strengthening programs to raise the skills of contractors, farmers, and Project staff, and develop an environmental monitoring and measurement program. About 45 person-months of international consultants and 117 person-months of domestic consultants will be required under the direction of the PMO and another 142 person months of domestic consultants under the direction of the PIOs in the four provinces. Terms of references for the consulting services are given in Appendix 7.

5. Disbursement

91. The Borrower will disburse subloans and eligible expenditures under the Project through (i) imprest accounts to be established at PIOs immediately after the effective date of the Loan Agreement, or (ii) ADB's direct payment, commitment, or reimbursement procedures. The imprest account will be established within the four provincial governments. Initial advances will be equivalent to the PIOs' anticipated disbursements to subborrowers over a six-month period or 10 percents of loan proceed whichever is less. The imprest account will be established, managed, replenished, and liquidated in accordance with ADB's *Loan Disbursement Handbook*, as amended from time to time. ADB's statement of expenditures procedure will be used to liquidate advances provided into the imprest account. The accounting systems and internal control procedures of the Department of Finance in the four project provinces are assessed. Their financial controls and discipline are adequate for the application of the statement of expenditure procedure.

6. Project Accounts, Audits, and Reports

92. Municipal and County PIUs will maintain records and accounts in accordance with sound accounting principles, and sufficiently detailed to identify subloans and subprojects financed by the loan and to disclose the use under the Project. The records and accounts will be forwarded regularly to the provincial PIOs. PIOs will maintain records of all expenditures and prepare consolidated project accounts. The PIOs will ensure that the consolidated provincial project accounts are forwarded to PMO at MOA for final consolidation and to be audited annually by independent auditors acceptable to ADB. The PMO and ADB will review these records on a random basis. The audited reports will be submitted to ADB not later than 9 months after the end of the fiscal year. PMO, in coordination with the PIOs, will submit consolidated semi-annual progress reports to ADB within three months of the close of the semi-annual period. The semi-annual progress reports will follow the Project Performance Report (PPR) format proposed by ADB and should contain (i) physical and financial accomplishments; (ii) Project performance indicators; (iii) problems accounted or anticipated and actions taken; and (iv) a work plan for the next report period; among others. Within six months after Project completion, the PMO will prepare, in coordination with PIOs, and submit to ADB a Project Completion Report

summarizing the loan utilization, Project implementation, the attainment of objective and targets, and an objective evaluation of implementation experience and Project performance rating. The EAs and PIOs were informed on the ADB's new policy on submission of audited financial statements and the strict penalties for non-compliance.

7. Implementation Reviews

93. At the commencement of Project implementation, an inception mission will be fielded to finalize the Project Administration Memorandum. Details on implementation arrangements will be fine tuned and further details on the poverty targeting mechanisms and monitoring indicators will be formulated and agreed upon with the provincial governments. In year 2004, a midterm review of the Project will be done as part of Project monitoring and evaluation to further enhance the efficiency of Project implementation. Annual review missions will be conducted to assess implementation progress and examine appropriateness of the Project design and scope, the effectiveness of poverty targeting mechanisms, the criteria for credit assistance, and find ways to further improve Project implementation efficiency.

8. Project Monitoring and Performance Evaluation

94. PMO, in coordination with PIOs, will establish a PPMS system in PMO and PIOs to monitor and assess Project impact and achievement of the Project objectives. Sample surveys using the rapid rural appraisal method and household interviews will supplement and generate data and socioeconomic information for the PPMS. The impact on the target beneficiaries, particularly on the poor and disadvantage groups, will be monitored by the PIOs and PIUs with assistance from local Poverty Alleviation Offices and the Women Associations. Special poverty focused surveys will be conducted by local universities to complement the data generated under the PPMS and results monitoring evaluation.

9. Governance and Anticorruption Measures

95. During Project processing, ADB's anticorruption policy was explained to the national and provincial governments and to the PMO and PIOs in the four Project provinces. The Project officials were briefed on the anticorruption provisions which were incorporated into the ADB's *Guideline on the Use of Consultants*. Attentions were drawn on the need for PMO and PIOs staff to observe the highest standards of ethics in the procurement and implementing ADB-financed contracts to ensure that local consultant salaries are fully-paid without any deduction, and sanctions apply if fraud and corruption are discovered. Similarly, the section on fraud and corruption in ADB's *Guideline on Procurement* was also discussed with the Project officials.

96. The Government is increasingly concerned with governance issues and has conducted well-publicized campaigns against corruption. ADB's country assistance program is supporting the Government in improving governance and providing incentives to reduce the incidence of corruption in the long run. In 1997, ADB provided a TA 2845-PRC²³ to draft procurement regulations and standard bidding documents. This assistance culminated in the promulgation of the Law on Tendering and Bidding, which became effective on 1 January 2000. The law stipulates that bidding activities will follow the principles of openness, fairness, impartiality, and good faith. The law also specifies that no organizations or persons shall by any means limit or exclude legal persons or other organizations from other regions or systems from participating in

²³ TA 2845-PRC: Establishment of National Procurement Regulation for the Public Sector, for \$565,000 approved on 20 August 1997.

the bidding procedure; no illegal interference in any form is permitted in the bidding process. Bribes and collusion are prohibited by means of appropriate sanctions for all abuses of the law, including substantial fines and criminal prosecutions. Work is underway under TA 3457-PRC (Implementation of the Tendering and Bidding Law and Related Regulations) to help develop and strengthen the implementation of the Tendering and Bidding Law and related regulations on procurement in the public sector at the national, provincial, and county municipality levels. In 1998, ADB provided a second TA 3138-PRC²⁴ relating to the consulting industry and auditing that include the main elements of ADB's anticorruption policy. In the TA, detailed guidelines were developed for selecting and engaging consultants. The Government's auditing system is being strengthened to conform to the requirements of the Audit Law and, as far as practicable, international auditing standards. ADB is now working with the Government under TA 3631-PRC: Formulation of the Government Procurement Law to support good governance, including efforts to combat corruption and ensure the rule of law through the establishment of a sound legal framework for the development of the Government's procurement system.

F. The Executing Agency

97. The MOA through FECC at the national level, and provincial governments in Henan, Hubei, Jiangxi, and Shanxi through their Departments of Agriculture at the provincial level will be the EAs of the Project. All the EAs involved in this Project have considerable experience in implementing not only locally funded projects, but have also implemented foreign assisted projects such as those funded by the World Bank, FAO, IFAD, UNDP, and those funded by bilateral agencies. The EAs have established a permanent PMO and the provincial PIO organizational structure to be used by this Project. The EAs performance in past foreign funded projects has been satisfactory. The Project staff are full time permanent staff and have significant project implementation experience.

G. Environmental and Social Measures

1. Environmental Measures

98. An initial environmental examination (IEE) was undertaken and the summary of IEE (SIEE) was prepared during Project preparation. Subsequently, each subproject investment will be required to prepare its IEE or EIA report and submit to the respective environmental authorities for approval. The IEE concluded that the proposed Project would promote efficient utilization of agricultural waste products to improve the physical environmental in the rural areas. The environmental benefits of the Project will include reduction of CO₂ and SO₂ emissions; eliminate non-point pollution from intensive livestock production; and stop exploitation of forest for fuelwood. The Project benefits will also include improvement in health and increase vegetative coverage of non-productive lands with fruit trees. The IEE also concluded that the adverse environmental impacts arising from the four type subprojects will be minimized to acceptable levels through the implementation of mitigation measures and monitoring programs included in the Project in compliance with the ADB's environmental requirements and those applicable at the national, provincial, and county levels.

99. To ensure that all applicable national, provincial, and local environmental regulations and standards, as well as ADB's environmental requirements, will be met during implementation

²⁴ TA 3138-PRC: Regulatory Framework for the Engagement of Consultants, for \$700,000 approved on 22 December 1998. TA 3103-PRC: Strengthening the Government Auditing System, for \$700,000 approved on 26 November 1998.

of the Project, an environmental management and monitoring program will be prepared by PIOs at each province within six months of loan effectivity and will include the following elements: (i) an environmental management structure for the Project including responsibilities; (ii) detailed measures to improve the quality of the site environment; (iii) initial environmental examination of each subproject; (iv) a program for training and education of staff to ensure that they are up-to-date on all aspects of the subproject, particularly technology and the environmental implications; (v) relevant environmental monitoring systems for selected sites, and (vi) conduct of impact assessment during and after completion of the subproject ensuring that applicable environmental regulations are adhered to by the investors.

100. The Provincial Agricultural Stations will be responsible for the implementation of the Environmental Management and Monitoring Program; and the Provincial Environmental Protection Bureaus (PEPBs) will oversee the implementation of the program. Monitoring results will be reported in the semi-annual progress reports on project implementation and annual reports in environmental monitoring. An environmental evaluation report will be carried out one year after completion of the Project. This will be done in collaboration with the Environmental Protection Agency in each province. MOA will provide these reports to ADB. If any subproject is cited for a violation of any regulation, law, standard, or ordinance related to environmental protection within the reporting period, it must include a certification from the environmental authorities concerned that the defect has been corrected or a corrective action plan has been accepted or approved.

2. Public Consultation

101. From the time when MOA proposed the Project for ADB funding in 1999, there has been extensive consultations with all levels of stakeholders. In the four Project provinces, MOA held meetings with senior officials at all levels of government down to the municipalities and counties. Officials from the provincial Rural Energy Offices held extensive discussions with Village Committees who in turn held public consultations with villagers. During Project preparation, public consultation included 43 public meetings, 63 in-depth interviews, 11 participatory assessments, and 150 household interviews. Villagers were engaged in focus group meetings with participants from: Village People's Committee, community leaders, elders, women representatives, and youth associations to collect broad-based opinions on the Project. In depth interviews were done to understand socioeconomic, poverty, and environmental implications of the Project. Particular attention was given to foster the participation of villagers, in particular women, during Project preparation.

3. Social Analysis

a. Social and Poverty Assessment

102. The Project will be implemented in about 150 villages in 38 counties. A detailed social and poverty assessment is given in Appendix 9. All four Provinces have experienced rapid growth in Ninth Five-Year Plan with annual GDP growth ranging from an average of 7.9 percent in Jiangxi to 10.1 percent in Henan. Total rural population in the participating counties is 17.3 million people with average annual per capita income ranging from Y1,906 in Shanxi to Y2,269 in Hubei. Over half of the population have average annual income below Y2,000. The average farm size in the four provinces ranged from 3-5 mu²⁵ with an average household size of 3.7 person. The main sources of household income are from crops, livestock and seasonal off-farm

²⁵ 15 mu is equivalent to 1 ha.

employment. Within a village, households share similar livelihoods, assets, and living standard. The majority of the poor villages are located in degraded hilly land with limited resources and rural infrastructure.

103. In the Project counties, 14 percent of the population are without access to clean water and about 60 percent of the villages have inadequate or poor sanitation. Less than half of the households have toilets and waste disposal facilities. About 12 percent of villages in Project areas have no access to basic health services. Lack of fuel and water are the two main problems most often encountered by the household women. Main sources of household energy for cooking are fuelwood, straw, and coal. Women often have to walk several kilometers to fetch water. Excessive use of agro-chemicals in current farming practices and the health implications to farmers and consumers are of general concern to farmers.

104. Financial services in the Project areas are not well developed. Access to credit is a major problem among the small farmers who have no collateral. For farmers with access to small loans, the loans are given only for short periods of three to twelve months. In view of longer production cycle of agriculture, farmers need longer-term credit with at least 2 years repayment period for annual cropping systems and 10-year repayment period for perennial crops.

105. Analysis of income distribution in the Project area showed that about 3 million people living in the Project area are poor and live in poverty. The percentage distribution of population living below poverty line in the Project areas are about 28 percent in Shanxi, 21.4 percent in Jiangxi, 18 percent in Henan, and 12 percent in Hubei. Participatory poverty assessments and field information collected indicated the Project rural population can be classified into four district income groups:

- (i) **Absolute Poor:** This group consists of families with an average income of less than Y700 per capita per year. This group includes about 1.4 million or approximately 7.9 percent of population in the Project counties. These families require assistance to meet their basic needs. They are those who are incapable of working and of taking care of themselves, such as the old, sick, disabled, and widows living alone; and (ii) those who live in areas of poor physical resources and do not have the know-how to better utilize the assets they have. In general, they are with very low levels of education, illiterate, and without access to information.
- (ii) **Poor:** This group consists of families with income of between Y700 and Y1,000 per capita per year. They consist of 9.4 percent of the population in the Project area. In general, these households receive their main income from rainfed agriculture. Their main sources of household energy are fuelwood, straw, and low-grade coal. These households usually have access to land and labor but have no access to information and credit.
- (iii) **Vulnerable Poor:** This group consists of families with an estimated average income of Y1,000 and Y2,000 per capita per year. It is the largest group (about 40 percent) in the Project area. Their production systems ranged from rainfed areas of larger sized land (>10 mu) to small irrigated areas (3-4 mu). The income of these families just about covers all the family needs. Sources of household energy are similar to the poor. Household heads are generally literate and well informed but have no access to credit.

- (iv) **Non-poor:** This group consists of families with average per capita income of higher than Y2,000 per year. It includes progressive farmers, traders, and owners of local cottage industries. The household heads generally have at least secondary school education and the families have assets that can be used as collateral for credit. In more accessible areas, households in this group use LPG for cooking, coal for heating, and electricity for lighting.

b. Gender Analysis

106. Women in the Project areas are in general faced with inequality in social status, in access to resources, in access to assets especially housing and credit, and in decision-making. In addition to household work, women in the Project areas hold main responsibilities for on-farm activities. This is due partly to the fact that 30-40 percent of men in the Project areas do off-farm jobs in or outside of their villages. In most cases, men only work on agriculture activities during the peak season leaving the women with farm works throughout the year. In most cases, the responsibilities of collecting fuelwood, straw and fetching water are undertaken by women. Statistics confirmed that women work 25 percent longer hours than men and thus have less leisure and sleeping time.

107. Due to the lack of clean energy for cooking and heating, women in these households are constantly exposed to smoke, dust and therefore have a higher risk of respiratory diseases. Thus, the Project output to generate clean renewable energy (biogas) will benefit women significantly. With access to biogas for cooking, about one hour of cooking time will be saved each day and potential health risk will be significantly reduced. In addition, time will be saved on collecting fuelwood or straw for cooking.

108. Because the illiteracy rate among adult women in the Project areas is doubled to that of men, women are in a disadvantage position in absorbing new information and technologies. To address this, the Project will develop special training materials and training courses targeted at women. Training sessions will be designed to suit the schedule of women and arrangement for household care will be organized to enable the women to attend training courses. Training will be provided both on farming activities, operation of biogas digester, and other women empowerment topics. Through the participatory process carried out during the Project preparation, local officials are more aware that women hold the key to the success of Project and therefore have given special attention to ensure that women are represented in all aspects of Project operations.

V. PROJECT JUSTIFICATION

A. Financial and Economic Analysis

1. Incremental Outputs

109. The Project will provide funds from which borrowers may draw as credit for investment in four types of biogas systems. About 4,700, 10,900, 14, and 28 units of Type I, II, III, and IV biogas systems, respectively, will be established under the Project.

110. In the Shanxi and Henan provinces, a total of 18,800 mu (1,253 ha) will be cultivated under all Type I biogas systems mainly comprising of greenhouse vegetables (e.g., onion,

melon, and cucumber), grains (i.e., winter wheat, maize, soybean, millet, and mungbean), and livestock, such as pigs and a few head of sheep and goats. Incremental annual vegetable production generated by Type I biogas systems is estimated at 882 t. Total annual incremental grain production is about 312 t while annual incremental pig production is 105,750 head or about 10,575 t (at 100 kg/head). All Type I biogas systems will generate a total annual incremental production of 2.82 million cu m of biogas, 183,558 t of digested effluent, and 44,310 t of sludge.

111. Type II biogas systems, mainly in Hubei, Henan, and Jiangxi provinces, will generate an annual incremental of 209,280 tons of citrus production. Total annual pig production under these systems is projected to increase from 21,800 head (or 2,180 tons of pork) to 109,000 head (10,900 tons of pork) or an incremental production of 87,200 head (8,720 tons of pork). The Type II systems will generate an incremental production of 6.5 million cu m of biogas, 138,213 t of digested effluent, and 33,365 t of sludge which will be used by the farm household.

112. Type III biogas systems will generate an annual incremental production of about 1.2 million cu m of biogas, 96,830 head of pigs (or 9,683 tons of pork), and about 246,500 tons of digested effluent and sludge. The Type IV gasification systems will generate an annual incremental production of about 31 million cu m of producer gas.

113. Appendix 8 Table A8.2 provides the details on the production figures of each type of the biomass system. The total projected incremental production of crops and livestock accruing to the Project is less than one percent of current agricultural production in the Project area. Their impact on local prices of these commodities will be insignificant.

2. Financial Analysis

114. Financial analysis was carried out for each of the four types of biomass systems. Assumptions underlying the analysis are presented in Appendix 8. The financial performance of each individual biogas system was assessed using financial ratios which provide information on the capability of these systems to: (i) cover operating expenses (i.e., operating ratio); (ii) generate returns (income ratios such as return on sales, return on equity, and return on assets); and (iii) cover financial obligations (i.e., current ratio, debt service ratio, and debt coverage ratio). The operating ratios of the biogas systems range from 35-93 percent with Type II biogas systems exhibiting the lowest and Type III systems, which incur relatively higher operating costs, exhibiting the highest values. All systems exhibited income ratios higher than the average cost of capital of 4.3 percent and all were found to generate adequate funds from their operations to cover financial obligations as exhibited by the creditworthiness ratios (i.e., current ratio, debt service coverage ratio, and debt coverage ratio) which were all greater than one (Appendix 8).

115. Financial farm analysis for each biomass system was undertaken (details are given in Supplementary Appendix D). The financial analysis for Type I biogas system is based on two Type I sub-systems: (i) Type Ia system which compares full technology adoption vs traditional technology; and (ii) Type Ib system which compares full technology adoption vs improved technology. Farms under Type Ia system will generate annual incremental benefits of about Y4,013 (or \$485) while those under Type Ib system will produce about Y2,478 (or \$299) in annual incremental benefits. In the case of farms operating Type II biogas systems, the financial farm budget analysis indicated that farmers' income would increase by about Y14,254 (\$1,724) per annum at full production. Type III biogas systems will generate an annual incremental

income of Y377,416 (\$45,637) while newly constructed Type IV gasification systems, which will realize an annual net income of Y246,396 (\$29,784).

116. The results of the financial analysis indicate that each type of system is financially viable (see Appendix 8 Table 8.8). The financial internal rate of return (FIRR) for the small biogas type Ia system yields a FIRR of about 16 percent; type Ib system, 17 percent; and type II, 17 percent. For the medium scale type III biogas plant, the FIRR is about 16 percent while the type IV gasification plant, the FIRR is about 14 percent. The sensitivity analysis indicated that the FIRR value of all types of biogas systems is sensitive to changes in revenue and production cost as implied by the sensitivity indicator which exhibited a value greater than one for each corresponding change in revenue, production cost, or both. A delay in benefits by one year will not significantly affect the FIRR value of each type of biogas system. The FIRR is also not sensitive to changes in exchange rate. In the sensitivity analysis, a 30 percent devaluation rate in the Yuan exhibited a sensitivity indicator of less than one. The summary of the results of the financial and sensitivity analyses is presented in Appendix 8 Table A8.8.

3. Economic Internal Rate of Return

117. Based on economic benefits derived from investments in biogas systems, the EIRR for the whole Project is estimated at about 18 percent. Details are presented in Appendix 8 (Table A8.11).

118. The analysis indicated that the Project as whole is not sensitive to changes in revenue and production costs as the sensitivity indicators, in general, exhibited values close to one. A delay in Project benefits by one year indicated insignificant effect on the base EIRR. More results and details of the sensitivity analysis are given in Appendix 8 (Tables A8.12 and A8.13).

