ADB/GEF PROJECT COVER PAGE

1. IDENTIFIERS

Project Number:	1105
Project Name:	PRC: Efficient Utilization of Agricultural Wastes Project
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 CO_2 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

GEF:	US$6.36 million
CO-FINANCING:	
ADB:	US$33.12 million
Government/Beneficiaries	US$37.79 million
TOTAL PROJECT COSTS:	**US$77.27 million**

4. OPERATIONAL FOCAL POINT ENDORSEMENT

Name: Mr. Yang Jinlin — Title: GEF Operational Focal Point
Organization: Ministry of Finance (MOF) — Date: 27 June 2001

5. ADB CONTACT

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PRC: EFFICIENT UTILIZATION OF AGRICULTURAL WASTES PROJECT[1]
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 Driveness

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 (CO_2) 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 CO_2 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 CO_2 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 existing farming system to

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[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.

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 CO_2 emissions from coal, rural agriculture is a major source of GHG emissions.[4] These emissions include methane (CH_4) from the livestock sector and crop residues, and nitrogen oxide (N_2O) 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 for improving the quality of life of the population, attracting foreign investment, and achieving

[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.*

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 applications, and within the context of replicability and sustainability.[9] The Project conforms to the

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[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).
[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.

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.

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]

[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.

(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.

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 unable 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 waster-water 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), other 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. GEF fund will support the implementation of this component in year 1 to year 3 (phase I) involving 2,353 poor farmers. The Government has assured that the poverty alleviation office will continue to provide funding for years 4 and 5 of (phase II) of this component. 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 $6.36 million to finance activities as described in Section II E.

39. The total base cost of the Project is $61.49 million. The total Project cost is $77.27 million including total incremental cost of $6.36 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 $77.27 million (including contingencies, interest and other charges, project preparatory technical assistance cost), ADB will provide a loan of $33.12 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 $23.60 million, GEF $6.36 million, and the beneficiaries $14.20 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, deposal 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. Response to GEF Council Comments

54. The Swiss constituency made the following technical comments on the Project:

"Logically, the Project concentrates on thermal application of gasification. However, in regards to the potential of this technology in the future for power generation, it seems that it would make sense to include the pilot projects with biomass gasification based power generation.

The history of technology development of biomass gasification has shown that very often universities have developed interesting and convincing concepts, but the transfer of technology to the field has been too fast, with corresponding poor results. It is recommended that private manufacturersq2, with the help of international support, if necessary, should re-engineer and further develop the technology package so that plant reliability be improved, maintenance might be reduced and manufacturing costs also.

We support this project."

55. The comments from the Swiss Constituency are very valid. Under the Project, pilot projects will be carried out by research institutes and universities to further improve the efficiency of biomass gasification based power generation. This is to be carried out in Activity 2 of the Project.

56. The second point that technology development of biomass gasification done by universities often result in poor implementation is well taken. The preparation of this Project had fully considered this point. The approach taken by the Project is in line with the suggestions given by the Swiss Constituency viz. private entrepreneurs will be selected to participate in Type III and Type IV models of biogas and producer gas (biomass gasification) production, with funding provided by international funding agencies (Asian Development Bank and GEF). This, with the help of local research institutes and universities, will further improve and develop the biomass technology package to reduce operational and maintenance costs, and to improve the efficiency of the plant operation.

D. GEF CEO Endorsement Conditions

57. The GEF CEO endorsement conditions and the response and fulfillment of the conditions are given below:

1. Section 2: Program and Policy Conformity

(i) *detailed phasing approach for poverty alleviation component, including commitment of China for second phase subsidy:* both the cover note and the Project Brief (RRP attached) have been revised to meet the CEO endorsement conditions. The condition was satisfied by providing a detailed phasing approach in the Cover Note (paras. 19, 27, and 32) and in the RRP para. 65 as well as a new appendix table outlining the phasing approach (Table A3.5 of the RRP). The financing commitment by the Government for the second phase is also contained in the Assurances section of the RRP (para. 125) and in the Government's letter to the Asian Development Bank dated 8 March 2002 (Attachment C of this Cover Note);

(ii) *need for a vision of and action plan for service industry build up in the provinces:* this condition was met with inclusion of additional write-up in para. 62 of the Project Brief (RRP) and a new Table A4.1 in the Appendix section of the RRP;

(iii) *need for commitment of the PRC Government to continue the operation of the mechanism after the project completion if it is proven successful:* this condition was met based on the assurances by the Government as contained in para. 125 of the

Project Brief (RRP) as well as in the loan conditions in the legal document and the letter from the Government dated 8 March 2002 (Attachment C); and

(iv) *need for commitment of the PRC Government to replicate the Project approach outside the provinces if it is proven successful:* this condition was met by the assurances and letter dated 8 March 2002 from the Government [similar to those cited for condition (iii) above].

E. PRC Endorsement

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

Attachment A

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 CO_2) 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	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. Cost: $56,642,300	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. Cost: $56, 642,300	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. Cost: $0.0 (GEF)
Activity 2. Introduce Improved Mechanisms for Transferring Biomass Technology	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. Cost: $143,300	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. Cost: $1,237,200	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. Cost: $1,093,900 (GEF)
Activity 3. Rehabilitate Farmer-Selected Farm-to-Market Facilities	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. Cost: $1,195,100	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. Cost: $1,195,100	None. Cost: $0.0 (GEF)
Activity 4. Environment Policy Implementation and Awareness	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.	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.	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

Activity	Baseline[a]	Alternative	Increment
		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.	greater BIORETS adoption and to improve environment. GEF support is crucial for the success and sustainability of this activity.
	Cost: $1,173,300	Cost: $1,962,400	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.	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.	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: $1,542,000	Cost: $3,279,800	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 consulting services to

Activity	Baseline[a]	Alternative	Increment
	Cost: $4,734,600	Cost: $7,476,600	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 $5,478,300.

Table A.1: 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 A.2: Total Project Cost by Components and Financiers

Component	Financier ($'000)				
	ADB	GEF	Beneficiaries	Government	Total
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 $5,478.3 in thousands.
[b] Figures may not add up due to rounding of decimals.

Attachment B

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: load lender for the Project t
- 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 country 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 FIRRs of Project seem high. Based on my own experiences in China's rural area, personally I think the FIRRs 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 FIRRs 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 in1990s, 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.

Attachment C

INTERNATIONAL DEPARTMENT
MINISTRY OF FINANCE
Sanlihe, Xicheng District
Beijing 100820 People's Republic of China

MOF

中华人民共和国财政部
国际司
中国北京三里河三条3号 100820

June 27, 2001

Mr. Nessim 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

Tel: (86-10) 6855 1133, 6855 1183 Fax: (86-10) 6855 1183, 6855 1125

8 March 2002

Mr. Katsuji ~~Matsunami,~~

Director,

Agriculture, Environment and Natural Resources Division (ECAE),
East and Central Asia Department
Asian Development Bank
P.O. Box 789,
Manila 0980, Philippines

Dear Mr. Matsunami,

PRC: Efficient Utilization of Agricultural Wastes Project

Congratulations on your recent appointment as the Director of ECAE. It is with great pleasure that I would like to inform you that the Government of PRC has completed its internal process of approving the project and that the loan negotiations is scheduled sometime in the middle of May 2002. The MOF has, in its letter dated 28 February 2002, informed the ADB's resident mission in Beijing (PRCM) about the loan negotiations date. On our part at the Ministry of Agriculture, we would like to thank Dr. John Y.L. Yee, the mission leader of the project, for his hard work and extremely well managed appraisal team to complete the ADB appraisal work, and in preparing the numerous drafts of the GEF documents leading to GEF Council's approval of the grant financing by GEF in December 2001. We appreciate very much for Dr. Yee's effort in making this loan successful in a most effective manner.

To ensure the success of the project implementation, we would like to reiterate our assurance that we are committed to:

(i) make available the best project staff for the PMO and PIOs;
(ii) establish a suitably staffed project performance management system (PPMS) unit within the PMO and PIOs within the first year;
(iii) make funds readily available to municipal and county finance bureaus for onlending to end users in a most efficient manner and at terms and conditions satisfactory to ADB;
(iv) ensure the provincial government will provide adequate counterpart funding for the project implementation activities and that all facilities will be provided in accordance to the needs of the project;
(v) ensure that all project provinces will follow ADB's policy on gender development, environment protection, poverty alleviation etc.;
(vi) ensure that the financing commitment for the phase two of the poverty alleviation component will continue to be provided through the provincial poverty alleviation offices for the development of the poor farmers to enable them to participate in the project activities. Phase 1 financing is to be provided by GEF;
(vii) ensure that the provincial governments will continue to adopt the financial mechanism developed by the project for the poor farmers, if proven to be successful, long after the project completion; and

(viii) ensure that the development approach adopted by this project, if proven to be successful, will be effectively replicated to other non-project provinces in China.

We are committed to a successful implementation of this project and look forward to a most fruitful cooperation venture with your office in the years ahead.

Yours sincerely,

Qian Fa Gen
Director General,
Foreign Economic Cooperation Center
Ministry of Agriculture

8 March 2002

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

April 2002

CURRENCY EQUIVALENTS

(as of 1 March 2002)

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
CRESP	–	China Renewable Energy Scale-up Program
DFID	–	Department for International Development
EIA	–	environmental impact assessment
EIRR	–	economic internal rate of return
FECC	–	Foreign Economic Cooperation Center
FIRR	–	Financial internal rate of return
GEF	–	Global Environmental Facility
GHG	–	greenhouse gas
IEE	–	initial environment examination
IREDP	–	Integrated Rural Energy Development Program
JBIC	–	Japan Bank for International Cooperation
LIBOR	–	London interbank offered rate
MMS	–	mandated market share
MOA	–	Ministry of Agriculture
MOF	–	Ministry of Finance
NGO	–	nongovernment organization
NPCC	–	National Project Coordination Committee
O&M	–	operations and maintenance
PCR	–	project completion report
PIO	–	project implementation office
PIU	–	project implementation unit
PLG	–	provincial leading group
PMO	–	project management office
PPMS	–	project performance management system
PRC	–	People's Republic of China
PV	–	photovoltaic
SCF	–	standard conversion factor
SEPA	–	State Environmental Protection Administration
SO_2	–	sulphur dioxide
TA	–	technical assistance
TFP	–	Tenth Five-Year Plan
TSP	–	total suspended particulates
TVE	–	township or village enterprise
UNDP	–	United Nations Development Programme

WEIGHTS AND MEASURES

Ha	–	hectare
m^2	–	square meter
m^3	–	cubic meter
Mu	–	15 mu equivalent to 1 ha
MW	–	megawatt
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	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 Henan, Hubei, Jiangxi, and Shanxi provinces. The Project will provide funding support to small household farms through the development of an integrated farm production system by expanding livestock, vegetable, fruit, and other crop 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 the 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 rural areas. Special efforts will be taken to ensure that poor and disadvantaged farmers and women participate in all aspects of project activities.
Classification	Poverty Intervention The 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 of the PRC. Thematic: Environment Protection The environmental benefits of the Project will include reduction of carbon dioxide and sulphur dioxide emissions, nonpoint pollution from intensive livestock production, and decreased exploitation of forests for fuelwood. The benefits will also include improved health of the rural population and increased forests and vegetative coverage of nonproductive lands with pasture and tree crops.
Environmental Assessment	Category B. An initial environmental examination was undertaken, and a summary initial environmental evaluation was prepared.
Rationale	Improving the PRC's environment is possible 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 rural households, the environment, and the economy. At present, large quantities of agricultural wastes are disposed off inappropriately (e.g., burning of crop residues in open fields 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, which 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 digesters will reduce the dependence of poor households on coal, straw, and firewood for heating and cooking, thus promoting a better living environment, improved health from reduced air pollution, and less stress on forest resources. Integrated agricultural production systems with biomass technology have proven to be an effective means to generate cleaner, renewable energy for environmental improvement as well as to improve the quantity and quality of farm outputs. However, biomass technology faces numerous constraints and barriers for mass adoption, particularly in rural areas. These barriers include shortage of credit facilities, weak institutional and technical expertise, inadequate service infrastructure, lack of environmental awareness, and few policy incentives. Farmers face constraints in obtaining access to credit for the adoption of biomass-based renewable energy systems to integrate with existing farming practices. Current interest rates in the PRC are set at levels below market rates, creating excess demand within which rural investments have received low priority. As a consequence, farmers cannot access longer term loans with the grace period necessary for rural capital investments, which require time to generate a positive cash flow. The commercial financial institutions and banks are not certain about the viability of biogas systems and do not provide longer term credit to large numbers of small farmers. This Project will overcome these major constraints and barriers. It represents a significant 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 the feasibility and profitability of 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 the 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, sustainable, and replicable financing model and will organize and will 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 improve and increase farm produce. This component

will ensure efficient management of project loans for rehabilitating and constructing 15,600 of small-scale farms incorporating 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 to 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 the private service sector for the operation and maintenance (O&M) of farmers' biogas digesters, including access to spare parts, to ensure the 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 a pricing policy for project outputs, and O&M that integrates 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 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 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 institutional barriers to the promotion and expansion of biomass technology adoption for environmental improvement and public awareness. It will provide technical support to assist the four provincial governments in removing barriers to environment improvement as well as to provide environmental monitoring facilities to assure high environmental standards for air, water, soil, and other elements and to highlight beneficial environmental impact. The Project will focus on four environmental 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 the positive impacts from a 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 and 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, which contribute to significant environmental 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 integrated agricultural production with biomass systems for cleaner energy production. It will serve as a demonstration model for government agencies (such as the Poverty Alleviation Office) to replicate on a 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 implementing agencies. It will strengthen their institutional capacity to manage and supervise project activities that are essential to ensure the 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)

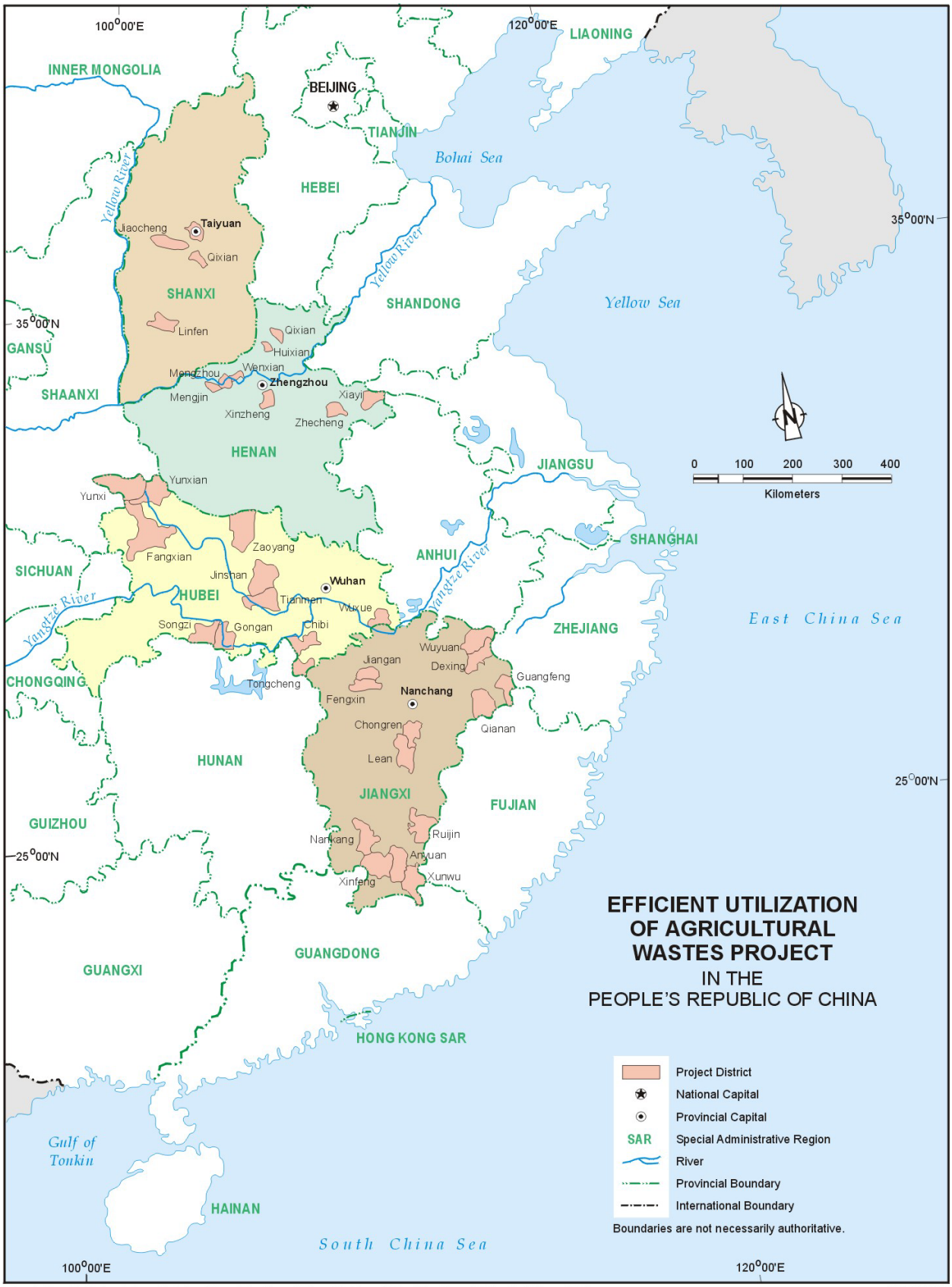
Source	Foreign Exchange	Local Currency	Total	Percent
Asian Development Bank	33.12	0.00	33.12	43
National and Provincial Governments	1.10	22.49	23.59	31
Beneficiaries	0.00	14.20	14.20	18
Global Environmental Facility (GEF)	2.05	4.31	6.36	8
Total	**36.27**	**41.00**	**77.27**	**100**

