FINAL PROJECT BRIEF

1. IDENTIFIERS

PROJECT NUMBER :	
PROJECT NAME:	**Wind Power Development Project in the People's Republic of China (PRC)**
PROJECT DURATION:	3 years
IMPLEMENTING AGENCY:	United Nations Development Programme (UNDP)
EXECUTING AGENCY:	Asian Development Bank (ADB)
NATIONAL COORDINATING AGENCY:	State Development Planning Commission (SDPC)
REQUESTING COUNTRY:	People's Republic of China (PRC)
ELIGIBILITY:	***The PRC ratified the UNFCCC on January 5, 1993***
GEF FOCAL AREA:	Climate Change
GEF PROGRAMMING FRAMEWORK:	Operational Programme No. 6: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs

2. SUMMARY:

This Project aims to reduce GHG emissions by accelerating the growth of large-scale grid-connected wind power development to replace current fossil fuel consumption in the PRC. The objectives of the Project are to a) remove the policy, information, and institutional barriers to wind power development to promote wide replication of wind power commercialization in the PRC; and b) facilitate the implementation of three wind farms to be financed by ADB through GEF contingent loan support which will reduce performance risks associated with the deployment of this new technology and accelerate commercialization of wind farms in the PRC. This Project adopts a bottom-up approach to complement the overall national policy framework that is expected to be developed by the Government under its partnership program for renewable energy development and for which assistance will be provided by GEF and the World Bank. The Project focuses primarily on acceleration of commercialization of wind power development in the three provinces selected for the ADB-financed Project, and then promote and disseminate these provincial experience and lessons across the nation.

3. COSTS AND FINANCING (MILLION US$)

GEF:	US$ 12.0 million
CO-FINANCING:	
ADB:	US$ 58.0 million
Provincial Power Companies:	US$ 18.6 million
Domestic Banks:	US$ 9.4 million
TOTAL PROJECT COSTS:	**US$ 98.0 million**

4. OPERATIONAL FOCAL POINT ENDORSEMENT

Name: Mr. Yang Jinlin — Title: GEF Operational Focal Point

Organization: Ministry of Finance — Date: 26 June, 2000

5. GEF Executing Agency/Implementing Agency Contacts

Asian Development Bank: Edu Hassing, Mission Leader, ADB, tel 632-6326544; fax 632-636 2444; email ehassing@adb.org

United Nations Development Programme: Richard Hosier, Task Manager, tel 1 212 906 6033; fax 1 212 906 6998; email: richard.hosier@undp.org

PRC: WIND POWER DEVELOPMENT PROJECT (THE PROJECT)

RESPONSE TO GEF PROJECT REVIEW CRITERIA

IV. I. COUNTRY OWNERSHIP

A. Country Eligibility

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

B. Country Drivenness

2. Renewable energy incentive policies in the PRC include two levels: central governmental policy and local governmental policy. The central governmental policy provides guidelines at the macro-level, while local government policies are detailed implementation policies. However, an appropriate central government policy framework only could create the appropriate conditions for large-scale renewable energy projects to develop in the PRC.

3. Central Government policies to promote renewable energy development include three categories. The first category concerns general macro policies, such as the Program on New and Renewable Energy Development in the PRC (1996-2010) jointly prepared by the State Development Planning Commission (SDPC), Ministry of Science & Technology (MOST) and State Economic & Trade Commission (SETC). The Program provided the objectives and targets of renewable energy development in the PRC. As part of this program, the Government gives priority to grid-connected wind power development, and sets a target of 300-400 MW of installed capacity of wind power by the year 2000, and 1,000-1,100 MW by 2010. Given the latest development and plans from the major wind-producing provinces, the SETC and State Power Corporation (SP) recently updated their objectives and proposed more ambitious targets for wind power development in the PRC, as shown in Table 1. The 1995 Electricity Law also extends support to the solar, wind, geothermal, and biomass energy for power generation.

Table 1: Target of Wind Power Development in the PRC

	1998	2000	2005	2010	2015
"Program"	224	300-400		1,000-1,100	
SETC	224	740	3,000	4,900	7,000
State Power	224	763	3,117	5,066	7,313

Source: the "Program", SETC, and State Power Corporation.

4. The second category concerns the government regulations prepared by the associated administration ministries and commissions. The three major regulations to support grid-connected wind power development are the following:

(i) In 1994, the Ministry of Electric Power issued the "Regulation on Large Scale Wind Power Connected to Grid" as the first mandatory regulation for wind power development. The regulation specified that the grid must

purchase all the wind power generation. The power purchase price of wind power should be based on the debt repayment pricing principle and include VAT. The debt repayment pricing includes operating cost, repayment of loan capital with interest, and reasonable profit. The difference of the wind power purchase price and the grid average power price should be shared by the whole grid, but the regulation did not clearly specify the scope of the grid -- provincial, regional, or national grid.

(ii) In January 1999, SDPC and MOST jointly issued No. 44 document to further support renewable energy development. This regulation defined renewable energy, proposed investment subsidy measures for renewable energy projects through State Development Bank, and clarified the project approval procedure.

(iii) In November 1999, SETC issued another regulation to further promote wind power development in the PRC. For the first time, it specified that the price difference between the wind power and grid average price should be shared by the provincial grid, and encouraged wind power sales between the provincial grids.

(iv) In November 1999, SDPC announced its plan to establish under its tenth five year plan (TFYP) from 2001-2006 a Strategic Partnership for Renewable Energy with the main objective to reduce environmental emissions from coal-fired power generation by developing sustainable commercial markets for electricity from renewable energy. The Project fits with this partnership by giving momentum to a stagnant wind power market in anticipation of further policies such as a renewable portfolio standard to be formulated under the TFYP. Also, a World Bank/GEF pilot program for the partnership has been formulated, i.e., the China Renewable Energy Scale-up Program (CRESP), phase one, which aims at enabling commercial renewable electricity suppliers to provide energy to the electricity market efficiently, cost-effectively, and on a large scale. GEF assistance for CRESP, phase one, was approved during the GEF Council meeting in May 2001.

5. The Government also provides investment subsidies for renewable energy projects, such as the “Wind Plan” to support domestic manufacturing of wind turbines and the “Sunshine Plan” to encourage off-grid wind and solar PV for rural electrification by SDPC, and the “Foreign Capital Utilization Policy” and the “Double Push” investment in renewable energy by SETC. Local government policies could include investment subsidy, power purchase price subsidy, and taxation subsidy at the provincial level to support the renewable energy development.

C. Country Operational Focal Point

6. The National Operational Focal Point for GEF in the PRC is Mr. Yang Jinlin of the Ministry of Finance (MOF), who has endorsed the proposed Project. The letter of endorsement was signed on 26 June2000, and is in Appendix 3.

II. PROGRAM AND POLICY CONFORMITY

A. Program Designation

7. During its meeting of 1-3 November 2000, the GEF Council approved the Project for work program inclusion under Operational Program (OP) #6 on Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs as an intervention that supports the objectives of GEF assistance for the Strategic Partnership for Renewable Energy of the PRC.

B. Program Conformity

8. Development of grid-connected wind-based power generation as envisaged under the Project is a key objective of OP#6 and the Government's Strategic Partnership for Renewable Energy Development. The PRC has a rich wind resource base, and "world class" wind resources at wind farm sites. The Project conforms to the Operational Program and with its status of implementation, as set out in the *GEF Corporate Business Plan*. The Project will contribute to creating a firmer market for the supply of wind turbines which would make it economical for overseas manufacturers of wind turbines to transfer their assembly and manufacturing operations to the PRC thereby lowering the costs of the wind turbines. Also, the Project's demonstration effect with regard to the efficient construction and operation of wind farms will promote the development of additional grid-based wind farms.

C. Baseline Development Path

9. Despite the PRC's considerable national wind resource potential of more than 250 gigawatts (GW) the total installed capacity of grid-connected wind farms was about 265 MW only by the end of 1999. Most of them have an installed capacity of less than 20 MW and have been built with financial assistance through Government subsidies and/or soft loans from bilateral agencies and financing of wind farms on a commercial basis and with private sector involvement has not yet begun in a serious manner. The baseline path consists of what the Government would do without GEF support. Under the baseline, a number of barriers exist to the large-scale grid-connected wind power development in the PRC. These barriers comprise (i) high costs of wind-based electricity; (ii) lack of specific regulations for full payment of the price difference between conventional electricity and wind-based electricity; (iii) lack of competition for developers of wind-based power generation projects; (iv) lack of standard financial evaluation methods to determine tariffs for wind-based electricity; (v) limited market-oriented framework for development of wind-based power generation projects; and (vi) lack of reliable high-quality site-specific wind data. Without the removal of these barriers through this Project, the wind power market will remain undeveloped and the share of wind-based power in the national power mix is likely to remain negligible. Although the Government has begun promoting the use of alternative energy sources to replace coal and improve energy efficiency, coal is still likely to continue to provide two thirds of the PRC's commercial energy in 2020. This corresponds to a three-fold increase in coal consumption by the year 2020, and would lead to a threefold increase in GHG emissions by 2020. The US Energy Information Administration (EIA) has projected that the PRC will become the world's largest carbon emitter before the year 2020.

D. Global Environmental Benefits and Alternative Development Path

10. In this context the global environmental objective of the Project is the reduction of GHG emissions by removing major barriers to the development of wind-based power generation projects to replace fossil fuel use in the PRC. However, without the removal of such barriers through the Project it is unlikely that a widespread national program of replication of wind-based power generation will take place. Under the alternative development path the Project with GEF support will play a catalytic role in helping the PRC to begin capturing its enormous potential for wind-based power generation in a sustainable and efficient manner. GEF support is required for the following activities:

(i) Activity 1 is designed to decrease the wind power tariffs. This activity will develop a standard financial evaluation method specifically for calculating wind power tariffs, and estimate an appropriate wind power tariff benchmark level as an upper limit for wind power pricing approval. It will also improve the incentive regulations that clearly spell out the financing schemes and develop a mechanism for full compensation of the electricity distributors of the price difference between the wind-based electricity and the grid average price. It will hold wide consultations with key stakeholders to reach an agreement in this regard. Finally, this activity will provide training at the provincial level in the standard financial evaluation method for wind power tariff and implementation of standard power purchase agreement. This activity is targeted to remove the financial barriers (ii) and (iv), thereby making wind power more competitive and attractive.

