PROPOSAL FOR REVIEW

GLOBAL ENVIRONMENT FACILITY

Project Title:	**CHINA: CAPACITY BUILDING FOR THE RAPID COMMERCIALIZATION OF RENEWABLE ENERGY**
GEF Focal Area:	Climate Change
Country:	China
Country Eligibility:	Date of Ratification of FCCC: 5 January 1993 Eligible under financial mechanism of UN-FCCC
Total Project Cost:	US $ 27.652 million
GEF Funding:	US $ 8.827 million GEF Grand Total US$ (-) 25,000 PDF A US $ 8.802 million GEF Project Budget
Chinese Government Co-Financing: Other Chinese Co-Financing UNDP Co-Financing:	US $ 4.12 million US$ 4.8 million US $ 0.5 million
Parallel Financing: Other Parallel Financing	US DoE US $875,000 US $ 8,555,000 Requested from other donors and sources
GEF Implementing Agency:	United Nations Development Programme
Executing Agency:	UN Execution
Local Implementing Agency:	State Economic and Trade Commission (SETC) and the National Environment Protection Agency (NEPA
Estimated Starting Date:	July 1997
Project Duration:	4 years
Government Approval Date:	November 1996
GEF Preparation Costs:	PDF A US$25,000
Other Preparation Costs:	Norwegian Ministry of Foreign Affairs US $100,000

A major policy initiative for the development of alternatives to expanded coal burning in China was the GEF/UNDP/World Bank study entitled "Issues and Options for Greenhouse Gas Emissions Control in China". This study has led to the identification of both priority energy efficiency projects and needs for further work on renewable energy development. As a follow-up to this study, the World Bank initiated, in July 1995, a one-year study on renewable energy assessment in China, in cooperation with relevant Chinese ministries and agencies. The China renewable energy study had two components:

Renewable technology applications for power generation: This component identified the most promising renewable energy applications for on-grid and off-grid electricity generation.

- Renewable technologies application for supplying heat: This component examined the possibility of thermal applications for renewable energy to replace coal.

Carried out by the State Economic and Trade Commission (SETC) and the World Bank, this TA project has identified priorities for power and heat-related renewable energy development in China. The study includes: (a) assessments of the economic and financial viability of renewable energy for the two sectors, (b) a review of institutional and policy issues affecting their development; and (c) an outline of priorities for investment and technical assistance.

This present technical assistance proposal draws on the recommendations put forth in the World Bank study on power-related renewable energy development in China and will closely complement the World Bank's follow-up investments in renewable energy in China. The SETC will be the lead Government agency for both the technical assistance and the investment initiatives undertaken under this programme. Both this UNDP/GEF technical assistance project and the complementary World Bank investment project, as well as bilateral assistance, will be required to fully address barriers and cost issues under GEF Operational Programme #6 "Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs" and GEF Operational Programme #7 "Reducing the Long-term Costs of Low Greenhouse Gas Emitting Technologies".

1.4 Barriers to the Greater Use of New and Renewable Energy in China

Despite their environmental and social benefits, renewable energy sources in China remain on the margins of the energy sector. While national wind resource potential exceeds 250,000 megawatts (MW), China had only 14 grid-connected windfarm sites with a total installed capacity of 30 MW in 1993. At the same time, there was no more than 3 MW of solar photovoltaic systems in use, 30 MW of installed geothermal generating capacity and 7 MW of biomass-fueled systems in the country (see Table 2). Tremendous efforts will be required to initiate large-scale renewable energy activities.

The rapid deployment of renewable energy in China faces more than its share of implementation barriers. In fact, given the complex nature of China's mixed economy, the intended deployment of renewable energy is doubly challenging: the normal barriers faced in the deployment of renewable energy are complicated by the economic transition from centrally-planned to market solutions.

Under central planning, the Chinese approach to any form of technology development has been to create manufacturing and technological infrastructure as a prelude to the "popularization" of a given technology. This approach was used in the development of small hydro, which was developed through a

combination of developing technology packages, staffing local offices to provide small hydro support, and providing state credits to participating communities. Neither the Chinese Government nor local governments have the resources to further support this approach to technology deployment.

The approach to technology deployment which is consistent with the current socialist market-oriented economy would make use of similar activities, but in the reverse order: the first step would be the creation of demand for the technologies and the services they provide--the second step would be the enhancement of supplies to meet that demand. The successful experiences of every other country in the world has shown that once the demand for a technology is created, meeting that demand through indigenized production is a relatively natural second step. This approach has been used to accelerate the adoption of renewable energy in a number of developed and developing economies. Financial incentives and government-assisted investment programmes have been used to "kick-start" markets in most of the leading countries in renewable energy deployment, including the United States, the United Kingdom, Denmark, Germany, India and the Netherlands. A similar approach could also prove sucessful in China should the national market for renewable energy be strengthened.

Studies and demonstration projects have shown that the current limited strength of China's market for renewable energy is attributable to several barriers which will have to be overcome if the use of renewable energy is to become technically, fiscally, and economically sustainable. Some of the most important of these barriers are listed below:

- Limited capacity to disseminate renewable energy Through Market Mechanisms: Although a number of policies which have played a significant role in opening markets in other countries to renewable energy are being reviewed for possible adoption by China, there is still a limited capacity for market-based dissemination of renewable energy in China. This limitation is seen both in the lack of a market orientation by renewable energy research institutions and in the limited familiarity with renewable energy technologies found among entrepreneurs, commercial institutions and investors.

  Institutional fragmentation: In addition to three Government Commissions responsible for overseeing renewable energy, there are many government agencies at different levels as well as several research institutions and manufacturing organizations in China working on the development of renewable energy projects. In the absence of a single institution to facilitate information exchange and promote common policies and methodologies, renewable energy activities are often implemented in a fragmented manner.

  Lack of business skills: Few professionals familiar with the state of the art in several renewable energy technologies have any more than a passing familiarity with market finance, commercial enterprise operation, and economic project appraisal. Those with the technical skills have little understanding about how to use those technical skills in a private sector setting. In part, this is due to the rapid technological developments in these fields, and in part to the heritage of the centrally-planned economy.

- Incomplete assessment of renewable resources: The current understanding of the quantity and distribution of renewable resources and the data collecting system for renewable resources assessment is largely inadequate, particularly for data on wind regimes and solar insolation levels in much of the country. This limited information poses a serious constraint to policy formulation and investment

promotion. Where data do exist, they are often gathered by meteorological offices on an infrequent basis at locations not necessarily suitable for wind or solar applications. However, siting wind or solar facilities requires the availability of continuous data over several years in order to minimize the risk of resource inavailability;

Lack of facilities for testing and certifying equipment; In many countries including China, early enthusiasts who installed renewable energy facilities found that the equipment did not live up to expectations. The manufacturers of such equipment were usually small companies that were not making use of the experience that had been gathered worldwide. As a result, there has been some public skepticism about the viability of renewable energy systems. The low quality of the renewable energy equipment and the resulting lack of consumer confidence in it has been shown to be an important barrier to the adoption of renewable energy technologies in China;

High cost of renewable energy systems: Although they have generally low recurring costs, most renewable energy systems have a high up-front cost. While some renewable energy sources can provide energy at a cost which is competitive with conventional energy sources, others are still not competitive. In part, this is due to the limited scope of renewable energy market activities in China with the resulting absence of economies of scale in either production or distribution;

Lack of suitable funding mechanisms: Individual households and small communities in remote locations, who are most likely to benefit from the short-term gains of renewable energy, are frequently unable to pay the up-front costs for such projects. A variety of funding mechanisms need to be tested to determine which would be most appropriate under differing circumstances.

The provision of renewable energy on a large-scale will require a reduction in implementation costs, achieved through technological advancement, efficiency gains, low-cost equipment manufacturing and the capturing of scale economies. Financing requirements and efficiency concerns dictate that development should be undertaken through the market. Concerted action will also be necessary to develop market infrastructure, improve information access, improve commercial capabilities in the renewable energy field, and put in place efficient market-based incentives, where appropriate. The scale of development needed to make a meaningful contribution to the global environmental agenda will require time. But ambitious efforts are required now to deepen and accelerate the renewable energy market development process. Given the nature of the challenge, there is no time to wait for events to take care of themselves.

2. Project Strategy

This project represents an initial foray by the GEF into the field of renewable energy market development for China. Its goal is to initiate activities which will result in the removal of some of the above-mentioned barriers to renewable energy deployment. It seeks to assist in creating a process wherein the above barriers are removed and to build capacity for the market-based deployment of renewable energy. It aims to create a virtuous cycle for renewable energy development through which an increased demand will lead to an increased supply, a reduction in production costs and, consequently, a sustained increased demand. The project will build capacity to promote renewable energy by operationalizing the recent policy recommendations for renewable energy; strengthening a national institution to serve a clearinghouse function for the development of renewable energy; training and facilitating information exchange on renewable energy development; strengthening the national renewable resource base; and facilitating the creation of standards and codes of conduct for renewable energy technologies.

As a complement to these national-level capacity development activities for rapid commercialisation of renewable energy, the project will begin the process of removing barriers to the dissemination of four promising renewable energy: namely (i) rural electrification by solar and wind hybrids; (ii) wind farm development; (iii) biogas production; and (iv) bagasse cogeneration. The selection of technologies has been made in consultation with the Chinese authorities and collaboration with the World Bank on the basis of recently undertaken assessments of market conditions and potential for future GHG reductions.

Three of the four technologies selected represent renewable power applications for on-grid generation of power. This emphasis reflects the better understanding from the experience of other countries of the market and policy conditions necessary for a rapid commercialisation of these applications. They also pose the most significant potential reductions in GHG emissions. However, the fourth technology-- solar and wind hybrids-- represents a relatively new undertaking into the provision of electricity services to people living in areas where the electricity grid is not accessible. While a number of barriers remain in the widespread expansion of this technology to rural China, it has considerable promise to meet the electricity needs at small and medium rural load conditions with little or no GHG emissions.

Because China is the largest country in the world, the scale of assistance required to move toward full commercialization of renewable energy is immense. This magnitude has two implications. First, this project proposed for funding by GEF through UNDP will be used to catalyze as much additional donor support for renewable energy activities in China as is possible. Even so, there will remain a great deal of work to be done in this country and in this sector. Second, it would be unrealistic to expect one small technical assistance project to be able to remove all of the binding constraints to renewable energy commercialization in China. Some barriers will remain, and others will become apparent as these recognized barriers are removed. There will be a need for further investment and technical assistance if all of the barriers to renewable energy deployment through the market mechanism are to be removed. Therefore, rather than viewing this project as the final piece of technical assistance for renewable energy in China, it would be both more constructive and more realistic to view it as an important first step for the international community to help China down the road to sustainable development through the deployment of renewable energy.