Loan Amount and Terms

A loan of $33.1 million from the Asian Development Bank's (ADB) ordinary capital resources will be provided under ADB's London interbank offered rate (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 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 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 Henan, Hubei, Jiangxi, 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	The 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 departments of agriculture at the provincial level
Implementing Agencies	The project management office (PMO) in MOA and the project implementation offices (PIOs) of Henan, Hubei, Jiangxi, and Shanxi will implement the Project in conjunction with relevant agencies at the municipal, county, and township levels. The PMO director will have overall responsibility for project implementation.
Implementation Arrangements	A national project coordination committee based at the 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, effect intersector coordination, and assist in solving implementation issues at the field level. The PIOs will oversee the activities of the PIUs established at the municipal or county agricultural bureaus to supervise and implement subproject activities in conjunction with relevant technical agencies and nongovernment organizations.
Procurement	Goods and services financed by the ADB loan and the GEF grant will be procured in accordance with ADB's *Guidelines for Procurement.* Each contract estimated to cost $100,000 or more, but less than $500,000, will be awarded through international shopping. Contracts for less than $100,000 will be by direct purchase. Civil works contracts will be relatively small, relating to construction of greenhouses and biogas digesters, and 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 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 a reduction in carbon dioxide emissions of about 78,338 tons (t) 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 systems that 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 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 economic internal rate of return for the Project as a whole is 18.2 percent. About 26 percent of the beneficiaries or 9,000 households will be from low-income groups. They will be provided with a special support to make it possible to eliminate the socioeconomic barriers that currently prevent them from adopting integrated biomass farming systems. The Project will produce an annual incremental output of about 882 of greenhouse vegetables, all organic; about 209,280 t of citrus fruits; and 289,780 pigs. The Project will utilize over a million tons of agricultural wastes per year that would otherwise contaminate the soil and river/water systems, and provide over 600,000 t of sludge and effluent as farm organic fertilizer.



1st proof, 23 apr 01 - 2nd proof, 3 aug 01 - 3rd proof, 5 sept 01 - 4th proof, 24 sept 01 - 5th proof, 29 oct 01 - 6th proof, 07 dec 01 - 7TH proof, 12 dec.
01-1099 RM

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 the 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 the PRC, which feeds 22 percent of the world's population on 7 percent of the world's arable land. Few opportunities exist in the country 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 reduce poverty and in reversing the environmental degradation caused by rapid industrialization and agricultural intensification. Arable land in the PRC is actually 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 (TA).[1] The study examined resource availability and the technical and economical feasibility of converting agricultural wastes (such as household wastes, straw, and other crop and animal residues) into a clean source of energy for lighting, heating, and cooking through integration into the farmers' agricultural production system. The study also examined the feasibility of reducing chemical fertilizer usage on farms, 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 project preparation and the feasibility study in January 2001, a Fact-Finding Mission visited the PRC in February 2001 to refine the project design and discuss various issues with the national and provincial governments of Henan, Hubei, Jiangxi, and Shanxi. The Appraisal Mission, conducted from 25 May to 16 June 2001,[2] finalized the details of various project components. The linkages among 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 environmental protection.

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[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), S. Emma Yang (Senior Financial Management Specialist), J. Yang (Program Officer), S. Setboonsarng (Poverty Specialist), D. Tang (Environment Specialist), and J. F. Sison (Staff Consultant).

III. BACKGROUND

A. Sector Description

1. The Agriculture Sector

4. Agriculture plays a major role in the economic development of the PRC. It provides an important source of income directly or indirectly for about 240 million rural families, which constitute about 64 percent of the country's total population. The sector accounted for about 16 percent of the PRC's gross domestic product in 2000. About 95 million hectares (ha) of the PRC's land area of 960 million ha is cultivated. Until 1998, about half a million ha of arable land was annually converted from agricultural to industrial, infrastructure, or housing use. With ADB assistance, the Government amended the Land Administration Law in 1998 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 require innovative solutions.

5. The economic reform programs that started in the late 1970s provided a good model to enable the agriculture 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 wherein plots of collectively owned land were subdivided and allocated to individual households for farm production. Over the years, this household responsibility system has been gradually revised and is now moving towards a market-based economy. The reforms in the last two decades have resulted in an increase in agricultural productivity and improved terms of trade. 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 a year in the early 1990s, but in recent years it has increased to about 4.6 percent per annum, well in excess of the population growth of less than 1 percent per annum.

6. While the reforms in the rural sector have resulted in significant increased output and higher incomes, the disparity between urban and rural income has grown. The 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 this 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.

7. 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 of chickens and pigs. Total meat production in the 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 township and village enterprises (TVEs) and small private farms involved in livestock production. The number of medium- to large-scale commercial pig farms has increased significantly from less than 5,000 in the 1970s to over 16,000 in 2000. The amount of wastewater discharged from each animal is about 20 liters per day. The effluent discharge from

these pig farms is well in excess of a billion tons a year, but 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. The output from pig production is forecast to increase by about 8 percent per year, and pig wastes could increase to about 5 billion tons a year 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 subsector, total grain production is expected to increase from about 407 million tons in 1995 to about 499 million tons by 2005, or a 23 percent increase in a decade. This increase in grain production will generate large quantities of straw, which is normally burned in the field under current farming practices, leading to further environmental degradation such as carbon dioxide ($CO_{2)}$ release and haze.

2. The Environment Sector

8. 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, the 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 were estimated to be about Y98.6 billion or about 4 percent of gross domestic product 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. The 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, the PRC now accounts for about a tenth of total global greenhouse gas (GHG) emissions and is the world's second largest producer of CO_2. The use of coal has resulted in the emission of high levels of sulfur dioxide (SO_2) and 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 causes severe health problems, particularly those related to respiratory illnesses. The economic losses due to high air pollution in the 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.

9. The extensive use of coal has adverse ecological and human health impacts on the environment at all levels (globally, nationally, locally, and in the household). GHG emissions (measured in CO_2 equivalent) impact on the rural sector and in severe cases could result in worsening soil erosion; increasing loss of fertile soil and decreasing soil humidity; rising temperatures, which affect plant growth; and changes in precipitation levels. These impacts mean lower crop yields and increased crop losses. With fewer and lower quality crops and livestock to sell while facing continuing declines in farm productivity, farm incomes will decrease. As the rural agricultural sector is the keystone of the national economy, addressing GHG emissions is a fundamental issue for the economy.

10. In addition to CO_2 emissions from coal, rural agriculture is a major source of GHG emissions.[4] These emissions include methane from the livestock sector and crop residues, and nitrogen oxide produced from fertilizers and field burning of crop residues These emissions are

[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. PRC.

[4] For details, see ADB/GEF/United Nations Development Programme. Asia Least-Cost Greenhouse Gas Abatement Strategy – People's Republic of China (ALGGAS). Oct. 1998. Table 1-1, p.5.

predominantly due to poor farming practices and inefficient use of biomass resources (e.g., wood from forests, straw, organic wastes from animals and humans). About 100 million tons of crop residues are burned 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. Fermentation from livestock waste, a significant source of CH_4, is also on the increase. If the current practices continue unabated, GHG emissions will continue to increase.

11. Economic growth in the PRC will continue to be rapid for the foreseeable future. This will result in further expansion of energy and raw material usage. Environment quality will 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 the country.

12. Since the early 1990s, the Government has 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. 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 has provided economic incentives for environment-friendly production processes. Some of the command-and-control measures have 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.

13. In response to the 1992 Earth Summit, the 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. The 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 the PRC's programs to develop the economy and protect the environment, ADB provided TA 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 gas,[7] (iii) develop strategies to minimize SO_2 emissions that cause acid rain,[8] and (iv) participate in regional activities relating to global warming and transboundary environmental cooperation in Northeast Asia.[9]

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[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 on

14. The rapid changes in household energy production, poor farming practices, and the underutilization of biomass surpluses exacerbate 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, which include reliance on inorganic fertilizers, inappropriate fertilizer application, and uncontrolled discharge into rivers, also represent a serious threat to the regional environment.

3. Renewable Energy Development

15. The PRC is the second largest energy user in the world behind the United States. The dominant source of energy in the PRC is 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). The PRC's total rural energy consumption in 2000 was about 600 million tons of coal equivalent, with crop residue (mainly straw) accounting for about 18 percent and firewood for 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. Energy is a major source of GHG emissions, and the PRC accounts for about 10 percent of global GHG emissions from energy use. Its share will continue to grow as rapid rates of economic growth continue well into the next decade.

16. Renewable energy is an important component of the PRC's long-term energy strategy for rural development. The country's primary energy needs are still dependent on coal, even though the use of oil and natural gas has increased in recent years. Renewable energy technologies offer an environmentally sound source of energy, especially in the rural and remote areas. The 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 the 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. 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 used mainly for cooking, lighting, and heating by individual farm households. Biogas is produced 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 is connected to employees' houses or is sold to nearby rural households. Biomass, i.e., fuelwood and crop residues, accounts for nearly a quarter of the country's energy supply, and about three quarters of energy consumed by rural households.

17. 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 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

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1 August 1996; and TA 5865-REG: *Transboundary Environmental Cooperation in Northeast Asia,* for $350,000, approved on 13 October 1999.

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. The agriculture 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.

18. The PRC has significant experience in developing biomass technology. Productivity from biomass digesters has increased by 50 percent during the last two decades. Since the 1960s, about 7.5 million biogas generation units have been built for energy production in the rural areas. However, many earlier units have been abandoned due to factors such as outdated technology and weak technical and institutional support. The major lessons learned from the past are the need (i) to integrate biomass technology with existing farming systems 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 (iv) to ensure effective extension services and competent technicians to assist continued biomass technology development. Since the mid 1990s, special emphasis has been given to developing efficient biogas digesters integrated into the existing farming systems for small farm households. The integration aims to combine environmental and economic benefits within a rural farming system to provide biogas for cooking, heating, and lighting for farm households and to 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 present situation of biogas technology development in rural areas is optimum for development intervention because (i) the Government is committed to instituting policies and measures to protect the deteriorating environment in both the urban and rural areas; (ii) appropriate biomass technologies have improved significantly and are suitable for small farmers' adoption; (iii) provincial governments are committed to promote and expand biomass technology adoption for production of green vegetables; (iv) improved service infrastructure makes spare parts and accessories readily available; and (v) small farmers are interested in adopting biomass technology to eliminate the use of coal, firewood, and straw for heating and cooking and to produce higher quality green vegetables.

4. Agriculture and Renewable Energy Development in the Project Provinces

19. The middle and lower reaches of the Yellow River (Huanghe) and the Yangtse River (Changjiang) basins are the regions where the PRC's agricultural civilization started 5,000-7,000 years ago. The four project provinces—Henan, Hubei, Jiangxi, and Shanxi— represent a typical sample of the PRC's oldest farming areas (see Map). With the Huai River as a demarcation (close to Latitude 32°), Hubei and Jiangxi 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 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 Appendix 2.

20. 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 biomass technology have shown highly satisfactory results. Biogas generation from small-scale digesters is becoming popular in the four project provinces, and many villagers indicated their willingness to adopt the technologies. The project provincial governments are emphasizing the development of an integrated farming system

incorporating biomass technologies to generate cleaner biogas for lighting and cooking and for organic fertilizer. Local governments are encouraging rural farm households to build biogas digesters integrated into their farming systems to reduce the need to use firewood and coal, and the burning of straw in the fields. These programs should improve the environment and raise farmers' living conditions. Land used for biogas digester construction is normally exempted from tax.

21. Hubei and Jiangxi have pioneered an integrated farming system with biomass generation called the 3-in-1 model (see Supplementary Appendix A for details) which incorporates pigs (or other livestock), digester, and an orchard (alternatively the orchard can be substituted by either vegetables, cotton, fish or other agriculture crops). This biomass technology is well accepted among farmers. The provincial governments are promoting the use of biomass technology to help improve the living standards of the farmers and to improve the environment.

22. In Henan and Shanxi, biomass technology development has also progressed steadily. The 4-in-1 model based on integration of biogas digester, greenhouse, vegetables, and pig production was developed under the Government's promotion program. To eliminate the need to burn 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.

5. Barriers to the Expansion of Biomass Renewable Energy

23. 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 environmental degradation and health problems), the use of firewood (which causes destruction of forested areas), and no alternate means to utilize crop residues and animal wastes, farm households would continue to heat and cook as they presently do and continue to burn crop residues in open fields. Consequently, GHG emissions from coal, firewood, animal wastes, and crop residue burning would continue. It is therefore important that the barriers to the promotion and rapid adoption of biomass energy systems be identified and removed. The proposed Project aims to identify those barriers and provide the means and resources to remove them and to develop sustainable and replicable models for further expansion to other provinces.

24. The key barriers that restrict the promotion and expansion of biomass renewable energy in the four project provinces are as follows:

(i) **Lack of a replicable financing model and shortage of available capital and credit in 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, 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 with 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.[10]

(ii) **Weak institutional capacities, inadequate technical expertise, and a lack of viable service infrastructure along with incentives for continued operation.** The 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. 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 costs restrict 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, and cost estimates, and to 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, operation and maintenance (O&M) services and to help to improve technology as new techniques become available. Incentives such as concentration of a minimum number of biogas units in one location to support a service agency unit must be ensured, along with government policy to provide incentives for service personnel to earn an 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 hampers the efficient extension of technical services and the availability of spare parts and accessories for effective O&M of biogas digesters. It also causes 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 developing a reliable data base and social monitoring, and lack of public awareness and information.** At the provincial level, there is a need for assistance to develop environmental programs and to assist in their implementation. Environmental monitoring at the county level is poor due to inadequate equipment and personnel. The generation of quality environmental data and information could provide a good demonstration effect to convince local governments to develop 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

[10] 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.

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.