(ii) Activity 2 is intended to develop a competitive institutional model for development of wind-based power generation projects. It will identify options for private sector involvement in the three wind farms under the Project and provide technical assistance in restructuring of existing wind power companies at Dabancheng, in the Xinjiang Uygur Autonomous Region. This activity aims to introduce competition in the development wind-based power generation facilities thereby decreasing wind-based electricity costs in the PRC. It is designed to remove the economic and institutional barriers (i) and (iii).

(iii) Activity 3 will assist the three provinces under the Project—the Xinjiang Uygur Autonomous Region and Liaoning and Heilongjiang provinces—in formulating and implementing market-oriented renewable energy policies, within the national renewable energy policy framework. It will assist in developing provincial wind power development plans; identifying options for development of provincial market-oriented wind power policies; developing RPS targets and implementation plans for wind power in the three provinces; and in conducting feasibility studies for green certificate trading. This activity is designed to directly remove the policy barrier (v) and facilitate future replication of wind power in the PRC.

(iv) Activity 4 will provide assistance for the preparation of the technical specifications for the wind turbines, procurement of the most efficient wind turbines in accordance with ADB's *Guidelines for Procurement*, and construction supervision of the same to ensure that the most efficient,

technically proven wind turbines will be procured and installed. This activity will also include conducting wind measurements at 25 promising sites in the three areas, transfer wind measurement data into the national wind resource database, as well as develop competitive bidding procedures for potential wind farm developers who may be interested to invest at these potential wind sites. This activity is designed to increase confidence in the construction and operation of grid-connected wind farms. It will also provide reliable site-specific wind resource information to potential investors, hence reducing the transaction costs for potential wind developers and facilitating future investment in wind power. This will directly remove the information barrier (vi). This activity is also targeted to promote economies of scale with regard to development of new wind farms and introduce competition among potential wind farm developers. It is expected to create a larger and firmer market for wind turbine manufactures and promote technology transfer and the development of a domestic wind turbine manufacturing industry, thereby reducing the costs of wind-based power generation and removing the economic barriers (i) and (iii). This activity is crucial to remove both the information and economic barriers and facilitate future replication of wind power projects in the PRC.

(v) Activity 5 will strengthen the evaluation capabilities of provincial decision-makers and increase their awareness and support with regard to wind power development. It will also strengthen the business development and management skills of staff of the wind farm companies.

(vi) Activity 6 will promote and disseminate at the national level the experience and lessons learned from the previous activities. This will further remove the information barrier and facilitate the larger replication of wind power development nationwide.

(vii) Activity 7 includes the provision of a GEF contingent loan to the respective provincial power companies, which will act as Executing Agency for the construction of the concerned wind farm. The contingent loan will have no interest charges and will need to be repaid in full after ten years following completion of the wind farms if the Project is successful. However, if the wind farms are not successful, the loan will become a grant for that/those wind farm(s) only, which had an unsatisfactory performance that was beyond the control of the concerned wind farm(s). These performance risks comprise lower than expected wind speeds (wind resource risk) and wind turbine reliability in view of the new technology and operation and maintenance procedures being applied as well as the present inadequate local availability of technical support from overseas wind turbine manufacturers in a fledgling market for grid-connected wind farms (technology risk). Experience in the PRC shows that the operation and maintenance of wind farms have often not been up to international standards and that sometimes wind farms have been constructed on the basis of overly optimistic assumptions with regard to the expected wind speeds, which has resulted in lower energy outputs than originally calculated in the feasibility studies and subsequent losses to the developers. For the three Executing Agencies, construction

of the three wind farms represents the first large-scale grid-connected commercial wind farm construction financed from ADB's ordinary capital resources at normal interest rates, which they therefore perceive as riskier investments than equivalent investments in fossil-fuel power plants. Use of the relatively modest contingent loan of $6 million constitutes an innovative tool that is provided to share with the wind farms perceived performance risks associated with operating wind farms under the present circumstances in the PRC, build confidence in the new technology, and leverage $92 million in mainstream financing from domestic and international partners. Also, under the Project options will be evaluated for increasing private sector participation in the wind farms in the future and the inclusion of a contingent loan in the financing arrangements for the wind farms is expected to promote the interest of the private sector in such participation.

E. Replicability

11. The Project's potential for replicability in other parts of the PRC is very good since the Project constitutes a bottom-up approach within the overall policy framework that is envisaged to be developed by the Government under its Partnership Program for Renewable Energy Development for which assistance is expected to be provided by GEF, the World Bank, and ADB. Support for barrier removal and institutional strengthening will facilitate such replicability since it will create at provincial levels the required institutional, policy, and technical conditions to enable the mobilization of funds for the development of additional wind farms. In addition, as mentioned above Activity 6 will promote and disseminate lessons learned at provincial level at the national level.

F. Sustainability

12. From a technical point of view, the technical feasibility of grid-connected wind power technologies has been proven in both the international market and the PRC context. In anticipation of a separate market for renewable energy, which is expected to be established under the Government's TFYP but will require at least a few more years from now before it will become operational, the Project will help create a sustainable demand for wind farms through building local capacity, supporting three wind farms, and disseminating information. These efforts should ensure the long-term sustainability of wind power technology in the PRC.

13. From a financial point of view, the Project will first help improve the wind power tariff structure, decrease the wind power tariffs in the PRC, and clearly establish a mechanism to fully pay the provincial power companies for the price difference between wind-based electricity and conventional electricity. Subsequently, it will help introduce competition by developing a competitive institutional model for wind power project development for both the three wind farms under the Project as well as subsequent wind farms that would be constructed at some of the 25 selected promising sites where wind measurements will be conducted. These measures will cause a decrease in the cost of wind-based power generation in the PRC. Further, the Project will provide training to wind farm companies in business development and management skills to reduce the operating costs for the wind farms. It will also develop market-oriented renewable energy policies and implementation action plans for the provinces to provide additional incentive

policies and market-mechanisms to promote commercialization of wind power development in the PRC and will make high-quality site-specific wind measurement data available to potential investors to attract increased investments in wind power development in the PRC.

14. From an institutional point of view, the Project will strengthen the evaluation capabilities of provincial decision-makers and increase their awareness and support with regard to wind power development in the PRC. The Project will also make recommendations for development of a competitive institutional model for development of wind power projects in the PRC. All these efforts will ensure the institutional sustainability.

G. Public Involvement

15. Public involvement in the Project has been assured. During the Project preparation stage extensive discussions were held with local stakeholders and socioeconomic profiles were prepared for all sites and all local communities support the development of the wind farms. All sites are uninhabited and adequate compensation will be paid to original users of the land. At the site of the wind farm in the Xinjiang Uygur Autonomous Region, Kazakhs ethnic minority herdsmen have been using the land of the site for cattle grazing during the seasons when grass is available. About 3 to 4 families will lose their seasonal grazing rights and will be compensated. Finalization of adequate compensation packages is a condition for financing of the wind farms. The dissemination at the national level of the experience and lessons learned under the technical assistance for barrier removal and institutional strengthening will also ensure that a wide audience interested in the further development of wind-based power in the PRC will be able to learn from the Project.

H. Private Sector Involvement

16. The Project is also expected to be instrumental in promoting private sector investments in wind farms in the PRC. Under the Project feasibility studies on options for attracting private investors and nongovernment investment funds in the wind farms will be undertaken to facilitate the mobilization of such financing. Also, competitive bidding procedures will be developed to attract potential wind farm developers who may be interested to invest at any of the 25 potential wind sites where wind measurements will be conducted.

I. Monitoring, Evaluation, and Indicators

17. The Project will be monitored and evaluated in line with ADB rules and procedures and the GEF guidelines for M&E. ADB will undertake this activity in coordination with the GEF focal point ministry in the PRC, MOF, and the National Coordinating Agency of the Project (SDPC). ADB's extensive experience in monitoring large projects will be drawn upon to ensure that all Project activities are carefully recorded, documented, and accounted for. Data will be collected on the key performance indicators and results of the monitoring and evaluation surveys will be used to implement changes to the Project, if necessary, and for future reference in the development of similar projects. Annual Performance Reports will be prepared and discussed with the national coordinating agency, the Executing Agencies, and Project staff. The progress of the various barrier removal and institutional strengthening

activities will be discussed in semi-annual Tripartite Review meetings with the National Coordinating Agency, the Executing Agencies, consultants, and ADB, so as to take the necessary action to improve and maximize Project impact and implementation. The Project will be subject to at least two to three external evaluations. The contingent loan is to be repaid in full after ten years following completion of wind farms if the Project is successful. The Project is considered successful if during the three years prior to repayment all wind farms have achieved an availability of more than 95 percent, complied with the financial covenants, and made a reasonable profit. If the Project is not successful, repayment of the GEF contingent loan by the concerned wind farm(s) is not required only if it has been established that its/their failure to become successful is due to wind resource and/or technology deficiencies that were beyond the control of the wind farms as explained in paragraphs 66-68 and 75 of the attached Report and Recommendation (RRP) of the ADB President on the Project (Attachment 1).[1]

18. ADB will undertake continuous monitoring of the Project activities through regular Review Missions, submission of Quarterly Progress Reports and annual Audited Financial Statements by the Executing Agencies, and consultants' reports. ADB will also carefully monitor the external conditions related to the critical assumptions listed in the Project's logical framework as shown in Attachment 1 (Appendix 1). At the outset, detailed and measurable performance indicators for the overall Project will be prepared by ADB in consultation with UNDP, MOF, SDPC, the provincial power companies, the wind power companies, and other concerned stakeholders, which will be incorporated in a comprehensive monitoring and evaluation (M&E) program. This M&E program will be implemented by the provincial power companies and supervised by SDPC. It will form part of ADB's Project Administration Memorandum (PAM) for the Project that is to be finalized as soon as the ADB loan has become effective. The M&E program will measure and evaluate not only the progress of the project activities but also the impact of the project on the environment, local communities, the economy, and further development of grid-connected wind farms in the three areas. Post-construction performance indicators will include (i) prices and sales of wind power, (ii) avoided greenhouse gas emissions and generated 'green' credits, (iii) economic and health status of concerned local communities, (iv) number of additional wind farms to be developed in the three provinces as a result of barrier removal and institutional strengthening undertaken under the Project, and (v) comparison of the baseline scenario with actual achievement for each activity supported by GEF. In addition, the Government and ADB have agreed to maintain financial covenants as defined in the Loan and Project Agreements to ensure an acceptable financial performance of the wind power companies. To determine whether repayment of GEF contingent loan after 10 years following completion of the wind farms is required, the M&E program will evaluate whether the Project can be considered successful or unsuccessful at that time. For this purpose, the M&E program will specifically monitor and evaluate (i) the annual availability achieved by each wind farm, (ii) their annual compliance with agreed financial covenants, (iii) their annual profit/loss statements, (iv) the wind resource measurements, and (v) operation and maintenance records and equipment failure reports of the wind power companies. The Project is considered successful if during the three years prior to repayment all three wind power companies have achieved an availability of 95 percent, complied with the financial covenants, and made a reasonable profit, i.e., an average return on equity of at

[1] Since ADB approval of the Project in December 2000, the project implementation schedule as reflected in Attachment 1 (Appendix 8) has become outdated and an updated project implementation schedule is shown in Appendix 4.

least 15 percent, in which repayment of the GEF contingent loan is required as a bullet payment. In all other cases, the Project is considered unsuccessful; however, repayment of the GEF contingent is still required except if it can be proven that the unsuccessfulness of the Project is due to wind resource and/or technology deficiencies that were beyond the control of the wind power companies. The former will be evaluated against the projected wind resources and the actual wind resource data as maintained by the wind power companies while the latter will evaluated against operation and maintenance reports and equipment failure reports of the wind power companies.