4. Environmental Cum Economic Benefits

119. Current practices in rural PRC of burning agricultural crop residues *in situ*, spreading untreated manure on fields and using coal and firewood with high ash and sulfur content for cooking result in serious long-term negative environmental and health impacts. A reduction of these negative effects could be made by replacing traditional fuels (such as coal and firewood) with biogas. Improved use of agricultural wastes also results in a reduction of pollution and greenhouse gas emissions. The positive effects of adopting the four types of biomass systems include a reduction of carbon dioxide emissions, harmful emissions such as SO₂, soot, and dust and reducing time spent on collecting firewood or straw and cooking. The Project will also result in an improvement in the health of the beneficiaries and biogas is more convenient to use for lighting and cooking. Reduction in the amount of dumping of untreated solid and liquid wastes will result in lower levels of contamination in surface and groundwater. By substituting biogas for firewood, there is the added benefit of reducing exploitation of forests resulting in less soil erosion and flooding and better management of natural resources.

120. The Project will bring about significant benefits to the rural environment by converting large quantities of agricultural wastes (crop residue, livestock solid and liquid waste, domestic waste, etc.) into organic fertilizer and biogas (33 million cu m per annum) thus eliminating the pollution caused by agricultural wastes and reducing the burning of coal. The Project will improve the sanitation of farm households as sanitary wastes are easily disposed off in the digester thus alleviating the filthy conditions around and within the house, especially during the wet season. The use of organic fertilizer and year-round greenhouse vegetables and pig

production would enhance the quality and quantity of farm production, increasing farmers' income and generating incremental workdays.

121. The biogas produced will benefit the farm households in terms of savings in coal and other energy costs, savings in cooking time for the female household members, and better health. Project estimates on these are: (i) savings in fuel: annual fuel saving per household for each type of biogas system is about Y512 for households using Type I biogas system, Y624 for households using Type II biogas systems, Y77 for households using biogas from Type III biogas system, and Y187 for households using biogas from Type IV system; (ii) savings in cooking time: about one hour per day will be saved in cooking time when using biogas or producer gas instead of conventional fuels such firewood, coal or straw. Based on a 12 hour-day worked by the average woman and a daily wage of Y20, the average annual saving per household is about Y608 per year; (iii) impact on health: firewood and coal are inefficient fuels for cooking and can cause health problems connected to smoke inhalation. When biogas is used in cooking, there is a negligible emission of dust, soot, and carbon dioxide due to its chemical composition. The average household using biogas will realize a saving of Y30 per year in medical expenses; and (iv) carbon dioxide reduction: the Project estimated that the use of biogas will result in reduced annual carbon dioxide emissions of about: (i) 4.6 tons per household per year under Type I biogas system; (ii) 4.2 tons per household under Type II biogas system; (iii) 1.8 tons per household using biogas from Type III system; and (iv) 0.7 tons per household using biogas from Type IV system or an annual average of about 2.8 tons per household. The Intergovernmental Panel on Climate Change (IPCC) has calculated the damage cost of carbon dioxide emissions to be at about Y83 per ton or an average value of Y232 per household per year. Table 4 compares the carbon dioxide emissions of cooking with traditional fuels and that of cooking with biogas.

Table 4: Comparison of Emissions of Carbon Dioxide by Type of Biomass Gas System Used

No. of Households per Type	Type I 1	Type II 1	Type III 120	Type IV 600
By day:				
Emissions using traditional cooking (CO ₂ kg/day)	13.65	12.51	680.4	3,402
Emissions using biogas (CO ₂ kg/day)	1.16	1.19	97.2	2,172
By year:				
Emissions using traditional cooking (CO ₂ ton/day)	5.0	4.6	248	1,242
Emissions using biogas (CO ₂ ton/day)	0.4	0.4	35.5	792.6
Total CO ₂ reduction/year (tons)	4.6	4.2	212.5	449.4
Total CO ₂ reduction/year (%)	91.6	90.5	85.7	36.2

122. The results indicate that the percentage of carbon dioxide reduction through substituting biomass gas for conventional fuels is substantial. For example, in the case of Type I system, the reduction in carbon dioxide emissions using biogas in cooking is about 92 percent while for Type IV it is about 36 percent.

e. Unquantified Long-term Benefits

123. Future savings based on the reduction of damage to the environment and the ensuing reduction in clean-up costs are difficult to quantify. In addition, there are costs associated with reforestation which is required to absorb excess carbon dioxide and the cost of continued soil erosion and flood damage. The Project will reduce deforestation activities of poor households living near forests by introducing biomass technology as an alternative to fuelwood, and increase forest coverage by planting fruit trees on over 10,000 ha of degraded hillside land mostly in watershed areas. Organic fertilizer made available from biomass technology will replenish the land with macro and micro soil nutrients necessary for long-term sustainability of soil development. These benefits are significant, and will increase over the long-term.²⁶ The adoption of biomass gasification technologies will result in significant reduction of smoke from burning crop residues and this would lead to improved public health and reduce road and air accidents. Appendix 8 Table 8.14 provides further details on the positive environment impact of the Project.

B. Social Dimensions

124. The Project will improve the environment and overall farm productivity in Project areas through an integrated agriculture approach in which agricultural wastes will be efficiently used for production of low-cost and cleaner energy sources and improved agriculture production. The Project will address environmental poverty of poor and low-income people. The poverty reduction impacts of the Project will be considerable. Within the 5-year Project period, about 34,080 households will benefit directly from the Project intervention: 15,600 households will invest in small-scale biogas-farming system and 18,480 households will have access to clean energy from the medium scale biogas and gasification plants. The Project will have a demonstration effect to attract commercial sources of credit to provide loans for similar activities beyond the Project period. About 9,000 poor households with incomes of less than Y1,000 per capita per year will be lifted out of poverty during the Project period.

a. Income and Employment Impacts

125. For participating households, the average incremental household income for full adoption of Type 1 over the traditional farming system will be Y4,013 (\$485), an increase of about 36 percent. For Type 2, the average incremental household income will be about Y14,254 (\$1,724) or an increase of 73 percent over the without project situation. At full development, incremental agriculture products produced during the Project period will be: 882 tons of vegetables, 312 tons of grains, 209,280 tons of citrus and 289,780 head of pigs. An area of 8,066 ha of degraded mountainous land will be reforested with fruit trees.

126. Adopting Type 3 technology will generate 20,000 local jobs. For each biogas plant, 1,200 labor-days for construction will be required, and 30 jobs will be created in the pig farms. About 300 villagers (mainly women) will increase their earnings by raising piglets. Jobs will be created in the upstream and downstream sectors of the local economy, including feed processing, slaughtering, meat processing and transportation. Adopting Type 4 technology will result in financial benefits accruing to households through switching to producer gas for cooking and lighting. These benefits are derived from reduced medical expenses as a result of cleaner cooking conditions, estimated to be over Y1.0 million a year for the whole Project. In addition,

²⁶ Adopting the biogas producer systems will contribute to gradually reducing the destruction of forests as less firewood is burned. Forests act as carbon dioxide sink helping in the reduction in levels of carbon dioxide in the atmosphere. Denudation of the forests also contributes to soil erosion, flooding and changes in natural habitat. The Government recognizes the problem, and is investing in a major reforestation project.

the poor farm households will have the opportunity to earn income by bringing straws from the fields to sell to the biomass gasification plants.

127. Distribution analysis conducted on quantifiable economic benefits of the Project shows that the share of benefits accruing to the poor is about 21 percent of total Project benefit (Supplementary Appendix E). This poverty impact ratio of 0.21 indicates that the proportion of Project benefits that goes to the poor exceed the current poor's 10 percent share in national income.

128. In addition to overcoming income poverty, the Project will have impacts on human and environmental poverty. Sanitary conditions in the Project areas will be improved through proper disposal and treatments of animal and human wastes. The wastes will no longer be left to contaminate household water resources. Rather, through biomass technologies, they will be transformed to organic fertilizers for use in the local farming systems. Availability of organic fertilizers along with technical and marketing assistance provided by the Project will make it possible for farmers to adopt organic farming practices which will reduce their current health risks due to excessive exposure to agro-chemicals. Consumers of 'reduced-chemical' and organic agriculture products will benefit from improved quality of agriculture products produced by the Project. Environmental protection not only tackles non-point pollution problems in the PRC rural areas but also helps the poor who are most vulnerable to soil erosion, air and water pollution, and poor sanitary conditions.

129. Reduction of greenhouse gas emissions and reforestation activities will positively impact the global environment. At the community level, construction of type IV biomass gasification plants will reduce problem of air pollution due to burning crop residue in the fields. At the household level, availability of clean energy to replace fuelwood and coal will benefit daily livelihood of women both in terms of health and of time spent in firewood collection.

130. A pilot poverty-focused component is included in the Project design to target poor and disadvantaged households. Through the Project, local officials and the Women Association will help in social mobilization to enhance participation of the poor. Special training programs for low-skilled adult will be provided to the poor and disadvantaged households to increase their capacity to adopt biomass technologies. Because 40 percent of men are involved in off-farm employment to earn cash income and women are mostly responsible for household and agriculture work, special attention will be given to develop training programs for women. Demonstration farms will also be selected from poor households and women farmers will be encouraged to become lead farmers to train other farmers. The poor, particularly the poor women, will be empowered through special training programs and through the participatory process promoted by the Project.

131. Poor households with basic labor skills but with a lack of capital will be assisted by the Project through the provision of basic facilities in the form of a biogas digesters, pigpens, and other equipment. The selection of poor household beneficiaries will be carried out in a transparent manner through participation of representatives from Village Committees, Women Associations, Poverty Alleviation Offices, Rural Energy Offices, the Agriculture Department and representatives of poor households.

132. To facilitate adoption of the new farming system by the poor, a traditional household assistance model whereby rich or better-off households are assigned to aid poorer households on a one-to-one basis will be established to provide needed assistance. To facilitate the smooth implementation of the pilot poverty component, participatory poverty monitoring and feedback

system will be established and operated by the Project. Best practices of poverty alleviation experiences will be systematically documented and publicized among domestic and international development communities to benefit development efforts elsewhere.

133. Poor villages, which were physically excluded or inadequately linked to the transportation and marketing networks in the past, will be connected through rural roads construction financed under the Project. Identification of the location of farm-to-market roads and bridges to be constructed will be carried out in a participatory manner to ensure that the locations of infrastructures will serve the poor and disadvantaged households. The poor will also have a significant role in constructing infrastructure and maintaining infrastructure. The participatory process will foster community ownership and transparency in implementing Project activities.

C. Gender Impacts

134. At the household level, women will benefit from the availability of clean cooking energy which will reduce their exposure to smoke, dust, and therefore lower their risk of respiratory and eye diseases. With households and agricultural wastes properly disposed in biogas digester, and with reduced use of agro-chemicals, the immediate environment surrounding the women who spend most of their time in the farm and in the house will greatly improve.

135. Women will be empowered through training activities, through being supported as demonstration households and through participatory process promoted by the Project. Every effort would be made to ensure an equitable gender balance in selection of beneficiaries, with special consideration to women who are head of households. With the Women Associations involving in the implementation of the pilot poverty focus component of the Project, the needs and concerns of women will be sufficiently addressed.

D. Replicability and Sustainability

136. Replicability and sustainability of the biomass renewable energy systems nationwide will be better secured with the eventual outcome that there will be a very significant reduction in GHG emissions throughout the country. The Project design took into consideration of the lessons learned in the past decades of biomass technology development and adoption in PRC. The Project design will “glue” together all elements of biomass technology adoption incorporating existing farm production system, along with strengthening the institutions, technical capability, developing marketing facilities, promoting viable private service sector, and providing incentives and train service personnel for continued operation. The Project will require targeted research, institutional strengthening and capacity building, environmental monitoring, and technical expertise. Addressing the barriers will eventually reduce the costs of the biomass systems and improve the cost-effectiveness thus resulting in sustainability and replication. Health benefits are also derived throughout the region through cleaner air and water (i.e., reductions in point and non-point source pollution). An added benefit is the contribution that a healthier household makes to society in general. Rural households will realize increased annual and disposable income as a result of increased worker productivity and increased agricultural and livestock production. An increase in disposable income means increased spending locally and throughout the region as a result of the multiplier effect. Water quality improvements will be especially enhanced through wastewater treatments, and better farming practices including the use of organic fertilizers, reduced fertilizer applications, and improved disposal of animal wastes. The proposed biomass systems will reduce point and non-point sources of water pollution.

137. The Project's potential for replicability in other parts of China is excellent as it is a grass roots approach and is fully supported at all levels of Government. The Project constitutes a bottom-up approach within the overall policy framework that is envisaged to be developed by the Government under its Partnership Program for Renewable Energy Development. Addressing the various barriers and institutional strengthening will facilitate replicability since it will serve as an important demonstration effect and will create the required institutional, policy, and technical conditions to enable the mobilization of funds for the development of additional investments and wide expansion of the program. Within the Project, numerous replication activities have been included. These activities, among others, include study tours to neighboring provinces, training for government officials (including officials from the Ministry of Agriculture), seminars, workshops, exchange of technical visits and information with other non-project provinces, field days, media campaigns, exhibitions and other dissemination activities that will promote and expand the biomass technology information into other non-project provinces. The Ministry of Agriculture at the national level will also organize exchange programs between officials of various provinces in China to learn from each other on the latest development of biomass technologies resulting from Project investment.

138. Sustainability within the environmental context is also developed through the Project because renewable energy reduces the reliance on fossil fuel (coal) and biomass (firewood). A reduction in the use of these two fuels means reduced GHG emissions, and improvements in the forest sector has the added benefit of improving a natural emissions sink. The biomass system produces organic fertilizer, that has the effect of soil improvements, reductions in point and non-point pollution (by not using inorganic fertilizer) and improved agricultural outputs. Livestock are raised in more sanitary conditions by eliminating their waste through the biomass digester and enteric emissions are reduced, with the result of healthier livestock reaching the marketplace. Human health is improved, reducing the amount of time lost to sick days, increasing the household social structure, and improving the ability of household members to work and attend school.

139. Successful implementation of this Project will provide the demonstration effect for further enhancing the sustainability of Project with respect to:

- (i) long-term finance for small farmers – Component A will develop an appropriate financing model in the finance bureaus for adoption by rural financial institutions like Agricultural Bank of China and Rural Credit Cooperatives. The provincial governments have already provided a major share of the long-term finance under the Project. At the completion of this Project (after exhaustion of ADB line of credit), the provincial governments and the rural financial institutions will adopt the financing model that is successfully implemented under the Project to ensure sustainable financial support to small farmers who need assistance to adopt the biomass technologies. Replicability of Project finance is thus ensured;
- (ii) appropriate and effective environment programs and implementation: Environment awareness is currently very poor in rural areas. Component D will generate quality environment data and information would serve as an important demonstration effect for government to promote public awareness on environment protection in the rural areas and solicit political support to alleviate environmental pollution with regional significance. It will help to raise public awareness, train the government officials, and provide the

necessary data to formulate programs for effective implementation of national government environment policy contributing to sustainable development of biomass technology development; and

- (iii) involvement of disadvantaged and poor small farmers: The Project area has about 3 million poor. This is a significant proportion and sustainable development of biomass technology in rural areas must involve poor small farmers. The pilot poverty-focused component of the Project (Component E) will develop the most appropriate approach to enable the poor to participate in the Project and move out of poverty trap eventually. Successful implementation of this component will serve as a key demonstration effect for the Poverty Alleviation Office to continue this approach with its own fund after Project Completion, thus ensuring sustainability and replicability in other parts of the country. Successful implementation of this activity will result in replication action by government in other parts of the country.

E. Risks

140. The Project design includes measures to mitigate potential institutional, marketing, and technical risks. The Project is not expected to face major institutional or technical risks. However, the Project must ensure that the subborrowers are committed to participating in the Project and that they realize their obligations under the repayment terms for the subloans. There is also need to ensure that the provincial and county financial bureaus are capable of administering and manage the loan repayment schemes for different types of borrowers (Type I to Type IV). With regard to the latter, the Project financing scheme is similar to Loan 1386-PRC on Fujian Soil Conservation and Rural Development Project and the recently approved West Henan Agriculture Development Project. Experience from the Fujian Soil Conservation and Rural Development Project has been good and no major problems have been encountered in the financing scheme using the provincial and county finance bureaus to channel project fund and collect repayments.²⁷ Established criteria will be followed in selecting project beneficiaries. The EA of the Fujian project gave preference to poorer members of local communities. Project performance indicates that about 54,000 rural households of which about 37 percent are poor farmer families, have directly benefited from the development or rehabilitation of 20,000 ha of orchards/tea gardens/bamboo plantations and the development of lowland aquaculture. Average annual income increases have increased between 10 and 30 percent because of project activities. None of the participating farmers now have income below the poverty line and their quality of life has improved markedly. About 3,700 new employment opportunities have been created and market development has improved access and resulted in better prices for farm production. Key elements contributing to the Fujian Project's good initial performance include (i) adequate capacity to appraise investment fund and loan appraisals, (ii) good loan portfolio management, (iii) ability to establish an effective system for debt collection, and (iv) continue process of capacity building. These factors have been built into the Project design.

141. Another potential risk the Project could encounter is a lack of trained and experienced technical personnel in the private sector to help service and maintain the equipment. The Project design reduces this risk by providing substantial funding for training private contractors and lead farmers who would establish private enterprises in each Project county to provide maintenance and repair services. This will help to ensure sustainability of the Project activities.

²⁷ See PPR for Fujian Soil Conservation and Rural Development Project (Loan 1386-PRC).

VI. ASSURANCES

142. The National Government and the four participating provincial governments have given the following assurances, in addition to the standard assurances, which have been incorporated in the legal documents:

- (i) The PIO will include officials from Poverty Alleviation Office and Women Association in the committee to refine the selection criteria for the poor farmer participants before the final selection criteria are adopted. The criteria will be designed to ensure that at least 30 percent of the farmers selected are poor (farmers with low income, and who suffer from other dimensions of poor such as poor sanitary conditions, low level of literacy, over dependent of fire wood and coal for cooking and heating, etc.).
- (ii) Within twelve months of loan effectiveness, the EAs will establish a suitably staffed PPMS unit within the PMO and PIOs. The PIOs will conduct routine results monitoring evaluations and socioeconomic surveys, and report the results to the Government, GEF, and ADB.
- (iii) All activities supported under the Project (particularly the type III and IV models) will meet the national environmental standards and the EIA procedures which are based on ADB's *Environment Guidelines for Selected Agriculture and Natural Resources Development Projects and for Selected Infrastructure Projects*. No Category A or B subprojects will be approved for financing without an EIA report reviewed and approved by the respective Provincial Government' Environmental Protection Bureau.
- (iv) The MOF will relend the Loan fund to the Provincial Department of Finance, which will onlend the proceeds of the subsidiary loan to municipal and county finance bureaus at the same interest rates and terms as the ADB Loan. The provincial government will ensure that adequate counterpart funds are made available in a timely manner for PIUs to implement planned Project activities. With the exception of relending to Type III and Type IV enterprises, the municipal and county finance bureaus, where appropriate, will bear the foreign exchange risks.
- (v) The municipal and county finance bureaus will onlend their portions of the Loan fund to the end users at terms and conditions satisfactory to ADB and at a rate of interest not lower than the rates of interest for equivalent lending by commercial banks.
- (vi) The provincial governments will ensure that adequate counterpart funds are made available in a timely manner for PIOs and PIUs to implement planned Project activities.
- (vii) The PMO and PIUs will establish an internal audit unit during the construction and operation of the Project.
- (viii) Each province will ensure that the PIO will obtain, on a timely basis, all funds and resources necessary for the implementation of all Project activities, as well as maintenance and management of all Project assets.

- (ix) The Provinces will ensure that the facilities are constructed and operated in accordance with national and local government environment procedures and guidelines.
- (x) Each province will follow ADB's Policy on Gender Development during implementation of the Project and take all necessary actions to encourage women living in the Project areas to participate in planning and implementing the Project.
- (xi) Each province will monitor and evaluate Project impacts and effects through PPMS to ensure that the Project facilities are managed effectively and the benefits are maximized.

143. **Subproject Selection Criteria.** Each subproject shall meet the following criteria:

- (i) The purpose of each subproject shall be construction of biogas and biomass facilities using either type I, II, III or IV technology; and
- (ii) the subproject is located in the rural area in either of the four Provinces.