(v) **Lack of confidence for Government to provide adequate assistance to the poor, resulting in the inability of a large number of disadvantaged and poor households to participate in biomass development.** Disadvantaged and poor households have been unable to participate in renewable energy program, even though they are important partners to meet the Government's overall environmental objectives, as well as to 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 efforts to help the poor are constrained by lack of an appropriate approach to enable a 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 in implementing 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

25. 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. 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 reducing poverty in the less accessible areas. The medium-term sector strategies are designed to increase food production and 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 underutilized and waste land, diversifying crop production, and adopting integrated approaches to farming that are friendly to the environment. The strategy also seeks to increase value added for agricultural produce and to increase off-farm employment opportunities. The TFP emphasizes adopting an integrated system of farming with biomass technology to generate biogas and other renewable energy to improve the environment.

2. Poverty Reduction

26. The Government is committed to poverty reduction. The 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.[11] 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 this remarkable success, the 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 agricultural 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.

27. The PRC's poverty reduction-related objectives, as expressed in the TFP and the Ten-Year Poverty Reduction Strategy, call for significant effort to increase the incomes of farmers; provide physical infrastructure; develop industries for processing, storing, and transporting agricultural products; create off-farm employment opportunities for the rural poor; and increase standards of living for the urban and rural poor in terms of housing, education, health, and environment. The Government is also promoting labor-intensive industries, especially in the service sector, to increase job opportunities, and is offering incentives for people to start their own businesses.

28. Since 1986, the State Council's Leading Group for Poverty has launched a number of poverty reduction programs. These previous programs are periodically revised to better respond to the challenges of poverty reduction. The previous 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 needs assessment of the poor at the village level to develop a specific poverty reduction strategy for each area.

29. The strong government commitment to reduce poverty is witnessed by the increased allocation of budgetary funds for poverty reduction. Since 1994, real annual Government spending on poverty reduction has increased by 260 percent. In 2002, the budgeted funds for the poverty reduction program totaled Y26 billion ($3.1 billion). In this new program, the Government is committed to increasing the budget by Y1 billion-Y5 billion to a total of Y5 billion ($121 million to $605 million) annually.

3. Energy

30. 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 the use of renewable energy as outlined in its Program on New and Renewable Energy Development (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

[11] These figures are based on the PRC's Chinese poverty line, which is about $0.66 per capita expenditure a day on a purchasing power parity basis.

energy to (i) diversify power generation, (ii) accelerate rural development, (iii) develop sustainable resources, and (iv) derive environmental benefits.

31. 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 policy. The key elements of the new policy are to (i) create a mandated market share 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 the PRC. The Government intends to gradually introduce a requirement that 5 percent of electricity supplied to consumers be generated from renewable energy sources. To support the development and implementation of the new renewable energy policy and to catalyze international financing, the Government has also initiated the development of the Partnership for Renewable Energy with support from the World Bank and GEF. The Partnership will provide an umbrella for all renewable energy activities within the country during the next decade. It will support the Government's Renewable Energy Program during the Tenth and Eleventh Five-Year Plans to create a mandated market and reduce costs for mature technologies such as wind farm, small hydroelectric, and biomass. Maintaining the current share of 5 percent renewable energy in power generation is being taken as the tentative goal for the purpose of preparation of the Government's Program. In May 2001, a World Bank mission visited the PRC to prepare the World Bank/GEF China Renewable Energy Scale-up Program (CRESP). The GEF Council approved the CRESP Project Brief at its May 2001 meeting and is supporting it with a grant of $140 million. Under the CRESP, the World Bank will provide assistance to recommend revisions to current pricing policies that are consistent with the PRC market economy and international best practice, as part of CRESP preparation.

4. Environment

32. In the environment sector, the Government's strategic objectives are to (i) control environmental pollution; (ii) improve the quality of the environment, particularly in major cities; (iii) reduce degradation of natural ecological systems; and (iv) integrate environmental planning with social and economic development. The major emphasis will be given to reducing air and water pollution in 52 major cities where it 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.

33. In the TFP, the Government will continue to improve ecological conservation and strengthen environmental protection. To this end, it 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 environmental, meteorological, and seismological monitoring systems to help prevent and reduce natural disasters.

C. External Assistance

34. The World Bank and the Japan Bank for International Cooperation (JBIC) are the major sources of external assistance to the PRC. JBIC has provided over $20 billion to the country, mainly for infrastructure and environmental development. As of 30 June 2000, the World Bank

had financed about 234 projects with loans totaling 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 totaling $2.4 billion were to help improve the environment. The World Bank is assisting the Government in formulating a Partnership with GEF to provide the Government with about $100 million in loans through its CRESP. In the development of renewable energy resources in the PRC, the World Bank's $100 million renewable energy development project includes a wind farm component, a solar PV component, and a technology improvement component.

35. ADB is another major international lender to the PRC. As of December 2000, the country had 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 the PRC in developing renewable energy. A Renewable Energy Development TA addressed barriers to the commercial development of renewable energy through reviewing the policy and institutional framework, developing and evaluating prioritized investment programs for commercialization, and identifying specific investment requirements for external financing.[12]

36. The United Nations Development Programme (UNDP) and GEF have also contributed to the PRC's renewable energy development. GEF has financed two projects in Yunnan Province: (i) the 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[13] 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 Heilongjiang, Liaoning, and Xinjiang. The Capacity Building for the Rapid Commercialization of Renewable Energy in the PRC Project 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 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 its goals to 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 various professionals in the skills needed to attain the previous three goals. The project took place from January 1992 through March 1994. The CRESP (para. 31) will support the implementation of a national policy framework that will legally require a share of electricity to be met from renewable energy resources.

37. UNDP has a number of ongoing and pipeline programs to support the commercialization of renewable energy. These include (i) the ongoing Resources Concessions for Sustainable Development of Renewable Energy Project, focusing on policy implementation with respect to wind energy; (ii) a pipeline project that aims to develop a National Energy Strategy and Plan; identify energy-related issues/strategies, and set options for energy policy development; (iii) a

[12] TA 3056-PRC: Renewable Energy Development Project, for $566,000, approved on 19 August 1998.
[13] Project Number CPR/00/G31.

proposed demonstration project to promote modernized biomass energy in Jilin Province; (iv) a project to help strengthening the Chengdu Biogas Research and Training Center; and (v) the ongoing Capacity Building for the Rapid Commercialization of Renewable Energy Project.

38. Bilateral assistance agencies are focusing on installing PV systems and developing grid-connected wind farms. Denmark, Germany, and Spain are the main bilateral sources of 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 Cooperation was signed in June 2000 covering scientific and technological activities that provide support for the exchange of PRC and Italian researchers. The Department for International Development (DFID) of the United Kingdom recently financed Rural Energy in China–A Scoping Study but has not made any commitment in the renewable energy sector for the next few years. DFID's emphasis is mainly on poverty reduction, concentrating on provinces of Ganzu, Sichuan, and Yunnan provinces.

D. Lessons Learned

39. Since the PRC joined ADB in 1986, a number of projects in the agriculture, energy, and environment sectors have been implemented and completed. Similarly, the 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 assessment of ADB's Country Assistance Program in the PRC, conducted in 1998,[14] noted that the country has a strong capacity for project implementation, 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, and economic viability as well as debt servicing capability; (ii) strong commitment and technical capability of executing agencies; (iii) appropriate project activity 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 improve when TA is provided to upgrade the capabilities of executing agencies 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.

40. However, not all ADB-funded projects have been successfully implemented. There are areas of weaknesses that need to be highlighted. ADB's operations in the agriculture sector over the period 1986-1999 revealed some poor performances. Less than satisfactory performance was noted in a project associated with state-owned agroprocessing industries (Hexian Pulp Mill Project, Loan 937-PRC), involving an inward-looking state-owned entity that 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 community participation in production, harvesting, and downstream processing were more successful.

[14] CAP: PRC 98026: *Country Assistance Program Evaluation in the People's Republic of China*, January 1999.

These lessons have been considered and incorporated in the design of subsequent projects, including the proposed Project.

41. 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 ones 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 include the need for: (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 being taken to allow for project activities to be implemented in the four provinces in a flexible manner; to provide extensive technical training, extension, and support to small farmers to enable them to increase productivity and income; and to effect improvement in the environment.

42. In the energy and environment sectors, the Country Assistance Program Evaluation for the PRC (para. 39) concluded that ADB's 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 Sector Strategy

43. In pursuit of ADB's overarching poverty reduction objective, the current PRC Country Operational Strategy[15] 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 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 a greater voice and participation in decisions affecting them.

44. 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 to a market economy through improved incentives for private sector investment and establishment of a market information system; and (v) supporting enterprise reforms. ADB's operations are designed to narrow the gap between rural and urban income opportunities by assisting in land reform, improving agricultural production and productivity, providing better postharvest processing facilities, developing efficient markets 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-

[15] STS: PRC 95021: *Country Operational Strategy Study, People's Republic of China,* May 1997. ADB's New Country Strategy and Program is under preparation.

based policy changes to attract more foreign and domestic investments; (ii) address rural infrastructure and institutional constraints; (iii) develop integrated agriculture and agro-based industries; (iv) develop transportation, communications, and marketing linkages between interior and coastal provinces; (v) locate developmental projects in poverty counties; and (vi) incorporate project components to minimize or reverse environmental pollution due to agricultural wastes.

45. In the environment sector, the strategy focuses on (i) strengthening the legal, policy, and regulatory framework for sustainable environment management; (ii) supporting institution building in 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 the 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, beneficiary welfare, and natural resources management.

F. Policy Dialogue

1. Land Tenure Reforms

46. 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 the PRC in drafting the Land Administration Law, which became effective on 1 January 1999. The law provides for a national land-use plan that will stipulate the total amount of arable land to be put under protection. Every province, county, and township will be assigned a quota of arable land for protection. The area of cultivated land should comprise 80 percent of the 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 wetlands, hilly areas or other marginal lands) 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 has been 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 draft a model enabling provincial law, which could be adopted by other provinces. The Sichuan land law provides that: (i) there is 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 governments are given the responsibility for preparing 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 on full compensation for collective farm organizations and individual families; and (iv) citizens participate in the process of land use and planning and in the procedures for conversion of rural land to urban uses. Representatives from the four project provinces attended a workshop that reviewed the model Sichuan law. ADB also funded a Land Use and Land Use Tenure Policy Study in Fujian Province.[16]

[16] TA 2408-PRC: Land Use and Land Tenure Policy in Fujian Province, for $600,000, approved on 28 September 1995.

47. 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 was undertaken to highlight the importance of land use tenure, and the recommendations of the ADB-assisted Sichuan Province report were discussed. The Appraisal Mission urged the respective provincial governments to consider the study and adopt the recommendations.

2. Promotion of Biogas Energy Development and Barrier Removal

48. The Government initiated the promotion of biogas energy development under the framework of the Seventh Five-Year Plan (1986-1990), which established 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 biogas digesters and biomass gasification plants using low-cost agricultural wastes.

49. 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 dialogue with the Government to promote biogas renewable energy development. In 1996, ADB financed the Rural Energy Development Study,[17] following which ADB engaged in active discussion with the Government that resulted in the preparation of the Efficient Utilization of Agricultural Wastes feasibility study.[18] Policy dialogue undertaken during the current project processing aimed at promoting larger scale biogas energy development in the PRC. However, impediments exist for the development of biomass renewable energy in the rural sector. These barriers are inhibiting rapid adoption of biomass technologies (para. 24).

50. 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 be operational in the near future, and several more years will probably be required before an appropriate regulatory and policy framework is established for renewable energy development. In the meantime, the Government will actively pursue the TFP target of 300,000 rural households adopting biomass technologies. The Project will support the partnership by providing momentum for the adoption of biomass energy systems in rural areas during the transition period.

51. 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 have access to longer term credit. Steps will also be taken to strengthen institutional capacity and to overcome shortages of technical expertise. Weaknesses related to environment policy implementation and environmental management capacity will also be addressed. The Project will develop approaches to enable a large number of poor and disadvantaged rural households to adopt the

[17] TA 2100-PRC: Rural Energy Development Study, for $500,000, approved on 16 June 1994.
[18] TA 3370-PRC: Efficient Utilization of Agricultural Wastes, for $703,000, approved on 26 December 1999.

biomass technologies. In view of the global, regional, and national benefits associated with the Project, ADB approached GEF for assistance in overcoming 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 the PRC, was accepted into the GEF formal pipeline in June 2000.

3. Environment Protection and Promotion of Clean Technologies

52. 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 the 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 sources such as straw and dung for fuel and heating. Many rural households with higher than average incomes have increasingly switched to coal or liquified petroleum gas. For most of the poorer farm households, biomass gas provides an appropriate and sustainable alternative.

53. The 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.

54. The Mission emphasized to the Government that the market potential for biogas in the PRC is considerable and that there is scope for expansion. For example, more than 14,000 large-scale livestock breeding farms exist in the country; 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 burned, causing air pollution and respiratory diseases. The Government should promote biomass gasification technology to reduce crop residue burning. Progress so far has been limited. By year 2000, there were only about 300 crop residue biomass gasification plants in the PRC, each providing producer gas to about 600 rural households. The market potential of gasification systems is large. If only 1 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 gasification plants and to strengthen its institutional capability to provide technical support and extension services. The Government will ensure that continued funding will be provided to support the development of gasification technology and to ensure its sustainability.

IV. THE PROPOSED PROJECT

A. Rationale

55. The strategy for industrial growth and agricultural intensification adopted by the PRC in the past decades resulted in environmental problems, particularly 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 ecosystems, declining agricultural production, increasing emissions of greenhouse gases, and occurrences of acid rain. Total GHG emissions from all components of the

agriculture sector account for 12-18 percent of the national total. These emissions are predominantly due to poor farming practices and inefficient use of biomass resources.

56. 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, and 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 practices 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, doubled from about 300 million tons in 1978 to over 600 million tons in 2001. Over 100 million tons of crop residues are burned each year in open fields, contributing to high levels of air pollution. Air pollution in turn contributes to respiratory illnesses.

57. 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 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.

58. The PRC produces over 10 billion tons of agricultural wastes per year. Inappropriate disposal contributes to environmental and groundwater pollution. During the last three decades, the Government has spent significantly to develop biomass technologies that are integrated into existing farming systems. Biogas digesters and crop residue gasification technologies have the potential to become increasingly popular, particularly among small farmers. However, small and poorer farmers face constraints in obtaining credit to adopt biomass technologies. Rural financial institutions are reluctant to lend to them due to lack of collateral and the 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 barriers can be overcome with assistance to develop an appropriate financial model and mechanisms for longer term lending that could be replicable in other parts of the PRC. Although the end users of the biomass technologies are in the private sector, there is strong public sector interest and significant environmental benefits associated with the adoption of biomass technologies. The Government has made a concerted effort to promote renewable biomass energy to improve the environment, enhance the quality and quantity of agricultural production, and improve the health and income of small poor farmers. Four enthusiastic inland provinces (Henan, Hubei, Jiangxi, and Shanxi) have 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 proportions of poor farmers living in marginal areas, and have expressed great enthusiasm to implement the Project. The Project will also have demonstration effects 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

59. The long-term goals of the Project are to improve the environment, to promote sustainable agricultural production to enhance economic growth, and to improve welfare and living conditions of rural households, particularly the 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

60. 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 have 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 to adopt biomass technologies through special training and provision of biogas adoption facilities. The Project has six components:

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

61. This component will provide funding assistance to Project beneficiaries for the development and adoption of biomass technology and will 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 technologies.[19] The longer term financing will allow the beneficiaries to construct the following:[20]

(i) 4,700 greenhouses with small biogas digesters for project farmers (type I technology). This is commonly referred to as the 4-in-1 model ecofarm. The four

[19] Details of biomass technology are given in Supplementary Appendix A.
[20] The figures given are indicative only, as the number will depend on the actual demand during implementation.

elements are: greenhouse, pigs in an integrated pigpen inside the greenhouse, vegetable crops, and a 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 CO_2 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 smaller scale orchard plantations with biogas digesters (type II technology). This is commonly referred to as the 3-in-1 model ecofarm. The three elements are pigs (or other livestock), orchard (1 hectare), and a digester. The model can also use vegetables, cotton, fishponds, grain crops or other crops to substitute for the orchard. 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 farm or for 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 fruits from the Project will be sold to nearby cities such as Guangzhou, Hong Kong, and Shanghai, where the market demand is high.