J. Lessons

19. The design of the Project has drawn lessons from previous UNDP/GEF sponsored wind projects. To date, the first lesson learned is the importance of an appropriate level of power purchase price and priority dispatch in the power purchase agreement (PPA) to ensure the financial viability of the wind farms. Appropriate PPAs for the wind farms under the Project will need to have been developed, agreed, executed, and delivered as a condition for financing while Activity 1 (for barrier removal and institutional strengthening) under the Project is designed to address this issue in more detail for subsequent wind farms through the development of benchmarks for wind power tariffs in the concerned areas. The second lesson is the importance of reliable high-quality wind resource data, which will be addressed under Activity 4. The third lesson is the importance of the market mechanism policies to reduce the costs of wind-based electricity, which will be addressed under Activity 3.

III. FINANCING

A. Budget and Financing Plan

20. No GEF financing under PDF (blocks A, B, and C) has been requested for Project preparation. GEF has agreed to provide a zero-interest contingent loan of $6 million to address the incremental financial risks associated with the construction and operation of the wind farms providing approximately US$2 million of the contingent loan for each wind farm. If the wind farms are successful, it will be repaid to GEF by the 10th year following completion of the wind farms through ADB. If the wind farms are unsuccessful as a result of wind resource and/or technology deficiencies beyond the control of the wind farm operators (see paragraph 17), it reverts to a grant. The remaining foreign exchange costs of $58 million will be financed by a loan from ADB that will carry a front-end fee of 1 percent, an interest rate to be determined in accordance with ADB's pool-based variable lending rate system for US dollar loans, and a commitment charge of 0.75 percent a year. The loan will have a repayment period of 20 years and a grace period of 3 years. The GEF contingent loan and the ADB loan will be provided under a joint cofinancing arrangement which will result in a net effective interest rate of the combined proceeds of about 5.9 percent. The local currency costs associated with the construction of the wind farms will be financed by the Executing Agencies (the provincial power companies) through mobilizing equity participation in the wind farms from their own and other sources and arranging loans from domestic banks and/or financial institutions. Support for barrier removal and institutional strengthening of $6 million equivalent is envisaged to be financed by GEF on a grant basis. As agreed with the GEF Secretariat, $2 million of the GEF contingent loan as well as $400,000 of the GEF grant (for consulting services for construction of the wind farm in Heilongjiang

Province) will be made available when ADB has declared its loan effective. As each successive wind farm meets the conditions for loan disbursement, an additional $2 million of the GEF contingent loan and the corresponding $400,000 of the GEF grant will be made available. The remainder of the GEF grant of $4.8 million for barrier removal will be made available only when both the wind farms in the Xinjiang Uygur Autonomous Region and Liaoning Province have met the conditions for disbursement under the ADB loan. The financing plan for the Project is given below.

Table 2: Financing Plan
($ million)

Item	Foreign Exchange	Local Currency	Total	Percent of Total
Equity				
XEPC (Executing Agency)		7.0	7.0	7.2
HEPC (Executing Agency)		5.9	5.9	6.0
LEPC (Executing Agency)		5.7	5.7	5.8
Total Equity		18.6	18.6	19.0
Loans				
ADB	58.0		58.0	59.2
GEF (contingent loan)	6.0		6.0	6.1
Domestic Banks		9.4	9.4	9.6
Total Loans	64.0	9.4	73.4	74.9
GEF Grant (support for barrier removal and institutional strengthening)	5.0	1.0	6.0	6.1
Total Project	**69.0**	**29.0**	**98.0**	**100.0**

B. Incremental Cost

21. The total baseline costs of the Project are $86.0 million. The total Project costs are $98.0 million including total incremental costs of $12 million. The detailed costs are given in the section E of the Project Brief. An incremental cost assessment, including incremental cost matrix, is provided in Appendix 1. It discusses the baseline scenario and the GEF alternative scenario and identifies incremental cost components.

C. Financial Modality

22. The use of the contingent loan can be seen as a temporary, evolving, financing tool to be used in the early technology development stage of wind-based electricity generation and in the absence of a separate market for renewable energy when the cost of the capital goods and produced electricity are still relatively high in comparison with conventional power generation and financing for construction of the same on a non-concessionary basis is considered relatively risky in view of the perceived performance risks. The GEF contingent loan for the Project will merely balance the higher risks and costs and associated with developing the initial wind farms in an incipient market that is not at a level playing field with the market for conventional power generation. The contingent loan approach will help reduce the performance risks i.e, the wind resource and technology risks, associated with the operation of the three wind farms, which have high front-end costs. It will make the first time financing of wind farms through a non-

concessionary loan from a multilateral development agency less risky and acceptable to the investors/Executing Agencies (the provincial power companies). These efforts will ensure the financial sustainability and viability of the wind power development after Project completion. It will thereby facilitate the investments to be made by the Executing Agencies while ensuring the effectiveness of the associated loans from domestic banks and ADB. The success of the three wind farms will demonstrate the technical and commercial viability of large-scale grid-connected wind farms in the PRC largely financed from non-concessionary sources. It will therefore facilitate the development of future wind power in the PRC, thereby reducing future perceived performance risks.

D. Financial Sustainability

23. The financial sustainability of the GEF-financed wind farms will be ensured through the policy dialogue that ADB had with regard to the dispatch and distribution of the electricity. First, the Government has agreed that the purchasers/distributors of the electricity, the provincial power companies, will be fully compensated for the incremental cost of the electricity and second, under the PPAs the provincial power companies will be required to give priority to the dispatch of the electricity. This will substantially increase the use and availability of the wind farms in comparison with other wind farms in the PRC and reduce the tariffs. Also, the O&M capability of wind farm personnel will be strengthened through O&M training by the turbine manufacturers during the first year of operations. The implementation arrangements for construction of the wind farms with separate Project implementation offices for construction of each wind farm assisted by Project implementation consultants will also ensure that the required technical and organizational skills will be available to plan and supervise the construction of the wind farms and operate the same after one year of operation by the contractors.

IV. INSTITUTIONAL COORDINATION AND SUPPORT

A. Core Commitments and Linkages

24. The ADB's Country Assistance Plan for the PRC is aimed at helping the country achieve economic growth in an efficient, equitable, and sustainable manner. In the power sector ADB is placing priority on the need to meet the growth in power demand, and enhance energy efficiency and reduce adverse environmental impacts. In this context ADB promotes the development of cleaner energy sources including renewable energy. ADB has provided grants with an estimated total value of more than $6 million for a number of technical assistance projects to promote renewable energy development and reduce GHG emissions in the PRC. The Project will be the first ADB-financed project for renewable energy development in the PRC and has been developed following a detailed feasibility study financed and implemented by ADB.

B. Consultation and Coordination

25. During the Project's design close consultations were held with the relevant Government agencies, UNDP, and the World Bank to coordinate the proposed activities under the Project with their ongoing and planned activities to promote renewable energy development in the PRC. Complementarity of the bottom-up approach of the Project activities in the three provinces with the activities envisaged under the future GEF/World Bank input for the Government's Strategic Partnership for Renewable Energy

Development has been assured through the design of specific activities at the level of the three concerned provinces where until now no barrier removal activities have taken place and coordination of these activities by SDPC which is also the National Coordinating Agency for the Government's Partnership for Renewable Energy Development. During Project implementation, coordination of activities will be facilitated through the sharing of the findings and reports as well as regular meetings of ADB staff with UNDP and World Bank counterparts to discuss the same.

V. RESPONSIVENES TO REVIEWS

A. Comments on the Concept Paper

26. The GEF Council has made no comments on the Concept Paper upon pipeline entry. Comments made by the GEF Secretariat concerned (i) the confirmation of country drivenness and conformity with the current renewable energy priorities of the Government, (ii) the need for clarification on how the Project relates to ongoing renewable energy efforts in the PRC and how it will be coordinated, (iii) the need for clarification how the Project relates to currently ongoing efforts to develop a strategic renewable energy market development framework, and (iv) the need for one lead agency to be designated by the Government for the development of the programmatic renewable energy framework which would avail of PDF funding. Issue (i) has been addressed in paragraphs 2-8 above. With regard to issues (ii) and (iii) it has explained in the previous paragraph that the Project has been developed at the provincial level and will operate within the framework envisaged to be developed under the Government's Partnership for Renewable Energy Development. ADB is also expected to contribute further to this partnership which will facilitate coordination of the activities under the partnership with activities under the Project and ADB consultations with all other parties contributing to the partnership. The Government considers the Project to be part of this partnership. With regard to issue (iv) the Government has decided that SDPC, the National Coordinating Agency for the Project, will be the lead agency for the development of the programmatic renewable energy framework (under the partnership). The World Bank's comments on the Concept Paper mainly concerned the overlap of activities that at the time of preparation of the Concept Paper were envisaged for GEF financing under the Project. However, the presently envisaged activities as listed in paragraph 10 do not overlap with any other ongoing or envisaged activity and will complement or strengthen ongoing activities such the establishment of a national wind resource database and promotion of private sector investments in wind farms.