VII. RECOMMENDATION

144. I am satisfied that the proposed loan would comply with the Articles of Agreement of ADB and recommend that the Board approve:

- (i) The loan of \$33.1 from ADB's ordinary capital resources to the People's Republic of China for the Efficient Utilization of Agricultural Wastes Project, with interest rate to be determined in accordance with ADB's LIBOR-based loan facility, an amortization of 25 years, including a grace period of 5 years, and such other terms and conditions as are substantially in accordance with those set forth in the draft Loan and Project Agreements presented to the Board; and
- (ii) ADB administering a grant of \$8.5 million to be provided by the Global Environment Facility to the Government of the People's Republic of China for the Efficient Utilization of Agricultural Wastes Project.

Tadao Chino
President

00 December 2001

APPENDIXES

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SUPPLEMENTARY APPENDIXES

(available on request)

- A Description of Biomass Technologies
- B Summary of Initial Environment Assessment
- C Detailed Cost Estimates
- D Financial and Economic Analyses
- E Poverty Assessment
- F GEF Incremental Cost Analysis

PROJECT FRAMEWORK

Design Summary	Targets	Means of Verification	Risks and Assumptions
<p>1. Project Goal</p> <ul style="list-style-type: none"> • Improve environment; • Promote long-term sustainable agriculture productivity to enhance economic growth and to reduce rural poverty in disadvantaged areas in Henan, Hubei, Jiangxi and Shanxi Provinces. 	<ul style="list-style-type: none"> • Improved quality of air, soil, and water. • Increased clean renewable energy supply and improved quality of agricultural outputs; • Expanded rural production and decreased number of households living below the poverty line. 	<ul style="list-style-type: none"> • Provincial statistics; • Project Performance Management System (PPMS) reports; • Project Completion Report; • Environment Monitoring reports; • Results Monitoring Evaluation (RME). 	<ul style="list-style-type: none"> • Government policies are favorable to promote generation of renewable energy; • Sustainable Government investment in rural infrastructure; • Government remains committed to poverty reduction.
<p>2. Project Purpose</p> <ul style="list-style-type: none"> • Demonstrate economic viability of sustainable biomass technology for efficient utilization of agricultural waste for generation of clean, renewable energy and to promote private sector participation; • Enhance agricultural productivity and rural income through recycling of biomass resources and to reduce poverty. 	<ul style="list-style-type: none"> • Sustainable incremental annual production of <ul style="list-style-type: none"> - 41 million cubic meters of biogas/producer gas renewable energy; - 289,780 pigs; - 882 tons of green vegetable (comprising various types of greenhouse vegetables like cucumber, squash, tomato, etc.); - 209,280 tons of citrus fruit; - 645,932 tons of digested effluent/sludge (organic fertilizer); • Sustainable annual incremental environmental benefits estimated for: <ul style="list-style-type: none"> - 78,338 tons of carbon dioxide reduction; - Annual treatment of over a million tons of agricultural wastes (pig manure, crop residues, vegetable wastes, etc) resulting in improved air and groundwater quality; • Increased incomes and quality of life for about 34,080 household families, including about 9,000 poor household families. 	<ul style="list-style-type: none"> • Provincial statistics on agriculture and renewable energy; • Project Progress and PPMS reports; • Project Completion Report; • Postevaluation Report; • Environment Monitoring reports. 	<ul style="list-style-type: none"> • Market prices for renewable energy (Biogas) and agricultural products are favorable and stable; • Farmers respond favorably to efficient utilization of renewable energy and management of biogas technologies; • Sufficient counterpart funds are provided; • Appropriate policies on renewable energy expansion are implemented; • Provincial government officials capable of handling credit and debt repayment services.

Design Summary	Targets	Means of Verification	Risks and Assumptions
<p>3. Component/Output</p> <p>3.1 Funding for Renewable Energy Generation and Eco-environment Development</p> <ul style="list-style-type: none"> • Rehabilitation/construction of greenhouses for all year round organic vegetable production; • Establishment of orchards plantations for citrus production; • Construction of household biogas digesters, medium scale biogas plants, and biomass gasification plants. 	<ul style="list-style-type: none"> • Rehabilitate/construct 4,700 greenhouses for organic vegetable production under 4-in-1 model; • Develop 10,900 ha citrus, under the 3-in-1 model; • Construct 15,600 household biogas digesters each producing about 600 cubic m of biogas per year; • Construct 14 large scale biogas plants; each produce 87,600 cubic m biogas per year supplying to 120 households; • Construct 28 biomass gasification plants; each produce 1.1 million cubic m producer biogas per year supplying to 600 households; • 34,080 households benefiting cheaper biogas and cleaner environment. • About 31,200 farm beneficiaries trained in biogas technology; • 4,700 farmers qualified to produce “green” vegetables. 	<ul style="list-style-type: none"> • Project Progress reports and review missions; • PPMS annual survey; • NGO reports; • Environment Monitoring reports; • Project Completion Report; • Postevaluation Report. 	<ul style="list-style-type: none"> • Orchard farmers issued with land use rights long enough to provide them incentives for investing in land development and orchard establishment; • Provincial finance bureaus capable of administering credit disbursement and loan repayment; • Adequate technical services made available to advice and monitor construction and operation of biogas production units; • Sustainable operation and maintenance for biogas digesters; • Adequate quantity of straw for soil mulching.
<p>3.2 Introduce/ Improve Mechanisms for Transferring Biomass Technology</p> <ul style="list-style-type: none"> • Conduct courses for transfer of engineering and technical skills to biogas digester contractors; • Provision of Training and extension services beneficiaries and Project officials; • Conduct workshops and study tours to acquire biomass technology. 	<ul style="list-style-type: none"> • 120 biomass digester contractors and technicians trained to provide services to farmers; • About 33,000 farmers trained; • About 650 extension workers trained • 20 annual workshops conducted; • 100 study tours to neighboring counties/provinces. 	<ul style="list-style-type: none"> • Project Progress Reports; • Mid-term Review Report; • PPMS • PCR 	<ul style="list-style-type: none"> • Effective development of training programs by PMO; • Farmers and county officials training programs effectively carried out; • PIO officials effectively organized courses, workshops, and study tours.

Design Summary	Targets	Means of Verification	Risks and Assumptions
<p>3.3 Rehabilitation of Farmer-selected Farm-to-market Facilities</p> <ul style="list-style-type: none"> Development of rural infrastructure including farm-to-market access roads and bridges, and other rural marketing facilities at village level. 	<ul style="list-style-type: none"> Construct/rehabilitate 60 km farm-to-market rural roads and bridges/drainage in four provinces; 100 organized community groups participate in the construction and maintenance of the rural infrastructure facilities. 	<ul style="list-style-type: none"> Project progress reports and review missions; NGO and PPMS reports; Project Completion Report; Postevaluation Report. 	<ul style="list-style-type: none"> Farmers organized for O&M activities of rural infrastructure facilities; Adequate counterpart funds provided by provincial governments for construction and maintenance of major roads leading to farms
<p>3.4 Environment Protection and Monitoring</p> <ul style="list-style-type: none"> Barrier removal for adoption of renewable energy; Development of facilities and establishment of system for monitoring environment to assure high environmental standards for air, water, soil and farm produce; Promotion of public awareness and political support for healthy environment; Establishment of system to monitor emission of environment contaminants; Provision of technical assistance and training for environment protection and monitoring. 	<ul style="list-style-type: none"> Develop system and policies to remove barriers for renewable energy development; Develop communication strategy in each Project Implementation Office (PIO) to encourage public awareness of environmental issues; Establish system to monitor emission of environmental contaminants by providing 38 sets of environmental monitoring equipment; Provide 4 sets of gasification monitoring equipment for tar and ash analysis; Train staff of Agriculture Environment Protection Stations in 38 counties (3 person from each station) by domestic consultants; <ul style="list-style-type: none"> Establish four environment monitoring and training stations. 	<ul style="list-style-type: none"> Project progress reports; PPMS reports; NGO and review missions reports; Project Completion Report; Postevaluation Report. 	<ul style="list-style-type: none"> Environmental protection policies implemented in all project provinces; Supports from rural communities for environmental protection and improvement; Government provided sufficient counterpart funds to Agriculture Environment Protection Bureaus to effectively carry out environment awareness and environmental monitoring activities;
<p>3.5 Poverty Focused Pilot Scheme</p> <ul style="list-style-type: none"> Establishment of financially viable and sustainable scheme to provide credit to poorer segments of rural villagers (living below poverty line) for biogas generation and greenhouse vegetable production. Provide specific training targeting the poor farmers. 	<ul style="list-style-type: none"> 9,000 poor households lifted from poverty; Provide specific training to poor farmers; Provide basic biogas facilities to 9,000 poor households. 	<ul style="list-style-type: none"> Project progress reports and review missions reports; NGO and PPMS reports; Project Completion Report. 	<ul style="list-style-type: none"> Effective village committee formed with strong support from county finance bureaus; Clear criteria to identify poor farm families;

Design Summary	Targets			Means of Verification	Risks and Assumptions																																					
<p>4. Activities/Inputs</p> <ul style="list-style-type: none"> • Funding for renewable energy generation and eco-environment improvement • Improve mechanism for transfer of biomass technology • Rehabilitate farmers-selected farm-to-market facilities • Assist in environment policy implementation and awareness • Develop pilot poverty-focused approaches for biomass development • Improve Project implementation and capacity development <p>Base Cost</p> <p>TA Preparatory Cost</p> <p>Physical Contingency</p> <p>Price Contingency</p> <p>IDC, Commitment, FF</p> <p>Total</p>	<p>\$ million</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><u>Foreign Exchange</u></th> <th style="text-align: left;"><u>Local Currency</u></th> <th style="text-align: left;"><u>Total</u></th> </tr> </thead> <tbody> <tr> <td>23.7</td> <td>24.8</td> <td>48.4</td> </tr> <tr> <td>0.3</td> <td>0.8</td> <td>1.1</td> </tr> <tr> <td>0.2</td> <td>0.8</td> <td>1.0</td> </tr> <tr> <td>0.5</td> <td>1.2</td> <td>1.7</td> </tr> <tr> <td>0.1</td> <td>2.7</td> <td>2.8</td> </tr> <tr> <td>1.6</td> <td>4.9</td> <td>6.5</td> </tr> <tr> <td>26.4</td> <td>35.1</td> <td>61.5</td> </tr> <tr> <td>0.2</td> <td>0.0</td> <td>0.2</td> </tr> <tr> <td>2.6</td> <td>3.5</td> <td>6.1</td> </tr> <tr> <td>1.8</td> <td>2.4</td> <td>4.2</td> </tr> <tr> <td>5.3</td> <td>0.0</td> <td>5.3</td> </tr> <tr> <td>36.3</td> <td>41.0</td> <td>77.3</td> </tr> </tbody> </table>	<u>Foreign Exchange</u>	<u>Local Currency</u>	<u>Total</u>	23.7	24.8	48.4	0.3	0.8	1.1	0.2	0.8	1.0	0.5	1.2	1.7	0.1	2.7	2.8	1.6	4.9	6.5	26.4	35.1	61.5	0.2	0.0	0.2	2.6	3.5	6.1	1.8	2.4	4.2	5.3	0.0	5.3	36.3	41.0	77.3	<ul style="list-style-type: none"> • Project progress reports; • PPMS reports; • Project Completion Report; • Postevaluation Report. 	<ul style="list-style-type: none"> • Sufficient local counterpart funds available on timely basis.
<u>Foreign Exchange</u>	<u>Local Currency</u>	<u>Total</u>																																								
23.7	24.8	48.4																																								
0.3	0.8	1.1																																								
0.2	0.8	1.0																																								
0.5	1.2	1.7																																								
0.1	2.7	2.8																																								
1.6	4.9	6.5																																								
26.4	35.1	61.5																																								
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1.8	2.4	4.2																																								
5.3	0.0	5.3																																								
36.3	41.0	77.3																																								

IDC = interest during construction, FF = front-end fee.

PROJECT LOCATIONS AND OTHER PARAMETERS

Table A2.1: Summary of Agricultural Statistics in the Four Project Provinces in 1999

Item	Shanxi	Henan	Hubei	Jiangxi
1. Total land area ('000 sq.km)	156	167	185	167
2. Total population (million)	32	94	59	42
3. Rural population (million)	24	77	43	32
4. Number of townships	1,839	2,130	1,355	1,816
5. Arable land ('000 ha)	4,357	6,826	3,310	2,273
Irrigated area	1,246	4,649	1,786	1,901
6. Gross production (Y billion)				
Agriculture	21	123	65	39
Animal husbandry	9	61	31	22
Fishery	0	N/A	13	9
7. Crop production ('000 ton)				
Rice	33	3,330	16,856	16,193
Wheat	2,665	22,915	3,047	96
Maize	3,754	11,566	2,041	75
Millet	419	187	N/A	N/A
Sorghum	234	31	N/A	N/A
Soybean	269	1,152	437	237
Potato and sweet potato	543	2,946	1,727	606
Oil bearing crops	255	3,493	2,283	944
Cotton	44	707	282	63
Jute and hemp	0	49	53	14
Sugar beet	205			
Sugar cane	N/A	211	1,142	1,720
Tobacco	10	284	140	17
Vegetables	7,196	33,924	N/A	N/A
Fruits	2,102	3,494	2,085	704
8. Meat production ('000 ton)				
Pork	438	3,140	2,098	1,602
Beef	70	822	131	52
Mutton	64	300	25	8
Poultry	37	515	1,055	317
Fish, crab, etc.	25	N/A	2,290	1,221
9. Animals (Year end stock, '000 head)				
Cattle and buffalo	2,249	13,410	4,299	3,747
Horse	58	283	19	N/A
Donkey	376	510	10	N/A
Mule	427	282	3	N/A

N/A = not available.

Source: Year Book of Statistics (2000) of Shanxi, Henan, Hubei and Jiangxi.

Table A2.2: Agricultural Output from the Four Project Provinces in 1999

Item	Hubei	Shanxi	Henan	Jiangxi
Crop area (million ha)	7.8	4.0	12.7	5.9
Grain crops	4.7	3.2	9.0	3.5
Others crops	3.0	0.9	3.7	1.9
Crop production (million tons)	30.6	10.8	51.0	20.8
Grain crops	24.5	8.2	42.5	17.3
Others crops	6.1	2.6	8.3	3.5
Livestock (million heads)	287.3	80.1	427.9	190.2
Pigs	21.2	5.0	35.6	15.5
Cattle & buffaloes	4.3	2.2	13.4	3.7
Sheep & goats	1.7	10.2	27.9	0.8
Poultry	234.6	62.7	396.0	170.2
Livestock production ('000 tons)	2,658.0	623.0	4,851.0	1,983.0
Pigs	2,098.0	438.0	3,140.0	1,602.0
Cattle & buffaloes	131.0	70.0	822.0	52.0
Sheep & goats	25.0	64.0	300.0	8.0
Poultry	1,054.5*	37.1	514.7	317.2

Sources: China National Statistics Yearbook 2000, Shanxi, Henan, Hubei and Jiangxi Statistics Yearbooks, 2000.

Table A2.3: Details of Key Project Parameters

Item	Type I	Type II	Type III	Type IV
Number of Units				
- Shanxi	3,500	0	4	2
- Henan	1,200	1,500	8	15
- Hubei	0	4,400	2	11
- Jiangxi	0	5,000	0	0
Total	4,700	10,900	14	28
Beneficiary Household per Type	1	1	120	600
Total Beneficiary Households	4,700	10,900	1,680	16,800
Total Annual Incremental Pig Production (no.)	105,750	87,200	96,830	0
Total Annual Incremental Vegetable Production (t)	882	0	0	0
Total Annual Incremental Citrus Production (t)	0	209,280	0	0
Annual Gas Production per Unit ('000 m ³)	0.6	0.6	87.6	1,095.0
Total Annual Gas Production ('000 m ³)	2,820	6,540	1,226	30,660
Total Annual Digested Effluent and Sludge Production ('000 t)	227.9	171.6	246.5	0

Table A2.4: Project Locations in Four Provinces

Province	Municipality/County	Number of Villages
Shanxi	Jiaocheng	13
	Qixian	11
	Linfen	12
	Xiaoden	6
	Jinyuan	6
	Hongdong	1
	Subtotal	6
Henan	Mengzhou	4
	Mengjin	6
	Qixian	5
	Xinzheng	7
	Xiayi	6
	Zhecheng	5
	Wenxian	4
	Huixian	5
	Liangyuan	3
	Subtotal	9
Hubei	Tianmen	4
	Zaoyang	2
	Chibi	3
	Fangxian	2
	Songzi	2
	Jingshan	2
	Tongcheng	2
	Yunxian	3
	Wuxue	3
	Gong'an	2
	Yunxi	2
	Subtotal	11
	Zhanggong	2
	Xinfeng	2
	Nankang	2
	Xunwu	2
	Jing'an	2
	Hukou	2
	Qianshan	2
	Le'an	2
	Dexing	2
	Fengxin	2
	Yujiang	2
	Chongren	2
	Subtotal	12

Table A3.1: Components Project Cost Summary
Whole Project

Component	(Yuan '000)			(\$ '000)			%	% Total
	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	Base Costs
Funding for Renewable Energy Development and Eco-Environment	205,628.1	196,395.4	402,023.6	24,774.5	23,662.1	48,436.6	49	79
Improve Mechanisms for Transferring Biomass Technology	6,401.9	2,244.3	8,646.2	771.3	270.4	1,041.7	26	2
Rehabilitate Farmers-Selected Farm-to-market Facilities	6,472.2	1,982.7	8,454.9	779.8	238.9	1,018.7	23	2
Improve Environment Policy Implementation and Awareness	10,089.5	4,110.2	14,199.6	1,215.6	495.2	1,710.8	29	3
Pilot Poverty-Focused Approaches for Biomass Development	22,542.1	531.2	23,073.3	2,715.9	64.0	2,779.9	2	5
Improve Implementation and Capacity Development	40,317.8	13,628.5	53,946.2	4,857.6	1,642.0	6,499.5	25	11
Total BASELINE COSTS	291,451.6	218,892.2	510,343.8	35,114.6	26,372.6	61,487.2	43	100
Physical Contingencies	29,089.4	21,875.3	50,964.7	3,504.7	2,635.6	6,140.3	43	10
Price Contingencies	19,773.6	14,802.8	34,576.4	2,382.4	1,783.5	4,165.8	43	7
Total PROJECT COSTS	340,314.5	255,570.3	595,884.8	41,001.8	30,791.6	71,793.4	43	117
TA Preparatory Cost		1,709.80	1,709.8		206.0	206.0	100	
Frontend Fee		2,748.80	2,748.8		331.2	331.2	100	
Commitment Fee		2,336.23	2,336.2		281.5	281.5	100	
Interest During Construction		38,675.29	38,675.3		4,659.7	4,659.7	100	
Total	340,314.5	301,040.4	641,354.9	41,001.8	36,269.9	77,271.7	47	126