3. Project Objectives

3.1 Global Environmental and Development Objectives

The global environmental objective of the project is to reduce CO_2 emissions by beginning the process of replacing fossil fuels with the use of renewable energy sources. The development objective is to promote the widespread adoption of renewable energy sources in China by removing the barriers to increased market penetration. Initial estimates anticipate a potential of up to 10 million tons of CO_2 emissions avoided per year. This figure, however, depends upon the success of the project in stimulating further replication of the technologies.

3.2 Objectives

In order to realize the global environmental and development objectives, the two following objectives must be achieved:

1. To develop the national capacity for the rapid commercialization of renewable energy in China by: (i) developing an overall market-based policy framework for renewable energy deployment; (ii) training a core group of key policy decision-makers and sector professionals; (iii) strengthening the center for renewable energy development; (iv) assessing renewable energy resource potential for follow-up investments; and (v) establishing standard specifications and codes of practices for the most promising renewable energy technologies.

2. To begin removing barriers to the widespread dissemination of promising alternative energy technologies: namely (i) rural electrification by solar and wind hybrids; (ii) wind farm development; (iii) biogas production; and (iv) bagasse cogeneration.

4. Project Description

4.1 Objective 1: To develop national capacity for the rapid commercialization of renewable energy systems in China.

The activities included under this objective are expected to overcome barriers to the market-based expansion of renewable energy in China. These elements are intended to strengthen the ability of the Chinese Government to implement identified policies, to strengthen the national institution charged with facilitating renewable energy development, to build up a body of skilled professionals, to develop a system of national standards to increase the quality of locally-produced renewable energy technologies; and to improve the information base necessary for renewable energy investments. These activities focus on the removal of barriers which are endemic to all renewable energy interventions, as opposed to those activities under Objective 2, which are specific to a particular technology. A detailed description of each of these activities is given in Annex I.

Activity 1.1: Operationalizing market-oriented renewable energy dissemination.

In recent years, a number of innovative technical assistance activities have been undertaken recently in the renewable energy sector in China. Currently, the assistance of UNDP is requested to see that these activities get operationalized with a minimal delay. UNDP's initiative will review all recent recommendations and organize a serious of information and training workshops to provide a forum in which these proposed policies can be reviewed by a wider audience. The activities to be considered in this activity are the factors determining the market penetration of renewables, impacts and determinants of foreign investment in China, the formulation of *pro forma* power purchase agreements for renewable energy supplies, and the information needs to make the policies a reality. Care will be taken to coordinate closely with initiatives sponsored by the World Bank, the Asian Development Bank, other donor agencies and relevant Chinese initiatives.

Activity 1.2 : Strengthen an existing institution to serve as a major renewable energy center

The center's role is envisioned not as a research institution but rather as a clearinghouse for renewable energy information, technologies, developing training and facilitation programs of different types. The proposed center is not meant to centralize all work related to renewable energy, but rather facilitate the work of existing institutions in this field and draw on their expertise to address the challenges China faces in accelerating the use of renewable energy. It will also serve as a broker for information for individuals, organizations, and companies both inside and outside of China.

Activity 1.3: Train policy makers, renewable energy professionals and businessmen in market-based renewable energy development.

The success of China's renewable energy program will be determined to a large extent by the availability of an adequate number of well trained professionals familiar with the development of market-based renewable energy options. This will be achieved by a variety of means, including longer courses, study tours, seminars, and workshops bringing in foreign experts, entrepreneurs, consultants, and potential joint venture partners to explain how renewable energy businesses have worked in other countries.

Activity 1.4: Development of National Capacity to Assess Renewable Energy Resource Potential in China.

Accurate and reliable resource data and information are necessary to develop long term strategies and to implement successful renewable energy projects. However, the current data collection system for China relies almost exclusively on existing weather stations. The locations of most of these stations and the type of measurement systems used in these stations is inadequate for assessing the resources at the best wind and solar regimes in China. Investments cannot procede ahead without a better assessment of wind speeds and solar resources. This project will build capacity in techniques for assessing the geographic and temporal distribution of resources in the absence of adequate ground-based data currently being collected in China, and for validating the resource at candidate sites where renewable energy applications appear feasible. Information collected on renewable energy resources will be incorporated into a Geographic Information System database, which can also be used to display other relevant information, such as the location of transmission and distribution lines, existing generating facilities, roads, land use, and population centers, to assist in the site selectiodn and evaluation process.

Activity 1.5 : Development of standards, codes of practice and certification procedures for the renewable energy industry.

As part of this activity, standards will be developed for the various renewable energy technologies, using both international practices and local experience. These standards and codes of practice will be developed on the basis of a participatory process incorporating inputs from national, regional and local industry associations. These will be designed to ensure reliable renewable energy system operation in accordance with high quality design criteria and will be utilized to lead to the overall improvement in the quality of the renewable energy equipment available in the Chinese market. Procedures will be developed to certify the

quality of manufactured products as a positive incentive for both producers and a positive signal for consumers. The Government will select appropriate institutions to serve as certification centers. Product testing will be undertaken at existing qualified test facilities for which retrofitting or upgrading of facilities will be required, and additional resources will be required for the certification laboratories. The installation and performance of renewable energy technology systems will be certified based on field testing when appropriate.

4.2 Objective 2: To remove barriers specific to four promising renewable energy technologies.

Earlier studies have examined the economic and financial viability of various renewable energy technologies as well as their investment potential. However, before moving to large-scale implementation of the investment projects, several technology-specific barriers to the widespread adoption of these projects through market channels needs to be addressed. Four promising technologies are selected for inclusion in this project, and the nature of the activities to achieve the objective are described below. In accordance with the project strategy, the objective will be the development of both a policy environment and technology packages that are cost-competitive with conventional technologies and can be sustained through market activity.

Activity 2.1: Removing Barriers to Electrification through Solar and Wind Hybrid Systems

It is estimated that nearly 200 million Chinese do not have access to the electricity grid. Many of those that do have access to the grid cannot obtain electricity from that grid due to power shortages. Hybrid technologies making use of solar, wind, and in some cases, diesel generators hold the potential to help provide power to this large group of people. While estimates of the potential for electricity generation through hybrid technology cannot be calculated accurately, it is clear that they will provide a key element in meeting the electricity needs of China's rural population over the long term. The hybrid power technology component builds on existing Chinese expertise to establish the in-country capacity to bring high-quality reliable renewable energy-based hybrid power technologies to the Chinese market for off-grid electricity services. This project activity will expand local capacity to facilitate hybrid power technology commercialization through four field tests, designed to the technical, economic, and socio-cultural effectiveness of this technology under typical market conditions. For residential applications, small-scale PV/wind/battery/inverter units will be installed in approximately 200 homes in a pilot region. Three hybrid power systems with different size specifications (PV/wind/diesel combinations) will be installed in three adjacent communities where they can be served by a single local operations and maintenance center. Consideration will be given to re-powering three of the village-scale decentralized grids where, due to logisitcal problems, generation is rarely undertaken.

The capacity-building portion of this project will support international workshops, meetings, and tours of commercial manufacturing facilities and hybrid power installations. It will assist the Chinese in improving the designs of their hybrid systems and establishing international collaboration which will result in the local production of high quality hybrid power components and systems.

Activity 2.2 : Removing Barriers to Wind Farm Development

While the definition of optional sites for windfarms is still rudimentary, it is estimated that windfarm development has a short-term potential of 1000 MW and a long term potential of up to two hundred fifty times this amount. The barriers to realizing this potential are: (i) A lack of experience on windfarm performance and electric grid intercation parameters; (ii) The limited demonstration of the financial and economic viability of wind farms in China; (iii) An inadequate policy environment for investment in wind farms, notably the lack of a standard independent power purchase agreement (PPA) and supporting regulatory framework; (iv) the cost of advanced wind-farm components in China; and (v) the limited availability of wind resource data suitable for wind farm project identification.

This project is designed to begin removing these barriers by: (i) helping Chinese evaluate the international best practices in the areas site selection, planning, O&M and electricity utility grid integration as well as the manufacture of wind turbine equipment; (ii) developing the capacity for wind farm site identification, screening and characterization; (iii) conducting pre-feasibility assessments for several of the leading sites building on the wind resource data collected under 1.4 to bring down the cost of commissioning wind-farms; and (iv) identifying optimal power-sector development plans which will enable the Chinese electric grids to incorporate an intermittent power source like wind.

Activity 2.3: Removal of Barriers to Large-Scale Anaerobic Biogas Production

Current estimates place the fraction of liquid organic waste from agricultural and industrial process that are processed in anaerobic digestors at less than 10% of the potential. If all of this waste from medium to large pig farms were captured, this would result in the capture of roughly 600 Mm3 per year of methane, enough to fuel roughly 100 MW of power. If the distilleries and other industrial entities processed their wastes in biogas digestors, this would account for another 900 Mm3 of methane annually--approximately another 150 MW. Despite China's positive experience with small-scale biogas, its utilization of larger-scale biogas digestors in the agricultural and industrial sectors is quite limited, attributable to the existence of a number of barriers to development. The major barriers at the project level preventing anaerobic digestion applications from reaching economic and financial viability are a complex mix of technical, policy and financial issues include: (i) lack of standardization of the design and construction of large-scale anaerobic digestion systems; (ii) inappropriate separation, control and handling equipment; (iii) limited application of knowledge gained from the operation of existing plants in the design of future plants and poor acquaintance with international best practices; (iv) low financial returns for small-size biogas systems; and (v) policies creating few, if any, incentives to increase biogas production.

The project is expected to remove these barriers by:

Developing a biogas strategy to address the need for large scale community sized biogas digesters: This will involve a survey of the market potential and a plan of action to meet the market demand in the short and medium terms.

- Designing typical large size biogas plants which will serve as demonstration projects for the widespread dissemination of biogas technology: Demonstration units will vary among specific feedstocks, but will incorporate pig farm waste, distillery waste, and other feedstocks. The objective will be the

development of standardized biogas plants that are cost-competitive, are inexpensive to design, and are sustainable through market activity.

- Building several biogas digestion plants and monitoring their performance: This will require technical assistance to improve local practices in the areas of waste handling, separation, and process control. An attempt will be made to bring international best practice to the attention of the Chinese participants. Promising new technology which obtains a higher yield per unit of input has been developed in Germany using an enameled steel anaerobic digestion chamber. The viability of this method will be studied as a contrast to experience with the traditional masonry construction method.
- Disseminating results of biogas demonstration: The performance of the pilot systems will be reviewed with an eye toward both the standardization of the designs for easy implementation and the dissemination of further information to interested farmers, communities and local governments through seminars, workshops and public meetings.