(iii) 14 medium-scale biogas plants (type III technology). The biogas plants will be located in large commercial pig farms. Pig manure and other liquid wastes and sludge will provide the fuel for the biogas plants. Each plant will be able to supply up to 120 households and the central pig farm with biogas for lighting and cooking. Organic manure, which is the by-product of the plant's effluent, will be sold to adjacent farms.

(iv) 28 medium-scale straw biomass gasification plants (type IV technology). The gasification plants will be located in farming villages where there is abundant wheat or other grain straw that is normally burned in the field after harvesting the crop. The plants will use mostly crop residues for 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.

b. Component B: Improve Mechanisms for Transferring Biomass Technology

62. 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 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 agricultural 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 will be awarded on biomass energy system improvement, environmental protection, and monitoring

of biomass technologies. Promotion and expansion of biomass technology and renewable energy policy will be included. Consulting services will be provided to help the local government to develop and adopt appropriate policies and incentives to encourage biomass technology adoption in rural areas. This component will integrate all elements of biomass technology adoption, incorporating the existing farm production system along with strengthening the institutions, and will 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. About 15 to 20 biogas units will be able to support one service provider. Over the project implementation phase, these service providers will receive training and guidance from project consultants in the establishment of their service entity. It is expected that more than 300 viable private service units will be established in the project areas. A vision for the service industry build up in the provinces is given in Appendix 4, Table A4.1.

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

63. This component will provide rural infrastructure to link agricultural production areas to the existing road network. The Project will construct or rehabilitate about 60 kilometers 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, supply of inputs, easy access by extension officers to promote and enhance biomass technology adoption by rural households, and easier access to obtain spare parts necessary for O&M of the biogas digesters. Construction will be undertaken with the cooperative efforts of each village's farm labor on a volunteer basis, while the local government will provide the materials. The project implementation agencies will organize the civil works. Road maintenance will be done by volunteer farm 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, facilitate O&M services, and reduce high transportation costs and damage to produce, particularly in the more remote and disadvantaged areas.

d. Component D: Improve Environmental Policy Implementation and Awareness

64. This component is designed to assist and develop environmental frameworks and programs to assist the provincial governments to effectively implement the national environmental policy, particularly in those areas relating to biomass technology development and adoption. It will provide environmental equipment, technical support, and training to improve environmental policy implementation and awareness and to establish facilities and systems for environmental monitoring to assure higher environmental standards. This will assist the establishment of a benchmark for environmental standards and the measurement of environmental 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 environmental 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, and mount public information campaigns and barrier removal targeting (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 to Biomass Development

65. This component will introduce an improved and innovative biomass development approach especially 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 semiliterates and extension services will be developed for this group of beneficiaries.[21] Women's associations at the village level will help farmers to participate in the adoption of biomass technology through special training that will upgrade their technical capabilities, and to prepare subloan applications. To enable the poor to participate in the Project (i.e., to be eligible for assistance under component A), they will be provided with basic biogas facilities such as biogas digester, pig pen, and other equipment that will form part of their own equity contribution, in addition to their labor, for the application of project financing to undertake the biogas production investment. A traditional household assistance model will be adopted to provide assistance to poor families. This 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 poor and 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 the PRC receives a substantial budget from the national government (over $600 million annually), and its rural county offices will be actively involved in the project implementation activities for this component. The component will be implemented in two phases. Phase 1 (years 1-3) involves the selection and provision of assistance to about 15 percent of project beneficiaries who live below the poverty line (about 2,353 households). GEF funds will be used to introduce this improved approach in phase 1. In phase 2 (years 4-5), the Government, through its Poverty Alleviation Office, will continue to pilot test this approach using its own resources. Detailed phasing approach for this component is given in Appendix 3, Table A3.5. A successful outcome of this component will enable the Poverty Alleviation Office to replicate the activity in other provinces.

f. Component F: Improve Project Implementation and Capacity Development

66. The component will provide consulting services to strengthen the coordination of technical support, 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 Henan, Hubei, Jiangxi, and Shanxi as executing agencies. The project county governments 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

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

provision will be provided to the staff of finance bureaus. Consulting services will be provided to strengthen the executing agencies' institutional capacity to implement and monitor all project activities. The executing agencies will be supported technically and financially to assume the coordination, monitoring, and evaluation functions at both the provincial and county levels.

C. Cost Estimates

67. 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, and $41.0 million equivalent or 53 percent is in local currency. A summary of the cost estimates is given in Table 1, and details are given in Appendix 3. About 79 percent of total base cost will be spent on renewable energy development and eco-environment, and about 11 percent on improving project implementation and capacity development. The component on improving project implementation and capacity development is a larger than normal expenditure item due mainly to allocating all Project Management Office (PMO) consulting services to 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 the current London interbank offered rate (LIBOR)-based interest rate of 3.8 percent.[22]

Table 1: Summary of Project Cost Estimates

($ million)

Item	Foreign Exchange	Local Currency	Total Cost
A. Base Cost			
1. Fund for Renewable Energy Generation and Eco-Environment Development	23.66	24.77	48.43
2. Improve Mechanism for Transferring Biomass Technology	0.27	0.77	1.04
3. Rehabilitate Farm-to-Market Facilities	0.24	0.78	1.02
4. Improve Environmental 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 factors in local currency of 3 percent for year 1 and 2 percent for year 2 onwards; and in foreign currency of 2.4 percent for year 1 onwards.

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

Source: Asian Development Bank estimates.

[22] At the time of appraisal in July 2001.

D. Financing Plan

1. Sources

68. A summary of the financing plan is given in Table 2. 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 to help finance the Project. The loan will finance about 91 percent of the foreign exchange cost. 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 1 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 as set forth in the Loan Agreement. The provincial governments will contribute $23.6 million and the beneficiaries $14.2 million. GEF is envisaged to provide $6.4 million on a grant basis.

Table 2: Financing Plan
($ million)

Source	Foreign Exchange	Local Currency	Total Cost	Percent
Asian Development Bank (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
Global Environment Facility (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.
Source: ADB staff estimates.

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

2. Relending and Onlending

70. The PRC will be the Borrower of the ADB loan. On behalf of the Borrower, the Ministry of Finance (MOF) will enter into subsidiary loan agreements with Henan, Hubei, Jiangxi, and Shanxi as provincial governments subborrowers. MOF will relend the proceeds of the ADB loan to the four provincial governments at the same rates and terms for financing component A. 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 eligible enterprises, and to eligible farmers through the township government finance bureaus. The ADB loan proceeds will be used to finance 50 percent of the cost of each subproject.[23] The provincial

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

governments 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 (types I and II), and servicing the debt obligations of the Borrower. However, for the medium-scale biogas and gasification plants (types III and IV), the subborrowers will bear the foreign exchange and interest rate variation risks.

71. Farmer and enterprise beneficiaries will enter into legally binding contracts with the relevant project implementation units (PIUs) and the finance bureaus (county, municipal, or township) on the same terms and conditions of the investment loan. The onlending interest rates to the farmers and enterprises will 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 investment. For types I and II investments, the township will onlend to the farmers in local currency with a repayment period of not more than 10 years and a grace period of not more than 5 years. For types III and IV investments for the enterprises, the municipal or county finance bureau will onlend the ADB loan funds in US dollars with repayment terms of 8-10 years, and a grace period of 3-5 years, depending on the projected cash flow and profitability of the investment subproject.

72. The finance bureaus[24] will review and appraise each subloan application and evaluate its merits based on the 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 the onlending interest rate as described above. Beneficiary contributions can be in the form of labor, existing assets, and/or cash.

E. Implementation Arrangements

1. Project Management

73. 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 policy, implementation, coordination, and issues beyond the control of the provincial governments. NPCC is comprised of a vice minister of MOA as the chairperson with senior directors from the State Development and Planning Commission; MOF; and SEPA; and representatives of MOA from the Department of Development Planning, Department of Research, Education and Rural Environment, Poverty Alleviation Office, and FECC as members. At the national level, the PMO will be established at FECC for overall project management, coordination, training, recruitment of consultants, and other implementation and monitoring activities. The PMO will be the secretariat of NPCC, and the PMO director will serve 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, establishing a monitoring system, and evaluating overall project

[24] 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.

performance; (vi) recruiting and supervising consultants; and (vii) providing technical and management training including training provincial officials on the adoption of a project performance management system (PPMS).

74. MOA and the four provincial governments will be the executing agencies of the Project. A provincial leading group (PLG) will be established in each province to oversee project implementation, review and approve project plans, source counterpart funding, effect inter sector coordination, and provide guidance and advice to resolve field-level project implementation issues. Each PLG will have the vice governor as the chairperson, with senior directors of the department of agriculture, development planning commission, department of finance, women's 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) will be established to manage and oversee project implementation activities in each province. The duties of the PIO will include (i) organizing and compiling all medium-scale biogas and biomass gasification feasibility studies and investment plans of types I and II subprojects; (ii) drawing up annual work programs and budgets; (iii) applying approved selection criteria in selecting subprojects of large-scale biogas plants; (iv) reviewing and approving county PIUs' work plans and verifying the costs of proposed subprojects; (v) supervising and managing procurement activities; (vi) supervising construction, inspection, and acceptance; (vii) monitoring physical and financial progress and setting up a 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; and (x) preparing and submitting withdrawal applications to ADB. The PIOs will also serve as the secretariat for the PLG. Each PIO will be 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 will be appointed as the deputy director of the PIO to manage all financial aspects of the Project.

75. The municipal and county governments will be the PIUs for field-level project activities. The PIUs will be located in the Bureau of Agriculture and will be supported by local bureaus of livestock, renewable energy offices, poverty alleviation offices, and other relevant technical agencies. The municipal and county PIUs in turn will work closely with the township governments and village committees, and with civil society organizations such as women's associations, research institutes, and universities.

76. The provincial finance bureaus will be responsible for management of the project finances. The project funds will be released from the provincial finance bureaus to the municipal and county finance bureaus, in accordance with the recommendations of the PIOs, and in turn disbursed to project beneficiaries. The disbursement, repayment, and other financial 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 in the case of small biogas investors.

2. Implementation Schedule

77. The Project will be implemented over a period of five years commencing in 2002 (Appendix 5). In 2004, ADB and the Government will jointly undertake a comprehensive midterm review of the Project to assess its implementation status, review its parameters, and

take appropriate measures to further improve its implementation efficiency to ensure the achievement of its objectives and the anticipated socioeconomic impacts.

3. Procurement

78. All goods and services to be financed by the ADB loan and GEF grant will be procured in accordance with the ADB's *Guidelines for Procurement*. Most of the loan funds will be used by subloan borrowers to construct small and medium-scale biomass systems integrated with existing agricultural production. Procurement will be mainly for environmental 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 are estimated to cost less than $500,000 and will be done by international shopping or local competitive bidding, except those estimated to cost less than $100,000, which will be done by direct purchase. The civil works for rehabilitation of local farm roads and bridges are simple, and the materials 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 done on a force account basis. Indicative procurement packages are given in Appendix 6.

4. Consulting Services

79. Consulting services will be required to assist the executing agencies, through the PMO and 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 an individual basis through arrangements satisfactory to ADB. The consultants will assist the Government in addressing key barriers that are contributing to lack of widespread 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 to oversee the implementation of selected activities; assist in setting 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 will come under the direction of the PIOs in the four provinces. Terms of references for the consulting services are given in Appendix 7.

5. Disbursement

80. The Borrower will disburse subloans and eligible expenditures under the Project through (i) imprest accounts to be established at the PIOs immediately after the effectiveness date of the Loan Agreement; or (ii) ADB's direct payment, commitment, or reimbursement procedures. An imprest account will be established within each of the four provincial governments. Initial advances will be equivalent to the PIOs' anticipated disbursements to subborrowers over a six-month period, or 10 percent of loan proceeds, 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 have been assessed; their financial controls and discipline are adequate for the application of the statement of expenditure procedure.

6. Project Accounts, Audits, and Reports

81. 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 of funds under the Project. The records and accounts will be forwarded regularly to the provincial PIOs. The 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 the 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 nine months after the end of the fiscal year. The 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 format proposed by ADB and should contain (i) physical and financial accomplishments; (ii) project performance indicators; (iii) problems encountered 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 the 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 executing agencies and PIOs will be informed of ADB's new policy on submission of audited financial statements and the strict penalties for noncompliance.

7. Implementation Reviews

82. 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 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 the appropriateness of the project design and scope, the effectiveness of poverty targeting mechanisms, and the criteria for credit assistance, and to explore ways to further improve project implementation efficiency.

8. Project Monitoring and Performance Evaluation

83. The PMO, in coordination with the PIOs, will establish a PPMS system in the PMO and PIOs to monitor and assess project impact and the 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 disadvantaged groups, will be monitored by the PIOs and PIUs with assistance from local poverty alleviation offices and the women's associations. Special poverty-focused surveys will be conducted by local universities to complement the data generated under the PPMS and the results of monitoring and evaluation.

9. Governance and Anticorruption Measures

84. 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, which were briefed on the anticorruption provisions incorporated into ADB's *Guidelines on the Use of*

Consultants. Attention was drawn to the need for PMO and PIO staff to observe the highest standards of ethics in the procurement for and implementation of ADB-financed contracts to ensure that domestic consultant salaries are fully paid without any deduction; it was explained that sanctions will be applied if fraud and corruption are discovered. Similarly, the section on fraud and corruption in ADB's *Guidelines for Procurement* was also discussed with the project officials.

85. The Government is increasingly concerned with governance issues and has conducted well-publicized campaigns against corruption. ADB's country assistance program supports the Government in improving governance and providing incentives to reduce the incidences of corruption in the long run. In 1997, ADB provided TA[25] 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 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 prosecution. Work is under way under another TA[26] 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[27] relating to the consulting industry and auditing that included 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 another TA[28] 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

86. MOA through FECC at the national level, and the provincial governments in Henan, Hubei, Jiangxi, and Shanxi through their departments of agriculture at the provincial level, will be the executing agencies of the Project. All have had considerable experience in implementing locally funded projects, and all have also implemented foreign-assisted projects such as those funded by the World Bank, Food and Agriculture Organization, International Fund for Agricultural Development, UNDP, and bilateral agencies. The executing agencies have established a permanent PMO and the provincial PIO organizational structure to be used by this Project. Their performance in past foreign-funded projects has been satisfactory. The project staff are full-time, permanent, and have significant project implementation experience.

[25] TA 2845-PRC: *Establishment of National Procurement Regulation for the Public Sector*, for $565,000, approved on 20 August 1997.
[26] TA 3457-PRC: *Implementation of the Tendering and Bidding Law and Related Regulations*, for $565,000, approved on 14 June 2000.
[27] 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.
[28] TA 3631-PRC: *Formulation of the Government Procurement Law*, for $578,000, approved on 20 February 2001.

G. Environmental and Social Measures

1. Environmental Measures

87. An initial environmental examination (IEE) was undertaken, and the summary IEE was prepared during project preparation. Subsequently, each subproject investment will be required to prepare its IEE or EIA report to submit to the respective environmental authorities for approval. The IEE concluded that the proposed Project will promote efficient utilization of agricultural waste products to improve the physical environmental in rural areas. The environmental benefits of the Project will include reduction of CO_2 and SO_2 emissions; elimination of nonpoint pollution from intensive livestock production; and cessation of exploitation of forests for fuelwood. The Project benefits will also include improvements in health and increased vegetative coverage of nonproductive 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 ADB's environmental requirements and those applicable at the national, provincial, and county levels.

88. 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 of the Project, an environmental management and monitoring program will be prepared by the PIOs in each province within six months of loan effectiveness 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) an IEE for 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.

89. The provincial agricultural stations will be responsible for the implementation of the environmental management and monitoring program; and the provincial environmental protection bureaus will oversee the implementation of the program. Monitoring results will be reported in the semiannual progress reports on project implementation and in annual reports on 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

90. 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 which 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's

representatives, and youth associations to collect broad-based opinions on the Project. In-depth interviews were done to clarify the socioeconomic, poverty, and environmental implications of the Project. Particular attention was given to fostering the participation of villagers, in particular women, during project preparation.