Table A3.2: Expenditure Accounts Project Cost Summary
Whole Project

Expenditure Accounts	(Yuan '000)			(\$ '000)		
	Local	Foreign	Total	Local	Foreign	Total
Investment Costs						
Civil Works						
Roads Materials	3,682.1	1,982.7	5,664.8	443.6	238.9	682.5
Roads Labor	2,790.1	-	2,790.1	336.2	-	336.2
Office Renovation	557.8	139.4	697.2	67.2	16.8	84.0
Biomass Development for the Poor	19,754.0	-	19,754.0	2,380.0	-	2,380.0
Subtotal	26,784.0	2,122.1	28,906.1	3,227.0	255.7	3,482.7
Vehicles						
Vehicle for Work	307.1	921.3	1,228.4	37.0	111.0	148.0
Motorcycles	153.6	460.7	614.2	18.5	55.5	74.0
Subtotal	460.7	1,382.0	1,842.6	55.5	166.5	222.0
Equipment						
Office Equipment	2,177.6	1,451.7	3,629.3	262.4	174.9	437.3
Training Equipment	597.6	398.4	996.0	72.0	48.0	120.0
Environmental Facilities	6,015.8	4,010.6	10,026.4	724.8	483.2	1,208.0
Subtotal	8,791.0	5,860.7	14,651.7	1,059.2	706.1	1,765.3
Special funds						
Biogas Development						
Credit Funds (ADB Loan)	-	195,845.8	195,845.8	-	23,595.9	23,595.9
Credit Funds (Local Government)	97,922.9	-	97,922.9	11,797.9	-	11,797.9
Beneficiary contribution	97,922.9	-	97,922.9	11,797.9	-	11,797.9
Subtotal	195,845.8	195,845.8	391,691.6	23,595.9	23,595.9	47,191.8
Consultants, Training, Workshops, Special Studies, and Tours						
Consulting services						
International Consultants	-	11,205.0	11,205.0	-	1,350.0	1,350.0
Domestic Consultants	9,673.7	-	9,673.7	1,165.5	-	1,165.5
Student Fellowships	1,338.0	-	1,338.0	161.2	-	161.2
Subtotal	11,011.6	11,205.0	22,216.6	1,326.7	1,350.0	2,676.7
Training	7,275.8	405.0	7,680.8	876.6	48.8	925.4
Workshop	2,136.9	-	2,136.9	257.5	-	257.5
Special Studies	664.0	-	664.0	80.0	-	80.0
Tours	3,107.5	2,071.7	5,179.2	374.4	249.6	624.0
Subtotal	24,195.8	13,681.7	37,877.5	2,915.2	1,648.4	4,563.6
Reports	2,095.8	-	2,095.8	252.5	-	252.5
Project Management Operating Costs						
Project Management Staff Salaries	15,238.8	-	15,238.8	1,836.0	-	1,836.0
Project Management Travel	4,834.1	-	4,834.1	582.4	-	582.4
Project Management Office Expenses	4,968.4	-	4,968.4	598.6	-	598.6
Subtotal	25,041.3	-	25,041.3	3,017.0	-	3,017.0
Total Investment Costs	283,214.3	218,892.2	502,106.5	34,122.2	26,372.6	60,494.8
Recurrent Costs						
Salaries						
Provincial	840.6	-	840.6	101.3	-	101.3
Municipal	249.0	-	249.0	30.0	-	30.0
County	5,371.4	-	5,371.4	647.2	-	647.2
Subtotal	6,461.1	-	6,461.1	778.4	-	778.4
Operation and Maintenance	1,776.2	-	1,776.2	214.0	-	214.0
Total Recurrent Costs	8,237.3	-	8,237.3	992.4	-	992.4
Total BASELINE COSTS	291,451.6	218,892.2	510,343.8	35,114.6	26,372.6	61,487.2
Physical Contingencies	29,089.4	21,875.3	50,964.7	3,504.7	2,635.6	6,140.3
Price Contingencies	19,773.6	14,802.8	34,576.4	2,382.4	1,783.5	4,165.8
Total PROJECT COSTS	340,314.5	255,570.3	595,884.8	41,001.8	30,791.6	71,793.4
TA Preparatory Cost	-	1,709.8	1,709.8	-	206.0	206.0
Frontend Fee	-	2,748.8	2,748.8	-	331.2	331.2
Commitment Fee	-	2,336.2	2,336.2	-	281.5	281.5
Interest During Construction	-	38,675.3	38,675.3	-	4,659.7	4,659.7
Total	340,314.5	301,040.4	641,354.9	41,001.8	36,269.9	77,271.7

Table A3.3: Project Expenditure Accounts by Financiers
(\$ '000)

Expenditure	Asian Development Bank		Global Environment Facility		Beneficiaries		People's Republic of China		Total	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Investment Costs										
Civil Works										
Roads Materials	-	-	-	-	-	-	800.9	100.0	800.9	1.1
Roads Labor	-	-	-	-	394.2	100.0	-	-	394.2	0.5
Training Station	-	-	-	-	-	-	-	-	-	-
Office Renovation	-	-	-	-	-	-	85.2	100.0	85.2	0.1
Biomass Development for the Poor	-	-	1,306.6	46.4	-	-	1,510.1	53.6	2,816.7	3.9
Subtotal	-	-	1,306.6	31.9	394.2	9.6	2,396.2	58.5	4,097.0	5.7
Vehicles										
Vehicle for Work	-	-	-	-	-	-	164.8	100.0	164.8	0.2
Motorcycles	-	-	-	-	-	-	82.4	100.0	82.4	0.1
Subtotal	-	-	-	-	-	-	247.1	100.0	247.1	0.3
Equipment										
Office Equipment	-	-	-	-	-	-	487.2	100.0	487.2	0.7
Training Equipment	-	-	80.2	60.0	-	-	53.5	40.0	133.7	0.2
Environmental Facilities	-	-	200.0	14.6	-	-	1,173.4	85.4	1,373.4	1.9
Subtotal	-	-	280.2	14.1	-	-	1,714.1	85.9	1,994.3	2.8
Special funds										
Biogas Development										
Credit Funds (ADB Loan)	27,639.7	100.0	-	-	-	-	-	-	27,639.7	38.5
Credit Funds (Local Government)	-	-	-	-	-	-	13,804.7	100.0	13,804.7	19.2
Beneficiary contribution	-	-	-	-	13,804.7	100.0	-	-	13,804.7	19.2
Subtotal	27,639.7	50.0	-	-	13,804.7	25.0	13,804.7	25.0	55,249.1	77.0
Consultants, Training, Workshops, Special Studies, and Tours										
Consulting services										
International Consultants	-	-	1,530.7	100.0	-	-	-	-	1,530.7	2.1
Domestic Consultants	-	-	1,001.1	75.0	-	-	333.7	25.0	1,334.8	1.9
Student Fellowships	-	-	189.9	100.0	-	-	-	-	189.9	0.3
Subtotal	-	-	2,721.7	89.1	-	-	333.7	10.9	3,055.4	4.3
Training	-	-	1,069.0	100.0	-	-	-	-	1,069.0	1.5
Workshop	-	-	299.5	100.0	-	-	-	-	299.5	0.4
Special Studies	-	-	92.3	100.0	-	-	-	-	92.3	0.1
Tours	-	-	593.5	83.0	-	-	121.6	17.0	715.1	1.0
Subtotal	-	-	4,776.0	91.3	-	-	455.3	8.7	5,231.2	7.3
Reports	-	-	-	-	-	-	297.0	100.0	297.0	0.4
Project Management Operating Costs										
Project Management Staff Salaries	-	-	-	-	-	-	2,141.9	100.0	2,141.9	3.0
Project Management Travel	-	-	-	-	-	-	679.7	100.0	679.7	0.9
Project Management Office Expenses	-	-	-	-	-	-	698.2	100.0	698.2	1.0
Subtotal	-	-	-	-	-	-	3,519.8	100.0	3,519.8	4.9
Total Investment Costs	27,639.7	39.1	6,362.8	9.0	14,198.9	20.1	22,434.1	31.8	70,635.6	98.4
Recurrent Costs										
Salaries										
Provincial	-	-	-	-	-	-	118.2	100.0	118.2	0.2
Municipal	-	-	-	-	-	-	35.0	100.0	35.0	-
County	-	-	-	-	-	-	755.0	100.0	755.0	1.1
Subtotal	-	-	-	-	-	-	908.1	100.0	908.1	1.3
Operation and Maintenance	-	-	-	-	-	-	249.7	100.0	249.7	0.3
Total Recurrent Costs	-	-	-	-	-	-	1,157.8	100.0	1,157.8	1.6
Total	27,639.7	38.5	6,362.8	8.9	14,198.9	19.8	23,591.9	32.9	71,793.4	100.0
TA Preparatory Cost	206.0								206.0	
Frontend Fee	331.2								331.2	
Commitment Fee	281.5								281.5	
Interest Charges	4,659.7								4,659.7	
Total Project Cost	33,118.1	42.9	6,362.8	8.2	14,198.9	18.4	23,591.9	30.5	77,271.7	100.0

**Table A3.4: Components by Financiers
Whole Project**

Component	Financier (\$'000)				Total
	ADB	GEF	Benficiaries	Government	
Funding for Renewable Energy Generation and Eco-Environment Development	27,639.7	0.0	13,804.7	15,197.9	56,642.3
Improve Mechanisms for Transferring Biomass Technology	0.0	1,093.9	0.0	143.3	1,237.2
Rehabilitate Farmers-Select Farm-to-Market Facilities	0.0	0.0	394.2	800.9	1,195.1
Improve Environment Policy Implementation and Awareness	0.0	789.1	0.0	1,173.4	1,962.5
Pilot Poverty-Focused Approaches for Biomass Development	0.0	1,737.8	0.0	1,541.9	3,279.7
Improve Project Implementation and Capacity Development	0.0	2,742.0	0.0	4,734.6	7,476.6
Total^a	27,639.7	6,362.8	14,198.9	23,592.0	71,793.4^b

^a Excluding interest and other charges totaling to \$5,478.4 in thousands.

^b Figures may not add up due to rounding of decimals.

Table A3.5: Project Cost Summary for Jiangxi

Component	(Yuan '000)			(\$ '000)			%	% Total
	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	Base Costs
Funding for Renewable Energy Development and Eco-Environment	53,833.1	49,891.3	103,724.4	6,485.9	6,011.0	12,496.9	48	78
Improve Mechanisms for Transferring Biomass Technology	2,289.1	600.9	2,890.1	275.8	72.4	348.2	21	2
Rehabilitate Farmers-Selected Farm-to-market Facilities	2,970.7	910.0	3,880.8	357.9	109.6	467.6	23	3
Improve Environment Policy Implementation and Awareness	3,155.7	1,226.7	4,382.4	380.2	147.8	528.0	28	3
Pilot Poverty-Focused Approaches for Biomass Development	5,705.9	132.8	5,838.7	687.5	16.0	703.5	2	4
Improve Implementation and Capacity Development	11,250.6	645.8	11,896.4	1,355.5	77.8	1,433.3	5	9
Total Baseline Costs	79,205.1	53,407.6	132,612.7	9,542.8	6,434.7	15,977.4	40	100
Physical Contingencies	7,905.9	5,337.1	13,243.0	952.5	643.0	1,595.5	40	10
Price Contingencies	5,322.5	3,660.5	8,983.0	641.3	441.0	1,082.3	41	7
Total Project Costs	92,433.5	62,405.2	154,838.7	11,136.6	7,518.7	18,655.3	40	117
TA Preparatory Cost		427.5	427.5		51.5	51.5	100	
Frontend Fee		700.0	700.0		84.3	84.3	100	
Commitment Fee		563.8	563.8		67.9	67.9	100	
Interest During Construction		9,952.0	9,952.0		1,199.0	1,199.0	100	
Total	92,433.5	74,048.5	166,482.0	11,136.6	8,921.5	20,058.1	44	126

Table A3.6: Project Cost Summary for Hubei

Expenditure	(Yuan '000)			(\$ '000)			%	% Total
	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	Base Costs
Funding for Renewable Energy Development and Eco-Environment	50,357.6	49,143.6	99,501.2	6,067.2	5,920.9	11,988.1	49	82
Improve Mechanisms for Transferring Biomass Technology	1,687.0	680.6	2,367.6	203.3	82.0	285.3	29	2
Rehabilitate Farmers-Selected Farm-to-market Facilities	1,531.8	469.2	2,001.0	184.6	56.5	241.1	23	2
Improve Environment Policy Implementation and Awareness	2,818.7	1,147.1	3,965.7	339.6	138.2	477.8	29	3
Pilot Poverty-Focused Approaches for Biomass Development	4,844.4	132.8	4,977.2	583.7	16.0	599.7	3	4
Improve Implementation and Capacity Development	7,961.9	671.1	8,633.0	959.3	80.9	1,040.1	8	7
	69,201.3	52,244.5	121,445.8	8,337.5	6,294.5	14,632.0	43	100
Physical Contingencies	6,904.2	5,220.5	12,124.7	831.8	629.0	1,460.8	43	10
Price Contingencies	4,624.9	3,525.9	8,150.8	557.2	424.8	982.0	43	7
	80,730.4	60,990.8	141,721.2	9,726.6	7,348.3	17,074.8	43	117
TA Preparatory Cost		427.5	427.5		51.5	51.5	100	
Frontend Fee		688.8	688.8		83.0	83.0	100	
Commitment Fee		545.3	545.3		65.7	65.7	100	
Interest During Construction		9,867.1	9,867.1		1,188.8	1,188.8	100	
Total	80,730.4	72,519.5	153,249.9	9,726.6	8,737.3	18,463.8	47	126

Table A3.7: Project Cost Summary for Henan

Expenditure	(Yuan '000)			(\$ '000)			%	% Total
	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	Base Costs
Funding for Renewable Energy Development and Eco-Environment	50,301.2	48,623.4	98,924.6	6,060.4	5,858.2	11,918.6	49	81
Improve Mechanisms for Transferring Biomass Technology	1,487.8	547.8	2,035.6	179.3	66.0	245.3	27	2
Rehabilitate Farmers-Selected Farm-to-market Facilities	755.1	231.3	986.5	91.0	27.9	118.9	23	1
Improve Environment Policy Implementation and Awareness	2,383.8	987.7	3,371.5	287.2	119.0	406.2	29	3
Pilot Poverty-Focused Approaches for Biomass Development	7,321.8	132.8	7,454.6	882.1	16.0	898.1	2	6
Improve Implementation and Capacity Development	8,098.7	595.6	8,694.3	975.8	71.8	1,047.5	7	7
Total BASELINE COSTS	70,348.4	51,118.7	121,467.1	8,475.7	6,158.9	14,634.6	42	100
Physical Contingencies	7,021.6	5,108.5	12,130.1	846.0	615.5	1,461.5	42	10
Price Contingencies	4,968.1	3,702.9	8,671.0	598.6	446.1	1,044.7	43	7
Total PROJECT COSTS	82,338.1	59,930.1	142,268.2	9,920.2	7,220.5	17,140.7	42	117
TA Preparatory Cost		427.5	427.5		51.5	51.5	100	
Frontend Fee		678.1	678.1		81.7	81.7	100	
Commitment Fee		660.2	660.2		79.5	79.5	100	
Interest During Construction		9,212.5	9,212.5		1,109.9	1,109.9	100	
Total	82,338.1	70,908.4	153,246.5	9,920.2	8,543.2	18,463.4	46	126

Table A3.8: Project Cost Summary for Shanxi

Expenditure	(Yuan '000)			(\$ '000)			%	% Total
	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	Base Costs
Funding for Renewable Energy Development and Eco-Environment	51,136.3	48,737.1	99,873.4	6,161.0	5,871.9	12,032.9	49	86
Improve Mechanisms for Transferring Biomass Technology	937.9	415.0	1,352.9	113.0	50.0	163.0	31	1
Rehabilitate Farmers-Selected Farm-to-market Facilities	1,214.6	372.1	1,586.7	146.3	44.8	191.2	23	1
Improve Environment Policy Implementation and Awareness	1,731.4	748.7	2,480.0	208.6	90.2	298.8	30	2
Pilot Poverty-Focused Approaches for Biomass Development	4,670.0	132.8	4,802.8	562.7	16.0	578.7	3	4
Improve Implementation and Capacity Development	5,904.5	482.3	6,386.8	711.4	58.1	769.5	8	5
Total BASELINE COSTS	65,594.7	50,887.9	116,482.5	7,903.0	6,131.1	14,034.0	44	100
Physical Contingencies	6,550.2	5,086.5	11,636.6	789.2	612.8	1,402.0	44	10
Price Contingencies	4,446.2	3,534.0	7,980.2	535.7	425.8	961.5	44	7
Total PROJECT COSTS	76,591.0	59,508.3	136,099.4	9,227.8	7,169.7	16,397.5	44	117
TA Preparatory Cost		427.5	427.5		51.5	51.5	100	
Frontend Fee		682.3	682.3		82.2	82.2	100	
Commitment Fee		566.9	566.9		68.3	68.3	100	
Interest During Construction		9,643.5	9,643.5		1,161.9	1,161.9	100	
Total	76,591.0	70,828.5	147,419.5	9,227.8	8,533.6	17,761.4	48	127

IMPLEMENTATION ARRANGEMENTS, ORGANIZATION CHART, AND IMPLEMENTATION SCHEDULE

A. National Project Coordination Committee

1. The Government will establish a National Project Coordination Committee (NPCC) at the national level to provide overall policy and implementation guidance and to assist in resolving issues beyond those of provincial government jurisdiction or authority. The Vice Minister of MOA (or his or her representative) will chair the NPCC within the MOA. Members of the NPCC would comprise officials (Senior Director level) from SDPC, MOF, SEPA, Poverty Alleviation Office, Department of Research, Education and Rural Environment (MOA), Department of Development Planning (MOA), and the Foreign Economic Cooperation Center (FECC) of MOA. The NPCC would meet at least once every six months to coordinate and provide guidance to the EAs and implementation agencies.

B. Project Management Office (PMO)

2. A Project Management Office will be established within the FECC with the following functions:

- (i) supervise sub-project feasibility studies (large scale biogas and gasification plants) and ensuring quality sub-project preparation;
- (ii) review annual work programs and budgets of the four Project provinces;
- (iii) supervise and ensure that the Project procurement will strictly adhere to ADB and Government procedures and guidelines;
- (iv) recruit Project implementation and training consultants;
- (v) prepare Project training programs and coordinate training activities in each Project province;
- (vi) coordinate Project activities and compile Project progress and completion reports
- (vii) undertake Project monitoring and performance evaluation and assist to establish Project Performance Management System (PPMS) in the Provincial PIOs;
- (viii) audit Project accounts and other implementation activities; and
- (ix) report to NPCC on semi-annual Project progress and issues encountered and submit progress reports to ADB.

C. Provincial Leading Group

3. The provincial governments will each establish a Project Leading Group to provide policy guidance, supervision, and inter-sectoral coordination, review Project plan and sourcing counterpart funds, and resolving issues during the Project implementation. The Vice Governor will head the Provincial Leading Group, with directors of the Provincial Development Planning Commission, Provincial Department of Agriculture, Provincial Department of Finance, Provincial Poverty Alleviation and Development Office, Environment Protection Bureau, Agriculture and Livestock sector bureaus, Audit Agency, and other agencies as necessary, as members.

D. Provincial Project Implementation Office

4. Under the Provincial Government's Office, a Provincial Project Implementation Office (PIO) is established to undertake all aspects of Project implementation within the province. Major functions of the PIO will include:

- (i) coordinate with ADB, MOF, MOA, SDPC, PMO and other agencies at the national level on policy and Project implementation matters;
- (ii) formulate annual implementation plans and budgets;
- (iii) organize, compile, and review sub-project feasibility studies;
- (iv) review and approve County Project Implementation Units (PIUs) work plans;
- (v) supervise Project construction and quality control;
- (vi) undertake procurement of equipment;
- (vii) review applications of withdrawal and fund disbursement to implementing agencies (IAs);
- (viii) monitor physical and financial progress, set up PPMS and provide PMO with relevant progress reports;
- (ix) coordinating collection and repayment of loan;
- (x) maintain consolidated Project accounts; and
- (xi) provide technical support and training to municipal or county and township level staff.

5. The PIOs are assisted by county PIUs, which are established in each of the Project municipalities or counties within the province. The PIOs will also be assisted by various provincial technical support agencies like Bureau of Agriculture, Bureau of Livestock, Environmental Protection Bureau, Rural Energy Office, Women associations, Poverty Alleviation office and others.

6. A senior Director appointed by the Governor will head the PIO. To ensure strong financial management of the Project, a senior Director from the Provincial department of Finance is appointed as a Deputy Director with responsibility for reviewing and approval of all Project accounting and disbursement documentation. The PIO have staff responsible for finance, technical, and administration. A total of about 10 full time staff is appointed for each PIO.

E. Provincial Department of Finance

7. The provincial Department of Finance is in charge of the general financial management of the Project. A special Project Credit office is set up within the Department to (i) coordinate the preparation of annual budgets at the provincial level; (ii) distribute Project funds according to approved Project Plans; (iii) monitoring and accounting for funds spent; (iv) facilitate independent financial audit; and (v) accounting for the Project expenditure and collections to PIO.

F. Project Implementation Units

8. The Project Implementation Units (PIUs) is established within the municipal or county government. The PIUs will implement the Project activities as envisaged under the Project in its respective county. The PIU will prepare the annual work plans and budget and submit to PIO for approval and funding. Township governments and technical stations will provide the necessary support to the PIUs to implement various Project activities.