Activity 2.4: Removal of Barriers to Bagasse Cogeneration

The production of cane sugar is a major economic activity in China. While 7 provinces are involved in sugar production, the majority of the cane sugar production is focused in the three (3) provinces of Guangxi, Guandong, and Yunnan. There is a major sugar industry expansion program underway to increase sugar production to 10 million tons per year from 650,000 hectares of cane by the year 2000, up from the 6.2 million tons produced in the 1994/95 crop year from about 420,000 hectares of cane. Although the estimates are fraught with complications, one estimate of the total national surplus power gross potential from the sugar industry has been placed at between 688 MW and 870 MW. Using new higher pressure and temperature equipment, the expected investment requirements in the higher efficiency systems can be estimated to be Yuan 6,640. per kW installed (U.S.$800. per kW installed).

The objective of this activity is to provide the technical assistance needed by the Chinese sugar industry to overcome specified technical barriers which will enable them to develop a surplus power program for the entire sugar industry based on substantially increasing the cogeneration efficiency of the sugar mills, with the efficiency gain directed to producing electricity for export to the grid. These barriers involve (I) the lack of a power purchase agreement; (ii) limited familiarity with the higher pressure boiler design; (iii) a lack of financial and engineering capabilities; and (iv) a lack (perceived or real) or capital to support such projects. This project activity is explicitly designed to overcome these barriers by assessing the market potential, optimizing the sugar industry for both increased production of sugar and increased power generation, designing a demonstration plant using increasingly high pressures facilities that will result in significant co-generation, obtaining the capital to build the demonstration plant, and constructing and supervising the construction of that plant.

5. Rationale for GEF Financing

This project is designed to accelerate the commercialization of renewable energy in China, thereby reducing GHG emissions from China's energy sector. It has been designed as a technical assistance project to begin the process of removing specific, targeted barriers to the dissemination and commercialization of renewable energy. It has been prepared to be fully consistent with **GEF Operational Programme 6: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs.**

Following the United Nations Conference on Environment and Development (UNCED) in 1992, China affirmed its commitment to the development of renewable energy in "Ten Policies For Sustainable Development", China's Agenda 21 White Paper on China's Population, Environment, and Development in the 21st Century. China also completed the report on Issues and Options in Greenhouse Gas Emissions Control supported by GEF and formulated the China Environmental Action Plan supported by the World Bank. These documents support the importance of renewable energy technologies increasing energy supply and reducing CO2 emissions in China. Renewable energy use also provides to improve living standards and contribute to sustainable social development. Current policies aiming to maintain the rapid rate of economic growth are likely to keep China on a traditional development path with high coal consumption well into the next century, thereby ignoring the massive renewable energy potential in the country.

The proposed project is designed bearing in mind that this is a period of rapid economic transformation in China. It considers that strategic changes introduced into China's energy supply scenario now can have significant long-term impacts on both the local and the global environment, if the market commercialization process is strengthened. Therefore, the project has been designed to accelerate this commercialization process. Current electricity supply in China is approximately 180 GW and is expected to double within 20 years. Even if a mere 5-10% of this amount could consist of renewable energy supplies thanks, in part, to the early implementation of this project, GHG emissions could be significantly reduced.

In order to achieve the greatest potential in the area of renewable energy technologies, China requires both capital and technical assistance to improve its current production capabilities. As mentioned previously, the enormity of the task requires a concerted effort on the part of all donors to give renewable energy development in China a push toward market-based commercialization. This project is intended to form a catalytic part of the push. However, by itself, it will not be sufficient. Clearly, more assistance will be required to reduce implementation costs, remove additional barriers which may emerge, and to give renewable energy in China the type of attention it merits given the nature of the global environmental challenge.

6. Sustainability and Participation

The proposed project will be undertaken during a period of significant economic and regulatory reform in China. Sustainability of project initiatives will to some degree depend on the Government's continued commitment to such reforms, and the degree of private sector involvement. Demonstration of the technologies and applications as well as information dissemination are key elements of the proposed activities. The participation of NGOs and local communities in workshops and seminars will be essential to their success.

The implementation of the project will strengthen the political climate for renewable energy development; in particular, the project will increase awareness among policy makers of the importance of renewable energy supply and environmental protection. There is a need for increased funding of the renewable energy sector if any headway into the rapid deployment of conventional power sources will be required.. Appropriate government policy will create an enabling environment in which both domestic and foreign financial resources can contribute to the successful commercialization of renewable technologies. Relevant policy issues that will be addressed include: pricing, taxation and standards for renewable energy technologies.

Under typical conditions, the four technologies targeted for attention under Objective 2 of this project are nearly commercially competitive at the moment. With the support of this project, the World Bank's complementary investment project, and additional bilateral projects, it is possible that all of them could represent profitable avenues for future investment. On the basis of careful economic and technical analysis, hybrid systems-- both household-scale and community-scale-- may represent least-cost options for rural electricification in remote areas with adequate wind and solar resources. Wind-farms are not now commercially competitive with fossil-fuel generation of electricity. However, the activities proposed in this project will push them toward greater competitiveness by reducing implementation costs. With small technical improvements, livestock farms with more than 10,000 pigs can become competitive as a source of electricity, in addition to obtaining substantial local benefits for waste processing. Elsewhere in the world, bagasse-based cogeneration is an important part of the sugar industry. Once the activities under this project are completed, the door should be opened for more substantial investments in bagasse-based cogeneration to begin to generated power from excess steam on a profitable basis.

7. Institutional Arrangements for Implementation

The State Economic and Trade Commission (SETC) will be the Chinese implementing organization responsible for monitoring and guiding the overall implementation of the project. It is important that the institutional arrangement be well-defined and compatible with the project's overall goals, since a number of project components will be conducted in different locations by different actors. The project will be UN executed. In order to facilitate programme coordination, dissemination of project findings and policy development, a Programme Steering Committee will be established. The Committee will consist of representatives at a deputy-director level of key ministries for renewable energy dissemination. To ensure that that it remains manageable, the Steering Committee will be opened to only four or five key ministries. A comprehensive consultation process will be conducted to select the participating agencies and identify the most suitable chairperson. The membership and operational structure of existing inter-agency energy and environment coordination groups will be reviewed to assist in this selection.

The Steering Committee will meet at least once a year, with the first meeting to take place immediately following the project inception meeting. The Steering Committee will be responsible for: (I) advising beneficiary agencies regarding inter-project coordination and national dissemination of reports and findings; (ii) mobilizing inputs from all concerned ministries to support project activities; and (iii) providing guidance for policy issues for rapid commercialization of renewable energy.

A Project Management Office (PMO) will be established to act as a secretariat to the Steering Committee and a technical resource center for the different project components. It will closely liaise with the executing and implementing agency in the monitoring of the technical progress of each programme component. It will regularly report to all co-financing agencies. It will be headed by a full-time National Programme Director (NPD). The NPD will be assisted by a full-time international adviser and a multidisciplinary team of national and international consultants.

8. Project Financing, Budget and Work Schedule

The preliminary project budget is for US$ 27.0 million, of which US$ 8.802. million is requested from the GEF. The budgets for the individual components are given in the following table in US dollars. The

amounts in the first column represent the commitments of the Government of the People's Republic of China to provide funds in the indicated categories. The second column represents estimates based on discussions with beneficiary enterprises and households; the third contains information from bilateral donors or other funding organizations. The fourth column provides the budget requests from UNDP and the fifth contains those requested from GEF, representing incremental costs in the individual categories. The detailed calculation of Incremental cost is in the Annexes.

Should it prove impossible to mobilize the totality of the US$ 14.23 million expected from enterprises, household and bilateral aid agencies, the Government of China will cover any inadvertant shortfalls in order to preserve the financial soundness of the project. For example, for activity 1.2, the beneficiary center is expected to provide US$ 250,000 to complement Government and GEF financing. The Government implementing agency will have the responsibility to ensure that the selected center be in a position to mobilize the requested funds and that the totality of activities can be implemented in accordance with the agreed budget.

The project is envisaged as a four-year project. The draft timeline or Gant chart for all project activities are presented following the budget tables.

9. STAP Technical Review

The STAP technical review (attached as an annex) considered the proposal to be "excellent and technically sound". The corrections raised by the reviewer have all been made. The reviewer also raised a question about the above paragraphs regarding the Chinese contribution. In response to this question, UNDP has clarified the position of the the Chinese government on this contribution. Their position is that the State Economic and Trade Commission (SETC) has committed itself to meet any budget shortfall which might be encountered from either local or bilateral funding sources.

LIST OF ANNEX MATERIAL

Annex 1: Incremental Costs and Project Activities: Objective 1

Annex 2: Incremental Costs and Project Activities: Objective 2

Annex 3: Budget and Timeline

Annex 4: STAP Technical Review

Annex 5: Government of China Endorsement Letter

ANNEX I INCREMENTAL COSTS AND PROJECT ACTIVITIES: OBJECTIVE 1

Objective 1: To Develop National Capacity for the Rapid Commercialization of Renewable Energy Systems in China

The activities to be undertaken under Objective 1 are applicable to the development of the renewable energy sector in China. They are targeted at specific barriers to the rapid commercialization of renewable energy. As these barriers and the activities to remove them are generic to the renewable energy programme of China taken as a whole, the incremental cost discussion views the activities to be undertaken as a unit. Following a brief discussion of the incremental costs of these activities, the details of the activities to remove the identified barriers are discussed in greater detail.

I.1 Broad Development Goal:

The development goal being pursued by the Chinese government is the provision or supply of sufficient electricity and energy to meet national development needs at the lowest possible cost. Without any intervention, meeting this goal will require increased use of domestic coal for power generation and direct consumption.

I.2 Baseline:

In order to meet its development goal, the Chinese government has an ambitious power development plan, which will result in an increase of 5.7% per annum in coal use in the power sector between 1990 and 2020. Overall, coal use is expected to triple by the year 2020.

The Chinese government counterpart contribution of US$2.1 million and the contribution of other Chinese institutions of US$0.75m are considered as baseline expenditures for this project. In the absence of this project, the Chinese contribution will likely be spent anyway. However, it is not altogether clear that the funds will be devoted to the activities proposed in this project. It is likely that some renewable energy activities will be supported, but they will be undertaken in a less comprehensive and systematic manner.