3. Social Analysis

a. Social and Poverty Assessment

91. The Project will be implemented in about 150 villages in 37 counties. A detailed social and poverty assessment is given in Appendix 8. All four provinces have experienced rapid growth during the Ninth Five-Year Plan period with annual gross domestic product growth ranging from an average of 7.9 percent in Jiangxi to 10.1 percent in Henan. The 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 an average annual income below Y2,000. The average farm size in the four provinces ranges from 3 to 5 mu,[29] with an average household size of 3.7 person. The main sources of household income are from crops, livestock, and seasonal off-farm 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.

92. 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 the villages in the project areas have no access to basic health services. Lack of fuel and lack of 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 agrochemicals in current farming practices and the health implications for farmers and consumers are of general concern to farmers. 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 3-12 months.

93. 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 distributions of population living below the 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 that the project rural population can be classified into four distinct 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 the population in the project counties. These families require assistance to meet their basic needs. They are (i) 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 with poor physical resources and do not have the knowledge to better utilize the assets they have. In general, they have very low levels of education, are illiterate, and are without access to information.

[29] 15 mu is equivalent to 1 ha.

(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 rain-fed 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 between Y1,000 and Y2,000 per capita per year. It is the largest group (about 40 percent) in the project area. Their production systems range from rain-fed areas of larger sized land (>10 mu) to small irrigated areas (3-4 mu). The income of these families just about covers the family needs. Sources of household energy are similar to those of 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 liquified petroleum gas for cooking, coal for heating, and electricity for lighting.

b. Gender Analysis

94. 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 the main responsibility for on-farm activities. This is due partly to the fact that 30-40 percent of the men in the project areas do off-farm jobs in or outside of their villages. In most cases, men work on agricultural activities only during the peak season, leaving the women with farm work throughout the year. In most cases, the responsibility for collecting fuelwood and straw and for fetching water lies with the women. Statistics confirm that women work 25 percent longer hours than men and thus have less leisure and sleeping time. Illiteracy among adult women in the project areas is double that of men. Women are in a disadvantaged position in absorbing new information and technologies.

95. Due to the lack of clean energy for cooking and heating, women in these households are constantly exposed to smoke and 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 the potential health risk will be significantly reduced. In addition, time will be saved on collecting fuelwood or straw for cooking.

V. PROJECT JUSTIFICATION

A. Financial and Economic Analysis

1. Incremental Outputs

96. 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.

97. 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 greenhouse vegetables (e.g., onion, melon, and cucumber); grains (i.e., winter wheat, maize, soybean, millet, and mungbean); other agricultural crops and livestock such as pigs, cattle, sheep, and goats. Incremental annual vegetable production generated by type I biogas systems is estimated at 882 tons (t). Total annual incremental grain production will be about 312 t, while annual incremental pig production will be 105,750 head or about 10,575 t of pork (at 100 kilograms/head). All type I biogas systems will generate a total annual incremental production of 2.82 million cubic meters (m^3) of biogas, 183,558 t of digested effluent, and 44,310 t of sludge.

98. Type II biogas systems, mainly in Henan, Hubei, and Jiangxi provinces, will generate an annual increment of 209,280 t of citrus production. Total annual pig production under these systems is projected to increase from 21,800 head (or 2,180 t of pork) to 109,000 head (10,900 t of pork) or an incremental production of 87,200 head (8,720 t of pork). The type II systems will generate an incremental production of 6.5 million m^3 of biogas, 138,213 t of digested effluent, and 33,365 t of sludge, which will be used by the farm household.

99. Type III biogas systems will generate an annual incremental production of about 1.2 million m^3 of biogas, 96,830 pigs (or 9,683 t of pork), and about 246,500 t of digested effluent and sludge. The type IV gasification systems will generate an annual incremental production of about 31 million m^3 of producer gas.

100. Appendix 9, Table A9.2 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 1 percent of current agricultural production in the project area. Their impact on local prices of these commodities will be insignificant.

2. Financial Analysis

101. Financial analysis was carried out for each of the four types of biomass system. Assumptions underlying the analysis are presented in Appendix 9. The financial performance of each individual biogas system was assessed using financial ratios that 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 to 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 9).

102. Financial farm analysis for each biomass system was undertaken (details are given in Supplementary Appendix D). The financial analysis for a type I biogas system is based on two type I subsystems: (i) type Ia subsystem, which compares full technology adoption vs traditional technology; and (ii) type Ib subsystem, which compares full technology adoption vs improved technology. Farms under type Ia subsystem will generate annual incremental benefits of about Y4,013 (or $485), while those under type Ib subsystem will produce about Y2,478 (or $299). In the case of farms operating type II biogas systems, the financial farm budget analysis indicated that farmers' income will 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, will realize an annual net income of Y246,396 ($29,784).

103. The results of the financial analysis indicate that each type of system is financially viable (see Appendix 9 Table A9.8). The financial internal rate of return (FIRR) for the small biogas type Ia subsystem yields a FIRR of about 16 percent; type Ib subsystem, 17 percent; and type II, 17 percent. For the medium scale type III biogas plant, the FIRR is about 16 percent, while for the type IV gasification plant, the FIRR is about 14 percent. Sensitivity analysis indicates that the FIRR values of all types of biogas systems are sensitive to changes in revenue and production cost as implied by the sensitivity indicator, which exhibits 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 any 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 exhibits a sensitivity indicator of less than one. The results of the financial and sensitivity analyses are summarized in Appendix 9, Table A9.8.

3. Economic Internal Rate of Return

104. Based on economic benefits derived from investments in biogas systems, the economic internal rate of return (EIRR) for the whole Project is estimated at about 18 percent. Details are presented in Appendix 9 (Table A9.11).

105. The analysis indicates that the Project as a whole is not sensitive to changes in revenue and production costs, as the sensitivity indicators, in general, exhibit values close to one. A delay in project benefits by one year would have an insignificant effect on the base EIRR. More results and details of the sensitivity analysis are given in Appendix 9, Tables A9.12 and A9.13.

4. Environmental cum Economic Benefits

106. The 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 will also result in a reduction of pollution and GHG emissions. The positive effects of adopting the four types of biomass systems include a reduction of CO_2 and SO_2 emissions, soot, and dust and reduce time spent on collecting firewood or straw and on 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. A reduction in the amount of dumping of untreated solid and liquid wastes will result in lower levels of

contamination in surface water and groundwater. By substituting biogas for firewood, there is the added benefit of reducing exploitation of the forests, resulting in less soil erosion and flooding and better management of natural resources.

107. The Project will bring about significant benefits to the rural environment by converting large quantities of agricultural wastes (crop residues, livestock solid and liquid wastes, domestic waste, etc.) into organic fertilizer and biogas (33 million m^3 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 of in the digester, thus alleviating the unclean conditions around and within the house, especially during the wet season. The use of organic fertilizer, year-round greenhouse vegetables, and pig production will enhance the quality and quantity of farm production, increasing farmers' income and generating incremental workdays.

108. 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 as follows:

(i) **Savings in Fuel.** The annual fuel saving per household for each type of biogas system is about Y512 for households using the type I biogas system, Y624 for using type II, Y77 for type III, and Y187 for type IV.

(ii) **Savings in Cooking Time.** About one hour per day will be saved 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 used for cooking can cause health problems connected with smoke inhalation. When biogas is used in cooking, there is a negligible emission of dust, soot, and CO_2 due to its chemical composition. The average household using biogas will realize a saving of Y30 per year in medical expenses.

(iv) **CO_2 Reduction.** The Project estimated that the use of biogas will result in reduced annual CO_2 emissions of about 4.6 t per household per year under a type I biogas system; 4.2 t under type II, 1.8 t using type III, and 0.7 t using type IV or an annual average of about 2.8 t per household. The Intergovernmental Panel on Climate Change has calculated the damage cost of CO_2 emissions to be at about Y83/t or an average value of Y232 per household per year. Table 3 compares the CO_2 emissions of cooking with traditional fuels and that of cooking with biogas.

Table 3: Comparison of Emissions of Carbon Dioxide by Type of Biomass Gas System Used

Item	Type I (1)[a]	Type II (1)[a]	Type III (120)[a]	Type IV (600)[a]
Per Day:				
Emissions using traditional cooking (kg CO_2 /day)	13.65	12.51	680.4	3,402
Emissions using biogas (kg CO_2 /day)	1.16	1.19	97.2	2,172
Per Year:				
Emissions using traditional cooking (t CO_2/day)	5.0	4.6	248	1,242
Emissions using biogas (t CO_2/day)	0.4	0.4	35.5	792.6
Total CO_2 reduction/ year (t)	4.6	4.2	212.5	449.4
Total CO_2 reduction/ year (%t)	91.6	90.5	85.7	36.2

[a] Number of household for each type of biomass gas system.

109. The results indicate that CO_2 reduction through substituting biomass gas for conventional fuels is substantial. For example, in the case of the type I system, the reduction in CO_2 emissions using biogas for cooking is about 92 percent, while for type IV it is about 36 percent.

5. Unquantified Long-Term Benefits

110. 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 the reforestation that is required to absorb excess CO_2, and the costs of continued soil erosion and flood damage. The Project will reduce the deforestation activities of poor households living near forests by introducing biomass technology as an alternative to fuelwood, and will increase forest coverage by planting fruit trees on over 10,000 hectares of degraded hillside land, mostly in watershed areas. Organic fertilizer made available from biomass technology will replenish the land with the macro and micro soil nutrients necessary for long-term sustainability of soil development. These benefits are significant, and will increase over the long-term.[30] The adoption of biomass gasification technologies will result in a significant reduction of smoke from burning crop residues, which will lead to improved public health and reduced road and air accidents. Appendix 9, Table A9.14 provides further details on the positive environmental impacts of the Project.

B. Social Dimensions

111. 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 agricultural production. The Project will address the poverty of poor and low-income people. The poverty reduction impacts of the Project will be considerable. Within the five-year project period, about 34,080 households will benefit directly from the project intervention: 15,600 households will invest in small-scale biogas farming systems, and 18,480 households will have access to clean energy from the

[30] Adopting the biogas producer system will contribute to gradually reducing the destruction of forests as less firewood is burned. Forests act as CO_2 sink, helping in the reduction in levels of CO_2 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.

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.

112. For participating households, the average incremental household income for full adoption of type I over the traditional farming system will be Y4,013 ($485), an increase of about 36 percent. For type II, the average incremental household income will be about Y14,254 ($1,724), or and increase of 73 percent over the without-project situation.

113. Adopting type III 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 IV 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, the poor farm households will have the opportunity to earn income by bringing straw from the fields to sell to the biomass gasification plants.

114. Distribution analysis conducted on quantifiable economic benefits of the Project shows that the share of benefits accruing to the poor will be 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 exceeds the current poor's 10 percent share in national income.

115. In addition to overcoming increased income, the Project will have impacts on improving living conditions and environment. 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. The 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 agrochemicals. Consumers of reduced-chemical and organic agricultural products will benefit from improved quality of agricultural products produced by the Project. Environmental protection not only tackles nonpoint 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.

116. Reduction of GHG emissions and reforestation activities will have a positive impact on the global environment. At the community level, construction of type IV biomass gasification plants will reduce the problem of air pollution due to burning crop residues in the fields. At the household level, the availability of clean energy to replace fuelwood and coal will benefit the daily lives of women in terms of both health and the time spent in firewood collection.

117. 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's associations will help in social mobilization to enhance the participation of the poor. Special training programs for low-skilled adults will be provided to poor and disadvantaged households to increase their capacity to adopt biomass technologies. Because 40 percent of the men are involved in off-farm

employment to earn cash income, and the women are mostly responsible for household and agricultural work, special attention will be given to developing 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 poor women, will be empowered through special training programs and through the participatory process promoted by the Project.

118. 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's associations, poverty alleviation offices, rural energy offices, the agriculture department, and representatives of poor households.

119. To facilitate adoption of the new farming systems 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 reduction experiences will be systematically documented and publicized among domestic and international development communities to benefit development efforts elsewhere.

120. Poor villages, which were physically excluded or inadequately linked to the transportation and marketing networks in the past, will be connected through rural roads 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 location of infrastructure will serve poor and disadvantaged households. The poor will also have a significant role in constructing and maintaining this infrastructure. The participatory process will foster community ownership and transparency in implementing project activities.

C. Gender Impacts

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

122. Women will be empowered through training activities, through being supported as demonstration households, and through the participatory process promoted by the Project. Every effort will be made to ensure an equitable gender balance in the selection of beneficiaries, with special consideration given to women who are heads of households. With the women's 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. Risks

123. 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 it and that they realize their obligations under the repayment terms for the subloans. There is also the

need to ensure that the provincial and county financial bureaus are capable of administering and can 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: Fujian Soil Conservation and Rural Development Project and the recently approved Loan 1814-PRC: West Henan Agriculture Development Project. Experience from the former has been good, and no major problems have been encountered in the financing scheme using the provincial and county finance bureaus to channel project funds and collect repayments.[31] Established criteria will be followed in selecting project beneficiaries. The executing agency 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 hectares 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) continued process of capacity building. These factors have been built into the project design.

124. Another potential risk the current 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 can establish private enterprises in each project county to provide maintenance and repair services. This will help ensure the sustainability of project activities.

VI. ASSURANCES

125. 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 the poverty alleviation office and the women's association in the committee to refine the selection criteria for 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 poverty such as poor sanitary conditions, low level of literacy, and/or overdependence on firewood and coal for cooking and heating).

(ii) Within 12 months of loan effectiveness, the executing agencies 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.

[31] See the Project Performance Report for the Fujian Soil Conservation and Rural Development Project (Loan 1386-PRC).

(iii) All activities supported under the Project (particularly the type III and IV models) will meet national environmental standards and 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) 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 types III and 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.

(xii) Each province will ensure that the successful financial mechanism established for the poor farmers will continue to be adopted after project completion.

(xiii) The Ministry of Agriculture will ensure that successful implementation of the Project approach in biogas funding and development in the four project provinces will be replicated to other nonproject provinces.

VII. RECOMMENDATION

126. 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 $6.4 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 June 2002

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	Detailed Tables for Financial and Economic Analyses
E	Poverty Assessment
F	GEF Incremental Cost Analysis
G	Project Parameters and Implementation Arrangements

PROJECT FRAMEWORK

Design Summary	Targets	Means of Verification	Risks and Assumptions
Goals • Improve the environment. • Promote sustainable agricultural production to enhance economic growth and to improve welfare and living conditions of rural households in disadvantaged areas in Henan, Hubei, Jiangxi, and Shanxi provinces.	• 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	• Provincial statistics • Project performance management system (PPMS) reports • Project completion report (PCR) • Environment monitoring reports • Results monitoring evaluation	• Government policies are favorable to promote generation of renewable energy. • Sustainable government investment in rural infrastructure • Government remains committed to poverty reduction
Purposes • 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 reduce poverty.	• Sustainable incremental annual production of - 41 million cubic meters (m^3) of biogas/producer gas renewable energy; - 289,780 pigs - 882 tons (t) of green vegetables (comprising greenhouse vegetables like cucumber, squash, tomato, etc.) - 209,280 t of citrus fruit - 645,932 t of digested effluent/sludge (organic fertilizer) • Sustainable annual incremental environmental benefits estimated for - 78,338 t of carbon dioxide (CO_2) 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, including about 9,000 poor household families.	• Provincial statistics on agriculture and renewable energy; • Project progress and PPMS reports • PCR • Postevaluation report • Environment monitoring reports	• 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
3. Components/Output[a] **3.1 Fund Renewable Energy Generation and Eco-Environment Development** • Rehabilitation/construction of greenhouses for year-round organic vegetable production • Establishment of plantations for citrus production • Construction of household biogas digesters, medium-scale biogas plants, and biomass gasification plants	• Rehabilitate/construct 4,700 greenhouses for organic vegetable production under the 4-in-I model • Develop 10,900 hectares (ha) of citrus under the 3-in-1 model • Construct 15,600 household biogas digesters, each producing about 600 m^3 of biogas per year • Construct 14 large-scale biogas plants, each producing 87,600 m^3 of biogas per year supplying 120 households • Construct 28 biomass gasification plants; each producing 1.1 million m^3 of producer biogas per year supplying 600 households • 34,080 households benefiting from cheaper biogas and cleaner environment • About 31,200 farm beneficiaries trained in biogas technology • 4,700 farmers qualified to produce green vegetables	• Project progress reports and review missions • PPMS annual survey • Nongovernment organization (NGO) reports • Environmental monitoring reports • PCR • Postevaluation report	• 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 advise and monitor construction and operation of biogas production units • Sustainable operation and maintenance for biogas digesters • Adequate quantity of straw for soil mulching
3.2 Improve Mechanisms for Transferring Biomass Technology • Conduct of courses for transfer of engineering and technical skills to biogas digester contractors • Provision of training and extension services to beneficiaries and project officials • Conduct of workshops and study tours to acquire biomass technology	• 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	• Project progress reports • Mid-term review report • PPMS • PCR	• Effective development of training programs by Project Management Office (PMO) • Farmers and county officials' training programs effectively carried out • project implementation offices (PIO) officials effectively organize courses, workshops, and study tours.