G. Financial Management

9. MOF will be the borrower. MOF will relend the ADB funds at the same interest rate and conditions to the provincial government (Department of Finance). The Department of Finance will open a separate loan account in a commercial bank for the Project through which the funds for implementation will be channeled to the Project municipal or county finance bureaus. The provincial government will bear the foreign exchange risks.¹ The Project county finance bureaus will onlend the funds to the rural cooperatives (REC) or enterprises on terms and conditions that will vary according to the profitability of the activities and ability to repay the loans.

10. Provincial Department of Finance will process loan withdrawal applications, following preparation by the PIO and certification by the PIO that the works or procurement have been carried out to an acceptable standard. The Provincial Department of Finance will authorize the release of funds to bank branches at the township level, where they can be withdrawn by the borrowers (farmers/farmer groups or enterprises). ADB funds advanced to the imprest account will be reimbursed under ADB's statement of expenditure procedure.

11. Subject to the general principle that terms and conditions to end users will be no less than commercial bank lending, the county finance bureau will provide funds to end users in three modalities:

- (i) For farmers or farmer groups under type I technology, funds will be provided in local currency through township finance offices, at interest rates not lower than the prevailing commercial banks rates for equivalent loans, with a grace period of not more than 3 years and loan maturity period of not more than 7 years, depending on the nature of farm cash flow and profitability under the 4-in-1 model (type I technology). Whenever possible, loans will be secured by fixed assets collateral under a formal loan agreement. Emphasis will be on careful selection of participants and group pressure, where appropriate, for loan repayment.
- (ii) For farmers adopting the type II technology, ADB funds will be onlend to the farmers provided with same terms and conditions as (i) above, except that the grace period will be five years and a loan maturity period of not more than 10 years.
- (iii) For medium scale biogas and gasification plants, the ADB funds will be channeled through the county finance bureaus at the same terms and conditions as (i) above, except that the grace period will not be more than three years for type III technology (biogas plants) and not more than 5 years for type IV technology (gasification plants) and a maturity period of not more than 10 years. The borrowers or enterprises should provide collateral ranging from real estate,

¹ Except for Type III and IV borrowers who will bear the risk themselves.

equipment, or third party guarantee. The life of the collateral should be equal to the duration of the term loan. The subborrowers will bear the foreign exchange risks.

12. The repayments from the beneficiaries during the Project implementation period will be deposited into a special Project fund account to be maintained by the Provincial Department of Finance and be used for financing additional subproject loans if necessary. The account will be closed not later than the closing date of the ADB loan.

13. The finance bureaus will review each subloan application and evaluate its merits based on detailed criteria for subloan approval. The subloan approval is demand-based and only those qualified applicants can avail of the credit. Funds from ADB and the Government will be blended in a package for each subloan and onlend at an interest rate as determined above.

14. The municipal and county PIUs with assistance from township governments and village committees will be responsible to examine the subloan applicants to ensure that they are in compliance with the eligibility criteria at the time of assessment. A sub-borrower will be required, in the case of:

1. Small-scale integrated biogas system (Types I and II technology)

- (i) applicant should be a farmer, and with a household that must have at least two labor force to accomplish all the works required by the proposed subproject investment;
- (ii) have adequate collateral in the form of assets and/or credit guaranty;
- (iii) the household should have necessary land and farm facilities for adoption the biomass technology;
- (iv) the proposed subproject should be profitable and the projected FIRR should be no less than 12 percent; and
- (v) must take a commitment to participate in project training and other activities and agree to loan repayment obligations.

2. Medium-scale biogas plants (Type III technology)

- (i) applicant should be a registered legal entity and operated in the Project designated areas for at least three years;
- (ii) profitable for prior three years, a debt service ratio of 1.2 to 1 for the life of the subproject, the projected FIRR of no less than 12 percent, and positive net asset;
- (iii) creditworthiness as demonstrated by no previous loan or commercial defaults;
- (iv) adequate collateral/security in the form of asset;
- (v) should have sound and solid financial management system;
- (vi) should be in possession of or have an option on adequate land for construction;

- (vii) should have a pig farm of considerable size (at least 300 pigs) to provide sufficient pig manure and wastes necessary for the operation of the biogas plant;
- (viii) willing to bear the foreign currency exchange risk and agree to loan repayment obligations; and
- (ix) the subproject should comply with ADB and Government environmental requirements.

3. Medium-scale biomass gasification plants (Type IV technology)

- (i) the applicant should be a legal entity of individual or group of farmers, private enterprise, cooperative, or Township and Village enterprise;
- (ii) the entity should be creditworthiness as demonstrated by no previous loan or commercial defaults;
- (iii) the entity should have adequate collateral/security in the form of asset;
- (iv) the entity should have in possession of or have an option of adequate land for plant construction;
- (v) should have adequate supply of raw material such as rice or wheat straw from surrounding farms;
- (vi) the applicant should be able to prove that it has sufficient households willing to connect and purchase the producer gas;
- (vii) the proposed investment should have a debt service ratio of 1.2 to 1 for the life of the subproject, the projected FIRR should be no less than 10 percent, and with positive net asset;
- (viii) willing to bear foreign currency exchange risk and agree to loan repayment obligations; and
- (ix) willing to comply with ADB and Government environmental requirements.

15. Subproject Qualifying Criteria. Each subproject shall meet the following criteria:

- (i) The purpose of each subproject shall be construction of biogas and biomass facilities using either Type I, II, III or IV technology; and
- (ii) the subproject is located in the rural area of the four Project Provinces.

16. For the farmer households who propose to construct Types I and II subprojects, the sub-borrower shall meet the following criteria:

- (i) the farmer household proposing a subproject shall be the rural resident with the main business in farming, livestock raising, agriculture or aquaculture;
- (ii) the proposed subproject will be constructed on the land to which the sub-borrower has the land use right for farming business;

- (iii) for each such subproject the sub-borrower shall contribute at minimum 25 percent as counterpart fund for the subproject; and
- (iv) counterpart funds shall be available for the subproject from the local governments.

17. For the poor farmers who are consider living under poverty line (under component E on Pilot Poverty-Focused Approach Component) should meet the following criteria to qualify for GEF grant facilities to participate in type I or II investment:

- (i) Farmer with per capital income of less than 1200 Yuan per year;
- (ii) Farmer with less than 3 years of primary education;
- (iii) Farmer with poor housing and with few household assets;
- (iv) Farmer with household using coal and firewood/straw for cooking and heating; and
- (v) Farmer with farm producing lower than average farm productivity in the village and needs assistance advice in technical aspects of farm production.

18. For enterprise sub-borrowers, the sub-borrower shall meet the following criteria:

- (i) the proposed subproject shall be a biogas or biomass project using type III or IV technology;
- (ii) the sub-borrower shall be either a duly registered company or township or village enterprise;
- (iii) the sub-borrower shall demonstrate it has the technical, engineering and managerial capability to construct and operate and maintain the proposed subproject facilities; and
- (iv) the sub-borrower shall contribute not less than 25 percent of total construction costs as equity investment;

Figure A4.1: Project Organization Chart and Fund Flow

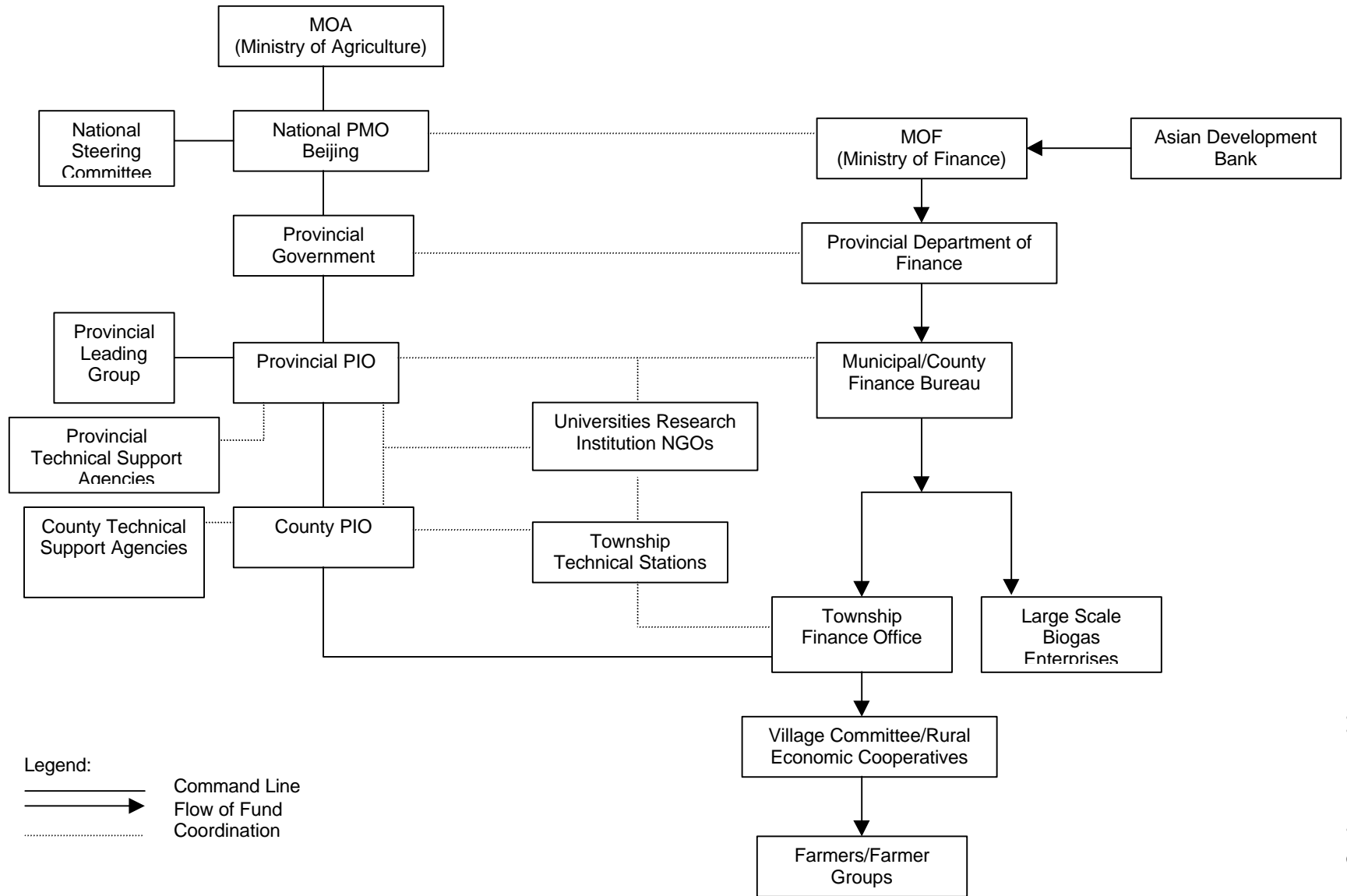
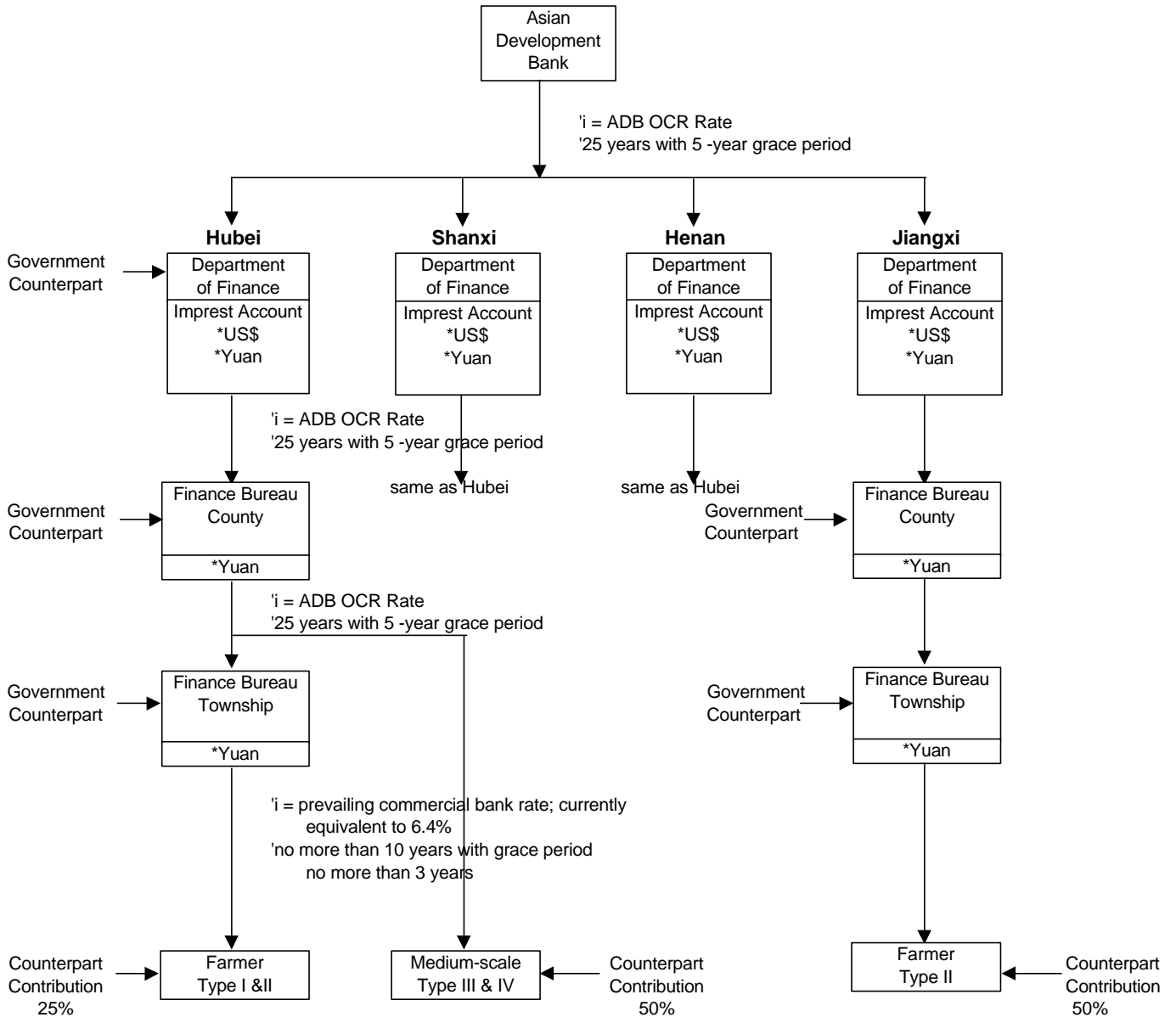


Figure A4.2: Project Funds Flow
Part A: Funding for Renewable Energy Generation and Eco-Environment Development



PROJECT IMPLEMENTATION SCHEDULE

PROJECT COMPONENT/KEY ACTIVITY	Year 1				Year 2				Year 3				Year 4				Year 5			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Funding for Renewable Energy Development Eco-Environment																				
a. Introduce improved loan processing skills																				
b. Operate investment funds and administer loans																				
2. Introduced Improved Mechanisms for Transferring Biomass Technology																				
a. Strengthen skills of biogas and gasification systems contractors																				
b. Extension officers and farmers on-site skill transfer training																				
c. Study tours and workshops																				
3. Rehabilitate Farmer-Selected Farm to Market Facilities																				
a. Rehabilitate access roads																				
b. Rehabilitate bridges, drainage crossings,																				
4. Assist Barrier Removal for Environment Improvement and Strengthen Environment Monitoring System																				
a. Develop Environment Awareness Program																				
b. Prepare publicity and extension materials																				
c. Provide student fellowships on environment research																				
d. Establish Renewable Energy, Environment Monitoring and Training Station																				
e. Provide environment monitoring equipment																				
5. Develop Pilot Poverty Focused Approaches for Biomass Development																				
a. Women training and participatory workshop																				
b. Selection and Provision of Basic Biogas Facilities																				
c. Special training for the poor farmers																				
d. Fellowship for poverty research																				
6. Improve Implementation and Capacity Development																				
a. Provide office support																				
b. Recruitment of consultants																				
c. Establish Monitoring and Evaluation System																				

INDICATIVE PROCUREMENT PACKAGES

Package	Units	Amount/ Unit	Loan/GEF Financing Package	Procurement Mode
1. Type 1 Model (Digester/Greenhouse/Pigs/ Vegetables)				
Shanxi	2,300	3,000	4,000	DP
Henan	600	2,000	4,000	DP
2. Type 2 Model (Digester/Pig/Orchard)				
Henan	700	3,600	4,000	DP
Hubei	2,300	2,500	4,000	DP
Jiangxi	3,200	2,400	4,000	DP
3. Environment and Training Equipment (Biomass Gasification Plant)				
Shanxi - Environment	1	50,000	148,500	DP
Training	1	33,400	20,100	DP
Henan - Environment	1	50,600	197,800	DP
Training	1	33,400	20,100	DP
Hubei - Environment	1	50,400	230,700	DP
Training	1	33,400	20,100	DP
Jiangxi - Environment	1	50,800	247,100	DP
Training	1	33,400	20,100	DP

DP = direct purchase.

OUTLINE TERMS OF REFERENCE FOR CONSULTING SERVICES

1. Consulting services will be required to assist the Executing Agencies (EAs) through the Project Management Office (PMO) and Project Implementation Offices (PIOs) to address several of the key barriers that are affecting the lack of wide spread dissemination and expansion of biogas/biomass renewable energy systems (BioRETs). For this, both international and domestic consultants will be engaged to develop synchronized programs to assist in removing the barriers and oversee the implementation of selected activities, assist to set up institutional strengthening programs to raise the skills of contractors, farmers, and government service staff, and develop an environmental monitoring and measurement program. The Project is expected to develop a sustainable and replicable program that serves as an example to expand the BioRETs elsewhere in PRC. The consultants will address the major problems associated with: (i) institutional barriers, (ii) financial barriers, (iii) public awareness and marketing barriers, (iv) technical barriers, (v) service infrastructure barriers; and (vi) disadvantaged and poor household barriers. It is anticipated that about 45 person-months of international consultants and 117 person-months of domestic consultants will be required under the direction of the PMO and about 142 person months under the direction of the PIOs in the four provinces.

A. Scope of Work

1. Overcoming the institutional barriers:

- (i) establishing sound management support to overcome deficiencies in design, quality assurance, environmental monitoring, and technical supervision;
- (ii) establish project management and coordination committees to promote inter-sectoral cooperation between different ministries dealing with biogas/ biomass technology and to supervise implementation of the proposed GEF project and the formulation and the implementation of the biogas/ biomass energy program as a whole;
- (iii) assist the provincial government to formulate and implement biogas energy program and action plan aimed at expanding the development of small-medium scale BioRETs in PRC;
- (iv) address the on-going policy and legal framework activities through national level steering committees and close liaison with other on-going renewable energy programs in order to be part of the strategic partnership agreements now being prepared by various donors in PRC;
- (v) assist to develop a market approach to expand the implementation of BioRETs country-wide and introduce organic farming and certification of organic foods to increase the incomes of beneficiaries; and
- (vi) provision of institutional strengthening and capacity building activities for government and private sector so they are better prepared to expand the biogas renewable energy program elsewhere in PRC.

2. Overcoming the technical barriers:

- (i) introducing improved technologies to increase the efficiency of biogas systems that have been developed outside of PRC; particularly for the Type IV gasifiers in order to further reduce the crop residue burning in the fields thus reducing GHG emissions;
- (ii) provide grants to universities to carry out further research and development programs for advanced biogas/biomass models;
- (iii) provide technical training to research and technical officials and private sector service contractors and technicians in order that they may understand new developments and problems in the biogas sector;
- (iv) develop, install, and train personnel in sound environmental measurement and monitoring programs in order to provide a sound data base to SEPA in order to quantify the reduction of GHG in the project areas and assist in further developing environmental standards applicable to the renewable energy sector for biogas/biomass development; and
- (v) provide extensive training and study tours to farmers, including the poor and disadvantaged group, on all aspects of biogas production and maintenance to ensure sustainability of biogas adoption;

3. Overcoming the financial barriers:

- (i) assist the provincial governments to develop a sustainable and a workable financing mechanism in order to overcome the credit problem in the rural areas so as to reach the subborrowers who want to invest in biogas production;
- (ii) assist to establish sound financial lending and collection procedures at the provincial financial bureaus through advanced training and institutional strengthening using up-to-date computer software and hardware;
- (iii) assist to develop a sustainable and replicable financial model for long term lending that is replicable in other parts of PRC until the rural financial sector is restructured and is willing to enter into this small but growing biogas market; and
- (iv) assist to establish a sustainable and replicable financing model of assisting the poor and disadvantaged farmers to adopt biogas production technology.