Although China has adopted a renewable energy policy to supplement its coal-based growth path, without further assistance, that policy is unlikely to achieve its stated goals. While the policy establishes targets for the use of specified renewable energy sources, many of the preconditions necessary for the rapid dissemination of these energy resources are not met. Support for renewable energy development has been complicated by the economic liberalization and reform process which is currently underway. The creation of a supportive policy environment and the establishment of the pre-conditions for rapid commercialization of renewable energy as contained in this proposal are essential if the stated goals and targets for renewable energy are to be met.

I.3 Global Environmental Objectives:

The global environmental objective being pursued through this project is the provision of increased quantities of energy from renewable sources. Increasingly, this energy will have to be produced in

response to market incentives and market mechanisms, which means that a great deal of technical assistance is required to commercialize the production of energy from renewable sources. The activities proposed in this project are consistent with GEF Operational Programme 6: Promoting the Adoption of Renewable Energy and Reducing Implementation Costs.

I.4 GEF Project Activities

In order to achieve this global environmental objective, a number of barriers found in the energy sector in China must be overcome. These barriers include a policy environment which has only recently been open to private investment; shortages of personnel familiar with renewable energy production in a market environment; institutions which focus on technical research in the context of a state-run economy but have no relation to commercial undertakings; a limited information base for locating and building renewable energy facilities; and low quality of some renewable energy technologies which results in limited consumer confidence. In order to overcome these barriers, a great deal of work must be undertaken to improve the policy environment, increase human resource potential, strengthen institutions, ensure high quality of renewable energy equipment produced in China and build consumer confidence in renewable energy supplies.

The discussion below summarizes the activities to be undertaken to remove barriers to the increased commercialization of renewable energy in China.

Activity 1.1: Removal of Policy Barriers to Renewable Energy Development

China's overall energy policy appears broadly favorable to renewable energy development, but to date, steps taken to operationalize this policy have been weak and have received little attention outside the circle of renewable energy experts. Although some small support is needed to provide more consistent information for the suggested policies, much information already exists. What is needed is a pragmatic approach on how to implement these policies to make widespread use of renewable energy in China a reality.

Two tasks are proposed under this activity. The first focuses on operationalizing the adopted recent recommendations on market-based renewable energy development made from the various activities. The second will focus on internalizing the external costs of energy production and use.

Tasks 1.1.1 Operationalizing Market-Oriented Policies for Renewable Energy Dissemination: A number of innovative technical asistance activities have been undertaken recently in the renewable energy sector in China. However, in the absence of follow-up support, there is a danger that these studies and recommendations will remain only in the heads and bookshelves of the participants. This activity, to be undertaken with the support of UNDP, will assess all of the recent work undertaken on renewable energy pricing, investment policy, and financial and economic incentives. It will identify potential gaps and provide support to address them. It will then organize a series of information and training workshops to provide a forum to discuss the proposed in centives for renewable energy policy with local decision-makers and potential entrepreneurs and identify urgent stpes to be taken to enable as rapid an implementation of these policies as possible.

Task 1.1.2 Internalizing the External Costs of Energy Production and Use: This task will draw upon the previous and ongoing research intended to estimate the externalities and environmental damages caused by energy production and use in China, to focus particularly on issues relating to the internalization of these costs *via* some form of carbon tax. Most of the work

undertaken in this activity will focus on environmental damages that are local or regional in nature, such as SOx, NOx and particulates. Recently, an interdisciplinary research programme has been initiated by Harvard University and Chinese experts in the resource economics of energy production and use. The UNDP/GEF project will rely upon the leadership of this other project in the area of the internalization of external costs of renewable energy. GEF support is requested for coordinating project activities with the portion of the Chinese/Harvard activity that will examine CO2 damage functions and its implications for carbon taxation, subsidies, and carbon trading.

Activity 1.2: Strengthening the Center for Renewable Energy Development

The Center for Renewable Energy Development (CRED) was established by the State Planning Commission under the auspices of the Energy Research Institute in early 1996. Its task is to facilitate the accelerated commercialization of renewable energy. CRED is presently supported by the Government, but the Center is expected eventually to become financially independent. The establishment of CRED and the level of the baseline support provided by the Chinese government represents a significant commitment promoting the widespread adoption of renewable energy through market channels. This UNDP/GEF project is intended to strengthen the Center by providing the funding essential to conduct activities that would otherwise not be carried out, but which are essential to the removal of barriers to renewable energy commercialization in China. As the CRED will play an important role in the implementation of this project, it is important that it also have the capacity for project supervision and technical and financial management. CRED will also serve as an information center and clearinghouse for renewable energy investments, and will be responsible for organizing workshops and training under Activity 1.3. It will provide free access to information on technology and resource endowments. As it is intended to become financially independent, one of its income-generating tasks will be the provision of services for the planning of rural electricity to communities and areas not connected to the grid. This activity is designed to help CRED achieve these goals.

Task 1.2.1 Training CRED Staff in Project Management: CRED staff will be responsible for undertaking analyses leading to the development of projects. They will also be responsible for the supervision of this and other projects. Therefore, there is a need for CRED staff to be trained in modern cost-benefit analysis as well as project management and supervision practices. This task will include two separate, but inter-related training activities for CRED staff. The first will be a training course focusing on financial and economic analysis of renewable energy projects and options for junior analysts from CRED, the Energy Research Institute (ERI), and other institutions in the energy sector. The second activity will provide the CRED staff members, who are expected to serve as individual task managers for this and other projects, with training in project management, accounting and reporting. The aim of this latter activity is to provide the managerial and accounting skills needed to track and manage renewable energy projects.

Task 1.2.2 Strengthening CRED's Information Management and Documentation Capabilities: As the Center will play a critical role in facilitating the commercialization of renewable energy activities and investments, it is important that it has a strong information center. This is intended both to provide actors within China as well as those from outside of China with free access to information. It will accumulate documentation about renewable energy technologies and projects from around the world, in both traditional and electronic form, including CD-ROM, as well as videotapes. It will also have active internet capabilities and eventually establish a CRED Home Page on the World Wide Web. The manager of the Information Center will visit several

major renewable energy information centers in other countries. This will provide essential knowledge of available renewable energy information and data resources, and on-line information available via the WWW and from specialized information centers. The CRED Information Center will establish operational links with a few key renewable energy centers such as Riso National Laboratory (Denmark), CASE (Western Australia), and NREL (United States), to leverage their information resources.

GEF support will provide ongoing access to international renewable energy journals via subscriptions and purchase of recent back issues, and permit the Center to establish a solid core library of reference books and materials in other media (CD-ROM, videotape). The Center will also maintain a current library of software tools (data bases, technical performance simulation models, financial and economic analysis models, etc.) for use by CRED staff. A renewable energy information specialist from an international renewable energy center will be retained to work with CRED in the design and launching of the Information Center.

As a key institution in the commercialization of renewable energy, CRED will also play an important role in documenting successful applications of renewable energy in China. It will also provide information on renewable energy investment opportunities for potential investors both inside and outside China. This role is particularly important when viewed in the context of the activities under Objective 2, but also in other technology areas in which this project is not active. CRED will actively post information on its WWW site. The ability to produce high quality newsletters and other publications in both Chinese and other languages, and publicity, including video materials, for successful renewable energy opportunities in China will help eliminate a major information barrier that is hindering the promotion of renewable energy in China.

Task 1.2.3 Capacity Building for Planning Services for the Provision of Electricity to Communities Not Connected to the Electricity Grid: A significant barrier to the widespread provision of renewable energy-based electricity services to off-grid communities is the lack in China of a systematic methodology for identification, design, and implementation of rural electricity service projects and enterprises. Screening and planning tools are required to assess the community energy needs and priorities, to evaluate the technical and financial opportunities to provide electricity services, and to design the projects to supply these services. Drawing on experience elsewhere, a methodology will be developed to identify communities suitable for renewable energy based electricity services. This methodology will serve as the basis for the rational planning of rural electrification throughout China. CRED will be able to utilize this methodology to help provincial authorities throughout China plan the provision of electricity to rural areas.

For communities with low energy needs, limited willingness and/or ability to pay for energy services, and scattered homes and community facilities, the least-cost options will be household-scale PV systems (solar home systems), wind electric systems, and PV/wind hybrid units. These may be purchased (outright or on credit), or leased by households, or a local energy services company owning the equipment would install the systems and bill for their use on a flat monthly fee basis that reflected the cost and energy supply capacity of the equipment and its maintenance. Larger and more wealthy off-grid communities will be technically and financially suitable for the use of renewable energy-based hybrid power systems, ranging from ca. 10 kWe to 100 kWe. Other renewable energy options such as microhydro or biomass-based power generation may also be options. The least-cost preferred option or mix of options (such as a hybrid system for the "core" of a village, and small PV/wind/battery units for distributed applications) will depend on the

solar and wind resources, the physical and topological characteristics of the expected electricity loads, the mix of productive and consumptive uses of electricity, and the willingness and ability of the community to pay for electricity services.

The methodology will combine field surveys with the use of technical, economic, and financial analysis tools (software and data bases), and will involve the use of computerized geographic information systems, databases, global positioning systems, and participatory evaluation techniques and fora. This activity will develop the tools for this analysis and field test them for the provision of electricity services to rural communities under Activity 2.1. Key elements of the methodology are shown in the box below.

Project Preparation
- Selection of pilot regions
- Identification and selection of candidate communities
- Preparation of rural socio/economic and energy survey instrument

Surveying and Mapping of Candidate Villages
- Socio/economic survey of utility- and privately-electrified villages (baseline)
- Socio/economic surveys, including participatory assessment
- Physical survey (GIS technology) and mapping (GPS technology)

Analysis and Assessment
- Energy demand and load profile calculations
- Assessment of renewable energy resources
- Power system selection (configuration, sizing)
- Power system capital and operating cost assessment
- Power system performance projections
- Design and costing of the low-voltage AC power distribution system
- Project/business economic and financial analysis
- Participatory review and appraisal

Project Design and Packaging
- Feasibility study report
- Project proposal (technical/economic/financing)
- Strategic business plan (if relevant)

Activity 1.3: Training and Information Exchange

Two of the barriers to renewable energy commercialization in China are the lack of information about investment opportunities and the limited numbers of individuals with experience relevant to a commercial market approach to renewable energy development. This activity has been designed to overcome these barriers through two tasks. Although the activity will involve individuals from a large number of organizations, enterprises, and agencies, its implementation will be managed by the CRED.

Task 1.3.1 International Utility Internship Programme: There are few Chinese professionals who are familiar with renewable energy technologies and also with project identification, development, negotiation, and contracting in a free-market environment with independent power producers (IPPs). Under this activity, ten Chinese professionals selected from several different agencies will be placed for internships of up to six months duration with agencies involved with independent power generation, negotiation, and management. UNDP will use its collaborative arrangements with the E-7 coalition of OECD electric utility companies to place these individuals in worthwhile internships and to supervise their experiences. The aim would be to select either utilities actively involved in purchasing power from independent generators or IPP's working with renewable energy generation to provide the Chinese with experience relevant to renewable electricity provision through independent generators.