B. Comments on the Project Brief

27. GEFSec commended the cover note as an excellent note that may serve as a role model for future submissions of cover notes by Implementing Agencies. GEFSec recommended the Project for work program inclusion as an intervention that meets OP#6 programming criteria and supports the objectives of the GEF renewable energy partnership with the PRC. In addition, it was agreed with GEFSec that to avoid misunderstandings on the nature of the contingent financing and the risks covered, a section would be added to the Project Brief, which underlines that the proposed financing modality does by no means constitute a capital cost subsidy. This is explained in the attached RRP (paragraph 75) and can be summarized as follows:

(i) The use of the GEF contingent loan is an innovative tool that will be provided to share with the wind farm companies the perceived performance risks associated with wind farms in the PRC and build confidence in the new technology. As explained in paragraph, item (vii) above, these performance risks comprise the wind resource risk and the technology risk as experienced by wind farm developers in the PRC. It can reasonably be expected only that these perceived risks will gradually decrease over time with leveling of the playing field for wind power vis-à-vis conventional power, increased construction of wind farms, and increasing experience in wind farm development and operations.

(ii) In this context, the use of the GEF contingent loan should be seen as a financing mechanism that is temporarily used for merely balancing the higher performance risks associated with developing wind farms in an incipient market that is not at a level playing field with the market for conventional power generation and from a financial perspective is not competitive with it.

(iii) The GEF contingent loan will provide the necessary encouragement to the Executing Agencies to invest in the development of wind farms prior to the establishment of a separate market for renewable energy that is expected to become gradually operational during the Government's TFYP only. In the meantime, use of the GEF contingent loan will thus help create a momentum for accelerated development of large-scale wind farms and will contribute to improved conditions for development of such wind farms once the separate market for renewable energy has become operational. Any hiatus in the establishment of new large scale wind farms until then will result in considerable opportunity costs in terms of a continuing stagnant market, delayed localizing of assembly/manufacturing of wind turbines, deferred gains in experience in operating large scale wind farms, postponement of mobilizing nongovernment funds for financing large scale wind farms, and delays in adopting appropriate policies and creating the necessary conditions for further wind power development in the three provinces.

(iv) As stated in paragraph 20, the effective interest rate of the combined GEF contingent loan and the ADB loan is 5.9 percent which is close to the estimated weighted cost of capital for the Executing Agencies at 6.0 percent and the present interest rate on local borrowings; any grant element in this financing arrangement is therefore expected to be marginal.

28. On 2 November 2000, the GEF Council approved the Project for work program inclusion as an intervention that meets OP#6 programming criteria and supports the objectives of the Government's renewable energy partnership with GEF. ADB has also addressed the following conditions set by GEFSec for GEF CEO endorsement:

(i) Demonstrate relationship of the Project to the Government's renewable energy partnership with GEF.

The attached RRP includes a specific section (paragraphs 48 and 49) that explains how the intervention relates to the Government's renewable energy partnership with GEF during the transitional period before the establishment of an appropriate regulatory and policy framework that will make a separate

market for renewable energy development and utilization viable. GEFSec also convened a meeting with the participation of the Ministry of Finance, The World Bank, UNDP, and ADB in Beijing on 1 December 2000 at which a common understanding on the guiding principles for GEF supported renewable energy projects in the PRC was reached.

(ii) Define risks that will be addressed by proposed contingent financing modalities, risk sharing arrangements, and related repayment and time frames.

The attached RRP (paragraphs 75, 106, and 107) explains in detail the risks that will be addressed by the GEF contingent loan, the risks sharing arrangements under the Project, and the conditions and terms for repayment of the GEF contingent loan (see also paragraphs 17 and 20 above).

(iii) Include performance indicators and monitoring arrangements required to guide the repayment of the contingent loan in a comprehensive M&E plan, which would also explain how the lessons learned in the investments sponsored by the Project would be disseminated and utilized to promote replication.

As explained in paragraph 75 of the attached RRP, the GEF contingent loan needs to be repaid in full after 10 years following the completion of the wind farms unless the Project is unsuccessful due to wind resource and technology deficiencies that were beyond the control of the wind farms. Criteria for determining whether the Project whether the Project is successful have been defined (see also paragraph 17 above). ADB will closely monitor the performance of the Project (see also paragraph 18 above) and the lessons learned from the Project will be disseminated through activity 6 of the GEF-financed activities for barrier removal and institutional strengthening (see paragraph 10 above).

29. At the GEF Council meeting of 1-3 November 2000, the Government of Switzerland commented that the project proposal is well-described and detailed and that it focuses on two crucial issues for adoption of renewable energy technologies, i.e., the successful demonstration of the technical and economic viability of three wind farms and removal of institutional barriers. The Government of France commented that the project description was well-documented and that the appraisal of the Project would benefit from a more in-depth analysis of the relationship between wind energy resources and wind power tariffs. This has been done and as in Appendix 11 of the attached RRP a model was developed that based on the probable wind speeds and agreed financial return for the various wind farms provides a wind power tariff to be used for each wind farm.

B. Other Technical Comments

30. As requested by the Government ADB is expecting to become more involved in the development and financing of renewable energy projects in the PRC in the coming years. It is taking steps to develop a pipeline of suitable projects and is expected to increase the number of staff assigned to renewable energy activities.

C. STAP Roster Review

31. An independent technical (STAP) review of the Project was carried out by D. Kammen of the University of California, Berkeley. The STAP review and ADB's response are attached in Appendix 2.

INCREMENTAL COST

A. Broad Development Goals

1. The overall development objective of the Project is the provision or supply of sufficient electricity and energy to meet national development needs at the lowest possible cost. Without GEF intervention, meeting this goal will require increased use of coal-fired power plants.

B. Baseline

2. The baseline consists of what the Government would do without GEF support. Under the baseline, a number of barriers exist to the large-scale grid-connected wind power development in the PRC. Without these barriers being removed through the Project, wind power market will remain undeveloped. The share of wind power in the national power mix is likely to remain negligible. Although the Government plans to launch aggressive programs to increase the use of alternative energy to replace coal and improve energy efficiency, coal is still likely to continue to provide two thirds of the PRC's commercial energy in 2020. This corresponds to a three-fold increase in coal consumption by the year 2020, and leads to a tripled GHG emission by 2020. The US Energy Information Administration (EIA) projects that China will become the world's largest carbon emitter before the year 2020.

C. Global Environment Objectives

3. The global environmental objective of the Project is the reduction of GHG emissions by removing the major barriers to the development of wind power to replace fossil fuel use in thee PRC. The Project has been designed to be consistent with GEF Operational Program #6 on "Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs".

D. GEF Alternative

4. Wind resource assessment studies have indicated that the PRC has a potential of 250 gigawatt (GW) of power capacity from wind. Although the Government has made aggressive efforts and placed a high priority to promote wind power development, the barriers that exist, prevent the PRC's enormous potential from being realized. Without the barriers being removed through the Project, however, a widespread national program of replication of wind power is unlikely to take place. GEF support will play a catalyzing role to help the PRC to tap its enormous potential.

5. Activity 1 is designed to decrease wind power tariffs. This activity will develop a standard financial evaluation method specifically for calculating wind power tariffs, and estimate an appropriate wind power tariff benchmark level as an upper limit for wind power pricing approval. It will also improve the incentive regulations that clearly spell out the financing schemes and develop a mechanism for full compensation of the electricity distributors of the price difference between the wind-based electricity and the grid average price. It will hold wide consultations with key stakeholders to reach an agreement. Finally, this activity will provide training at the provincial level in the standard financial evaluation method for wind power tariff and implementation of standard power purchase agreement. This activity is targeted to remove the financial barriers (ii) and (iv) thereby making wind power more competitive and attractive. This is

an activity entirely focused on removing barriers and building capacity, which would not take place without this project.

6. Activity 2 is intended to develop a competitive institutional model for development of wind-based power generation projects. It will identify options for private sector involvement in the three wind farms under the Project and provide technical assistance in restructuring of existing wind power companies at Dabancheng, in the Xinjiang Uygur Autonomous Region. This activity aims to introduce competition in the development wind-based power generation facilities thereby decreasing wind-based electricity costs in the PRC. It is designed to remove the economic and institutional barriers (i) and (iii).

7. Activity 3 will assist the three provinces under the Project—the Xinjiang Uygur Autonomous Region and Liaoning and Heilongjiang provinces—in formulating and implementing market-oriented renewable energy policies, within the national renewable energy policy framework. It will assist in developing provincial wind power development plans; identifying options for development of provincial market-oriented wind power policies; developing RPS targets and implementation plans for wind power in the three provinces; and in conducting feasibility studies for green certificate trading. This activity is designed to directly remove the policy barrier (v) and facilitate future replication of wind power in the PRC.

8. Activity 4 will provide assistance for the preparation of the technical specifications for the wind turbines, procurement of the most efficient wind turbines in accordance with ADB's *Guidelines for Procurement*, and construction supervision of the same to ensure that the most efficient, technically proven wind turbines will be procured and installed. This activity will also include conducting wind measurements at 25 promising sites in six selected provinces, transfer wind measurement data into the national wind resource database, as well as develop competitive bidding procedures for potential wind farm developers who may be interested to invest at these potential wind sites. This activity is designed to provide reliable site-specific wind resource information to the potential investors, hence reducing the transaction costs for potential wind developers and facilitating future investment in wind power. This will directly remove the information barrier (vi). This activity is also targeted to promote economies of scale with regard to development of new wind farms and introduce competition among potential wind farm developers. It is expected to create a larger and firmer market for wind turbine manufactures and promote technology transfer and the development of a domestic wind turbine manufacturing industry, thereby reducing the costs of wind-based power generation and removing the economic barriers (i) and (iii). This activity is crucial to remove both the information and economic barriers and facilitate future replication of wind power projects in the PRC.

9. Activity 5 will strengthen the evaluation capabilities of provincial decision-makers and increase their awareness and support with regard to wind power development. It will also strengthen the business development and management skills of staff of the wind farm companies.

10. Activity 6 will promote and disseminate at the national level the experience and lessons learned from the previous activities. This will further remove the information barrier and facilitate the larger replication of wind power development nationwide.