4. Overcoming the lack of public awareness, information, and marketing barriers:

- (i) prepare and disseminate public awareness material and advise local communities and industry on the latest available technical options, costs, and economic/financial benefits;

- (ii) organizing public information campaigns, seminars, study tours, media presentations, etc. in order to share the information on the advances and benefits to biogas/biomass systems and present lessons learned from other countries;
- (iii) assist to develop sound marketing and advertising campaigns, set up trade fairs, and other similar means in order to expand the interest in BioRETS;
- (iv) assist to develop an information campaign on the environmental and health benefits associated with BioRETS;
- (v) assist to establish the above campaigns through institutional strengthening and training of government, private sector, and farmers.

5. Overcoming weak service infrastructure and personnel along with incentives for continued operation:

- (i) assist to devise a strategic program to train private sector contractors and technicians and to help them to build up a viable service sector in local townships to provide continue service to the biogas farmers;
- (ii) assist the PIUs to concentrate the build up of biogas digesters in localize areas to ensure sustainability of service sector in providing O & M to the biogas farmers; and
- (iii) determine the parameters (such as economics of scale, pricing, technology improvement and availability of spare parts) to integrate the service sector to the biogas and farm production as an integrated farming process to ensure sustainability.

6. Overcoming the lack of involvement of disadvantaged households:

- (i) assist to set-up specially designed programs to assist disadvantaged households to overcome their social stigmas and to train, inform, and assist them in related small scale economic endeavors; and
- (ii) assist in promoting bottom-up participatory process to involve the socially vulnerable and disadvantaged households in planning and implementing project activities.

B. Expertise Required

1. International Consultants at the PMO

2. Environmental Specialist/Team Leader (18 person-months). The consultant should have at least 10 years of environment project implementation experience and fully familiar with the environment requirements of SEPA, GEF and ADB and have good knowledge of renewable energy policies of PRC. He or she will help to develop programs for environment protection through the development of renewable energy in the four Project provinces, assist to develop and provide policy advice to the provincial government, develop training programs, and provide

input for the preparation of environmental evaluations, monitoring programs, installation of measurement equipment and analysis. Assist SEPA and MOA to formulate renewable energy policies utilizing biomass resources as well as development of applicable environmental standards.

3. **Renewable Energy Specialist** (18 person-months). The consultant should have at least five years of experience in renewable energy development work and have good knowledge of renewable energy development in PRC. He or she will help to develop the planning, design, quality assurance, and construction programs for the biomass systems in all Project provinces as well as to assist in the preparation of research and development programs to develop or pilot test new technologies at qualified universities.

4. **Training Program Development Specialist** (9 person-months). The consultant should have at least 5 years of experience in developing and conducting training programs in developing countries, particularly in the area of Project management, energy and environment aspects. He or she should have a good knowledge of renewable energy development in PRC and will help to develop and carry out training programs for private sector, public sector, and small beneficiaries in all aspects of biomass technology.

2. Domestic Consultants at the PMO

5. **Biomass system specialist/Deputy Team Leader** (60 person-months). The consultant should have at least 10 years of working experience in PRC on Biomass system development. He or she will assist to set up the entire project implementation arrangements including planning, designs, feasibility studies, and quality assurance programs in the four provinces. Apart as a deputy team leader, the consultant will develop a quality control program, routine inspection systems, and liaison between the central and provincial authorities.

6. **Financial Management Specialist** (12 person-months). The Specialist should have at least five years experience in setting up financial management system and in implementing training for agricultural credit projects. The Specialist will assist the provincial, municipal and county finance bureaus to set up replicable and sustainable financing mechanisms for onlend credits to subloan borrowers and debt collection. He will review the existing system, determine the most appropriate and best model and mechanism for an onlending operating system, cash management system, risk management system, financial accounting system, general accounting and bookkeeping system, computer and data processing system, internal control system, etc. The Specialist will determine the nature and form of the accounting standards and policies to be used by the finance bureaus as well as recommending an appropriate auditing standards to be adopted.

7. **Environmental Specialist** (15 person-months). The consultant should have at least 5 years of working experience in environment related areas of renewable energy development in PRC. He or she will help to assist to conduct training in environment protection, help to collect information to create environment awareness, in setting up the overall environmental monitoring program and carry out random environmental evaluations.

8. **Biogas Training/Extension Specialist** (15 person-months). The consultant should have at least 5 years of working experience in areas related to biogas development and extension. He or she will help in the preparation of the various training programs and provide training to participants in all four provinces. The consultant will also train extension workers in all aspects of biogas development.

9. **Performance Evaluation Specialist** (15 person-months). The Specialist should have at least 10 years of experience in project performance evaluation in PRC. He or she should be familiar with ADB's project performance management system (PPMS) and able to provide training to provincial Project staff in performance evaluation based on PPMS. The specialist will develop a training program and provide the training required. The specialist will assist in setting up the baseline monitoring and evaluation program in each of the Project provinces and in PMO and help the Project staff in analyzing data in order to have a sound basis for expanding the program to other parts of PRC.

3. Domestic Consultants at the PIOs

10. The following domestic consultants will work closely with the consultants assigned to the PMO in order to develop the program in each province.¹

11. **Financial Management/Credit Specialist** (4 person-months). The Specialist should have at least five years experience in direct credit and finance management and in implementing training for rural credit officers. He or she should worked in Agriculture Bank of China or similar rural development banks or cooperatives for at least 3 years involving in all aspects of lending credit to rural enterprises and farmers. The Specialist will review the current credit and finance procedures of the finance bureaus, and propose the most effective and appropriate procedure which best serve the Project needs. The Specialist will formulate the onlending procedure and debt collection system for the medium scale enterprises borrowers and recommend a sustainable mechanism for the credit component of the Project. He or she will develop training programs for the project financial staff paying particular attention to general credit and risk management, credit department organization, and basic credit procedures including loan underwriting, credit analysis, loan application processing, collateral evaluation, and loan collections.

12. **Quality Control/Assurance Specialist** (24 person-months). The consultant should have at least 5 years of working experience in biogas development and familiar with all technical aspects of biogas digester, biogas and gasification plants construction. He or she will help the PMO to ensure all constructions carried out by the Project subborrowers meet the required standards and provide advise to contractors to ensure that they are able to conform to requirements.

13. **Information, Education, And Communication Specialist** (12 person-months). The consultant should have at least 5 years of working experience in information dissemination, communication and public campaigns. He or she will help the Provincial government in organizing environment field days, seminars, training, and public information campaigns to create public awareness in environment protection, etc.

14. **Environmental Awareness Specialist** (18 person-months). The consultant should have at least 5 years working experience in environment protection and is fully familiar with renewable energy and environment management. He or she will assist in setting up environment awareness system and in implementing a training program on environment awareness. The consultant will help to collect data and information which will help to create environment awareness and disseminate the information through effective media to the public.

¹ The total number of person-months are for all four provinces.

15. **Training Specialist** (36 person-months). The consultant will have extensive experience in developing training materials for agricultural extension activities for semi-literate adult. The consultant will assist PIUs and PIOs in each province to develop special training materials targeted at semi-illiterate adult on the subjects related to biomass integrated farming systems. The initial training materials will be pre-tested extensively before final production and distribution. Training materials will include both printing materials and audiovisual materials. The consultant will work closely with field offices of Rural Energy Offices, Agriculture Department, Poverty Alleviation Offices and Women Federation as well as gender specialist of the Project.

16. **Gender Specialist** (20 person-months). The consultant will have graduate degree in gender and development or related areas with extensive working experience in rural PRC. The consultant will assist PIOs and Women Federation to organize and initiate implementation of all activities in pilot poverty component. Initial training workshop will be held for PIOs, PIUs and Women Federation to clarify tasks and responsibilities of each party in particular the Women Federation at each level. The consultant will assist to institutionalize training programs for women on the operation of bio-gas digester, use of liquid affluent from digester, management of orchard and vegetable garden, food processing, marketing, household sanitation, environmental protection and other women empowerment activities. The consultant will assist to ensure that schedule and content of the training courses will be design with special considerations on women's needs i.e. shorter hours, closer to the house and arrangements for household helper during training hours

17. **Extension Specialist** (16 person-months). The consultant should have at least 5 years of work experience as an extension specialist and should be familiar with the rural energy policy and biogas development of PRC. He or she will assist in developing an extension and training program, in collaboration with the Training Specialist, to assist the farmers who are adopting the biogas technology. A special extension program will also have to be developed to cater for the poor and disadvantaged farmers who are the Project beneficiaries. The Extension Specialist will provide advice to the PIOs and PIUs in organizing and selecting Project farmers to ensure that a critical mass is realized within a location to enable economics of scale for establishing a biogas service infrastructure by private sector to provide sustainable O & M service to the biogas farmers. Extension training will also be provided to Project and Provincial field extension officials to ensure sustainability of Project benefits.

18. **Project Benefit Monitoring and Evaluation Specialist** (12 person-months). The consultant will be associated with a research institute or a university in each province. The consultant will work closely with the poverty specialist of PMO and the provincial gender specialist to establish and make operative participatory poverty monitoring system and provide intermittent supports in the operation of the poverty monitoring system. The consultant will provide supervision to student fellows who will be responsible for conducting poverty impact monitoring surveys and documenting experiences of best practices in poverty reduction in the Project. The consultant will also assist in the preparation of annual report on poverty impacts of the Project.

FINANCIAL AND ECONOMIC ANALYSES

A. Introduction

1. The financial analysis focuses only on the viability of the representative farm models envisaged to evolve under the Project. The analysis is based on incremental revenues derived from the sale of agricultural crops and livestock for Types I, II, and III biogas systems, and from the sale of biogas (for Types III and IV systems) and incremental costs incurred in farm development, working capital, farming operations, and operation and maintenance. The economic analysis was carried out for each type of biogas system and for the Project as a whole covering all six components. The Project life is assumed at 25 years, including an implementation period of five years. Costs included in the economic analysis consist of incremental capital and operating costs including physical contingencies, but excluding price contingencies, taxes, duties, and subsidies. Economic costs and benefits are derived by adjusting financial costs and benefits by a standard conversion factor (SCF) of 0.9 and a shadow wage rate of 0.8.

B. Assumptions

1. Types of Biogas Systems

2. The Project will provide funds from which potential borrowers may draw as credit for investment in four types of biogas units. It is expected that about 4,700, 10,900, 14, and 28 units of Type I, II, III, and IV biogas systems, respectively, will be established under the Project. Type I biogas farming systems consist of a biomass digester and greenhouse (area of about 0.5 mu¹ or about 333 sq m) for the production of vegetables and pigs with an annual throughput of 30 head. The average farm has a cultivated area of four mu. The financial and economic analyses take into consideration two scenarios in assessing the viability of investments in Type I biogas systems. The first scenario determines the incremental costs incurred and benefits derived by a farm which has fully adopted Type I biogas technology (i.e., construction of a biomass digester and a greenhouse which represents the “with” Project situation) and compares these with a similar farm applying traditional farming technology (i.e., no biomass digester and greenhouse which represents the “without” Project situation). This is presented in the analyses as Type Ia biogas system. The second scenario evaluates the incremental costs and benefits of a farm with a digester and greenhouse (representing full technology adoption under “with” Project situation) relative to one with a greenhouse but without a biogas digester (considered as improved Type I biogas system under “without” Project situation). This is presented as Type Ib biogas system in both the financial and economic analyses. Of the total 4,700 units of Type I biogas systems to be established, 2,350 units, or 50 percent, are assumed in each scenario.

3. Type II biogas farming systems mainly produce orchard crops (area of about 15 mu), such as citrus, and an annual throughput of 10 head of pigs to supply the manure requirements of its biogas digester. Type III biogas farming systems are large pig farms which are operated by farming communities or groups of individuals consisting of breeding and fattening stock with an annual throughput of 10,000 – 15,000 head of fattened pigs. These systems will generate additional income from the sale of biogas to consumer households for cooking and lighting as well as from the sale of digested effluents and sludge as farm fertilizer. Type IV systems are mainly biomass gasification plants that produce producer gas which will be sold to user-households. The plant consists of a

¹ 1 ha = 15 mn.

gasifier, a gas tank, building facilities, and biogas distribution facilities. In the analyses, it is assumed that new Type IV gasification systems will be constructed under the Project. The number of biogas system in each province is presented in Table A8.1.

Table A8.1: Biogas System Investments by Province

Province	Type I (units)	Type II (units)	Type III (units)	Type IV (units)
Jiangxi	-	5,500	-	-
Hubei	-	4,400	2	11
Henan	1,200	1,500	3	15
Shanxi	3,500	-	4	2
Total	4,700	10,900	14	28

4. Incremental costs incurred by the biogas systems include incremental investment costs, working capital requirements, and operating costs incurred during their production operations. Investment costs include capital investment in the construction of greenhouses, pigpens, toilet facilities, biogas digesters, and biogas distribution facilities.

2. Production

5. A total of about 4,700 farm households, each cultivating about 4 mu (2,668 sq m), is expected to invest on Type I biogas systems. In the provinces of Shanxi and Henan, a total of 18,800 mu (1,253 ha) will be cultivated under all Type I biogas systems comprising of grains (i.e., winter wheat, maize, soybean, millet, and mungbean), greenhouse vegetables (e.g., onion, melon, and cucumber), and livestock, such as pigs and a few head of sheep and goats. Incremental production generated by Type I biogas systems is based on production estimates under two Type I sub-systems: (i) Type Ia system which compares full technology adoption vs traditional technology; and (ii) Type Ib system which compares full technology adoption vs improved technology. The estimated incremental vegetable area under each sub-system is about 0.5 and 0.25 mu, respectively, or a total incremental vegetable area of about 1,175 mu for Type Ia biogas system and 587.5 mu for Type Ib biogas system. The annual incremental vegetable production of 0.6 t and 0.3 t for Type Ia biogas system and Type Ib biogas system, respectively, the corresponding total annual incremental vegetable production for Type Ia biogas system and Type Ib biogas system is about 705 t and 177 t, or a total annual incremental vegetable production for all Type I biogas systems of 882 t (see Table A8.2). Total annual incremental grain production is about 312 t while annual incremental pig production is about 105,750 head or about 10,575 t (at 100 kg/head). All Type I biogas systems will generate a total annual incremental production of about 2.8 million cu m of biogas, 183,558 t of digested effluent, and 44,310 t of sludge.

6. About 10,900 farm households, each comprising of about 15 mu (about 1 ha) for citrus orchard production, will invest on Type II biogas systems, mainly in the provinces of Hubei, Henan, and Jiangxi. Under “with Project” situation, each Type II biogas system is assumed to be planted with about 700 citrus trees and will produce about 10 head of pigs annually. Under “without Project” situation, a Type II system is assumed to cultivate 189 citrus trees and produces two pigs. The new system will produce about 24 t of citrus on a one ha orchard area (about 34.3 kg/tree) compared with the same type of system under “without Project” situation which produces 4.8 t on an orchard of 0.27 ha (about 25.4 kg/tree). Total annual citrus production under “with Project” situation is about 261,600 t compared with about 52,320 t “without Project” or annual incremental citrus production of 209,280

t. Total annual pig production will increase from 21,800 head (or 2,180 t at 100 kg/head) to 109,000 head (10,900 t) or an incremental production of 87,200 head or about 8,720 t. The Type II systems will generate an incremental production of about 6.5 million cu m of biogas, 138,213 t of digested effluent, and 33,365 t of sludge.

Table A8.2: Annual Incremental Production under Different Biomass Technologies

Type of Biogas System	Vegetables (t)	Grains (t)	Citrus (t)	Pig Meat (t)	Biogas (million cu m)	Digested Effluent (t)	Sludge (t)
Annual Production "With Project"							
Type Ia	926	3,120	0	7,238	1.410	91,779	22,155
Type Ib	1,617	3,120	0	7,238	1.410	91,779	22,155
Type II	0	0	261,600	10,900	6.540	138,213	33,365
Type III	0	0	0	14,452	1.226	198,684	47,822
Type IV	0	0	0	0	30.660	0	0
Total Production	2,542	6,239	261,600	39,828	41.246	520,455	125,497
Annual Production "Without Project"							
Type Ia	367	2,964	0	188	0	0	0
Type Ib	1,293	2,964	0	3,713	0	0	0
Type II	0	0	52,320	2,180	0	0	0
Type III	0	0	0	4,769	0	0	0
Type IV	0	0	0	0	0	0	0
Total Production	1,660	5,927	52,320	10,850	0	0	0
Annual Incremental Production							
Type Ia	558	156	0	7,050	1.410	91,779	22,155
Type Ib	324	156	0	3,525	1.410	91,779	22,155
Type II	0	0	209,280	8,720	6.540	138,213	33,365
Type III	0	0	0	9,683	1.226	198,684	47,822
Type IV	0	0	0	0	30.660	0	0
Incremental Production	882	312	209,280	28,978	41.246	520,455	125,497

7. About 14 Type III biogas systems will be established. A typical Type III system will produce about 87,600 cu m of biogas annually which will be distributed among consumer households. An annual incremental biogas production of about 1.2 million cu m will be produced by Type III biogas system. Under "with Project" situation, these systems will produce a total of 144,520 head of pigs (about 14,452 t) compared with about 47,690 head (4,769 t) under the "without Project" situation or an incremental pig production of 96,830 head (or 9,683 t). The Type III biogas systems will produce an increment of about 198,684 t and 47,822 t of digested effluent and sludge. Total incremental volume of digested effluent and sludge produced is about 246,506 t (Table A8.2).

8. About 28 gasification systems (Type IV systems) will be established. One gasification system (Type IV system) will produce about 1.1 million cu m of producer gas. Each gasification system is newly constructed. The annual incremental production of producer gas is estimated at about 30.7 million cu m (Table A8.2).

9. The total projected incremental production of crops and livestock accruing to the Project is less than one percent of current agricultural production in the Project area, agricultural prices of these commodities in the local market are not expected to be affected by Project output in each county.

10. A summary of the typical farm budgets of each Type Ia, Ib, and II biogas systems, under the "with" and "without" Project situations, are presented in Table A8.3.

Table A8.3: Typical Farm Budgets

Item	Type Ia 1/ (Yuan)	Type Ib 2/ (Yuan)	Type II (Yuan)
	"With Project"		
Revenue	19,110	19,110	64,940
Production and Maintenance Cost	11,974	11,974	22,707
Gross Margin Before Tax	7,136	7,136	42,233
Income Tax 3/	1,427	1,427	8,447
Gross Margin After Tax	5,709	5,709	33,786
	"Without Project"		
Revenue	8,613	11,641	33,151
Production and Maintenance Cost	6,493	7,604	8,735
Gross Margin Before Tax	2,120	4,037	24,416
Income Tax	424	807	4,883
Gross Margin After Tax	1,696	3,230	19,533

1/ This refers to comparison of Type I biogas system with full adoption of technology with a traditional production system which has no greenhouse and digester.

2/ This refers to comparison of Type I biogas system with full adoption of technology with a traditional production system which has a greenhouse but no digester.

3/ Tax assumed at 20 percent.

C. Financial Analysis

1. Financial Viability of Each Type of Biogas System

11. **Investment Cost.** Under the "with" Project situation, new investments will be made by Project beneficiaries on the various types of biogas systems. Total investment on each type of biogas system is as follows: (i) Type I, Y20,750 (or about \$2,500)²; (ii) Type II, Y27,245 (\$3,283)³; (iii) Type III, Y1,957,000 (\$235,783); and (iv) Type IV, Y1,094,056 (\$131,814). The investment on each type of system will require an equity contribution of 25 percent from beneficiary, 25 percent from government, and 50 percent from credit loan fund.