Following these internships, the CRED will organize a series of workshops to be held in various parts of the country to enable the returning interns to present summaries of their experiences to a wider Chinese audience. Past experience with internships and training workshops has shown that workshops of this kind not only helps inform a wider audience of the findings of the interns, but also forces the interns to consolidate their thoughts in a systematic way. Some help from sponsoring organizations may be needed to enable everyone involved to achieve the greatest possible benefit from this activity.

Task 1.3.2 Training in Business Financing, Establishment, and Operation for Renewable Energy Entrepreneurs: Achieving China's ambitious goals for renewable energy policy under a mixed socialist economy will require the establishment of a large number of business enterprises focuses on the production and sale of renewable energy technologies as well as the production of renewable energy by small, decentralized independent power producers. Providing business skills to those familiar with renewable energy technologies represents an important step toward overcoming this barrier. This workshop, the material for which is being developed under Activity 1.1, will attempt to provide potential Chinese entrepreneurs with the tools and perspectives they need to operate businesses. It will target businesses and the staff of technical institutes that may interested in operating businesses dealing with any renewable energy technology. Among its activities, the course will include IPP operators to relate their experiences, IFC representatives to explain their requirements for financing or cofinancing of business initiatives and renewable energy projects, and representatives of commercial investment houses to discuss business and project financing opportunities and requirements.

Task 1.3.3 Organization and Management of Renewable Energy Investment Fora: An important barrier to the establishment of renewable energy businesses in China is the lack of information on the part of both Chinese and outsiders about renewable energy business opportunities in China, and how to obtain business and project financing. This task will facilitate a series of workshops in China focusing on renewable energy in China and on relevant business opportunities. This activity serves two purposes. First, it will bring in industry leaders in renewable energy power generation from around the world to help them explain to interested Chinese parties about their operations in their home countries. Second, it will serve to expose them to potential investment opportunities in China. These workshops will be technology-focused. They will include a set each on wind farm operation; industrial-scale biogas production and biomass-based cogeneration; and off-grid renewable energy-based electricity supply options. These will be organized in several provincial locations where the renewable energy resources are significant. For example, wind farm workshops may be organized in Inner Mongolia, Ghansu, and Guangdong Provinces.

Activity 1.4 Capacity Building for Renewable Resource Assessment

One of the most important barriers preventing the expansion of China's renewable energy resources is the lack of detailed and reliable information on renewable energy resources. Without adequate information, potential investors have no idea of the feasibility of wind or solar investments. Little or no renewable energy development can proceed without a better information base. The following tasks are designed to create a process and the skills necessary to begin removing permanently the barrier of inadequate information about renewable energy resources. This barrier serves as an obstacle to investment in renewable energy and makes the process a piecemeal one. The incremental costs of the project are taken as the cost of these tasks designed to remove the information barrier:

Task 1.4.1 Training in Resource Assessment Techniques and Site Selection: Effective site selection first involves evaluation of existing resource data in a way that allows for the screening and selection of candidate sites. These sites will then undergo further on-site monitoring and evaluation. Products such as resource maps are used for accomplishing this. Typically, available data bases, such as those from the National Meteorological Bureau, do not include data from potentially good wind and solar sites. These products must be developed using models and data interpolation schemes. This task involves on-the-job training to enable Chinese analysts to use advanced screening techniques involving GIS and remotely sensed data to analyze wind-resource adequacy, site access (highway availability), and grid connectivity to select twenty potential sites for wind resource assessment data collection in Task 1.4.2. **It will also identify 10 potential** villages for hybrid electrification. This activity will involve the use of advanced models, global data sets, and interpolation procedures so other products can be developed for use as tools in identifying and evaluating candidate wind farms and sites for community-scale hybrid facilities.

Task 1.4.2 Renewable Resource Data Collection: This task involves the acquisition of and training in the installation and use of specialized wind and solar measurement equipment to be able to prepare pre-feasibility studies for a number of sites over a number of years. The availability of this data is a prerequisite to the establishment of wind-farms and an adequate resource base will greatly expedite, and therefore reduce the costs, of new wind-farm deployment. This equipment is to be installed at the candidate sites identified in Task 1.4.1. The information at these sites will be used in Activity 2.2 to carry out pre-feasibility studies. In addition to these monitoring facilities, equipment for data processing, archiving and calibration will have to be obtained and the participants trained in its use. Approximately 10 sites for wind measurements (5 stations per site) will be set up and 10 wind/solar measuring stations will be established in order to provide a solid information foundation for future investments in these technologies.

Activity 1.5 Specifications, Standards, Certification, and Codes of Practice

The successful widespread commercial diffusion of renewable energy equipment will require technical specifications for technical performance and safety, the development and use of standards for product testing, evaluation, and certification, and commercial codes of practice. Technical specifications lead to widespread standards, and agreed-upon test and evaluation methods are then used to certify that equipment meets the specifications required by the standards.

Standardization of equipment is yet another consideration; standardization can help assure that key components and subsystems can be interchanged, increasing the reliability of after-sales service, maintenance, and repair of systems in the field. Codes of professional practice for equipment suppliers, installers, and service organizations will also be necessary to ensure the reliability and sustainability of the equipment.

Technical specifications are required for such equipment as solar water heaters, wind turbines, inverters, PV panels, battery charge controllers, and for batteries used in specific applications. These specifications are necessary to ensure that reliable high-quality products can succeed in the marketplace. Without such specifications, shoddy inferior equipment may be sold, and when it fails to operate properly it will damage the entire process of commercial diffusion of similar products. Also, inferior and cheaper equipment will drive the needed high-quality products out of the market. European, Japanese, North American, and Australian companies, among others, have developed rigorous specifications for such equipment and systems. For some products, like PV panels, international technical specifications for PV panel performance and for PV testing and certification are well established. For others, such as charge controllers, they are still evolving. The establishment of specifications for technical components of hybrid power systems is essential to ensure the functional compatibility of the components in a reliable system.

Standards for testing and evaluating the performance and quality of individual components, subsystems, and systems will also be required as part of the commercialization process. The implementing agencies will work with their counterparts abroad to review existing test and evaluation procedures, and adopt them to local conditions as appropriate.

Some forms of *certification* are required for commercial products, such as safety standards for electrical equipment. Other forms of certification may be voluntary, but can enhance the value and marketability of a product if the certification means that the product has passed a rigorous set of standardized tests. Industry associations are important actors in the establishment of specifications, standards, and certification practices.

A standards committee will be established for the project, to coordinate this work. The project team will review and discuss available relevant technical specifications, and hold one or more small international workshops with experts to discuss the development of similar standards and certification procedures for China. The project team will review the certification procedures used in several other countries for solar, wind, and balance of system products to evaluate their relevance to the commercialization objectives that GEF project is supporting. The following activities are seen as essential to establish codes, standards, certification procedures and thereby remove an important barrier to renewable energy commercialization.

Task 1.5.1 Development of Process for Standard Specification, Certification, and Codes of Practice: Under this task, several workshops will be held to establish the process by which standards are specified and certification and codes of practice are established. The process will have to be participatory in nature, seeking to build consensus on both the process and the standards and codes. The process will have to be flexible enough to cover not only the technologies discussed below, but also other technologies which might require some form of assistance at a later date. The process will also establish a renewable energy technologies standards and certification team or committee (with government agencies and corporations participating, in addition to the GEF project team)

Task 1.5.2 Review of Standards for Intermediate-scale wind turbines (1-40 kWe): This task will involve the development of functional specifications reflecting system design requirements and field conditions. The development of technical standards will be undertaken through collaboration with standards institutes, specialized centers (e.g. Riso Lab, NREL), and wind industry associations (e.g. European Wind Energy Association, American Wind Energy Association). It will also focus on the development of test procedures for technical evaluation and certification.

Task 1.5.3 Development of Standards for Solar Water Heating Systems: Upon examination of the solar water heating industry in China, it was found that the expanded use of this technology has been hampered by the uneven quality of the product resulting in low consumer confidence in the technology. In most respects, the solar water heating industry faces no significant barriers to widespread dissemination and commercialization. However, the development of reasonably high standards for solar water heaters is an exception. Without significant assistance in the area of standardization of designs, it is unlikely that the industry will begin to achieve its potential. GEF support is required to remove this barrier of product quality and standards which stands in the way of the rapid commercialization of solar water heaters. This task will focus on the development of technical specifications for system components (solar thermal collectors, valves, control units, heat exchangers, and storage tanks), and for packaged systems. This will be done in association with standards associations, professional societies, industry associations, and specialized centers (especially those found in Scandinavia, Germany, Japan, US, Australia). The standards will then be publicized and utilized for system certification.

Task 1.5.4 Balance of System Standards and Certification: One of the greatest weaknesses found in small-scale renewable energy systems around the world is the relatively low quality of the balance of system (BOS) components. This equipment, particularly the inverters, batteries and controllers, are often the weakest part of any system and account for many of the system malfunctions. This activity will establish a set of standards for these components, and make recommendations for certification and test procedures for bi-directional single and three-phase inverters, industrial batteries, and controllers. These standards will be published and utilized for system certification.

Task 1.5.5 Development of Certification Center for Renewable Energy Technologies: Once the standards have been established, there will be a need to test the equipment being produced to certify that it complies with the standards. Under this task, all renewable energy certification needs will be analyzed, and the capabilities and needs of the different candidate laboratories will be assessed with the goal of a establishing testing and certification laboratory for small wind turbines, photovoltaic systems, solar hot water systems and the balance of system (BOS) components. While it is likely that more than one center will be selected, it will be important that laboratories meet international laboratory standards. Bilateral funding of $1.0 million is being sought to strengthen the facilities of the selected centers.

I. 5 System Boundary:

The boundary for the above analysis and discussion is the Chinese energy system.

I.6 Additional Domestic Benefits:

Some of the technical assistance activities to be undertaken under this objective would also carry over to help the acceleration of the commercialization of non-renewable energy resources in addition to accelerating the commercialization of renewable energy resources. In addition, the increased uptake of

renewable energy under this activity should also result in a decrease of emissions of local pollutants, notably SOx NOx and particulates.