11. Activity 7 includes the provision of a GEF contingent grant to the respective provincial power companies, which will act as Executing Agency for the construction of the concerned

wind farm. The contingent loan will have no interest charges and will need to be repaid in full after ten years following completion of the wind farms if the Project is successful. However, if the wind farms are not successful, the loan will become a grant for that/those wind farm(s) only, which had an unsatisfactory performance that was beyond the control of the concerned wind farm(s). These performance risks comprise lower than expected wind speeds (wind resource risk) and wind turbine reliability in view of the new technology and operation and maintenance procedures being applied as well as the present inadequate local availability of technical support from overseas wind turbine manufacturers in a fledgling market for grid-connected wind farms (technology risk). Experience in the PRC shows that the operation and maintenance of wind farms have often not been up to international standards and that sometimes wind farms have been constructed on the basis of overly optimistic assumptions with regard to the expected wind speeds, which has resulted in lower energy outputs than originally calculated in the feasibility studies and subsequent losses to the developers. For the three Executing Agencies, construction of the three wind farms represents the first large-scale grid-connected commercial wind farm construction financed from ADB's ordinary capital resources at normal interest rates, which they therefore perceive as riskier investments than equivalent investments in fossil-fuel power plants. Use of the relatively modest contingent loan of $6 million constitutes an innovative tool that is provided to share with the wind farms perceived performance risks associated with operating wind farms under the present circumstances in the PRC, build confidence in the new technology, and leverage $92 million in mainstream financing from domestic and international partners. Also, under the Project options will be evaluated for increasing private sector participation in the wind farms in the future and the inclusion of a contingent loan in the financing arrangements for the wind farms is expected to promote the interest of the private sector in such participation.

E. Incremental Cost Matrix

12. The total Project costs, including capital investments in the three wind farms, amount to a total of $98.0 million. GEF will contribute a total of $12 million; ADB financing is $58.0 million with an equity contribution by the provincial power companies of $18.6 million equivalent and loans from domestic banks of $9.4 million equivalent. The incremental cost matrix shown on the next pages.

A. INCREMENTAL COST MATRIX

Activity	Baseline	Alternative	Increment
Activity 1. Improve wind power tariff structure	There is a wide variation in wind power tariff in the PRC, because there is no standard financial evaluation method to calculate wind power tariff. In addition, wind power tariff is too high in the PRC, making wind power less competitive in the market.	A standard and transparent financial evaluation method will be available. A wind power tariff benchmark will be set up as an upper limit. The three provinces will have the capacity to implement the standard financial model and PPAs.	Wind power tariff will be lower. Estimating wind power tariff has to follow a standard approach. Wind farms with high wind power tariff will not be approved. Wind power will become more competitive in the market. People's misconception of wind power being too expensive will be corrected. The standard financial evaluation method and PPAs will be implemented smoothly at the provincial level.
	The provincial power companies do not incentives to develop or purchase wind power because they have to share at least part of the price difference between the wind power price and grid average price.	A mechanism will be developed for full compensation of the power distributors of the price difference between the wind-based electricity and the grid average price. The price difference will be allowed to fully pass on to consumers.	The price difference will not become a big burden to the provincial power companies. The utilities will have increased incentives to develop or purchase the wind power competitively.
	Cost: 0	Cost: US$550,000	Cost: US$550,000 (GEF)

Activity	Baseline	Alternative	Increment
Activity 2. Develop competitive institutional models	The three wind farms to be financed under the Project will continue to be either utility-owned or utility as a major shareholder. The utility monopoly will remain to exist. There will be no competition and private sector involvement in the three wind farms. The operation efficiency of wind farm companies will continue to be low. Wind power cost and tariff will remain to be higher than it should be. Cost: .0	Recommendations on introducing competitive institutional model and private sector involvement will be proposed. The wind power companies in Dabancheng wind site will be restructured. Cost: US$550,000	The three wind farms will demonstrate a competitive institutional model for wind project development. Competition will be introduced. Non-government funds will be attracted. The utility monopoly will be broken. The operation efficiency of the wind farms will be improved. The wind power cost and tariff will be substantially reduced. Wind power will become more competitive in the market. Cost: US$550,000 (GEF)
Activity 3. Implement market-oriented wind power policy at provincial level	There will be no wind power planning at the provincial level. There will be no provincial wind power policy and implementation action plans for national renewable energy policy framework. There will be limited market mechanisms to promote wind power in China. There will be no provincial RPS target and implementation plans for RPS and green credit trading. Wind power market remains undeveloped. Cost: 0	The three provinces will have wind power planning. The three provinces will have a market-oriented wind power policy within the national renewable energy policy framework. The three provinces will have a RPS target and implementation plan. The three provinces will have the information and capacity for green credit trading. Cost: US$875,000	The three provinces will serve as pilot models for provincial wind power planning, provincial market mechanisms to promote wind power, and implementation of RPS and green credit trading. Wind power market will be fully developed in the three provinces. Cost: US$875,000 (GEF)

Activity	Baseline	Alternative	Increment
Activity 4: Provide assistance for the construction of the wind farms and conduct wind resource measurements	Wind farms will be constructed without addressing the performance risk and ensuring the most cost efficient design. The information on wind resource data will remain inadequate and unreliable. The potential investors will continue to be inaccessible to wind resource data. Domestic wind manufacturing industry will remain undeveloped because of the small market. Cost: 0	Experienced and well-qualified consultants will be recruited to assist with the development of the wind farms. Professional and reliable wind measurements will be conducted at 25 promising sites. Wind measurement data will be made available for the potential investors. Competitive bidding will be conducted at these promising sites. Cost: US$2,075,000	Detailed tender documents for construction of the wind farms will be used and the most economical and technically qualified bidder will be selected. Technically qualified supervision and quality control of the construction of the towers and wind turbines will be provided and adequate operation and maintenance plans will be prepared. High-quality site-specific wind measurement data will be available for potential investors. Investment in wind farms is expected to increase. Transaction costs for wind developers are reduced. Economy of scale will be reached to promote the domestic manufacturing industry. Wind power cost will be lower. Competitive market will be formed. Cost: US$2,075,000 (GEF)
Activity 5: Build capacity at provincial levels	The provincial decision-makers will continue to have low awareness of wind power. It is difficult to implement wind power policies at provincial level. The operation efficiency of wind power companies will remain low. Cost: 0	The provincial decision-makers will have increased awareness and information of wind power. The wind power companies will have improved business management skills. Cost: US$1,300,000	The provincial decision-makers will have increased support to wind power development. The operation efficiency of wind power companies will improve. Wind power cost will be reduced. Cost: US$1,300,000 (GEF)

Activity	Baseline	Alternative	Increment
Activity 6: Promote provincial experience to the nation	The information on the three provinces will not be disseminated. The three provinces will not serve as a model across the nation. The replication of wind farms will not occur at the national level. Cost: 0	The experience and lessons learned in the three provinces will be promoted and disseminated across the nation. Cost: US$650,000	The three provinces will serve as pilot models for other provinces to develop wind power. A large-scale replication of wind power development will occur at the national level. Cost: US$650,000 (GEF)
Activity 7: Finance three wind farms	Because the three wind farms are one of the first large-scale grid-connected commercial wind farms in the country, the project investors are undertaking a high risk. Cost: US$87,290,000	GEF supports up to 10 percent of the ADB loans as contingent grant to help reduce the risks associated with the ADB loans. As a result, the pilot projects can move ahead. Cost: US$93,290,000	The pilot wind farms will demonstrate both technical and commercial viability as well as the competitive project development model for wind projects in the PRC and elsewhere. The contingent grant will be repaid back to GEF after 10 years operation if the wind farms are successful. Cost: US$6,000,000 (GEF) (repayment due after 10 years)
Global Environment Benefits	Wind power remains undeveloped. Barriers prevent widespread deployment of wind power. Baseline carbon emissions of 60,000 tons of carbon/year from an equivalent coal-fired power plant of the three wind farms, and 200 million tons of carbon/year from the equivalent coal consumption of the total 250 GW wind potential.	Wind power is widely replicated. Economic, financial, information, and institutional barriers removed. Assuming 100 percent of the wind power will replace fossil fuels, alternative carbon emission = 0 tons of carbon per year.	Significant GHG emissions are attained. Direct carbon emission reduction of 60,000 tons for the three wind farms within the project lifetime, and up to 200 million tons of carbon per year possible for the total 250 GW wind potential beyond project lifetime.
Domestic Benefits	Local and regional air pollution from coal burning is getting worse.	Local and regional air pollution will be reduced. Wind power business grows.	Public health impacts will improve from better air quality. Acid rain will be mitigated.

Activity	Baseline	Alternative	Increment
Costs	Total Baseline Costs: **ADB:** US$58,000,000 **Domestic equity:** US$18,600,000 **Domestic banks:** US$9,400,000	Total Project Costs: US$98,000,000	Total Incremental Costs: US$12,000,000 (GEF)

RESPONSE TO STAP REVIEW

I. General Comments

- Use of Benefit Transfer Method (paragraph 3, page 3)

  The ADB's *Workbook on Economic Evaluation of Environmental Impacts* uses the Benefit Transfer Method for evaluation. A more sophisticated approach is beyond the scope of the Project.

- Incremental cost calculation is incomplete (paragraph 5, page 3)

  An incremental cost appendix is presented in full as Appendix 1.

- Adoption of the RPS is deemed central to this loan, no measures are taken to tie the loan directly to progress in that area (paragraph 2, page 4)

  It is agreed that this is important for promoting wind power development in the PRC. However, for the Project to be viable, adoption of the RPS is not required. Mechanisms for introduction of RPS will be developed under the Government's Strategic Partnership for Renewable Energy Development with assistance from GEF, World Bank, and ADB.

- Development of a significant standing capacity for RET analysis and promotion within the ADB would also help the Government of the PRC in its anti-corruption campaign (paragraph 3, page 4)

  The need for increasing institutional strength within ADB is noted and will be addressed through ADB's proposed Regional Technical Assistance for Promotion of Renewable Energy, Energy Efficiency, and Greenhouse Gas Abatement Projects, which is expected to become operational in the third quarter of 2000.

- Evaluation and enactment of changes in market structure may in many cases be improved by conferences, training sessions outside China, and relatively long-term training courses within China as well as visits by external experts. Added funding is needed to support these activities (paragraph 4, page 4).

  It is envisaged that these activities will be included in activity (vi) for barrier removal and institutional strengthening. However, during Project appraisal, we will review whether there is a need to further expand such activities.

II. Specific Comments

- It appears that the Ministry of Finance will be the source of primary project operational management a broader range of technical and economic oversight is likely to result in superior project implementation, and broader dissemination of the project lessons of widespread applicability of renewable energy options (paragraph 5, page 4).

  The Ministry of Finance will be the conduit for sourcing of the funds. The State Development and Planning Commission (SDPC) will be the national coordinating agency for the Project and will involve the State Power Corporation (SP), the State Economic and Trade Commission (SETC), and the Ministry of Science and Technology in the implementation of the Project.

- The reviewer makes certain observations with regard to the financial structure of the loan (paragraphs 2 and 9, page 5).

  - Tie the loan repayment to power production.

  The experience of wind farms in the PRC shows that power purchase agreements (PPAs) based on debt repayment have led to underutilization of available wind power and inefficient operations of wind farms.