12. Loans for Type I biogas systems will have a maturity period of seven years. This includes a grace period of three years from the year of establishment (i.e., from Year 0 to Year 2), with repayment on principal loan and interest commencing on Year 3 until Year 6. Credit for Type II biogas systems is assumed to mature in 10 years, with a grace period of five years from year of establishment (i.e., from Year 0 to Year 4) and loan repayments commencing on Year 5, when the citrus trees start to bear fruits, until Year 9. Although the Type II biogas systems will generate positive cash flow on the first year of production, revenues will mainly be derived from pig production and will not be sufficient to cover interest charges and repayments on principal loan. Adequate cash flow will be realized on Year 5 when citrus trees start bearing fruits.

13. In the analysis, loans for Type III systems are assumed to have a maturity period of eight

² As the investment cost in Shanxi province and Henan province are at Y24,900 (\$3,000) and Y16,600 (\$2,500), respectively, an average investment cost of Y20,750 (\$2,500) was used in the analyzing the financial viability of the Type I biogas system.

³ As the investment cost in Hubei province, Henan province, and Jiangxi province are at Y18,675 (\$2,250), Y29,800 (\$3,600), and Y19,920 (\$2,400), respectively, an average investment cost of Y27,245 (\$3,283) was used for determining the financial viability of the Type II biogas system which includes purchase of planting materials and trace elements.

years with a grace period of three years (i.e., from Year 0 to Year 2). Full repayment on loan and interest charges covers a period of five years, i.e., from Year 3 to Year 7. For Type IV systems, loan repayment is assumed to start after a grace period of five years (i.e., from Year 0 to Year 4), with the loan to be fully paid within a five-year period (from Year 5 to Year 9) or a maturity period of 10 years. Details of the investment parameters of the different biomass technology types are presented in Table A8.4.

Table A8.4: Investment Parameters of the Different Biomass Technology Types

Type	Cost per Unit (\$)	First Year of Positive Cash Flow	Loan Maturity Period (years)	Grace Period (years)	Years of Loan Repayment (years)
Type I ^a	2,500	Year 1	7 ^b	3	4
Type II ^c	3,283	Year 1	10 ^d	5	5
Type III	235,784	Year 3	8 ^d	3	5
Type IV	131,814	Year 3	10 ^b	5	5

^a Average of estimated unit cost of \$2,000 and \$3,000 for Henan and Shanxi province, respectively.

^b Including a three-year grace period from Year 0.

^c Average of estimated unit cost of \$2,400, \$2,250, and \$3,600 for Jiangxi, Hubei, and Henan province, respectively.

^d Including a five-year grace period from Year 0.

14. All loans will be charged at prevailing commercial banks' interest rate (currently at 6.4 percent). The investment cost of each biogas system consists of investment requirements for the construction of greenhouses, pigpens, toilet facilities, and biogas digesters for Types I and II biogas systems. Type III system will require construction of additional pigpens and the construction of a biogas plant and distribution facilities. Type IV system will require the construction of a gasification plant and distribution facilities. All financial analysis used 2001 prices and was carried out covering a period of 15 years for Type I the biogas system and 20 years for Types II, III, and IV systems.

15. The total investments in all types of biogas systems under the Project is estimated at about \$47.2 million distributed as follows: (i) Jiangxi, \$12.0 million; (ii) Hubei, \$11.8 million; (iii) Henan, \$11.7 million; and (iv) Shanxi, \$11.7 million. The summary of total investment by type and province is presented in Table A8.5 below.

Table A8.5: Summary of Investment Costs by Type of Technology^a
(\$'000)

Province	Type I	Type II	Type III	Type IV	Total by Province
Jiangxi	-	12,000.0	-	-	12,000.0
Hubei	-	9,900.0	471.6	1,450.0	11,821.6
Henan	2,400.0	5,400.0	1,886.3	1,977.2	11,663.5
Shanxi	10,500.0	-	943.1	263.6	11,706.7
Total	12,900.0	27,300.0	3,301.0	3,690.8	47,191.8

^a Base cost covering ADB (50%), Government (25%), and beneficiary contribution (25%).

16. **Revenue.** For both "with" and "without" Project situations, farm revenues from crop, livestock, biogas, and digested effluents/sludge sales were valued using financial farmgate prices, expressed in 2001 terms. A summary of the prices use in the calculation of revenue for each biogas system is

given in Table A8.6 below.

Table A8.6: Summary of Commodity Prices

Commodity Price/ Cost Savings	Unit	Financial Price (Yuan)	Standard Conversion Factor (Yuan)	Economic Price (Yuan)
Producer Biogas	cu m	1.20	0.9	1.08
Digested Effluent	ton	10.00	0.9	9.00
Sludge	ton	45.00	0.9	40.50
Pig Live Weight	kg	7.60	0.9	6.84
Citrus	kg	3.00	0.9	2.70
Winter Wheat	kg	1.20	0.9	1.08
Maize	kg	0.80	0.9	0.72
Soybean	kg	2.40	0.9	2.16
Millet	kg	1.80	0.9	1.62
Green Onions	kg	0.40	0.9	0.36
Cucumber	kg	2.20	0.9	1.98
Melon	kg	1.80	0.9	1.62

17. **Annual Operating Cost.** Operating cost items, for both “with” and “without” Project situations, include expenditures covering labor cost, production materials, and interest payments on principal loan and working capital. Labor cost is estimated at Y20/person-day. These costs were estimated using 2001 prices.

18. **Gross Margin/Net Profit from Operations.** Estimates of gross margin/net profit from operations for each biogas system, under “with” and “without” Project situations, were projected over a period of 15 (for Type I biogas system) and 20 years (for Types II, III, and IV systems) using 2001 prices based the calculated biogas system-specific revenues and operating costs. Inflationary effects were excluded on the assumption that inflation will affect increases in input and output prices proportionately.

19. **Cash Flow.** Incremental cash flow projections were based on annual cash inflow and outflow streams under “with” and “without” Project situations.

2. Financial Performance of Each Type of Biogas System

20. Revenues are expected to be generated by each of the biogas systems starting on the first year of operation. For Type Ia, Type Ib, and Type II biogas systems positive cash flows are envisaged to be realized on the first year operation and are projected to adequately cover: (i) annual production and maintenance costs; (ii) income tax; and (iii) debt service requirements during the years when these are due for payment. Type III systems are expected to realize positive cash balances on the third year of operation and will be able to cover repayments on loan starting in Year 3. Type IV systems will realize positive cash balances in Year 3 but will only be able to sufficiently cover loan repayments and interest charges starting in Year 5. Details of financial analysis for each biogas system are given in Supplementary Appendix D.

21. The financial performance of each individual biogas system was assessed using financial ratios which provide information on the capability of these systems to: (i) cover operating expenses (i.e., operating ratio); (ii) generate returns (income ratios such as return on sales, return on equity,

and return on assets); and (iii) cover financial obligations (i.e., current ratio, debt service ratio, and debt coverage ratio). The operating ratios of the biogas systems range from 33-95 percent with Type II biogas systems exhibiting the lowest and Type III systems, which incur relatively higher operating costs, exhibiting the highest values (see Table A8.7). All systems exhibited high income ratios which are generally higher than the weighted average cost of capital (nominal value of 4.3 percent). The systems were able to generate adequate funds from their operations to cover financial obligations as exhibited by the creditworthiness ratios (i.e., current ratio, debt service coverage ratio, and debt coverage ratio) which were greater than one.

Table A8.7: Financial Ratios by Type of Biogas System

Item	Year										
	3	4	5	6	7	8	9	10	11	12	13-20 ^a
Type I											
Operating ratio ^b	0.79	0.79	0.76	0.75	0.73	0.73	0.72	0.73	0.74	0.74	0.72
Return on sales (%) ^c	17	17	20	20	22	21	22	22	21	21	22
Return on equity (%) ^d	63	66	77	80	90	90	96	96	94	96	104
Return on assets (%) ^e	16	17	19	20	22	22	24	24	24	24	26
Current ratio ^f	3.2	4.5	6.2	7.8							
Debt service coverage ratio ^g	1.3	1.3	1.5	1.5							
Debt coverage ratio ^h	3.8	5.2	6.8	8.4							
Type II											
Operating ratio ^b	0.76	0.75	0.68	0.65	0.59	0.47	0.41	0.37	0.33	0.33	0.33
Return on sales (%) ^c	3	5	14	22	25	37	44	47	51	51	51
Return on equity (%) ^d	5	10	47	90	122	283	406	493	602	615	628
Return on assets (%) ^e	1	3	12	23	31	71	101	123	151	154	157
Current ratio ^f			3.2	5.1	7.6	12.8	20.6				
Debt service coverage ratio ^g			1.3	1.9	2.4	4.9	7.0				
Debt coverage ratio ^h			3.9	5.8	8.3	13.5	21.3				
Type III											
Operating ratio ^b	0.89	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Return on sales (%) ^c	7	2	2	1	2	2	2	2	2	2	2
Return on equity (%) ^d	130	33	40	29	37	46	47	49	50	52	54
Return on assets (%) ^e	33	8	10	7	9	11	12	12	13	13	13
Current ratio ^f	1.4	2.4	3.6	4.3	6.0						
Debt service coverage ratio ^g	2.4	1.2	1.3	1.1	1.3						
Debt coverage ratio ^h	2.1	3.1	4.4	5.0	6.7						
Type IV											
Operating ratio ^b	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Return on sales (%) ^c	15	15	12	10	11	10	12	13	13	13	13
Return on equity (%) ^d	72	74	57	51	56	54	62	71	73	75	77
Return on assets (%) ^e	18	19	14	13	14	13	16	18	18	19	19
Current ratio ^f			2.8	4.2	5.7	6.6	8.9				
Debt service coverage ratio ^g			1.5	1.4	1.5	1.4	1.6				
Debt coverage ratio ^h			3.6	4.9	6.5	7.3	9.6				

^a Ratios generally remain the same from Year 13 to Year 20.

^b Operating ratio = Cost of operation/Sales revenue.

^c Return on sales = Net income after tax and debt service/Sales revenue.

^d Return on equity = Net income after tax and debt service/Equity.

^e Return on assets = Net income after tax and debt service/Assets.

^f Current ratio = Current assets/Current liabilities; current assets were mainly composed of cash while current liabilities consisted of the portion of the principal loan due during the current year.

^g Debt service coverage ratio = (Net income after income tax; before debt service)/(Interest payment + Repayment of long-term loan).

^h Debt coverage ratio = (Cash + Interest payment)/(Interest payment + Repayment of long-term loan).

22. The results of the financial analysis indicate that each type of system is financially viable as implied by their respective calculated financial internal rate of return (FIRR) value which is greater than the WACC which is estimated at 4.3 percent. Moreover, the sensitivity analysis indicated that the FIRR value of all types of biogas systems is highly sensitive to changes in revenue and production cost as implied by the sensitivity indicator which exhibited a value greater than one for each corresponding change in revenue, production cost, or both. A delay in benefits by one year will not significantly affect the FIRR value of each type of biogas system. The FIRR is also not sensitive to changes in foreign exchange. In the sensitivity analysis, a 30 percent devaluation rate in the Yuan exhibited a sensitivity indicator of less than one. A devaluation of the Yuan is highly unlikely to occur, however, given the country's significant trade surplus. The summary of the results of the financial and sensitivity analyses is presented in Table A8.8 below.

Table A8.8: FIRR and Sensitivity Analysis – by Type of Biogas System

Change in variable	Percent Change	Type Ia		Type Ib		Type II		Type III		Type IV	
		Base FIRR	FIRR	Base FIRR	FIRR	Base FIRR	FIRR	Base FIRR	FIRR	Base FIRR	FIRR
		15.9%		16.7%		16.6%		15.9%		13.8%	
		Recalculated FIRR	Sensitivity Indicator	Recalculated FIRR	Sensitivity Indicator	Recalculated FIRR	Sensitivity Indicator	Recalculated FIRR	Sensitivity Indicator	Recalculated FIRR	Sensitivity Indicator
		(percent)		(percent)		(percent)		(percent)		(percent)	
1. Decrease in revenue	10%	11.0	3.10	10.60	3.63	13.5	1.92	7.7	4.97	5.3	6.15
2. Increase in production cost	10%	13.1	1.75	12.80	2.33	15.7	0.58	8.4	4.48	7.0	4.96
3. Decrease in revenue and increase in cost	10%	8.0	4.98	6.40	6.15	12.7	2.37	5.5	6.54	5.1	6.30
4. Delay of one year in benefits whole Project		15.5		16.30		16.4		15.7		13.6	
5. Exchange rate change	30%	13.5	0.51	14.30	0.48	15.3	0.26	13.9	0.42	12.4	0.35

23. The switching values technique confirms the results of the sensitivity analysis (see Table A8.9). The summary of the results shows that the small-scale biogas systems (i.e., Types I and II biogas systems) require greater percentage changes in revenue and costs to maintain a FIRR value of 4.3 percent compared with the medium-scale biogas systems (i.e., Types III and IV).

Table A8.9: Switching Values Technique^a – by Type of Biogas System

Item	Base FIRR	Base FIRR	Base FIRR	Base FIRR	Base FIRR
	15.9%	16.7%	16.6%	15.9%	13.8%
	(percent)	(percent)	(percent)	(percent)	(percent)
1. Decrease in revenue	22.0	19.4	35.2	13.9	11.1
2. Increase in production cost	39.5	30.6	>100	15.2	13.6
3. Decrease in revenue & increase cost	14.2	11.9	33.0	11.2	10.9
4. Exchange rate change	>100	>100	>100	>100	>100

^a Percentage change in variable to maintain a FIRR of 4.3 percent.

3. Financial Performance of All Biogas Systems

24. The financial analysis was extended to determine the financial performance of all of the types of biogas systems established under the Project covering a period of 25 years. The analysis was based on projections of calculated financial incremental revenue and cost streams of each type of system which were derived from their respective farm budgets. The calculated Project FIRR, for the Project as a whole is about 15 percent (see Table A8.10).

Table A8.10: Financial Internal Rate of Return for Project Investment

Year	Net Benefits from Type I Investments (Y million)	Net Benefits from Type II Investments (Y million)	Net Benefits from Type III Investments (Y million)	Net Benefits from Type IV Investments (Y million)	Net Benefits from All Investments (Y million)
2002	-7.621	-29.697		-2.190	-39.508
2003	-10.554	-44.060	-7.828	-7.233	-69.674
2004	-20.213	-87.032	-7.933	-10.659	-125.838
2005	-16.704	-84.678	-6.182	-8.335	-115.899
2006	-1.080	-37.521	-3.150	-5.734	-47.484
2007	5.942	-19.217	4.780	1.020	-7.475
2008	4.126	-30.868	-1.693	-0.309	-28.745
2009	-5.245	-67.889	-0.636	-2.528	-76.298
2010	-1.688	-51.591	-0.136	-0.697	-54.113
2011	14.031	11.555	2.523	1.535	29.644
2012	20.911	50.598	10.063	7.919	89.491
2013	19.094	66.579	3.590	6.590	95.854
2014	9.771	55.192	4.648	4.371	73.982
2015	13.422	89.477	5.148	6.202	114.249
2016	29.000	163.139	7.806	8.434	208.379
2017	35.879	205.963	15.347	14.818	272.007
2018	34.205	221.944	8.874	13.489	278.512
2019	25.024	210.557	9.932	11.270	256.783
2020	28.676	244.842	10.432	13.101	297.050
2021	44.253	318.503	13.090	15.333	391.180
2022	51.132	361.328	20.631	21.717	454.808
2023	49.459	377.308	14.158	20.388	461.313
2024	40.278	365.921	15.216	18.169	439.584
2025	43.930	400.206	15.715	20.000	479.851
2026	59.507	473.868	18.374	22.232	573.981
FIRR (%)	16.3	15.1	14.5	12.0	15.1
NPV@4.3%	186.846	1,186.745	58.980	59.778	1,492.349

D. Economic Analysis

25. The economic analysis took into account the incremental benefits derived from investments in all types of biogas systems in the four selected provinces as well as the environmental economic benefits accruing to the Project. The overall economic evaluation of the whole Project was undertaken by applying the ADB's Guidelines for Economic Analysis of Projects.

1. Calculation of Economic Costs

26. For each type of biogas system, investment, production, and maintenance financial costs were converted to economic values by a SCF of 0.9, except for unskilled labor which was adjusted by a shadow wage rate of 0.8. All costs were expressed in 2001 constant prices and were projected over a period of 25 years, the Project life.

2. Calculation of Economic Benefits

27. All financial farm revenues of each biogas system, except for biogas, and costs of each type of biogas system, under both the “with” and “without” Project situations were adjusted by a SCF of 0.9 for the economic valuation. The financial revenue from biogas sales is based on a market price of Y1.20/cu m which, in turn, was converted into economic value using a price correction factor of 0.89 and 0.71 for Type III and Type IV systems.⁴ All economic benefits were expressed in 2001 constant terms and were projected over a 25-year period. Incremental economic benefits were estimated from the difference between the economic revenue and cost streams of each biogas system which, in turn, served as the basis for estimating the incremental economic benefits generated by all investments in the various types of biogas systems under the Project.

28. Environmental economic benefits accruing to the Project, in terms of cost savings, such as: (i) savings in fuel; (ii) reduction in cooking time; and (iii) medical savings resulting from positive impact on health were also quantified and included in the calculation of the economic internal rate of return (EIRR) value for the Project as a whole.

29. The financial value of annual fuel savings per household for each type of biogas system is estimated at about: (i) Y512 for households under Type I biogas systems; (ii) Y624 for households under Type II biogas systems; (iii) Y77 for households sourcing biogas from Type III biogas systems; and (iv) Y187 for households deriving biogas from Type IV gasification plants. Multiplying these estimated savings by a correction factor of 1.29, 1.15, 0.89, and 0.71, respectively, the corresponding economic value of fuel savings per household for each type of biogas system is at: (i) Y660 for households under Type I biogas systems; (ii) Y717 for households under Type II biogas systems; (iii) Y69 for households using biogas from Type III biogas systems; and (iv) Y133 for households sourcing biogas from Type IV gasification plants.

30. A saving of one hour/day in cooking time, on average, is estimated when using biogas or producer gas instead of conventional fuels. Based on a 12 hour-day worked by the average woman and daily wage of Y20, the average annual saving per household, in financial terms, is calculated at Y608. Applying a SCF of 0.8, the economic value of savings in cooking time is estimated at about Y487 per year.

31. Firewood and coal are inefficient fuels for cooking and can cause health problems connected to smoke inhalation. On the other hand, biogas used in cooking has negligible emission of dust, soot, and carbon dioxide due to its chemical composition. It is estimated that the average household using biogas can realize a financial saving of Y30 per year in medical expenses or, applying a SCF of 0.9, about Y27 per year.

32. The Project will generate considerable economic benefits in terms of reductions in carbon dioxide emissions. This, subsequently, will have positive effects on the environment. The use of biogas results in reduced carbon dioxide emissions of about: (i) 4.6 t per household under Type I biogas systems; (ii) 4.2 t per household under Type II biogas systems; (iii) 1.8 t per household using biogas from Type III systems; and (iv) 0.7 t per household using biogas from Type IV gasification plants or an annual average of about 2.8 t per household. As a consequence, total annual carbon dioxide emissions is envisaged to be reduced by 36-92 percent or about 75 percent per year. The Intergovernmental Panel on Climate Change (IPCC) has calculated the damage cost of carbon

⁴ The price conversion factor applied in converting the financial price of biogas to economic value for Type III and Type IV biogas system is calculated based on the market prices of LPG and coal, adjusted by their thermal efficiency, in terms of biogas and producer gas.

dioxide emissions to be at about Y83/t or an average financial value of Y232/household/year. This is about Y209/household/year in economic terms. These, however, are not included in the calculation of the economic internal rate of return (EIRR).

3. Economic Internal Rate of Return

33. The resulting economic net present value (NPV) showed that the Project is expected to generate approximately Y553.19 million for the economy. Including environmental economic benefits (i.e., savings in fuel, reduction in cooking time, and medical savings), the EIRR of the whole Project is about 18 percent. The summary of results of the economic analysis for the whole Project is presented in Table A8.11.