I.7 Incremental Cost Matrix

An incremental cost matrix is presented below summarizing the above discussion. The total costs of the activities to be supported under objective 1 of this project are estimated to cost US$8,700,000. Of this amount, US$2.85 million are to be contributed by Chinese sources, either the Chinese Government or individual cooperating Chinese entities. Because these expenditure would be made with or without the project, even though they might not fully be devoted to renewable energy in the absence of the project, they are considered as the baseline costs. UNDP is providing US$0.500 m as part of baseline support for renewable energy development in China. The incremental costs of the activities to be undertaken under Objective 1 are taken to be US$5.4 million, of which GEF is requested to provide US$3.25m; and other bilateral donors are providing US$2.150 m.

Table I.1 Incremental Costs of Activities Defined Under Objective 1

Costs		National Benefits	Global Benefits
Baseline	Support for activities which may or may not be devoted to renewable energy by Chinese government and other institutions: Gov't $2,050,000 Others $750,000 UNDP Policy Support for Renewable Energy Development $ 500,000 Total US$3,300,000	Energy sector continues to rely on coal	CO2 Emissions will continue as forecast in baseline
Project Case	Barriers removed to Rennewable Energy Commercialization, specifically From outside funding sources / Chinese & other funding sources / Total Activity 1.1 Policy Barriers $ 50,000 +$700,000 = $750,000 Activity 1.2 CRED Support $1,000,000 +$500,000 = $1,500,000 Activity 1.3 Trng & Info $750,000 +$700,000 = $1,450,000 Activity 1.4 Resource Assm't $1,950,000 +600,000 = $2,550,000 Activity 1.5 Standards/Codes 1,650,000 +800,000 = $2,450,000 Total from all sources US$5,400,000 +$3,300,000 = $8,700,000	Removal of some key barriers to the accelerated commercialization of renewable energy Reduction in emission of local pollutants	Reduction in CO2 emissions
Increment	Total Incremental Cost Required from outside sources = US$5,400,000 Amount Requested from: GEF US$3,250,000 Others US$2,150,000	Accelerated renewable energy uptake Carry-over to IPP's for conventional electricity generation Reduced Pollution	Acceleration of commercialization of renewable energy Reduction in CO2 emissions

ANNEX II: INCREMENTAL COSTS AND PROJECT ACTIVITIES: OBJECTIVE 2

Objective 2: To Remove Barriers Specific to the Commercialization of Four Promising Renewable Energy Technologies

Activities proposed under this objective address the removal of four sets of barriers to the commercialization of four specific renewable energy technologies considered promising for China. The four technologies--hybrid systems for decentralized power, wind-farms, medium and large-scale anaerobic digestors, and bagasse cogeneration--have been selected on the basis of a review of market conditions and barriers to their widespread dissemination. A number of other promising technological options are not addressed in this project because they were not considered promising, no barriers were identifiable to their dissemination, or the identified barriers could not be removed through technical assistance activities.

This annex presents an incremental cost analysis of the activities proposed under Objective 2 of the project. As the national and global development goals are the same for each of the four technologies, this part of the discussion is shared. The incremental cost matrix is shared for all proposed activities under this objective. It serves as a summary of the activities and costs. However, since the barriers and the activities to address the removal of those barriers differ per activity, the discussions of each of the project activities goes into greater detail about the nature of the proposed activities.

II. 1 Broad Development Goal:

The development goal of the Chinese government being pursued in this context is the provision of power to its population and economy in the most economically appropriate fashion.

II.2 Baseline:

To date, the pursuit of this goal has entailed a heavy reliance on coal for both power generation and direct thermal applications. In the future, this coal-dependence, and the concomittant increase in air pollution, can be expected to increase. Under the baseline, coal use can be anticipated to triple between the years 1990 and 2020.

In the absence of this project, the Chinese contributions of US$2.12 million from the Government of China, and US$4.05 million from other Chinese institutions will be made in the energy sector. Although these funds will not necessarily be devoted to the same renewable energy activities, it is possible to consider them as baseline activities. Without the support envisaged in this project, the barriers preventing these activities from expanding sustainably will not be removed and these baseline activities will largely be continued technical demonstrations. There can be no widespread dissemination or adoption of these renewable technologies unless these barriers are removed. For example, in the case of Activity 2.4 dealing with bagasse co-generation, Chinese sugar mills will replace existing boiler facilities with similar units instead of searching out improved boilers with cogeneration potential.

Under the centralized Chinese system of technology management, Government goals for priority technologies, such as renewable energy, could be enforced through the official budgeting process. With a socialist mixed economy as exists at the present, the Government can only state its goals and let market incentives drive the diffusion of the technology through the economy. While this new approach will

dynamize the private sector and result in the acceleration of the technological innovation, a number of barriers have been encountered which prevent this new approach from unleashing its full power. Once these barriers are removed, these important technological innovation will begin to disseminate themselves throughout the Chinese economy.

II.3 Global Environmental Objective:

The global environmental objective being pursued through this project is the provision of increased quantities of electricity and energy from renewable resources which will result in little or no increase in GHG emissions. These renewable energy technologies will have to be diffused through markets which are only weakly established in China. Technical assistance is required to get over the barriers to the commercialization and eventually the widespread dissemination of these technologies.

II.4 GEF Project Activities

As has been discussed elsewhere in the proposal, China's energy policy states that renewable energy resources will be given priority in the future. However, given the transition under way in the Chinese economy, the promotion of these resources and technologies will have to take place under a new mechanism which depends more upon the market than the state. In order to make the amrket-based dissemination possible, a number of activities to remove barriers to the market-based dissemination of four renewable energy technologies which are considered promising for China are proposed as part of this GEF project. These activities, and the barriers which have been identified as preventing their commercialization and subsequent widespread dissemination, are described in the following discussion.

Activity 2.1 Removal of Barriers to the Dissemination of Community and Residential Hybrid Systems

Analyses of the Chinese renewable energy system have demonstrated that hybrid systems hold significant economic and environmental advantages over fossil-fuel based power generation for supplying electricity to decentralized populations.[1] However, they have not managed to disseminate themselves throughout rural China because of the existence of a number of barriers which prevent their widespread dissemination throughtout China. These three barriers are:

Limited information about hybrid power systems: Hybrid systems are a relatively new innovation and only one Chinese research institution , with limited capacity and capabilities, has been actively working with them. As a result, policy-makers, businessmen, and the population at large know relatively little about these systems.

- **Technological weaknesses in system components found in China:** Although a few hybrid systems are currently being produced in China, several of the components used are of a poor quality. This has

[1] See J. Weingart, entitled "Incremental Costs of Hybrid Power Systems in China", (unpublished). and John Byrne et al (March 1996), *Levelized Cost Analyses of Small-scale Off-grid Photovoltaic, Wind, and PV-wind Hybrid Systems for Inner Mongolia, China.* University of Delaware: Center for Energy and Environmental Policy. summarized and presented in J. Weingart, entitled "Incremental Costs of Hybrid Power Systems in China", (unpublished).

and will continue to limit their ability to disseminate widely throughout the Chinese markets. In particular, charge controllers, inverters, and other components are not consistently of a high quality.

Institutional arrangements to insure delivery of technology: There is no institutional arrangement that will ensure the sales, installation and the after-sales service of these hybrid systems. In general, rural households and communities cannot finance, operate and maintain these systems on their own, but as of yet, there are no local businesses which have demonstrated their ability to fulfill these needs while maintaining financial viability.

The following tasks respond to the need to remove these barriers through training, the improvement of hybrid systems produced locally in collaboration with industry, and the collection of performance data through the establishment and careful monitoring of pilot facilities in rural China.

Task 2.1.1: Strengthening of Hybrid Technology Center: Under this task, the project will strengthen the Hybrid Technology Center of the Institute of Electrical Engineering for professional training in the design, testing and evaluation of components and systems. The goal is to utilize international experience, particularly from countries which have successful hybrid programmes (e.g., Australia) to improve upon the design of locally-produced hybrid systems. It would collaborate with local electrical goods producers to improve the quality of components and systems that are assembled and used for demonstration as part of this activity. This center would also collaborate in the development of standards for testing, evaluation, and certification of components and subsystems for hybrid power systems.

For the residential sector, PV/wind/battery/inverter hybrid units are presently being tested in a few homes in Inner Mongolia. This experience has revealed some technical weaknesses that must be corrected before large-scale application begins. The required improvements are in the battery charge controller components. The project will also identify areas of improvements to be considered by the suppliers of PV modules and batteries. However, the project will not directly address technical issues related to the improvement of either batteries or PV panels.

For the community-scale hybrid power units, improvements are needed in the system controllers, possibly in deep-discharge batteries for solar and wind applications, and in the design and manufacture of intermediate-scale wind turbines (1 kWe to 50 kWe). For wind turbines in the 5 kWe to 50 kWe range, there are several urgent needs with regard to upgrading Chinese products. These include design and production of the blades, improved gearing mechanisms, and advanced solid state controls. An important need is the development and in-country manufacture of high-quality single-phase and three-phase bi-directional inverters with embedded programmable controllers in the range of 5 kWe to 50 kWe. An additional technology commercialization effort is required in order to establish standard data acquisition and remote monitoring systems, to permit the monitoring and to some extent the control of community-scale hybrid power units by telephone, packet radio, or satellite links.

Task 2.1.2: Pilot demonstration of residential PV/wind hybrid power units: The UNDP/GEF project will support a closely monitored pilot demonstration for residential-scale hybrid systems. The hybrid center will provide small PV/wind hybrid units to households in Inner Mongolia, and will monitor and examine both the technical performance of the system and also the potential profitability of the units on either a sale or a utility-based ownership basis. Interested participants will be asked to choose a delivery model under which they can participate, and their payment schedule will be established and maintained accordingly. Between two and three hundred installations will be necessary to demonstrate the technology, the economics and business requirements for delivering electricity services through this technology. It is

essential to gather information on both the private sale and fee-for-service delivery means. Revenues generated on the basis of the resources provided through the GEF grant will be used as an endowment for a revolving fund to enable the hybrid center to expand its work to other areas.

In addition to this project activity, the Province of Inner Mongolia and the US Dept. of Energy are co-financing a project to assist suppliers in improvement of the quality and reliability of the equipment and support services for residential units. US-NREL is currently working with the GoC to facilitate US/Chinese collaboration for local production of high-quality charge controllers. About 300 systems will be installed under this parallel cofinanced activity to test technical and commercial viability over the next two years. The proposed activity will not only supplement the performance data assembled under this US collaborative effort, but it will augment that technical data with more information about the feasibility of profitably providing electricity services through this promising new technology.