[a] Project output does not include component f of the Project (para. 66) as it is a project management component.

Design Summary	Targets	Means of Verification	Risks and Assumptions
3.3 Rehabilitate Farm-to-Market Facilities • Development of rural infrastructure including farm-to-market access roads and bridges, and other rural marketing facilities at the village level	• Construct/rehabilitate 60 kilometers (km) of 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.	• Project progress reports and review missions • NGO and PPMS reports • PCR • Postevaluation report	• Farmers organized for operation and maintenance (O&M) activities of rural infrastructure facilities • Adequate counterpart funds provided by provincial governments for construction and maintenance of major roads leading to farms
3.4 Improve Environmental Policy Implementation and Awareness • Removal of barriers 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 environmental protection and monitoring	• Develop system and policies to remove barriers for renewable energy development • Develop communication strategy in each 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 persons from each station) by domestic consultants ▪ Establish four environmental monitoring and training stations.	• Project progress reports • PPMS reports • NGO and review mission reports • PCR • Postevaluation report	• Environmental protection policies implemented in all project provinces • Support from rural communities for environmental protection and improvement • Government provides sufficient counterpart funds to agriculture environment protection bureaus to effectively carry out environment awareness and environmental monitoring activities
3.5 Pilot Poverty-Focused Approaches to Biomass Development • Establishment of financially viable and sustainable scheme to provide credit to poorer segments of rural villagers (living below poverty line) for biogas	• 9,000 poor households lifted from poverty • Provide specific training to poor farmers	• Project progress reports and review mission reports • NGO and PPMS reports	• Effective village committees formed with strong support from county finance bureaus

Design Summary	Targets	Means of Verification	Risks and Assumptions
generation and greenhouse vegetable production. • Provision of specific training targeting poor farmers	• Provide basic biogas facilities to 9,000 poor households.	• PCR	• Clear criteria to identify poor farm families
4. Activities/Inputs • Fund for renewable energy generation and eco-environment development • Improve mechanism for transfer of biomass technology • Rehabilitate farm-to-market facilities • Improve environmental policy implementation and awareness • Pilot poverty-focused approaches to biomass development • Improve Project implementation and capacity development **Base Cost** TA Preparatory Cost Physical Contingency Price Contingency IDC, Commitment, FF **Total**	$ million Foreign Exchange / Local Currency / Total 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**	• Project progress reports • PPMS reports • PCR • Postevaluation report	• Sufficient local counterpart funds available on timely basis

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

PROJECT LOCATIONS AND OTHER PARAMETERS

Table A2.1: Key Agriculture Features of the Four Project Provinces

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

Source: Provincial statistical bureaus. 2000.

DETAILED PROJECT COST ESTIMATES

Table A3.1: Whole Project Cost Summary

Component	(Yuan '000)			($ '000)			% Foreign Exchange	% Total Base Costs
	Local	Foreign	Total	Local	Foreign	Total		
Fund for Renewable Energy Development and Eco-Environment Development	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 Farm-to-Market Facilities	6,472.2	1,982.7	8,454.9	779.8	238.9	1,018.7	23	2
Improve Environmental 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 to Biomass Development	22,542.1	531.2	23,073.3	2,715.9	64.0	2,779.9	2	5
Improve Project 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	340,314.5	255,570.3	595,884.8	41,001.8	30,791.6	71,793.4	43	
Technical Assistance 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 Project Costs	340,314.5	301,040.4	641,354.9	41,001.8	36,269.9	77,271.7	47	

Source: Asian Development Bank estimates.

Table A3.2: Expenditure Accounts Project Cost Summary

Whole Project

Item	(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
Training Station	-	-	-	-	-	-
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	**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	**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 Project Costs	**340,314.5**	**301,040.4**	**641,354.9**	**41,001.8**	**36,269.9**	**77,271.7**

Source: Asian Development Bank estimates.

Table A3.3: Project Expenditure Accounts by Financiers

($ '000)

Item	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							**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

Source: Asian Development Bank estimates.

Table A3.4: Components by Financier
Whole Project

Component	Financier ($'000)				
	ADB	GEF	Benficiaries	Government	Total
Funding 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 Farm-to-Market Facilities	0.0	0.0	394.2	800.9	1,195.1
Improve Environmental Policy Implementation and Awareness	0.0	789.1	0.0	1,173.4	1,962.5
Pilot Poverty-Focused Approaches to 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]

ADB = Asian Development Bank, GEF = Global Environment Facility.

[a] Excluding interest and other charges totaling $5,478,400.

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

Source: ADB estimates.

Table A3.5: Detailed Phasing Approval for Pilot Poverty Focused Approaches for Biomass Development

Year of Implementation	No. of Biogas Units			Cost ($'000)	Funding Source
Year 1	All provinces	=	600	333.2	GEF
	Shanxi	=	150	83.3	GEF
	Henan	=	150	83.3	GEF
	Hubei	=	150	83.3	GEF
	Jiangxi	=	150	83.3	GEF
Year 2	All provinces	=	800	444.4	GEF
	Shanxi	=	200	111.1	GEF
	Henan	=	200	111.1	GEF
	Hubei	=	200	111.1	GEF
	Jiangxi	=	200	111.1	GEF
Year 3	All provinces	=	953	529.3	GEF
	Shanxi	=	238	132.2	GEF
	Henan	=	239	132.7	GEF
	Hubei	=	238	132.2	GEF
	Jiangxi	=	238	132.2	GEF
Year 4	All provinces	=	1,298	720.8	PRC
	Shanxi	=	221	122.7	PRC
	Henan	=	505	280.4	PRC
	Hubei	=	240	133.3	PRC
	Jiangxi	=	332	184.4	PRC
Year 5	All provinces	=	1,299	721.3	PRC
	Shanxi	=	221	122.7	PRC
	Henan	=	505	280.4	PRC
	Hubei	=	240	133.3	PRC
	Jiangxi	=	333	184.9	PRC
Total	**316 units**				
Total Projects	All provinces	=	4,950	1,306.6	GEF
					PRC
	Shanxi	=	1,030	326.6	GEF
				245.4	PRC
	Henan	=	1,599	327.1	GEF
				560.8	PRC
	Hubei	=	1,068	326.6	GEF
				266.6	PRC
	Jiangxi	=	1,253	326.6	GEF
				369.3	PRC

ORGANIZATION CHART AND IMPLEMENTATION SCHEDULE

Figure A4.1: Project Organization Chart and Fund Flow

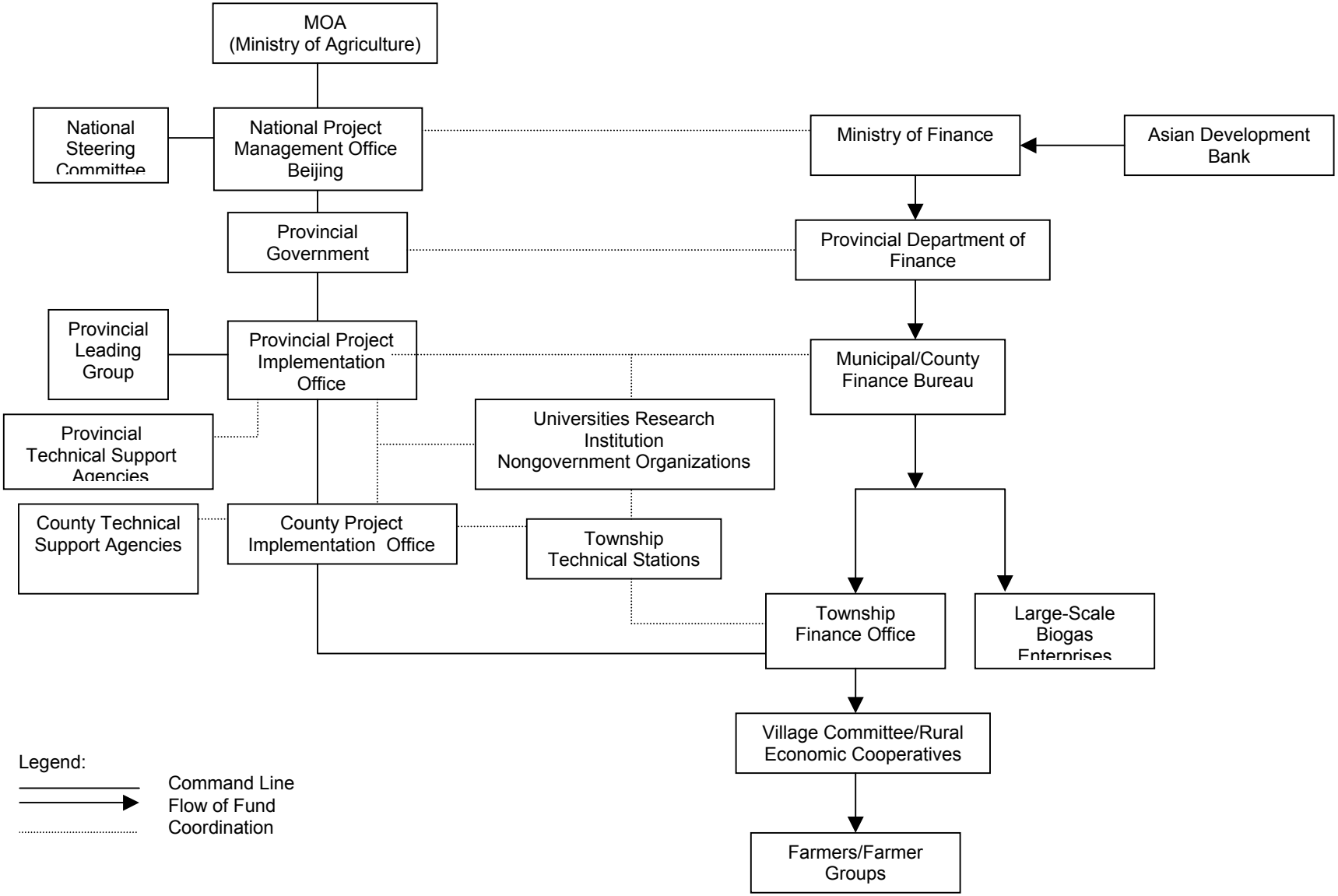

Figure A4.2: Project Funds Flow for
Part A: Fund Renewable Energy Generation and Eco-Environment Development

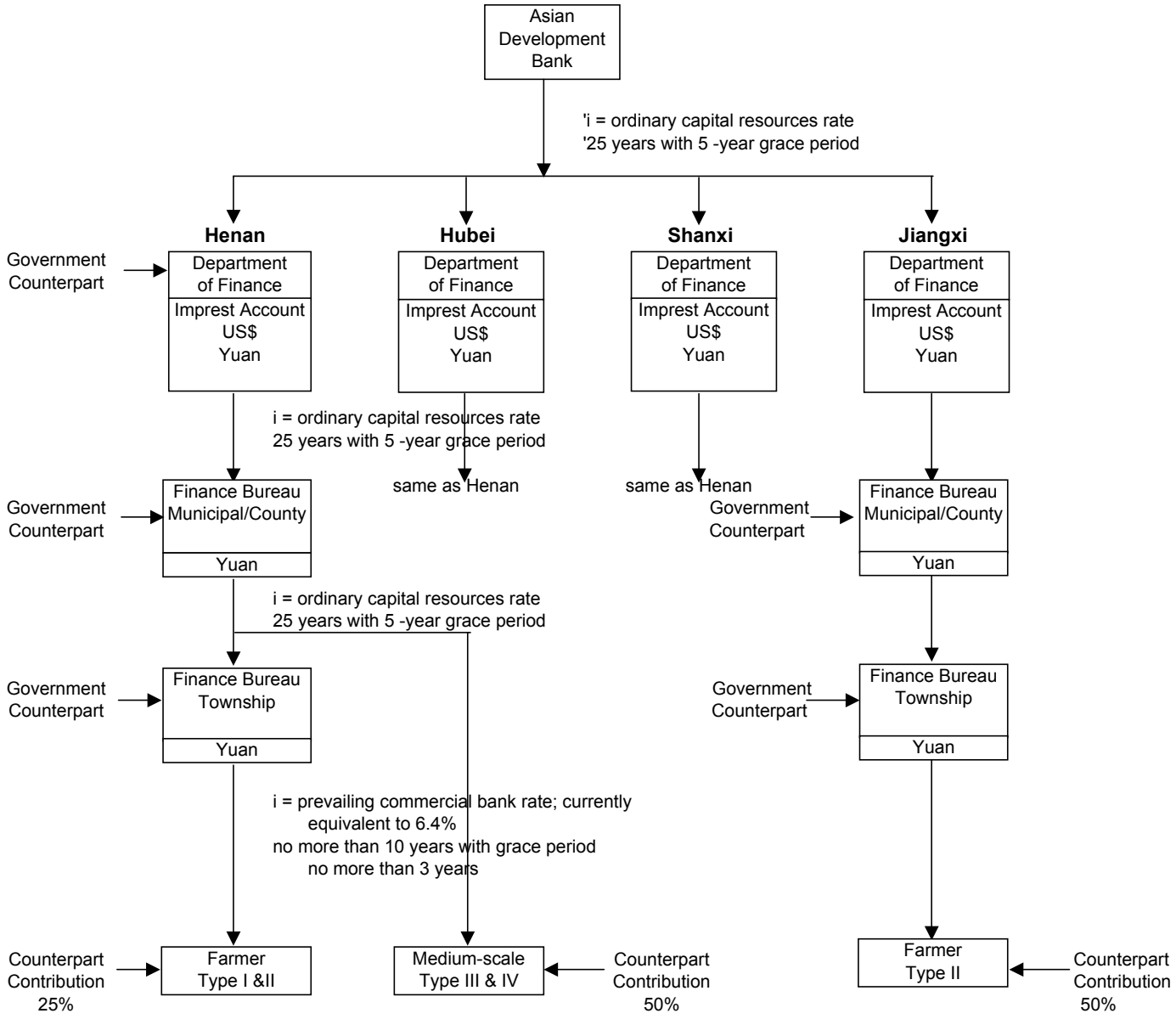

Table A4.1: Vision and Action Plan for Service Industry Build Up

Province	Municipality/ County	Incremental Service Unit to be Establised					Project Activities
		Year 1	Year 2	Year 3	Year 4	Year 5	
Shanxi	Jiaocheng	0	2	4	6	6	1,030 biogas units to be established over the five-year period and provision of training to service providers at the village level.
	Qixing	0	1	4	4	5	
	Linfen	0	1	2	4	4	
	Xiaoden	0	1	2	4	4	
	Linfen	0	1	2	4	4	
	Jinyuan	0	1	2	3	4	
Henan	Mengzhou	1	2	2	3	3	1,599 biogas units to be established over the five-year period and training to service providers and technical personnels will be provided.
	Mengjin	1	2	3	4	4	
	Qixian	0	1	2	3	4	
	Xinzheng	0	1	2	3	3	
	Xiayi	0	1	2	3	4	
	Zhecheng	1	2	2	3	3	
	Wenxian	1	2	2	4	4	
	Huixian	1	2	2	3	4	
	Liangyuan	1	2	2	3	4	
Hubei	Tianmen	0	1	2	2	3	1,068 biogas units to be established over the five-year period and training to service providers and technical personnels will be provided.
	Zaoyang	0	1	2	2	3	
	Chibi	0	1	2	2	3	
	Fangxian	0	1	2	2	3	
	Songzi	0	1	2	2	2	
	Jingshan	0	1	2	2	2	
	Tongcheng	0	1	2	2	2	
	Yunxian	0	1	2	2	2	
	Wuxue	0	1	2	2	2	
	Gong'an/Yunxi	0	1	2	2	2	
Jiangxi	Zhanggong	0	1	1	1	2	
	Xinfeng	0	1	1	1	1	
	Nankang	0	1	1	1	1	
	Xunwu	0	1	1	1	1	
	Jing'an	0	1	1	1	2	
	Hukou	0	1	1	1	2	
	Qianshan	0	1	2	2	2	
	Le'an	0	1	2	2	2	
	Dexing	0	1	1	2	2	
	Fengxin	0	1	1	2	2	
	Yujiang	0	1	1	2	2	
	Chongren	0	1	1	2	2	
Total	**316 units**						