4. Sensitivity Analysis and Switching Values Technique

34. A sensitivity analysis was undertaken to determine the effect of variations in the estimated benefits of the Project. The analysis indicated that the Project as whole is not very sensitive to changes in revenue and production costs as the sensitivity indicators, in general, exhibited values close to one. A delay in Project benefits by one year as well as a devaluation in the Yuan by 30 percent likewise indicated insignificant effect on the base EIRR. The results of the sensitivity analysis are presented in Table A8.12.

Table A8.11: Economic Internal Rate of Return – Whole Project

Year	Incremental Investment	Net Benefits from Biogas Investments	Savings in Fuel Expense	Savings in Medical Expense	Savings in Cooking Time	Net Incremental Benefits	Net Incremental Benefits	Net Incremental Benefits	Net Incremental Benefits
	(1)	(2)	(3)	(4)	(5)	(2)-(1)	(2+3)-(1)	(2+3+4)-(1)	(2+3+4+5)-(1)
	(Y million)	(Y million)	(Y million)	(Y million)	(Y million)	(Y million)	(Y million)	(Y million)	(Y million)
2002	82.808	- 28.048	1.252	0.075	1.343	- 110.856	- 109.604	- 109.530	- 108.186
2003	116.575	- 49.068	3.402	0.248	4.468	- 165.643	- 162.241	- 161.994	- 157.526
2004	136.823	- 87.534	7.350	0.517	9.315	- 224.357	- 217.007	- 216.490	- 207.175
2005	126.284	- 76.596	11.130	0.750	13.520	- 202.881	- 191.750	- 191.000	- 177.481
2006	58.449	- 24.517	13.272	0.920	16.586	- 82.966	- 69.694	- 68.774	- 52.188
2007	-	7.456	14.524	0.995	17.929	7.456	21.980	22.975	40.904
2008	-	4.969	16.673	1.168	21.053	4.969	11.705	12.873	33.926
2009	-	34.034	20.621	1.437	25.900	34.034	13.412	11.975	13.925
2010	-	11.672	24.402	1.670	30.105	11.672	12.729	14.400	44.505
2011	-	76.598	26.544	1.840	33.171	76.598	103.142	104.982	138.153
2012	-	148.389	27.795	1.915	34.514	148.389	176.184	178.099	212.614
2013	-	165.840	29.945	2.088	37.639	165.840	195.785	197.874	235.512
2014	-	155.711	33.893	2.357	42.486	155.711	189.604	191.962	234.448
2015	-	206.766	37.674	2.590	46.691	206.766	244.440	247.030	293.721
2016	-	311.089	39.815	2.760	49.757	311.089	350.904	353.665	403.422
2017	-	387.322	41.067	2.835	51.100	387.322	428.390	431.225	482.325
2018	-	404.958	43.217	3.008	54.224	404.958	448.175	451.184	505.408
2019	-	395.014	47.165	3.277	59.072	395.014	442.179	445.456	504.528
2020	-	446.069	50.945	3.511	63.276	446.069	497.014	500.525	563.801
2021	-	550.392	53.087	3.681	66.342	550.392	603.479	607.159	673.502
2022	-	626.389	54.339	3.755	67.686	626.389	680.728	684.483	752.169
2023	-	643.318	56.489	3.929	70.810	643.318	699.806	703.735	774.545
2024	-	632.429	60.437	4.197	75.657	632.429	692.866	697.064	772.721
2025	-	682.776	64.217	4.431	79.862	682.776	746.993	751.424	831.286
2026	-	786.392	66.359	4.601	82.928	786.392	852.750	857.351	940.279
EIRR=						14.2%	15.9%	16.0%	18.2%
NPV@12%=						192.986	348.490	359.250	553.190

Table A8.12: EIRR Sensitivity Analysis – Whole Project

Change in variable	Percent Change	Base EIRR 1/ 18.2%	EIRR Sensitivity Indicator
		Recalculated EIRR	
1. Decrease in revenue	10%	15.9	1.27
2. Increase in production cost	10%	16.2	1.10
3. Decrease in revenue & increase cost	10%	13.6	2.52
4. Delay of one year in benefits whole Project		17.8	
5. Exchange rate change	30%	16.4	0.32

1/ EIRR calculation is based on benefits derived from investments on biogas systems and environmental economic benefits.

35. The switching values technique confirms the results of the sensitivity analysis (see Table A8.13). The summary of the results shows that the Project will require significant changes (about 20-40 percent) in revenue and costs to maintain an EIRR value of 12 percent.

Table A8.13: Switching Values Calculation

Change in variable	Base EIRR 1/ 18.2%	Percent Change in Variable to Maintain an EIRR Value of 12%
1. Decrease in revenue		23.3
2. Increase in production cost		27.9
3. Decrease in revenue & increase cost		11.6

1/ EIRR calculation is based on benefits derived from investments on biogas systems and environmental economic benefits.

Table A8.14 – Summary of Environmental Benefit Valuation

Benefit/Impact	Description/Specification	Value	Comment
Carbon Dioxide reduction	1 kg coal (Chinese Standard) produces 2.7 kg CO ₂ 1 kg LPG (Chinese Standard) produces 1.8 kg CO ₂	In the Intergovernmental Panel on Climate Change (IPCC) the international damage costs are estimated at \$10/ton of CO ₂ emissions. IPCC, 1998	Further advantages are the serious SO ₂ reduction since coal being used for combustion normally contains 0.5% to 6% sulphur depending on origin
	Biomass is considered to be CO ₂ neutral, except only for fuel preparation and transport (less than 10%)	- At least \$10 USD savings per ton of coal replaced.	Other sources document total cost for CO ₂ removal from flue gases and final dumping is in the range of \$50.[EU Project Fossil Fuels 1999]
	Firewood can be considered also as CO ₂ neutral during combustion	- Protection of natural resources . - Reduced soil erosion so less flooding - Forests act as an important sink for CO ₂ . - Current price for firewood in the range of Y0.2/kg	Firewood should be replaced by biogas due to harmful components during combustion eg soot, tar and carcinogens
	Gas produced in gasification plants from agricultural waste	- Selling costs of the gas in the range of Y0.13 – 0.36 /m ³ based on calorific value comparison to LPG. - Coal cost per ton Y90-100 – Shanxi, Yuan Y170-270 /ton – Henan, Y300-400/ton – Hubei and Jiangxi - Savings: 0.92 kg of coal equivalent by replacing coal with 1.00 m ³ of producer gas	Environmentally friendly fuel which significantly reduces CO ₂ output as well as harmful emissions such as soot, tar and dust.
	Biogas by anaerobic digestion	- Selling costs of the gas in the range of Y0.9 – 1.50 /m ³ based on calorific value comparison to LPG. - Coal cost per ton Y90-100 – Shanxi, Y170-270 /ton –Henan, Y300-400/ton – Hubei and Jiangxi. - Calculations based on medium price of Y240/ton for coal. - Savings: 3.50 kg of coal equivalent by replacing coal with 1.00 m ³ of biogas	Environmentally friendly fuel which significantly reduces CO ₂ Minimum environmental impact from anaerobic digestion. SO ₂ emission possible when high H ₂ S content in gas mixture CH ₄ emission when not burnt Combustion behaviour comparable with natural gas
	- Emission dung is 1.6 kg CH ₄ /head/year)	- Equivalent reducing potential through anaerobic manure treatment instead of lagoons is 33.60 kg CO ₂ /head/year	IPCC, 1996, Workbook 2, Section 4
	Pigs manure managed as liquid: - N production per animal 16 kg N/head/year - Emission potential in N ₂ O is 38 % of the kg N produced/head/year	- Equivalent reducing potential through anaerobic treatment instead of lagoons is 1.763 kg CO ₂ /head/year	IPCC, 1996, Workbook 2, Section 4
Gas price	Which sources of energy can be replaced was determined in the economic evaluation by means of calorific value relations.	- Biogas Y1.5/m ³ - Producer Gas Y0.36/m ³ (To compare: Coal Gas: Y1.25/m ³)	

Benefit/Impact	Description/Specification	Value	Comment
Reducing energy for synthetic fertiliser production	Synthetic ammonia fertiliser production:	- 2.05 TCE of fossil energy/ton of synthetic fertiliser(1996) saved by use of N equivalent in biogas fertiliser	Source: State Planning Commission, Greenhouse Gas Mitigation from Sustainable Energy and Forestry Action in China, December 1998
Improved air quality	The high level of sulphur dioxide emissions from fossil fuel combustion is not only harmful to human health but also leads to acid rain.	- Kg SO ₂ emission from coal replaced - Levy: Y0.20/kg for SO ₂ emission for Industry, not for individual household	Source: ADB: PRC Robert C. Anderson and Ge Chao Zhong, Environmental Profile: Phase II Report, 14 April 2000
Improving of hygiene and sanitation	Schistosomiasis, previously a widespread, menacing disease in rural China, was reduced by 99% through the introduction of biogas technology. The number of tapeworm infections has been reduced to 13% of the pre-biogas level. Also reducing Hepatitis B cases, etc.	Y29.6 fewer medical expenses per family/year when using small-scale biogas plant.	Source: Wang Zhengkuan and Wang Xiaohua, One Method of Economic Analysis of Household Biogas Digesters in China, Rural Energy Office from Jinghu County in Jiangsu Province and Agricultural Engineering College of the Nanjing Agricultural University, Biogas Symposium, October 2000
Selling organic fertiliser	Selling digested slurry (liquid with 1 – 2% of Dry Matter)	Y5 - 15/ton	
	Selling digested and completely dried slurry (60 – 70 % of Dry Matter)	Y80 - 100/ton	
	Selling digested and dewatered slurry (semi-solid with 30% of Dry Matter))	Y45 - 50/ton	
	Selling composted solids without anaerobic treatment (30 % of Dry Matter)	Y30/ton	
CO ₂ used for plant growing	Greenhouse-Biogas: supplying CO ₂ to the vegetables grown in the greenhouse when it is burnt on site	- 47% higher yield by grapes	Source: Lin Guanjun, Chen Xi, Li Xia, Zhang Weixin, Zhou Jingru, Zhao Jinwen and Lin Songchang, Effect of CO ₂ Concentration, Sunlight, Anaerobic Digested Effluent on Grape Quality and Yield in the Four-in-one Greenhouse, Biological Faculty of Beijing Forestry University and Tongzhou District Agriculture Bureau, Biogas Symposium, October 2000

SOCIAL AND POVERTY IMPACT ASSESSMENT

I. METHODOLOGY

1. Assessment of socio-economic profile of target beneficiaries and poverty impact assessment were carried out using information from both secondary and primary sources. Secondary information was collected from Statistic Offices of Provinces, Counties, Townships and Village administrative offices. For primary information, series of field assessments were systematically carried out in at least one County in each Province, including Counties where the four case studies and two feasibility studies on the investments models were analyzed. In all four Provinces, total field assessment activities included 43 public meetings, 63 in-depth interviews, 11 participatory rural appraisals and participatory assessments, and 150 household interviews. Villagers were engaged in focus group meetings with participants from Village People Committee, community leaders, elders, and women representatives and youth associations to collect broad-based opinions on the Project. In depth interviews were done to understand socioeconomic, poverty, and environmental implications of the Project. Particular attention was given to foster the participation of villagers, in particular women, in all the field assessment activities.

Table A9.1: Summary of Field Activities Conducted by the Consultants

Province	No. of Meetings	No. of Interviews	No. of Questionnaires	Participatory Assessments
Shanxi	15	22	90	3
Hubei	21	19	30	5
Jiangxi	3	10	30	2
Henan	4	12	—	1
Total	43	63	150	11

II. SOCIOECONOMIC PROFILE OF TARGET BENEFICIARIES

2. The target beneficiaries of the Project are the rural population living in 145 villages in 38 counties of the four Provinces namely Jiangxi (12), Hubei (11), Henan (9), and Shanxi (6). While rural population in the 38 project counties includes about 17.3 million people, total population in population in project villages in the four provinces is estimated at 194,000 people in 51,380 households. Table A9.1 shows the estimated population and households in the Project villages.

Table A9.1: Estimated Population and Households in the Project Villages

Provinces	Target Number of Villages	Estimated Population in the Target Number Villages	Average HH Size	Estimated No. of HH	Total Beneficiaries HH
Shanxi	49	54,300	3.8	14,290	5,180
Henan	45	67,500	3.9	17,310	12,660
Hubei	27	48,600	3.5	13,885	11,240
Jiangxi	24	37,700	3.8	9,920	5,000
Total	145	194,000		55,405	34,080

3. The main sources of household income of the Project villages are from crops, livestock and seasonal off-farm employment. Within a village, households share similar livelihoods, assets, and living standard. Land ownership is relatively equal. Key factor in high incomes appears to be non-farm activities. Up to 50 percent or more of men below 40 years old in the Project areas are seasonal migrants working as construction workers or wage laborers in urban centers in their province or in coastal provinces.

4. Basic services in the Project villages are insufficient. As high as 12 percent of villages in Project areas have no access to basic health services. Infant mortality is high at about 0.5 percent. About 10 percent of the villages do not have appropriate access to clean water. Less than half of the villages (42 percent) have access to sanitation and toilet. The consequences are poor water quality and ultimately poor health. Main sources of household energy are fuelwood, straws and low-grade coal which, when use for cooking and heating, have strong potential to cause respiratory and eyes problems. In some villages, women and children have to walk up to two hours each day to collect fuelwood and to fetch water.

5. Deforestation and soil erosion in mountainous areas are common to all the Provinces. Population densities, which are in excess of the carrying capacity of resource base along with their high dependency on fuelwood for energy, are main factors in the ongoing environmental degradation. Majorities of the poor are concentrated in resource-deficient areas mostly in the upland section of the provinces.

III. PILOT POVERTY-FOCUSED COMPONENT

6. In order to target meaningful levels of assistance to poor and disadvantage households, included in the design of the Project is a pilot poverty component to enhance their participation of biomass technologies. As poor farmers may have necessary labor, land and resources but are lack of necessary skills and asset contribution normally required in order to benefit from Project activities and investment, this project component will directly assist to remove those barriers. Women's Association in each village will implement the pilot poverty component. The poor will be informed about the Project activities and general criteria¹ of eligibility to join the Project. Activities in the pilot poverty component include:

7. **Training for low-skilled households.** Special training materials targeted at the illiterate or the low-skilled adult will be developed in a participatory manner by the Project. Training will be conducted using adult learning method with emphasis on hand-on experience at farm sites. Training will be carried out topic by topic to avoid overloading the poor who have relatively low absorptive capacity. For necessary follow-up activities, Project extension staff will arrange for a better-off household to pair up with each of the poor household on a one-on-one basis to assist the poor households on labor and necessary skills to operate their biomass integrated farming systems.

8. **Demonstration households and training for women.** Demonstration households will be selected on a voluntary basis from among poor farmers in particular women farmers to form a basis for extension activities of the village. Study tours will be organized for poor households to visit demonstration households outside of their villages or counties. Arrangements will be made to release members of the poor households to participate in the study tour. Training

¹ General selection criteria of poor household include (i) farmer per capita income below poverty line of Y1,000 per day, (ii) farmers with less than 3 years formal education, (iii) farmers with poor housing conditions i.e. house with dirt floor and no glass window, (iv) s with high dependency on fuelwood/straw and coal for cooking and heating.

courses directed at women will include not only the operation of biogas digester and their associated farming systems, but also other topics include food processing, household sanitation, safe use of water, management of income and expenditure, etc. The schedule and content of the training courses will be design with special consideration on women's needs i.e. shorter hours, closer to the house and baby sitters during training hours.

9. **Bio-system adoption facilities.** To assist poor households, who are lack of capital, trained poor farmers who meet the basic requirements will be provided with initial biomass system which include biogas digester, pigpen and other basic fixtures. The basic requirements for receiving Project assistance will include (i) households with annual income below Y1,000 per capital per annum, (ii) household with appropriate land and at least two full-time adult labor, and (iii) households with no record of crime and with good reputation in helping others. Preliminary list of poor households selected to receive Project assistance will be made known publicly to all villagers before final approval. These poor household beneficiaries will be monitored through the participatory monitoring system set up by the Project. Lessons learnt through implementing this pilot poverty component will be systematically documented to expand these experiences to the wider development community.

IV. POVERTY IMPACTS

A. Income and Employment Impacts

10. The Project will improve the environment and livelihood of farm households in Project areas through an integrated agriculture approach in which agriculture wastes will be more efficiently used for production of low-cost cleaner energy and improved agriculture production. During the Project period, 34,080 households² (136,320 people) will benefit directly from the project intervention: 15,600 households of small-scale biogas-farming systems and 18,480 households with access to clean energy from biogas enterprises. About 9,000 beneficiary households are from poor households below poverty line. This is depicted in Table A9.3.

Table A9.3: Beneficiaries by Type of System

Type of System	No. of Enterprises	Number of Beneficiary Household	
		Total	Households with Income Below Y1,000/capita/yr
Type 1	4,700	4,700	1,410
Type 2	10,900	10,920	3,270
Type 3	14 ^a	1,680	420
Type 4	28 ^b	16,800	3,900
Total		34,080	9,000

^a Each Type 3 enterprise provide biogas to 120 households.

^b Each Type 4 enterprise provide biogas to 600 households.

11. In terms of income benefits, the average incremental household income for Type 1 will be Y4,013 (\$483), an increase of about 36 percent from traditional farming system. For Type 2,

² This includes 4,700 households of type 1, 10,900 households of type 2, 1,680 households to be serviced by 14 medium-scale biogas plants and 16,800 households to be serviced by 28 gassification plants.

the average incremental household income will be Y14,253 or an increase of 73 percent over the without Project situation. At full development, incremental agriculture products produced during the Project period will be: 882 tons of vegetables, 312 tons of grains, 209,200 tons of citrus and 289,780 head of pigs. An area of 8,066 ha of degraded mountainous land will be reforested with fruit trees. A number of upstream and downstream economic activities associated with the biogas farming system i.e. pig feed production, vegetable processing and services of biogas digester will also be promoted. The construction of Type 1 and Type 2 will require about 2 million labor-days from the households. Lower income households will have an opportunity to provide their services for this activity. It is estimated that lower income families will provide half of the labor requirement.

12. For Type 3, 20,000 labor-days of local employment will be generated. For each plant, 1,200 labor-days for construction will be required, and in addition to 30 jobs created on the pig farm, 300 farm households will increase their earnings by raising piglets on contract. A large number of jobs including feed processing, slaughtering, meat processing and transportation will be created for the local economy. For Type 4, it is estimated that financial benefits of over Y1.0 million per year will be realized for the whole Project. These benefits are derived from reduced cost of producer gas and reduced medical expenses as a result of cleaning cooking conditions. In addition, the poor will have the opportunity to earn income by bringing straw from the fields to sell to the gassification plants.

B. Non-quantifiable Impacts

13. Apart from income and employment impacts, other indirect benefits generated by the Project include, for example, lower food prices, better food availability, better quality of food (organically grown vegetables), time saving in cooking, cleaner air, cleaner soil and water, and better public sanitation practices. Excessive use of agro-chemicals in current farming practices and its health implications to farmers and consumers which are of general concerns to farmers will also be reduced by the Project. Recycling of on-farm agricultural resources will lower the cost of agricultural production. This is likely to bring wider profit margins for poor who are food producers and also net food consumers. The poor will benefit more than the non-poor from Project outcomes that affect public goods and other goods needed to satisfy basic human needs like clean water, energy and transport because these normally claim a higher proportion of the income of the poor household than of the rich household.

14. Women in the project areas anticipated that through the increased employment opportunities generated by the Project, majority of men who are seasonal migrants would return to take main responsibility of farm work in the villages. This will lessen the excessive burdens of farm work, household work and single parenting currently carry by women. The poor, and in particular the women, will be empowered through training activities provided by the Project. Every effort would be made to ensure and equitable gender balance in selection of beneficiaries, with special consideration to women who are heads of households.

15. Identification of location of roads to link the clusters of project investments to the existing road networks will be carried out in a participatory manner to ensure that locations of infrastructures will serve the poor and disadvantaged households. At the same time, poor can also have a significant role in constructing infrastructure and maintaining them. The participatory process will also foster community ownership and transparency in implementing project activities.