Task 2.1.3 Community-scale pilot projects using hybrid power units (10, 30, and 50 kWe): Three pilot facilities will be installed at three different levels of system capacity to meet three different community load profiles: 10kW, 30 kW, and 50 kW. These community-scale pilot projects, which will be clustered in the same province for logistical reason, will each embody a community-scale mini-grid of a different size that is of interest to Chinese conditions. Consideration will be given to refiring one of the local community diesel-based grids built by the Ministry of Power, but which do not now function effectively. PV/wind/diesel power units and associated low-voltage minigrids will provide energy at the level of 50 - 300 kWhe per day for economically productive uses, community needs (school, health clinic, potable water supply, telecommunications, etc.) local government offices, and limited residential energy demand. The performance, costs, and maintenance requirements of these systems will be established through these prototype commercial operations. Again, emphasis will be placed on carefully monitoring both the technical and financial performance of the systems.

The pilot hybrid system installations will incorporate suitable technologies to assure revenue collection, such as prepayment meters or power management units that deliver a specified amount of energy per day for a monthly flat fee). Communities, households and community-based organizations will be required to pay for the services they receive. Revenues generated by the pilot facilities on the basis of the resources provided for the community-based systems will serve as an endowment for a revolving to facilitate expanded work with hybrid systems.

The hybrid power system installations will be clustered so that they can be supported by an associated local center that will be established for operation, monitoring, maintenance, and repair. The establishment and operation of the local support facility will provide essential information on required staffing, training, equipment, and capital and operating expenditures for such centers as an essential component of large-scale commercial diffusion. The center staff will monitor the operations of the pilot installations using remote monitoring equipment, carry out routine and preventive maintenance, record and analyze system performance records, and monitor end use patterns. At present, many electric utility companies centrally monitor distributed large conventional power plants using remote monitoring equipment. For the hybrid activities involved in this proposal, remote monitoring and control will be an essential part of large-scale use of distributed hybrid power generation units. Data acquisition and remote monitoring packages will permit automatic monitoring and control of the hybrid power units from the nearby operations center. Packet radio (digital radio) will be used for remote monitoring and control if reliable telephone lines are not available. Low-earth orbit satellites using "store-and-forward" messaging may also be used for remote monitoring, although their availability for use in activities of this kind in China have not yet been explored.

Bilateral sources are being solicited to provide additional technical information exchange and community-based system demonstrations.

Activity 2.2 Removal of Barriers to Windfarm Development

Although the identification of prime sites for wind farms is still undertaken using rudimentary techniques, official estimates indicate China's near-term wind generation potential to be 1,000 MWe. Available data indicate that China has world-class wind resources, with a technical potential estimated at 250,000 MWe.[2] For wind to become competitive as a source of on-grid generation, a number of barriers to wind-farm development will have to be removed. The removal of these barriers and the enhancing of China's capacity in these areas will result in the reduction of implementation costs, which will, in turn, help make wind competitive with fossil-fuel-based generation in China.

The barriers to realizing China's enormous potential for the generation of electric power through wind-farms have been identified as the following:

- Limited demonstration of the financial and economic viability of wind farms in China;
- An inadequate policy environment for investment in wind farms, notably the lack of a standard independent power purchase agreement (PPA) and supporting regulatory framework. The lack of a standard PPA results in very high transaction costs in the negotiations between a wind farm developer and the electric utility company.
- The lack of reliable in-country supply of advanced wind turbines (which in the near term will be addressed through joint venture wind farm projects using imported components with local content in the form of site preparation, civil works, buildings, wind turbine towers, field wiring, and the electric utility interface)
- The limited availability of wind resource data suitable for wind farm project identification, and associated limitations in the identification of the most promising sites for wind farms; and therefore
- Substantial uncertainties in wind farm technical and financial performance and electric grid interaction parameters for specific locations and wind farm technical parameters.

Rapid removal of these barriers is essential if China is to reach its goals and to embark on a successful major program of wind electric power development.

The following technical assistance activities have been designed to assist the Chinese in overcoming these barriers to windfarm development. Although these activities will not directly result in the construction of wind-farms, they will provide the essential education, training, and experience to permit China to rationalize and rapidly expand its wind electric power development program.

[2] See "China: Power-Related Renewable Energy Development Study" (1996) ASTAE, IENPD World Bank Washington DC. (various pages)

Task 2.2.1 Assessment of International Experience of Windfarm Development The goal of this task is to familiarize the Chinese who might be involved with or make decisions relevant to the wind industry with the experience of windfarm development in other countries. Two sets of actors will be involved in this active programme of study tours and assessments. The first set of actors will be professional staff of the Electric Power Research Institute (EPRI), the Ministry of Electric Power and the Chinese windfarm companies. They will undertake study tours to windfarm sites and wind turbine manufacturers. The goal is to provide them with an understanding of wind-farm technology and how wind-farms are developed elsewhere in the world. The candidate locations would be India, Germany, Denmark, the Netherlands, the UK, Costa Rica, and the US. The second target group are policy makers from the Ministry of Electric Power, the Electric Utilities, and the Ministry of Industry. The purpose of their study tour will be to visit the industrial complexes in different countries around the world where wind-turbine components are produced. The focus will be less technical in nature than the first group of activities, but will be intended to convince them that the wind-energy industry can serve as a leading sector for development. The potential sites for visitation would be in India, Germany, the Netherlands Denmark and possibly the US. Both study tour programmes will be coordinated through the European and American Wind Energy Associations and are intended to feed back into the Chinese wind development effort.

Task 2.2.2 Utility Planning for Windfarm Integration with Electicity Grid: In all countries making use of intermittent energy sources such as wind, there are a complex set of engineering and economic questions. These questions involve issues of system optimization, cost-minimization, capacity utilization and capacity credits, and the potential risks of intermittent supplies. To date, the Chinese electricity systems have not faced these issues in a substantial way, and this shortcoming will serve as an additional barrier to windfarm development. The goal of this technical assistance activity is to assess the impact of intermittent technologies on the electricity systems and to optimize generation planning given the unique constraints posed by these intermittent power sources.

Task 2.2.3 Project prefeasibility assessments: Prefeasibility assessments require at least one year of hourly wind resource data, so they cannot begin immediately unless full wind data sets are synthesized using locally available wind data. Prefeasibility assessments will be conducted for ten of the leading sites for windfarms, using the sites identified under Activity 1.4. These assessments will be conducted by teams of international and Chinese professionals, drawing on experienced expert consultants in the wind energy field. The goal is twofold. First, the process is important because it will result in a number of Chinese teams who are trained in doing windfarm pre-feasibility assessments. Future prefeasibility studies will seem easier and their costs should be lower. Second, the product of the activity, the prefeasibility studies themselves, will give the Chinese agencies a ready pipeline of windfarm projects which can be allocated to developers who can then carry out their own feasibility work. This will serve to "pre-condition" the market and to accelerate and lower the costs of commissioning those ten facilities. ($600k)

Activity 2.3 Removal of Barriers to the Commercialization of Large-Scale Anaerobic Digestors

Despite China's relative success with small, household-size biogas units, there are still relatively few medium- and large-scale anaerobic digestors in operation in China. According to some estimates, the 750 plants of this size which are in operation in China manage to process only about 10% of the liquid organic waste generated on-site. If large-scale biogas digestors could be installed throughout China at large livestock farms having more than 10,000 pigs, there is potential production of over nearly 600 Mm3 of biogas, approximately equal to another 100 MW of generating capacity. If all of the distilleries in China were to install these systems, there would be an equivalent of 900Mm3 of biogas generated per year,

roughly enough to fire another 150 MW of generating potential.[3] The adoption of medium and large-scale biogas digestors by farms and industries has been hampered by a number of technical, political, and financial barriers. These barriers are listed briefly below:

- On the technical side, because of relatively simple traditional designs which make use of masonry tanks (as opposed to enamelized steel tanks) and the lack of automatic temperature sensor and control equipment, the yield is relatively low by international standards. In turn, this means that the economic return to the technology is marginal.

  On the policy side, the price of coal is still lower than international market prices and environment regulations requiring factories to process their effluent are not enforced.

- Financially, the current VAT system provides refunds on some fuel purchases, but nothing in the case of self-generated fuel. Consequently, the financial returns are weak. Although distilleries face higher rates of return from biogas system operation, livestock farmers are dependent upon a relatively weak market for fertilizer in order to ensure adequate financial returns using current technology. If productivity of the plants can be increased, the profitiability (and therefore the sustainability) of the installation of these facilities of these plants will increase, even for smaller-scale livestock producers.

With improved technology, gas production will increase, but at a higher capital cost. Commercialization of this technology is needed to make available improved technological components at a lower price.

This activity will focus primarily on the activities relating to anaerobic digestors of the wastes from livestock farms. A secondary focus of the activity will be digestors for distilleries and food processors. However, as the technical challenges are simpler and the economic returns higher in the latter case, and the distilleries are "required" to process their effluents (such requirements are only occasionally enforced), the attention of this GEF activity will be on the needs of livestock farmers for profitable biogas installations. Three Pilot Plants will be built, partially financed by loan resources and partially financed by GEF resources. The three plants are initially intended to test the potential financial and economic returns from utilizing the biogas directly in boilers, injecting into a town-gas system, and using it to generate electricity. With improvements and standardization in the design, these projects are expected to become commercially viable in the future.

Five activities will be undertaken in order to remove these barriers to the accelerated commercialization of medium and large scale anaerobic digestors.

Task 2.3.1 Assessment of Best Practice in Use of Anaerobic Digestors for Waste Processing and Energy Production: This activity is intended to provide greater information about the current state-of-the-art in anaerobic digestion and thereby stimulate technological innovation on Chinese biogas designs. The task will involve two steps. First, it will entail a visit by Chinese specialists to a number of countries where anaerobic digestors operate routinely making use of best-practice technologies. Particularly relevant in this case are Germany and Denmark. Second, there will be an international review of best-practice undertaken by a selected international group of experts in consultation with the Chinese counterparts. This is intended to ensure that Chinese experts are familiar with the current "best practices" from around the world.

[3] See analysis contained in "China: Power-Related Renewable Energy Development Study" (1996) ASTAE, IENPD World Bank. Washington DC. (various pages)

Task 2.3.2 Design and Construction Supervision of Three Pilot Plants: As part of this activity, a Chinese team will design and supervise the construction of three pilot anaerobic digestors using state of the art technologies, as identified in Activity 2.3.1. The goal is to adapt those practices to Chinese conditions and explore with various configurations to attempt to identify a design which maximizes gas yields subject to cost constraints. Three pilot plants are selected initially to test the feasibility and financial returns from using the gas directly, transmitting it into a town-gas system, and using it to generate power. These are the three most common options for use of the gas in China.