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. Fund Renewable Energy Generation and Eco-Environment Development																				
a. Introduce improved loan processing skills																				
b. Operate investment funds and administer loans																				
2. Improved Mechanisms for Transferring Biomass Technology																				
a. Strengthen skills of biogas and gasification system contractors																				
b. Extension officers and farmers on-site skill transfer training																				
c. Study tours and workshops																				
3. Rehabilitate Farm-to-Market Facilities																				
a. Rehabilitate access roads																				
b. Rehabilitate bridges and drainage crossings																				
4. Improve Environmental Policy Implementation and Awareness																				
a. Develop environmental awareness program																				
b. Prepare publicity and extension materials																				
c. Provide student fellowships on environmental research																				
d. Establish renewable energy, environment monitoring and training Station																				
e. Provide environmental monitoring equipment																				
5. Pilot Poverty Focused Approaches to Biomass Development																				
a. Women's training and participatory workshop																				
b. Selection and provision of basic biogas Facilities																				
c. Special training for poor farmers																				
d. Fellowship for poverty research																				
6. Improve Project Implementation and Capacity Development																				
a. Provide office support																				
b. Recruit consultants																				
c. Establish monitoring and evaluation system																				

Appendix 5

INDICATIVE PROCUREMENT PACKAGES

Package	Units	Amount/ Unit	Loan/GEF Financing Package	Procurement Mode
1. Type 1 Model (Digester/Greenhouse/Pigs/ Vegetables)				
Henan	1,200	2,000	1,000	DP
Shanxi	3,500	3,000	1,500	DP
2. Type 2 Model (Digester/Pigs/Orchard)				
Henan	1,500	3,600	1,800	DP
Hubei	4,400	2,500	1,125	DP
Jiangxi	5,000	2,400	1,200	DP
3. Type 3 Model (Biogas Plant)				
Henan	8	235,784	117,892	LCB/IS
Hubei	2	235,784	117,892	LCB/IS
Shanxi	4	235,784	117,892	LCB/IS
4. Type 4 Model (Biomass Gasification Plant)				
Henan	15	13,814	65,907	DP
Hubei	11	13,814	65,907	DP
Shanxi	2	13,814	65,907	DP
5. Environmental and Training Equipment				
Henan	1	50,000	50,000	DP
Hubei	1	50,000	50,000	DP
Jiangxi	1	50,000	50,000	DP
Shanxi	1	50,000	50,000	DP

DP = direct purchase, GEF = Global Environment Facility, IS = international shipping, LCB = local competitive bidding.
Source: Asian Development Bank estimates.

TERMS OF REFERENCE FOR CONSULTING SERVICES

A. Scope of Work

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 widespread 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; to oversee the implementation of selected activities; to assist in setting up institutional strengthening programs to raise the skills of contractors, farmers, and government service staff; and to 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 BioRETs elsewhere in the People's Republic of China (PRC). The consultants will address the major problems associated with (i) institutional barriers, (ii) technical barriers, (iii) financial barriers, (iv) public awareness and marketing 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 of domestic consultants under the direction of the PIOs in the four provinces. The scope of work are as follows:

(i) Overcoming institutional barriers

(a) Establish sound management support to overcome deficiencies in design, quality assurance, environmental monitoring, and technical supervision.

(b) Establish project management and coordination committees to promote intersector cooperation between different ministries dealing with biogas/ biomass technology and to supervise implementation of the proposed Global Environment Facility (GEF) project and the formulation and implementation of the biogas/ biomass energy program as a whole.

(c) Assist the provincial government in formulating and implementing a biogas energy program and action plan aimed at expanding the development of small- to medium-scale BioRETs in the PRC.

(d) Address ongoing policy and legal framework activities through national level steering committees and close liaison with other ongoing renewable energy programs in order to be part of the strategic partnership agreements now being prepared by various aid agencies in the PRC.

(e) Assist in developing a market approach to expand the implementation of BioRETs nationwide and introduce organic farming and certification of organic foods to increase the incomes of beneficiaries.

(f) Provide institutional strengthening and capacity building activities for the government and the private sector so they are better prepared to expand the biogas renewable energy program elsewhere in the PRC.

(ii) Overcoming technical barriers

(a) Introduce improved technologies to increase the efficiency of biogas systems that have been developed outside the PRC, particularly for type IV gasifiers, in order to further reduce crop residue burning in the fields, thus reducing greenhouse gas emissions.

(b) Provide grants to universities to carry out further research and development programs for advanced biogas/biomass models.

(c) Provide technical training to research and technical officials and private sector service contractors and technicians so that they may understand new developments and problems in the biogas sector.

(d) Develop, install, and train personnel in sound environmental measurement and monitoring programs to provide a sound database to State Environmental Protection Administration (SEPA) in order to quantify the reduction of greenhouse gases in the project areas and assist in developing environmental standards applicable to the renewable energy sector for biogas/biomass development.

(e) Provide extensive training and study tours to farmers, including the poor and disadvantaged group, on all aspect of biogas production and maintenance to ensure sustainability of biogas adoption.

(iii) Overcoming financial barriers

(a) 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.

(b) Assist in establishing 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.

(c) Assist in developing a sustainable and replicable financial model for long term lending that is replicable in other parts of the PRC until the rural financial sector is restructured and is willing to enter into this small but growing biogas market.

(d) Assist in establishing a sustainable and replicable financing model of assisting poor and disadvantaged farmers to adopt biogas production technology.

(iv) Overcoming public awareness and marketing barriers

(a) Prepare and disseminate public awareness material and advise local communities and industry on the latest available technical options, costs, and economic/financial benefits.

(b) Organize public information campaigns, seminars, study tours, media presentations, etc. To share information on advances in and benefits due to biogas/biomass systems, and present lessons learned from other countries.

(c) Assist in developing sound marketing and advertising campaigns, and set up trade fairs and other similar means to expand interest in BioRETs.

(d) Assist in developing an information campaign on the environmental and health benefits associated with BioRETs.

(e) Assist in establishing the above campaigns through institutional strengthening and training of government, the private sector, and farmers.

(v) Overcoming service infrastructure barriers

(a) Assist in devising 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 continued service to farmers using biogas technology.

(b) Assist the project implementation units (PIUs) to concentrate the buildup of biogas digesters in localized areas to ensure the sustainability of the service sector in providing operation and maintenance (O & M) to the farmers.

(c) Determine the parameters (such as economies of scale, pricing, technology improvement, and availability of spare parts) to integrate the service sector into farm production as an integrated farming process to ensure sustainability.

(vi) Overcoming disadvantaged and poor household barriers

(a) Assist in setting 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.

(b) Assist in promoting bottom-up participatory processes to involve 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 environmental project implementation experience; be fully familiar with the environmental requirements of SEPA, GEF, and the Asian Development Bank; and have good knowledge of renewable energy policies of the PRC. He or she will help to develop programs for environmental protection through the development of renewable energy in the four project provinces; assist in developing and providing policy advice to the provincial government;

develop training programs; provide input for the preparation of environmental evaluations, monitoring programs, installation of measurement equipment, and analysis; and assist SEPA and the Ministry of Agriculture (MOA) in formulating renewable energy policies utilizing biomass resources as well as developing 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 the 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 five years of experience in developing and conducting training programs in developing countries, particularly in the areas of project management, energy, and environmental aspects. He or she should have a good knowledge of renewable energy development in the 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 the PRC on biomass system development. He or she will assist in setting up the entire project implementation arrangements including planning, designs, feasibility studies, and quality assurance programs in the four provinces. As deputy team leader, the consultant will develop a quality control program involving routine inspections and liaison between central and provincial authorities.

6. **Financial Management Specialist** (12 person-months). The specialist should have at least five years of experience in setting up financial management systems 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 onlending to subloan borrowers and for debt collection. He or she will review the existing system and 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 recommend appropriate auditing standards to be adopted.

7. **Environmental Specialist** (15 person-months). The consultant should have at least five years of working experience in environment related areas of renewable energy development in the PRC. He or she will help conduct training in environmental protection, collect information to create environmental awareness, set 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 five 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 the 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 of experience in direct credit and finance management and in implementing training for rural credit officers. He or she should have worked in the Agriculture Bank of China or similar rural development banks or cooperatives for at least three years involving 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 that best serves the Project's needs. The specialist will formulate the onlending procedure and debt collection system for medium-scale enterprise borrowers and will 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 five years of working experience in biogas development and be familiar with all technical aspects of biogas digesters and biogas and gasification plant construction. He or she will help the PMO to ensure that all constructions carried out by the project subborrowers meet the required standards and will provide advice 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 five years of working experience in information dissemination, communication, and public campaigns. He or she will help the provincial governments in organizing environmental field days, seminars, training, and public information campaigns to create public awareness about environment protection, etc.

14. **Environmental Awareness Specialist** (18 person-months). The consultant should have at least five years of working experience in environmental protection and be fully familiar with renewable energy and environmental management. He or she will assist in setting up environmental awareness systems and in implementing training programs on environmental awareness. The consultant will help to collect data and information that will create environmental awareness, and will disseminate the information through effective media to the public.

[1] The total number of person-months is 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 semiliterate adults. The consultant will assist the PIUs and PIOs in each province to develop special training materials targeted at semiliterate adult on subjects related to biomass-integrated farming systems. The initial training materials will be pretested 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 the rural energy offices, agriculture departments, poverty alleviation offices, and women's federation as well as gender specialist of the Project.

16. **Gender Specialist** (20 person-months). The consultant will have a graduate degree in gender and development or a related area with extensive working experience in rural PRC. The consultant will assist the PIOs and women's federations in organizing and initiating implementation of all activities in the pilot poverty component. An initial training workshop will be held for PIOs, PIUs, and women's federations to clarify the tasks and responsibilities of each party, in particular the women's federations at each level. The consultant will assist in institutionalizing training programs for women on the operation of biogas digesters, use of liquid affluent from digesters, management of orchards and vegetable gardens, food processing, marketing, household sanitation, environmental protection, and other women's empowerment activities. The consultant will help ensure that the schedule and content of the training courses are designed with special consideration for women's needs, e.g., 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 five years of work experience as an extension specialist and should be familiar with the rural energy policy and biogas development of the PRC. He or she will assist in developing an extension and training program, in collaboration with the training specialist, for 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 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 economies of scale for establishing a biogas service infrastructure by the private sector to provide sustainable operation and maintenance services to the 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 domestic specialists of the PMO and the provincial gender specialist to establish and make operative participatory poverty monitoring system and provide intermittent support 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 an annual report on the poverty impacts of the Project.

SOCIAL AND POVERTY IMPACT ASSESSMENT

A. Methodology

1. A socioeconomic profile of the target beneficiaries and a 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 investment 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 (Table A8.1). Villagers were engaged in focus group meetings with participants from village peoples committees, community leaders, elders, and women's and youth associations to collect broad-based opinions on the Project. In-depth interviews were done to clarify the socioeconomic, poverty, and environmental implications of the Project. Particular attention was given to fostering the participation of villagers, in particular women, in all the field assessment activities.

Table A8.1: Summary of Field Activities Conducted by the Consultants

Province	Meetings	Interviews	Questionnaires	Participatory Assessments
Henan	4	12	—	1
Hubei	21	19	30	5
Jiangxi	3	10	30	2
Shanxi	15	22	90	3
Total	**43**	**63**	**150**	**11**

Source: Project feasibility study reports.

B. 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 Henan (9), Hubei (11), Jiangxi (12), and Shanxi (6). While the rural population in the 38 project counties includes about 17.3 million people, the total population in project villages in the four provinces is estimated at 194,000 in 51,380 households. Table A8.2 shows the estimated population and households in the project villages.

Table A8.1: Estimated Population and Households in the Project Villages

Province	Target Villages	Estimated Population in the Target Villages	Average Household Size	Estimated No. of Households	Total Beneficiaries Households
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
Shanxi	49	54,300	3.8	14,290	5,180
Total	**145**	**194,000**		**55,405**	**34,080**

Source: Project feasibility study reports.

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. The key factor in higher incomes appears to be nonfarm 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 the villages in the 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 toilets. The consequences are poor water quality and ultimately poor health. Main sources of household energy are fuelwood, straw, and low-grade coal which, when use for cooking and heating, have strong potential to cause respiratory and eye 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 the resource base along with their high dependency on fuelwood for energy, are the main factors in the ongoing environmental degradation. The majority of the poor are concentrated in resource-deficient areas, mostly in the upland sections of the provinces.

C. Pilot Poverty-Focused Component

6. To target meaningful levels of assistance to poor and disadvantaged households, included in the design of the Project is a pilot poverty component to enhance their participation in biomass technologies. As poor farmers may have the necessary labor, land, and resources but lack the necessary skills and assets normally required to benefit from project activities and investments, this project component will directly help remove those barriers. The women's association in each village will implement the pilot poverty component. The poor will be informed about the project activities and the general eligibility criteria[1] to join them. Activities in the pilot poverty component are discussed in paras. 7-9.

7. **Training for Low-Skilled Households.** Special training materials targeted at illiterate or low-skilled adults will be developed in a participatory manner under the Project. Training will be conducted using adult learning methods 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 absorbtive capacity. For necessary follow-up activities, project extension staff will arrange for a better-off household to pair up with each poor household on a one-on-one basis to help the poor households 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 in the village. Study tours will be organized for poor households to visit demonstration households outside of their villages or counties. Arrangements will be

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

made to release members of the poor households to participate in the study tour. Training courses directed at women will include not only the operation of biogas digesters and their associated farming systems, but also other topics including food processing, household sanitation, safe use of water, and management of income and expenditures. The schedule and content of the training courses will be designed with special consideration for women's needs, e.g., shorter hours, closer to the house, and baby-sitters available during training hours.

9. **Biosystem adoption facilities.** To assist poor households, which lack capital, trained poor farmers who meet the basic requirements will be provided with an initial biomass system that include biogas digester, pigpen, and other basic fixtures. The basic requirements for receiving project assistance among the poor households will include (i) household with appropriate land and at least two adults available full-time and (ii) household with no record of crime and with good reputation for helping others. A 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 learned through implementing this pilot poverty component will be systematically documented to expand these experiences to the wider development community.

D. Poverty Impacts

1. 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 agricultural wastes will be more efficiently used for production of low-cost, cleaner energy and improved agricultural production. During the project period, 34,080 households[2] (136,320 people) will benefit directly from the project intervention: 15,600 households with small-scale biogas-farming systems, and 18,480 households with access to clean energy from biogas enterprises. About 9,000 beneficiary households will be from poor households below the poverty line. This is depicted in Table A8.3.