  - Repayment rate scheme should be tied to the actual levelized tariffs for each wind farm.

  This is not practical. The tariffs cover all costs plus a reasonable return on equity. All wind farms will have the same relative amount of cash available to service debts; thus a uniform loan repayment scheme is the appropriate option.

  - Greater length of the grace period, or discounts from the ADB interest rate can be granted in response to better economic performance form the wind farms.

  The ADB grace period is determined on basis of the construction period that can reasonably be expected to be required. ADB's interest rates are fixed; however, the impact of the interest rate vis-à-vis the relatively higher risks of the Project needs to be addressed upfront; hence, the contingent grant.

- Attention needs to be paid to any problems that may arise in the power purchase agreements for the wind farms under the 1999 World Bank/GEF.

  Is being done. It is proposed to make availability of power purchase agreements initiated by the concerned parties a condition for loan negotiations.

- Consultations and review of this Project and other RET projects are important (paragraph 4, page 6).

We agree and will monitor the Project and other Projects closely in consultation with the concerned PRC authorities and if required, with assistance from consultants.

- The downgrading of the Fuel Conversion Project to "unsuccessful" is a concern.

  The project was exclusively premised on projected economic gains arising from fuel substitution which did not materialize and is therefore not directly relevant for the Project.

- Implementation in a non-competitive, or partially competitive market (as is likely in the PRC in the near and medium-term) has been shown to be a weak point of this plan (paragraph 1, page 7).

  Noted. Matter will be studied further at a national level under the Government's Strategic Partnership for Renewable Energy as well as at the level of the three provinces under the Project through the GEF contribution.

- It should be made more explicit what ADB expects from the PRC in terms of tariff reform for rural consumers (paragraph 2, page 7).

  This will be made more explicit in the final report based on the findings of the ongoing study.

- A combination of dual use (herding and turbine) for the land compensation (to the Kazakh herders), and the provision of wind energy-related technical, economic, and managerial training and jobs is recommended (paragraph 4, page 7).

  In accordance with ADB's *Policy on Indigenous Peoples*, an Ethnic Minority Development Plan will be prepared that will address these issues.

- Appendix 11, Tables 1-9. An uncertainty band should be developed for the long-term energy forecasts (paragraph 7, page 7).

  In accordance with ADB practice, the forecasts were made on a conservative basis.

- Appendix 13, page 4, Tables 1-4. The calculations should take into account personnel training in advance of wind farm operation (paragraph 2, page 8).

  Training of personnel will be provided by the main contractors for one year following commissioning and is included the cost estimates.

- Appendix 14. It is unclear how the global benefit of the EIRR Monte Carlo analysis was conducted (paragraph 3, page 8).

  In the final report, the Monte Carlo analysis will be conducted for the base case EIRR only (without global environmental benefits).

III. Other Comments

In addition, the reviewer proposes a number of studies including:

- Analysis of the role of market transformation opportunities through the support of renewable energy options in cases where ADB funds could improve the future market through volume-based price decreases.

- Options for building renewable energy infrastructure that is both technical and managerial within the international energy development organization, and within the commercial sectors of many nations.

- Analysis of the linkages and synergies between large-scale and small-scale power production, including opportunities for net-metered energy installations.

This has been noted and will be taken into consideration for study under the ADB's proposed Regional Technical Assistance for Promotion of Renewable Energy, Energy Efficiency, and Greenhouse Gas Abatement Projects.

Appendix 3

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

MOF

中华人民共和国财政部
国 际 司
中国北京三里河南三巷3号100820

June 26, 2000

Mr. Nessim J. Ahmad
GEF Focal Point
Asian Development Bank

ADB/GEF Wind Power Development Project

Mr. Ahmad:

Wind Power is an environment-friendly and sustainable energy. This ADB/GEF wind power project can assist the Government to achieve its agenda of renewable energy Partnership Program. It can also provide experiences and lessons to both central and provincial electric administration to further improve their wind power development program. Meanwhile, the project has global environment benefits, which is eligible to GEF financing.

Therefore, I would like to endorse this wind power project to request GEF assistance and incorporate it to the pipeline.

Best regards.

Sincerely yours,

(Jinlin Yang)
Operational Focal Point for China

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

PROJECT IMPLEMENTATION SCHEDULE

Activity		2002	2003	2004
Part A: Dabancheng Wind Farm	Site Preparation			
	Prequalification and Selection of Main Contractor			
	Selection of Minor Contractors			
	Construction and Commissioning			
	Recruitment of Project Implementation Consultants			
	Consulting Services			
Fujin Wind Farm	Site Preparation			
	Prequalification and Selection of Main Contractor			
	Selection of Minor Contractors			
	Construction and Commissioning			
	Recruitment of Project Implementation Consultants			
	Consulting Services			
Xiwaizi Wind Farm	Site Preparation			
	Prequalification and Selection of Main Contractor			
	Selection of Minor Contractors			
	Construction and Commissioning			
	Recruitment of Project Implementation Consultants			
	Consulting Services			
Part B:	**Consulting Services for**			
	- Wind Measurement			
	- Capacity Building and Training			
	- Benchmarking of Tariffs for Wind-Based Power Generation			
	- Commercialization of Wind Farms			
	- Implementation of National Policy for Renewable Energy at Provincial Level			
	- Dissemination of Results and Workshops			

Appendix 4

Attachment 1

RRP:PRC 31163

ASIAN DEVELOPMENT BANK

REPORT AND RECOMMENDATION

OF THE

PRESIDENT

TO THE

BOARD OF DIRECTORS

ON A

PROPOSED LOAN

TO THE

PEOPLE'S REPUBLIC OF CHINA

FOR THE

WIND POWER DEVELOPMENT PROJECT

November 2000

CURRENCY EQUIVALENTS

(as of 10 November 2000)

Currency Unit	—	Yuan (Y)
Y1.00	=	$0.1208
$1.00	=	Y8.2768

The exchange rate of the yuan is determined in relation to a weighted basket of currencies of the trading partners of the People's Republic of China. In this report, a rate of $1.00 = Y8.30 is used.

ABBREVIATIONS

ADB	–	Asian Development Bank
CO_2	–	carbon dioxide
EA	–	Executing Agency
EIRR	–	economic internal rate of return
EPC	–	engineering, procurement, and construction
GDP	–	gross domestic product
GEF	–	Global Environment Facility
GHG	–	greenhouse gas
HEPC	–	Heilongjiang Electric Power Company Ltd
IA	–	Implementing Agency
IEE	–	initial environmental examination
LEPC	–	Liaoning Electric Power Company Ltd
MBI	–	market-based instrument
MEP	–	Ministry of Electric Power
MOST	–	Ministry of Science and Technology
NO_x	–	nitrogen oxides
PMO	–	project management office
PPA	–	power purchase agreement
PPC	–	provincial power company
PRC	–	People's Republic of China
PV	–	photovoltaic
SDPC	–	State Development and Planning Commission
SEPA	–	State Environmental Protection Administration
SETC	–	State Economic and Trade Commission
SP	–	State Power Corporation
SOE	–	state-owned enterprise
SO_2	–	sulfur dioxide

NOTES

(i) The fiscal year (FY) of the Government.

(ii) In this report, "$" refers to US dollars and tons refer to metric tons.

TA	–	technical assistance
TFYP	–	tenth five-year plan
TSP	–	total suspended particulates
UNDP	–	United Nations Development Programme
WFC	–	wind farm company
XEPC	–	Xinjiang Electric Power Company Ltd

WEIGHTS AND MEASURES

GW	–	gigawatt (one billion watts)
km	–	kilometer
kV	–	kilovolt (1,000 volts)
kW	–	kilowatt (1,000 watts)
kWh	–	kilowatt-hour (power supply of 1,000 watts in one hour)
m^2	–	square meter
m^3	–	cubic meter
mg	–	milligram
m/s	–	meter per second
μg	–	microgram
MVA	–	megavolt-ampere
MW	–	megawatt (1,000,000 watts)
TWh	–	terawatt-hour (power supply of one trillion watts in one hour)

CONTENTS

LOAN AND PROJECT SUMMARY

Borrower	The People's Republic of China (PRC)
Project Description	The Project will help develop the PRC's renewable energy resources by financing the construction of three grid-connected wind farms with a total power generation capacity of 78 megawatts (MW). The Global Environment Facility (GEF) will provide financial support for the Project assistance to remove impediments and strengthen institutions to promote development of wind-based power generation in two provinces and one autonomous region.
Classification	Primary: Environment
Environmental Assessment	Category B. An initial environmental examination was undertaken
Rationale	The PRC's heavy reliance on coal as its primary fuel for power generation, as well as industrial, commercial, and residential use has led to high levels of air pollution, resulting in adverse health impacts and agricultural losses, and increasing emissions of greenhouse gases (GHGs), in particular carbon dioxide. The Project is designed to produce electricity in an environment-friendly manner. The Project will help accelerate the use of wind power in the PRC and thereby contribute to the 5 percent share of renewable energy sources in the power generation mix as envisaged by the Government under its tenth five-year plan, 2001-2005, while improving conditions for investment in wind-based power plants and avoiding air pollution and GHG emissions. The Project will create jobs and improve electricity supply in the three project areas. The Project is consistent with the Asian Development Bank (ADB) strategy to develop cleaner energy sources, such as renewable energy for power generation.
Objective and Scope	The objective of the Project is to produce electricity in an environment-friendly manner and increase the share of wind-based electricity in overall power generation by establishing three grid-connected wind farms, thus avoiding emissions of sulfur dioxide, nitrogen oxides, total suspended particulates, and carbon dioxide associated with conventional thermal power generation. The Project will (i) construct wind farms at Dabancheng in the Xinjiang Uygur Autonomous Region (30 MW), at Fujin in Heilongjiang Province (24 MW); and at Xiwaizi in Liaoning Province (24 MW), and (ii) provide assistance for barrier removal and institutional strengthening to promote wind-based power generation in the three project areas.
Cost Estimates	The total project cost is estimated at $98.0 million equivalent, comprising a foreign exchange cost of $69.0 million (70 percent) and a local currency cost of $29.0 million equivalent (30 percent).
Financing Plan	ADB will provide a $58.0 million loan, and GEF a zero-interest loan of $6.0 million (repayable after 10 years following project implementation if the Project is successful) to finance the foreign exchange cost of the construction of the wind farms. The GEF