Task 2.3.3 Construction of Three Pilot Phase Plants: In order to overcome the technical barrier to improved medium and large-scale biogas facilities in China, this task will construct three such plants to test and evaluate different design parameters prior to developing standards for the expanded procurement of these plants. This is important in order to reduce the risk of sub-optimal operation and to ensure that the improved designs work well under Chinese conditions. Because of the risk to the livestock farmers and the uncertainty of their economic returns, the GEF grant will pay for one third of the cost of the three plants being installed. The remainder of the costs will be borne either by the owners of the facilities themselves, financed either by Chinese government loans or soft loans being requested from bilateral sources. Because the market for the fertilizer by-product from livestock farm digestors is weak, the installations at livestock farms are at risk of obtaining relatively low returns, so that special care needs to exercised in the financial arrangements.

Task 2.3.4 Continuous Monitoring and Evaluation of Pilot Installations: After the pilot facilities are installed, continuous monitoring for the first year will be necessary to study the performance of the systems and obtain performance data for at least the first year's operations. A detailed evaluation of plant operation, including social, technical and financial performance, will be required in order to make recommendations for further design improvements and to prepare the model procurement specifications.

Task 2.3.5 Development of Model Procurement Specifications: This activity will involve careful study of the performance of the pilot installations in order to develop model procurement specifications for medium- and large-scale systems. These specifications will relate to tank size, material and construction, automatic sensor equipment, and the other key components in order to make possible their prefabrication. It will also make these specifications widely available to potential users of the technologies as well as to potential producers of the equipment. This is seen as a critical step in lowering the capital costs associated with these installations. This activity will also focus on the facilitation of the commercialization of large and medium-scale digestors. It will use the model procurement specifications to find local companies which can manufacture the main components of the new improved designs.

Activity 2.4 Removal of Barriers to Bagasse Cogeneration

China's Ninth Five-Year Plan aims to increase sugar production to 10 million tonnes per year from 6.2 million tonnes in 1995. At present, none of the wastes from this sugar milling activity are utilized for the generation of excess power for export to the electricity grid. For Guangxi Province (which contains roughly one third of the sugar production in China), the potential for excess power generation is estimated at 350 to 450 MW. Extrapolating from this figure to that for all of China given the nature of the facilities in existence provides an estimate of between 700 and 900 MW of excess power which can be exported from the sugar mills to the electricity grid based on current sugar production levels. As sugar production

increases, so too would the projected cogeneration potential.[4] All of this electricity generation potential would carry with it zero net emissions of greenhouse gases as the biomass feedstock is grown on an annual basis.

Investments in bagasse cogeneration can be profitable and sustainable once the technical designs and details of the installations are known in China. The technology is relatively well-known in the rest of the world and would bring a strong economic return. However, there are no such installations presently in operation in China. Analysis has indicated that there are several barriers to the implementation of surplus power projects based on efficiency increases in Chinese sugar mills. These are listed below.

- Limited Experience: Bagasse cogeneration has not been done in China previously. Sugar mills, by tradition, have been "energy self-sufficient" and there has been no incentive to develop a surplus energy condition. There is some familiarity with the concept of surplus power, but none with the complexity of technical and business issues involved in implementing such projects.

- Infrastructure: There is no infrastructure in place with which to develop the "business" of supplying surplus power to the grid, i.e., no contract mechanisms, no pricing schedules, and no guiding overall Government policy. There is also a limited set of technology available locally, and that which is available is not suitable for co-generation using bagasse as a feedstock

- Financing: A a very big obstacle to widespread adoption of surplus power supply from the sugar industry is a real or perceived lack of capital to support such projects. Electricity generation investments normally require access to capital with loan terms of at least 10 years which is possible because of the long term contracts available to sell power to a grid. Current sources of finance available to the Chinese sugar industry have 3 - 5 year terms and taking on a second (in addition to sugar production expansion) short-term debt service to enable surplus electricity generation has no appeal to the sugar mill operators.

The potential local and global environmental benefits that bagasse, as a renewable source of biomass fuel, inherently offers can only be taken advantage of if these barriers are removed. There is no opportunity to obtain these benefits if bagasse is used inefficiently or, in the worst case, is land-filled. The barriers can be overcome by providing appropriate technical assistance inputs and developing the contractual mechanisms for surplus power generation to be conducted as a routine business. These are the critical elements to address. A commercial-scale pilot project will provide the "come see and touch" example for the industry to follow. This project is expected to contribute to the removal of the barriers by providing appropriate technical guidance, training and capacity building, establishment of the essential contracting framework, and by assisting in the development of the framework for a longer-term financing plan. However, because of the profitable nature of the investment, GEF funds are being used for the technical assistance and engineering studies--either bilateral soft loans or State-financed loans will be used for the actual investment.

The following tasks are envisioned as being important to the removal of the barriers to bagasse cogeneration

[4] See "China: Power-Related Renewable Energy Development Study" (1996) ASTAE, IENPD World Bank. Washington DC. (pp 24-27 and Annexes). For more detail, see R. Chronowski, 1996, "Bagasse Cogeneration for Surplus power Production for Grid Supply" (unpublished).

Task 2.4.1 Evaluation of Technological Requirements and International Best Practices: Under this task, the Chinese team, in collaboration with a team of international consultants, will review international "best practices" in the fields of bagasse-based co-generation and review plans for adopting this technology in China. Study tours will be undertaken to Indonesia, Thailand, India, and possibly other countries with significant experience in this area. Again, the goal will be to learn from other countries' experiences for adaptation to China. (150k)

Task 2.4.2 Optimization of Technical and Agricultural Practices for Bagasse Cogeneration: Drawing upon task 2.4.1, this task will evaluate the various options for both boilers and sugar cultivation practices in order to optimize the systems used in China with respect to both sugar production and co-generation. On the technology side, local availability of key components will be important, and the activity will examine all of the relevant options from low-pressure to high pressure systems. The goal will be to identify the optimum configuration of boiler technology, turbine specifications, and instrumentation and control for bagasse-based cogeneration. This will result in a set of design specifications for improved bagasse facilities in China which will be used to design the initial Pilot Plant. It is possible that the efficient small and medium boilers developed under the World Bank GEF Project on Small Boilers may be a candidate for use in these facilities.

In addition to examining the technical options, the task will evaluate agricultural practices both species selection, agricultural productivity and the length of the sugar processing season with an eye toward altering current practices in order to maximize sugar production and increase cogeneration potential. Through a consultative process, the options will be screened, evaluated, and certain of them recommended for adoption in the areas where the pilot plant will be established. ($325k)

Task 2.4.3 Identification of Commercial Risks, Project Financing and Power Purchase Agreements: Under this task, the power purchase agreement for the power plant will be finalized and the commercial risk of the undertaking will be evaluated. This latter is important in order to remove the barriers to large-scale commercial financing. The project financing for the pilot plant will be facilitated and negotiated. It is important that the pilot plant goes through the same evaluation and implementation processes that other plants will face in order to ensure replicability. Finally, technical assistance will be needed to prepare the power purchase agreement for the Pilot Plant, which, if carefully prepared, can serve as a template for future bagasse-based co-generation plants.

Task 2.4.4 Design and Oversight of Construction of Pilot Plant: Under this task, a Chinese team assisted by experienced international engineers working in this area will design the pilot plant based upon the design decisions reached in Task 2.4.1 above. At this stage, the preferable option will be a high-temperature, high-pressure system. This design is expected to incorporate many of the best-practice elements identified above as well as serving as a model for future cogeneration plants at other sites. This task will also extend to overseeing the construction of the plant to ensure that it meets the design specifications. However, the actual financing for the plan will be obtained from bilateral or loan sources.

II.5 System Boundary

The boundary for the above analysis and discussion is the Chinese energy system.

II.6 Additional Domestic Benefits

If the technical assistance activities included in this project succeed in removing the barriers that they are intended to remove, these four renewable energy technologies will be able to diffuse themselves widely through profitable, commercial means throughout China. This means not only that increasing quantity of

energy will be produced, but that it will also be produced with little or no local pollution. Sulfur and particulate emissions which can now be linked to coal-fired power generation will be reduced. However, given the rapid growth of electricity demand in China and the need for time to disseminate the renewable energy technologies, there may be little noticeable difference which is attributable to this project. Such differences will only emerge over the medium to long-term.

In addition to the additional energy and air-pollution benefits, the installation of large-scale biogas plants in pig-farms will help reduce the water pollution, or more specifically, the CBOD in the wastes currently discharged from pig farms to water courses. This will be an additional domestic benefit from the proposed activity. With rare exceptions, livestock farms in China are not required to treat their effluent. In contrast, distilleries are increasingly required to treat their effluent. Because of this local environmental requirement, GEF support is being aimed at the pig-farms and not the distilleries.

II. 7 Incremental Cost Matrix

The incremental cost matrix is contained in the following page for the activities specified under Objective 2. Of the total incremental costs of US$12.2 million, GEF is being asked to provide US$ 4.935 million and the rest is being sought from bilateral soft-loan funds. If bilateral sources are insufficent to meet the needs, China State Economic and Trade Commission (SETC) has agreed to make state loans available.

Table II.1 Incremental Costs of Activities Defined Under Objective 2

Costs		National Benefits	Global Benefits
Baseline	Support for activities which may or may not be devoted to renewable energy by Chinese government and other institutions: Gov't $2,120,000 Others $4,050,000 Total US$6,170,000	Energy sector continues to rely on coal	CO2 Emissions will continue as forecast in baseline
Project Case	Removal of Barriers to Commercialization of Four Promising Renewable Energy Applications, specifically PV/Wind Hybrid systems for decentralized electrification, windfarm development, large-scale biogas, and bagasse cogeneration From outside funding sources / From Chinese funding sources / Total Activity 2.1 PV/Wind Hybrids $2,880,000 + $370,000 = $3,250,000 Activity 2.2 Windfarm Dev't $1,250,000 +$ 1,400,000 = $2,650,000 Activity 2.3 Large-scale Biogas $$2,075,000 +1,700,000 = $3,775,000 Activity 2.4 Bagasse Cogenm't $5,975,000 + $2,650,000 = $8,625,000 Total from all sources US$12,180,000 $6,120,000 = $18,300,000	Removal of barriers to the accelerated commercialization of renewable energy Accelerated uptake of promising renewable energy technologies through market mechanisms Reduction in local air pollution and reduction in BCOD in water bodies from pig-farm effluet	Reduction in CO2 emissions
Increment	Total Incremental Cost Required from outside sources = US$12,180,000 Amount Requested from: GEF US$4,900,000 Others US$7,280,000	Accelerated renewable energy Uptake Carry-over to IPP's for conventional electricity generation Reduced Pollution	Acceleration of commercialization of renewable energy Reduction in CO2 emissions