Table A8.3: Beneficiaries by Type of System

Type of System	Enterprises	Beneficiary Household	
		Total	Households with Income BelowY1,000/capita/yr
Type I	4,700	4,700	1,410
Type II	10,900	10,920	3,270
Type III	14[a]	1,680	420
Type IV	28[b]	16,800	3,900
Total		**34,080**	**9,000**

[a] Each Type III enterprise provides biogas to 120 households.
[b] Each Type IV enterprise provides biogas to 600 households.

Sources: Asian Development Bank estimates.

[2] This includes 4,700 households of type I, 10,900 households of type II, 1,680 households to be serviced by 14 medium-scale biogas plants (type III), and 16,800 households to be serviced by 28 gasification plants (type IV).

11. In terms of income benefits, the average incremental household income for Type I will be Y4,013 ($483), an increase of about 36 percent from traditional farming systems. For Type II, 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 (t) of vegetables, 312 t of grain, 209,200 t of citrus, and 289,780 pigs. An area of 8,066 hectares of degraded mountainous land will be reforested with fruit trees. A number of upstream and downstream economic activities associated with the biogas farming system, e.g., pig feed production, vegetable processing and servicing of biogas digesters will also be promoted. The construction of type I and type II 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 III, 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 IV, it is estimated that financial benefits of over Y1.0 million per year will be realized for the whole Project. These benefits will be derived from the 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 gasification plants.

2. Non-Quantifiable Impacts

13. Apart from income and employment impacts, other indirect benefits generated by the Project will include, for example, lower food prices, better food availability, better quality of food (organically grown vegetables), time savings in cooking, cleaner air, cleaner soil and water, and better public sanitation practices. Excessive use of agrochemicals in current farming practices and its health implications for farmers and consumers, which are of general concern 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 nonpoor 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 better-off household.

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

15. Identification of the 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 infrastructure will serve poor and disadvantaged households. At the same time, the poor can also have a significant role in constructing and maintaining infrastructure. The participatory process will also foster community ownership and transparency in implementing project activities.

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 type III system) and producer gas (for type IV system) 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 Biomass 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 mu[1] or about 333 square meters [m^3]) 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 that 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 the type Ia biogas subsystem. 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 the "without" Project situation). This is presented as the Type Ib biogas subsystem 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 pigs to supply the manure requirements of its biogas digester. Type III biogas farming systems are large pig farms that are operated by farming communities or groups of individuals, consisting of breeding and fattening stock with an annual throughput of 10,000-15,000 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 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 A9.1.

[1] 1 ha = 15 mu..

Table A9.1: Biogas System Investments by Province

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

Source: Project feasibility study reports.

4. Incremental costs incurred by the biogas systems include incremental investment costs, working capital requirements, and operating costs incurred during their operation. 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 m^3), are expected to invest on type I biogas systems. In the provinces of Shanxi and Henan, a total of 18,800 mu (1,253 hectares [ha]) will be cultivated under all type I biogas systems comprising 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 sheep and goats. Incremental production generated by type I biogas systems is based on production estimates under two type I subsystems: (i) type Ia subsystem, which compares full technology adoption vs traditional technology; and (ii) type Ib subsystem, which compares full technology adoption vs improved technology. The estimated incremental vegetable area under each subsystem is about 0.5 and 0.25 mu, respectively, or a total incremental vegetable area of about 1,175 mu for type Ia biogas subsystem and 587.5 mu for type Ib biogas subsystem. The annual incremental vegetable production will be of 0.6 tons (t) and 0.3 t for type Ia biogas subsystem and type Ib biogas subsystem, respectively; the corresponding total annual incremental vegetable production for type Ia biogas subsystem and type Ib biogas subsystem is about 705 t and 177 t, respectively, or a total annual incremental vegetable production for all type I biogas systems of 882 t (Table A9.2). Total annual incremental grain production is about 312 t while annual incremental pig production is about 105,750 head or about 10,575 t of pork (at 100 kg/head). All type I biogas systems will generate a total annual incremental production of about 2.8 million cubic meters (m^3) of biogas, 183,558 t of digested effluent, and 44,310 t of sludge.

6. About 10,900 farm households, each comprising about 15 mu (about 1 ha) for citrus orchard production, will invest in type II biogas systems, mainly in the provinces of Henan, Hubei, and Jiangxi. Under the “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 the “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 1 ha orchard area (about 34.3 kg/tree) compared with the same type of system under the “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 the “with Project” situation is about 261,600 t compared with about 52,320 t under the “without Project” situation or an annual incremental citrus production of 209,280 t. Total annual pig production will increase from 21,800 head to 109,000 head or an incremental production of 87,200 head or about 8,720 t of pork. The

type II systems will generate an incremental production of about 6.5 million m^3 of biogas, 138,213 t of digested effluent, and 33,365 t of sludge.

Table A9.2: 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	2,543	6,240	261,600	39,828	41,246	520,455	125,497
Annual Production "Without Project"							
Type Ia	367	2,964	0	188			
Type Ib	1,293	2,964	0	3,713			
Type II	0	0	52,320	2,180			
Type III	0	0	0	4,769			
Type IV	0	0	0	0			
Total	1,660	5,928	52,320	10,850			
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
Total	882	312	209,280	28,978	41,246	520,455	125,497

Source: Asian Development Bank estimates.

7. About 14 type III biogas systems will be established. A typical type III system will produce about 87,600 m^3 of biogas annually, which will be distributed among consumer households. An annual incremental biogas production of about 1.2 million m^3 will be produced by type III biogas systems. Under the “with Project” situation, these systems will produce a total of 144,520 pigs compared with about 47,690 under the “without Project” situation or an incremental pig production of 96,830. The type III biogas systems will produce an increment of about 198,684 t and 47,822 t of digested effluent and sludge, respectively. Total incremental volume of digested effluent and sludge produced will be about 246,506 t (Table A9.2).

8. About 28 gasification systems (type IV systems) will be established. One gasification system (Type IV system) will produce about 1.1 million m^3 of producer gas. Each gasification system will be newly constructed. The annual incremental production of producer gas is estimated at about 30.7 million m^3 (Table A9.2).

9. The total projected incremental production of crops and livestock accruing to the Project is less than 1 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.

10. A summary of the typical farm budgets of each type Ia, Ib, and II biogas system, under the “with” and “without” Project situations, is presented in Table A9.3.

Table A9.3: Typical Farm Budgets
(in yuan)

Item	Type Ia [a]	Type Ib [b]	Type II
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 [c]	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**

[a] This refers to comparison of type I biogas system with full adoption of technology with a traditional production system that has no greenhouse and digester.
[b] This refers to comparison of type I biogas system with full adoption of technology with a traditional production system that has a greenhouse but no digester.
[c] Tax assumed at 20 percent.
Source: Asian Development Bank estimates.

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 in the various types of biogas systems. Total investment in 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 the beneficiaries, 25 percent from the government, and 50 percent from a 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 in 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 in 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 be derived mainly from pig production and will not be sufficient to cover interest charges and repayments on principal loan. An adequate cash flow will be realized in Year 5, when the citrus trees start bearing fruits.

[2] As the investment costs in Shanxi province and Henan province are Y24,900 ($3,000) and Y16,600 ($2,500), respectively, an average investment cost of Y20,750 ($2,500) was used in analyzing the financial viability of the type I biogas system.
[3] As the investment costs in Henan province, Hubei province, and Jiangxi province are Y29,800 ($3,600), Y19,920 ($2,400), and Y18,675 ($2,250), 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.

13. In the analysis, loans for type III systems are assumed to have a maturity period of eight 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 A9.4.

Table A9.4: 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 provinces, respectively.
[b] Including a three-year grace period from Year 0.
[c] Average of estimated unit cost of $3,600, $2,250, and $2,400 for Henan, Hubei, and Jiangxi provinces, respectively.
[d] Including a five-year grace period from Year 0.
Source: Asian Development Bank estimates.

14. All loans will be charged at the prevailing commercial bank 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 systems will require construction of additional pigpens and the construction of a biogas plant and distribution facilities. Type IV systems will require the construction of a gasification plant and distribution facilities. The financial analysis used 2001 prices and was carried out covering a period of 15 years for type I biogas systems 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) Henan, $11.7 million; (ii) Hubei, $11.8 million; (iii) Jiangxi, $12.0 million; and (iv) Shanxi, $11.7 million. The summary of total investment by type and province is presented in Table A9.5 below.

Table A9.5: Summary of Investment Costs by Type of Technology [a]
($'000)

Province	Type I	Type II	Type III	Type IV	Total by Province
Henan	2,400.0	5,400.0	1,886.3	1,977.2	11,663.5
Hubei	-	9,900.0	471.6	1,450.0	11,821.6
Jiangxi	-	12,000.0	-	-	12,000.0
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 Asian Development Bank (50%), Government (25%), and beneficiary contribution (25%).
Source: Asian Development Bank estimates.

16. **Revenue.** For both "with" and "without" Project situations, farm revenues from crops, 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 A9.6.

Table A9.6: Summary of Commodity Prices

Commodity Price/ Cost Savings	Unit	Financial Price (yuan)	Standard Conversion Factor (yuan)	Economic Price (yuan)
Producer Biogas	m^3	1.20	0.9	1.08
Digested Effluent	t	10.00	0.9	9.00
Sludge	t	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 Onion	kg	0.40	0.9	0.36
Cucumber	kg	2.20	0.9	1.98
Melon	kg	1.80	0.9	1.62

Source: Asian Development Bank estimates.

17. **Annual Operating Cost**. Operating cost items, for both the "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.

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18. **Gross Margin/Net Profit from Operations**. Estimates of gross margin/net profit from operations for each biogas system, under the "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 the "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 types Ia, Ib, and II systems, positive cash flows are envisaged to be realized in the first year of 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 in the third year of operation and will be able to cover repayments on the loan starting in Year 3. Type IV systems will realize positive cash balances in Year 3 but will be able to sufficiently cover loan repayments and interest charges only starting in Year 5. Details of the 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 that 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 systems exhibiting the lowest and type III systems, which incur relatively higher operating costs, exhibiting the highest values (see Table A9.7). All systems exhibited high income ratios that

Table A9.7: Financial Ratios by Type of Biogas System

	Year										
Item	**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 consist 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).
Source: Asian Development Bank estimates.

are generally higher than the weighted average cost of capital (nominal value of 4.3 percent). The systems will be 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 are greater than one.

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 weighted average cost of capital, which is estimated at 4.3 percent. Moreover, sensitivity analysis indicates 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 exhibits 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 exhibits 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 A9.8.

Table A9.8: FIRR and Sensitivity Analysis – by Type of Biogas System

		FIRR									
		Type Ia		Type Ib		Type II		Type III		Type IV	
Change in Variable	Percent Change	Base 15.9%	SI	Base 16.7%	SI	Base 16.6%	SI	Base 15.9%	SI	Base 13.8%	SI
1. Decrease in revenue	10%	11	3.1	10.6	3.63	13.5	1.92	7.7	4.97	5.3	6.15
2. Increase in production cost	10%	13.1	1.75	12.8	2.33	15.7	0.58	8.4	4.48	7	4.96
3. Decrease in revenue and increase in cost	10%	8	4.98	6.4	6.15	12.7	2.37	5.5	6.54	5.1	6.3
4. Delay of one year in benefits whole Project		15.5		16.3		16.4		15.7		13.6	
5. Exchange rate change	30%	13.5	0.51	14.3	0.48	15.3	0.26	13.9	0.42	12.4	0.35

FIRR = financial rate of return, SI = sensitivity indicator.
Source: Asian Development Bank estimates.

23. The switching values technique confirms the results of the sensitivity analysis (Table A9.9). The summary of the results shows that the small-scale biogas systems (i.e., types I and II) 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 A9.9: Switching Values Technique[a] – by Type of Biogas System
(percent)

Change in Variable	Type Ia Base FIRR 15.9%	Type Ib Base FIRR 16.7%	Type II Base FIRR 16.6%	Type III Base FIRR 15.9%	Type IV Base FIRR 13.8%
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.
Source: Asian Development Bank estimates.

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 FIRR, for the Project as a whole is about 15 percent (see Table A9.10).

Table A9.10: Financial Internal Rate of Return for Project Investment

Year	Net Benefits from Type I Investments	Net Benefits from Type II Investments	Net Benefits from Type III Investments	Net Benefits from Type IV Investments	Net Benefits from All Investments
	(Y million)	(Y million)	(Y million)	(Y million)	(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

FIRR = financial internal rate of return.
Source: Asian Development Bank estimates.

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 Asian Development Bank'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. 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/m^3 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, respectively.[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 savings in fuel, reduction in cooking time, and 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 a 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 (CO_2) 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 reduction in CO_2 emissions. This, subsequently, will have positive effects on the environment. The use of biogas results in reduced CO_2 emissions of about (i) 4.6 t per household under type I biogas systems, (ii) 4.2 t per household under type II, (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 CO_2 emission is envisaged to be reduced by 36-92 percent or about 75 percent per year. The Intergovernmental Panel on Climate Change has calculated the damage cost of CO_2 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 EIRR.

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

3. Economic Internal Rate of Return

33. The resulting economic net present value shows 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 A9.11.

4. Sensitivity Analysis and Switching Values Technique

34. 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, exhibit values close to one. A delay in Project benefits by one year as well as a devaluation in the yuan by 30 percent likewise indicate insignificant effects on the base EIRR. The results of the sensitivity analysis are presented in Table A9.12.

Table A9.11: Economic Internal Rate of Return – Whole Project
(in million yuan)

Year	Incremental Investment	Net Benefits from Biogas Investments	Savings in Fuel Expense	Savings in Medical Expense	Savings in Cooking Time	Net Incremental Benefits			
	(1)	(2)	(3)	(4)	(5)	(2)-(1)	(2+3)-(1)	(2+3+4)-(1)	(2+3+4+5)-(1)
2002	82.808	(28.048)	1.252	0.075	1.343	(110.856)	(109.604)	(109.529)	(108.186)
2003	116.575	(49.068)	3.402	0.248	4.468	(165.643)	(162.241)	(161.993)	(157.525)
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	(202.880)	(191.750)	(191.000)	(177.480)
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)	11.704	12.872	33.925
2009		(34.034)	20.621	1.437	25.900	(34.034)	(13.413)	(11.976)	13.924
2010		(11.672)	24.402	1.670	30.105	(11.672)	12.730	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	212.613
2013		165.840	29.945	2.088	37.639	165.840	195.785	197.873	235.512
2014		155.711	33.893	2.357	42.486	155.711	189.604	191.961	234.447
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	353.664	403.421
2017		387.322	41.067	2.835	51.100	387.322	428.389	431.224	482.324
2018		404.958	43.217	3.008	54.224	404.958	448.175	451.183	505.407
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	607.160	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	699.807	703.736	774.546
2024		632.429	60.437	4.197	75.657	632.429	692.866	697.063	772.720
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	852.751	857.352	940.280
EIRR=						14.2%	15.9%	16.0%	18.2%
NPV@12%=						192.986	348.490	359.250	553.190

NPV = net present value.
Source: Asian Development Bank estimates.

Table A9.12: EIRR Sensitivity Analysis – Whole Project

Change in Variable	Percent Change	Base EIRR[a] 18.2% Recalculated EIRR	EIRR Sensitivity Indicator
1. Decrease in revenue	10%	15.9	1.27
2. Increase in production cost	10%	16.2	1.10
3. Decrease in revenue and increase in 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

EIRR = economic internal rate of return.
[a] EIRR calculation is based on benefits derived from investments in biogas systems and environmental economic benefits.
Source: Asian Development Bank estimates.

35. The switching values technique confirms the results of the sensitivity analysis (Table A9.13). 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 A9.13: Switching Values Calculation

Change in Variable	Base EIRR[a] 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 and increase in cost		11.6

EIRR = economic internal rate of return.
[a] EIRR calculation is based on benefits derived from investments in biogas systems and environmental economic benefits.
Source: Asian Development Bank estimates.