	contingent loan will be provided under a joint cofinancing arrangement with ADB. GEF will also provide a grant of $6.0 million to finance consulting services for project implementation and the assistance for barrier removal and institutional strengthening. Both the GEF contingent loan and the grant will be administered by ADB. The remaining local currency cost of $28.0 million equivalent will be financed by the Executing Agencies (EAs) and domestic banks.
Loan Amount and Terms	ADB's $58 million loan from ordinary capital resources will have a repayment period of 20 years, including a grace period of 3 years, with interest determined in accordance with ADB's variable lending rate system for US dollar loans, a front-end fee of 1 percent, and a commitment charge of 0.75 percent per annum in accordance with the current ADB policy. The loan proceeds will be relent by the Ministry of Finance to the EAs through subsidiary loan agreements under the same terms and conditions. The EAs will onlend the loan proceeds under the same terms and conditions to each of the wind farm companies (WFCs) that will operate the concerned wind farm.
Period of Utilization	Until 30 June 2004.
Executing Agencies	The respective provincial power companies will be the EAs for the Project: the Xinjiang Electric Power Company Ltd for the wind farm at Dabancheng, the Heilongjiang Electric Power Company Ltd for the wind farm at Fujin, and the Liaoning Electric Power Company Ltd for the wind farm at Xiwaizi. The EA for the assistance for barrier removal and institutional strengthening will be the State Development and Planning Commission (SDPC) in cooperation with the Ministry of Finance and the State Power Corporation. Each WFC will be the Implementing Agency for its respective component.
Implementation Arrangements	The EAs will establish project implementation offices and be responsible for procurement, preparation of legal agreements, and disbursement of funds, and Project monitoring and evaluation. The WFCs will be responsible for site preparation, construction supervision, and liaison with the concerned EA. SDPC will establish a project management office to coordinate implementation of the assistance for barrier removal and institutional strengthening with the relevant provincial planning commissions and stakeholders. Project implementation will commence by the end of 2000.
Procurement	The equipment, materials, and services financed from the proceeds of the ADB loan and the GEF contingent loan will be procured in accordance with ADB's *Guidelines for Procurement*. Items financed with local currency funds by the EAs will be procured following local competitive bidding acceptable to ADB. Advance procurement action has been approved for the prequalification and selection of contractors for the three engineering, procurement, and construction (EPC) contracts that will be used for the construction of the wind turbines, towers, and related facilities.
Consulting Services	International consulting services for 30 person-months will be provided to assist (i) the EAs in preparing tender documents for

	procurement and supply of the wind turbines and towers through EPC contracts, and (ii) the Implementing Agencies with supervising construction and commissioning of the wind farms. Domestic consulting services of about 190 person-months and international consulting services of about 70 person-months will be engaged for the assistance for barrier removal and institutional strengthening. All consultants will be selected and engaged in accordance with ADB's *Guidelines on the Use of Consultants* and other arrangements for the selection and engagement of domestic consultants.
Estimated Project Completion Date	31 December 2003
Project Benefits and Beneficiaries	The Project will produce electricity in an environment –friendly manner and thereby avoid air pollution. Over its lifetime, it will help avoid emissions of about 11,000 tons of sulfur dioxide, 7,400 tons of nitrogen oxides, 5,000 tons of particulates, and 1.94 million tons of carbon dioxide. The estimated net present value of the environmental benefits from avoided air pollution at the national level is about $15.4 million, and from avoided GHG emissions is estimated at $13.9 million (low case) to $31.2 million (high case). The Project will accelerate the use of wind-based electricity in the PRC and create a minimum of 25 jobs for the operation and maintenance of the wind farms. The financial and economic internal rates of return are satisfactory for the three wind farms. The former ranges from 9.4 percent to 13.4 percent, and the latter from 11.4 percent to 14.8 percent.

I. THE PROPOSAL

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

II. INTRODUCTION

2. The PRC is the third largest energy user in the world after the United States and Japan. Coal is the dominant primary source of energy accounting for 68.2 percent of total commercial energy production in 1999, followed by oil (20.9 percent), hydropower (7.8 percent),[2] and natural gas (3.1 percent). The continued dominance of coal in the energy mix has major environmental repercussions, including unacceptably high levels of air pollution resulting in health problems and increasing mortality rates, degenerating ecosystems, decreasing crop yields, and increasing emissions of greenhouse gases (GHGs) and occurrences of acid rain. The Government has recognized the need to address the environmental problems associated with the energy sector, and has reiterated its commitment to increased use of renewable energy as outlined in its Program on New and Renewable Energy Development in the PRC (1996-2010). Under the program, the Government gives priority to the development of grid-connected, wind-based electricity generation (wind farms) to (i) diversify the power supply; (ii) develop sustainable renewable energy resources; and (iii) derive environmental benefits, in particular, by reducing air pollution.

3. In 1997, the Government requested ADB assistance for wind farms in the Xinjiang Uygur Autonomous Region and in Heilongjiang and Liaoning provinces. In response to this request, in September 1998, ADB provided project preparatory technical assistance to examine the feasibility of establishing such wind farms.[3] Following completion of the project preparation studies in January 2000, the Fact-Finding Mission visited the PRC in March 2000, followed by the Appraisal Mission[4] in July 2000, to discuss the proposed Project with the Government and the Executing Agencies (EAs) and Implementing Agencies (IAs). The linkages of the policies, institutional framework, physical investments, and objectives of the Project are described in the project framework (Appendix 1). The Project's primary objective is the environment.

III. BACKGROUND

A. Sector Description

1. Status of Renewable Energy

4. The PRC's renewable energy resources comprise small-scale hydropower, wind, biomass, and solar and geothermal energy, and are mostly used in rural areas. About 90 percent of rural households are already connected to electricity distribution networks and pay relatively high electricity tariffs (on average 1.5 to 2 times the tariffs for urban households).

5. At present, renewable energy resources used for power account for about 5 percent of the total electricity generated. According to World Bank estimates, to maintain this share of renewable energy in the power supply mix over the next 10 years, about 18 gigawatts (GW) of

[2] Including small-scale hydropower (defined as hydroelectricity units with a capacity of 25 megawatts or less) that is estimated to account for about 25 percent of total installed hydropower.

[3] TA 3071-PRC: *Wind Power Development Project*, for $600,000, approved on 21 September 1998.

[4] The Mission comprised E. Hassing, Senior Project Officer and Mission Leader; J. Ordona, Senior Financial Analyst; P. Abeygunawardena, Senior Economist for Environment; and B. Q. Lin, Economist.

installed capacity will need to be added. Small-scale hydropower has been developed to commercial levels for decentralized rural use and totals about 18 GW. The installed capacity of wind-based power generation is about 500 megawatts (MW)[5] and of solar photovoltaic (PV) energy about 40 MW, with the Government targeting the installation of an additional 160 MW of PV energy over the next five years. Biogas power systems account for about 100 MW; geothermal energy, with an installed generating capacity of 30 MW, plays a minor role in energy supply.

6. The economically usable wind resource potential in the PRC is estimated as high as 160 GW. However, wind-based power generation, while increasing, is still very limited accounting for about only 3 percent of the renewable energy produced. This is due partly to the higher costs of wind energy and partly to the absence of appropriate policies to promote its development, and that of renewable energy in general. For example, the Government does not have a policy requiring that a certain percentage of electricity be generated from renewable energy sources, unlike some other countries that are promoting the development of separate markets for renewable energy.[6] Such separate markets are necessary as in the PRC electricity generated from renewable energy sources is more expensive than electricity generated by conventional thermal power plants using abundant and relatively inexpensive coal. The coal and thermal power pricing regimes do not internalize the environmental costs associated with air pollution, and no financial incentives encourage investment in renewable energy. Biomass, i.e., fuelwood and crop residues, accounts for nearly a quarter of the country's energy supply, and about three quarters of energy consumed by rural households. As a result, deforestation problems are prevalent in some areas, contributing to soil erosion and flooding. To address this problem, the Government is by encouraging more efficient use of fuelwood, improving natural resource management, promoting afforestation, and providing rural households with access to electricity.

7. The Project constitutes the first ADB-financed project for renewable energy development in the PRC. In 1994, ADB provided advisory technical assistance (TA) to help accelerate the pace of rural energy development based on renewable energy.[7] The TA was based on the concept that identifying rural energy supply options in pilot areas, coupled with training of Ministry of Agriculture staff, would accelerate rural energy development. The TA evaluated the economic and financial viability of possible ADB financing of (i) large-scale biogas systems, (ii) solar water heaters, and (iii) biomass cogeneration. However, the Government was reluctant to consider borrowing from ADB's ordinary capital resources for renewable energy projects unless such borrowing could be blended with concessionary financing. Another TA was recently provided to the Ministry of Agriculture to prepare a project for efficient utilization of agricultural waste products to improve the physical environment and reduce poverty.[8] Currently, TA is being implemented to (i) enhance the institutional framework for providing consumer-oriented financing with technical service support, (ii) develop and evaluate prioritized investment programs for commercializing selected renewable energy technologies, and (iii) identify specific investment requirements for external financing.[9] In addition to ADB, the World Bank and the United Nations Development Programme (UNDP), both working with GEF, have begun selective programs in this area (para. 33). The Government, under its recently announced development strategy development for the western regions, will promote the use of renewable energy to supply off-grid electricity to rural communities.

---

[5] Including about 265 MW of grid-connected wind farms.

[6] Suitable mechanisms for creating such markets with due consideration for efficiency include (i) following a bidding process for purchase by utilities of a fixed amount of electricity from renewable sources (i.e., the so-called non-fossil fuel obligation (NFFO), used in the United Kingdom); and (ii) establishing a renewable portfolio standard (RPS) that requires that a certain percentage of electricity generated be produced from renewable energy sources (used in Denmark, the Netherlands and certain parts of the United States).

[7] TA 2100-PRC: *Rural Energy Development Study*, for $500,000, approved on 16 June 1994.

[8] TA 3370-PRC: *Efficient Utilization of Agricultural Wastes*, for $703,000, approved on 26 December 1999.

[9] TA 3056–PRC: *Renewable Energy Development Project*, for $600,000, approved on 25 August 1998.

2. Energy Consumption and Production

8. Annual per capita energy consumption in the PRC is relatively low at 0.63 tons of oil equivalent in 1999, or about 40 percent of the world average. The energy intensity rate is still quite high (0.82 tons of oil equivalent per $1,000 of gross domestic product [GDP], or roughly twice the average for both ADB developing and developed member countries.) Nevertheless, energy intensity has been declining, from 1990 to 1999, the average annual real GDP growth rate was 9.7 percent, while energy consumption grew at only 2.3 percent. As a result, the energy intensity index[10] dropped from 61.1 in 1990 to 31.3 in 1999 (Appendix 2), reflecting changes in economic structure and sources of industrial value added, as well as energy efficiency improvements. The still high energy and intensity index is mainly attributable to (i) the legacy of the inappropriate pricing regime with inadequate market-based signals for energy conservation, (ii) an energy-intensive industry sector that accounts for a relatively high share of GDP, (iii) a poor fuel consumption mix, (iv) the use of obsolete industrial technologies, and (v) poor energy management.

9. The PRC is the second largest electricity producer in the world. Between 1980 and 1999, installed capacity and annual electricity generation grew at average annual rates of 8.3 percent and 7.7 percent, reaching 299 GW and 1,233 terawatt-hours (TWh) (Appendix 3). Every year since 1988, 11-25 GW of generating capacity have been added in response to the acute shortages of generating capacity.[11] Starting in 1997, the macroeconomic and industry sector changes, coupled with the indirect effects of the Asian financial crisis, slowed the growth of electricity consumption.[12]

10. In 1999, 75 percent of the total installed capacity of 299 GW used fossil fuels, 24 percent hydropower, and 1 percent was nuclear-based. The 1998 per capita annual electricity consumption of 909 kilowatt-hours (kWh) places the PRC at the mid level of ADB's developing member countries (DMCs).[13] Industries consume the most electricity (Appendix 3). Heavy industry consumed 58 percent in 1998, followed by light industry (14 percent), residential consumers (12 percent), public and commercial consumers (8 percent), agriculture (6 percent), and transportation and telecommunications (2 percent). Since 1985, relative shares of industry and agriculture have been declining, while those of residential, public, and commercial consumers have been increasing since 1985. About 98 percent of the nation's villages and 97 percent of the rural population have access to electricity, although service is of uneven quality.

3. Pricing

11. Electricity tariffs are set separately in each province. Tariff proposals are prepared jointly by the provincial power companies (PPCs) and the provincial governments (mainly the provincial price administration bureaus), and submitted to the Government for approval by the State Development and Planning Commission (SDPC). Tariffs generally have three components: (i) state catalog price, (ii) guidance price differential, and (iii) surcharges. The state catalog price is calculated to recover costs financed by Government grants (all plants built before 1985) and, in some cases, loans from the Government for plants built after 1985. Electricity from power plants financed by joint investment from central, provincial, and local governments; plants of independent power producers; and plants owned by local governments or industries that sell surplus power to the grid, is sold at a guidance price based on full cost recovery including debt repayment and a reasonable return on

[10] Expressed as unit of energy consumed per unit of GDP in 1978 constant prices, with the index set at 100 for 1978.
[11] This is equivalent to adding the existing installed capacity of countries such as Belgium, Finland, and Netherlands in one year.
[12] Compared with the installed capacity of 290 GW (comprising 220 GW of thermal power plants and 70 GW of hydropower) and an annual electricity generation of about 1,400 TWh (comprising 1,120 TWh of thermal power plants and 280 TWh of hydropower), envisaged for the end of the ninth five-year plan, 1996-2000.
[13] Malaysia, 1,636 kilowatt-hours (kWh); Thailand; 1,023 kWh; Philippines, 419 kWh; India, 325 kWh; and Sri Lanka, 224 kWh.

investment. Several surcharges are levied on the various consumer categories, primarily for different types of investment funds for the power sector. The most important levies are (i) the provincial and local government power investment surcharges, which raise funds for special power development projects (e.g., the Three Gorges project); and (ii) local fees to raise funds for distribution system investment. Surcharges usually account for 13 to 15 percent of the average tariff.

12. Before 1985, electricity tariffs remained low for many years, averaging about Y0.07 per kWh. In 1985, tariffs were increased in response to price increases of capital, fuel, and other operating costs, and to reflect a shift of Government policies to a market economy. However, the tariff adjustments had various shortcomings, as a result of which tariff systems became complicated and unfair to different consumer categories and similar consumers in different localities. The Government regards tariff reform as a prerequisite for developing the power industry. Unification of tariffs to ensure charging, on a cost recovery basis, the same price for the same quality of electricity to a given class of consumer in a particular grid is an important objective. In 1999 the average electricity tariff was about Y0.41 per kWh.

13. The Government is using a combination of administrative controls and market-based instruments (MBIs) to improve end-use energy efficiency. The administrative measures include reducing planned allocations of energy to major industrial users, tightening energy consumption norms and applying them more strictly with bonuses and penalties, and closing inefficient plants. The Government is giving increasing priority to MBIs, including price reforms, and aiming to achieve gains in end-use energy efficiency by implementing structural adjustments in the industry sector, promoting the upgrading of technology, and strengthening energy management.

4. Environment

14. The PRC has severe environmental problems, primarily air and water pollution associated with rapid economic growth and industrialization. Estimates of economic losses caused by pollution range from 3.5 to 8.3 percent of GDP. Based on a recent study by the Policy Research Center for Environment and Economy of the State Environmental Protection Administration (SEPA), pollution in the early 1990s caused annual economic losses of Y99 billion (about 4 percent of GDP), with air pollution accounting for 59 percent, water pollution 36 percent, and solid waste 5 percent. Much of these losses were due to the energy sector or related activities.

15. The high economic losses reflect waste and inefficiency in the utilization of energy, raw materials, and other resources in the production of goods and services. This is partly a legacy of the past practice of locating industrial enterprises in urban centers, and inappropriate regulatory measures and pricing policies that did not provide adequate incentives for conservation and environment-friendly behavior. Depending on the industry, 30 to 70 percent of industrial pollution is linked to waste and inefficiency resulting from the use of obsolete technology, inadequate knowledge of available cleaner technology, low level of environmental awareness, and poor enterprise management. Use of energy and raw materials will continue to grow in the PRC in tandem with economic growth. Unless better technologies are used, switching to cleaner fuels is encouraged, and use of renewable energy is increased in a major way, environmental quality will continue to deteriorate and related economic losses increase.

16. The PRC's heavy reliance on coal as its primary fuel for industrial production, power generation, and commercial and residential applications, mainly cooking and heating, contributes significantly to emissions of sulfur dioxide (SO_2) and total suspended particulates (TSP), and high levels of urban air pollution. Nine of the 10 cities with the worst air pollution in Asia and 5 of the 10 worst in the world are in the PRC. Air quality is poor in all of the PRC’s industrial cities. Airborne

concentrations of TSP and SO_2 often substantially surpass environmental standards.[14] The social cost of this pollution is high. Over 400 million people live in cities and this number is expected to double by 2010. Annual premature (compared with life expectancy) deaths related to excessively high TSP concentrations are currently estimated at 150,000 in urban areas. Chronic pulmonary diseases linked to TSP exposure are a leading cause of death among urban residents, accounting for 0.91 death per 1,000 people, five times more than in the United States. The combustion of coal in small boilers, mainly for commercial and residential use, is responsible for a significant portion of total air pollution. To combat air pollution from such sources, the Government gives priority to (i) developing district heating systems to replace individual coal combustion for residential heating; (ii) developing gas supply networks to replace coal combustion with a cleaner form of energy for household cooking and, in some instances, heating; and (iii) introducing clean coal technologies and other environment-friendly technologies for power generation. The introduction of advanced clean coal technologies such as pressurized fluidized bed combustion and integrated coal gasification combined-cycle technology is being considered.[15] In April 2000, the Prevention of Air Pollution Law was adopted, enabling the Government to take effective measures to encourage and support scientific research and technology development for the prevention and control of air pollution.[16] Implementation of the law began in September 2000.

5. Pollution Permits and Green Credits

17. The PRC has adopted several programs to guide development of the economy and protect the environment. Its Agenda 21 Program, developed in response to the 1992 Earth Summit, is designed to integrate economic and social development by improving the efficiency of energy utilization, introducing environment-friendly technologies, and managing toxic and hazardous wastes. The Government is beginning to respond to global environmental problems such as climate change. With ADB assistance, it developed methodologies to evaluate GHG emissions and outlined options for policy implementation.[17] Coalbed methane gas released in connection with coal mining is one of the major sources of GHGs, and ADB is providing assistance to evaluate possible options for more efficient capture and use of the gas.[18] Acid rain issues have been analyzed to establish the necessary database and undertake institution-building activities. Strategies to minimize SO_2 emissions that cause acid rain were formulated and are under implementation.[19] The Government has also participated in ADB's regional activities relating to global warming and transboundary environmental cooperation in northeast Asia,[20] identified 18 GHG abatement technology

[14] The concentration of TSP in residential areas increased from 276 micrograms (μg) per cubic meter (m^3) in 1986 to about 309 $\mu g/m^3$ in 1996, three to five times higher than the guidelines of the World Health Organization (WHO) of 60-90 $\mu g/m^3$. The concentration of SO_2 in these areas increased from 70 $\mu g/m^3$ to 120 $\mu g/m^3$, more than double the WHO standard of 40-60 $\mu g/m^3$. By 1997, in almost all major cities emissions of nitrogen oxides exceeded the Government standard for urban areas of not more than 50 $\mu g/m^3$.

[15] Under TA 2793-PRC: *A Study on Clean Coal Integrated Gasification Combined Cycle Technology*, for $500,000, approved on 19 May 1997, ADB helped assess suitable technologies.

[16] The law provides a legal basis for adopting the total load control strategy to reduce air pollution. It specifies the key pollutants for total load control (including SO_2), and establishes principles for total load allocation among polluting sources and air emission permits. However, it does not identify a mechanism for the transfer and trade of the permits. A new provision addresses clean energy; it specifies that "the state encourages and supports the exploitation of clean energy such as solar, wind and hydrological power."

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

[18] TA 3081-PRC: *Coalbed Methane Demonstration Project*, for $600,000, approved on 1 October 1998.

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

[20] TA 5592-REG: *A Study of a Least-Cost Greenhouse Gas Abatement Strategy for Asia*, for $8,237,000, approved on 4 August 1994; with supplementary TAs for $492,000, approved on 10 September 1996, and for $133,363, approved on 19 June 1998; TA 5695-REG: *Environmental Cooperation in Northeast Asia*, for $495,000, approved on 1 August 1996; and TA 5865-REG: *Transboundary Environmental Cooperation in Northeast Asia*, for $350,000, approved on 13 October 1999.

options, and prepared a portfolio of two TA and seven investment projects for GHG abatement, largely in the energy supply and demand sectors.

18. Pollution permit trading is an emerging MBI that is receiving increasing attention for air quality management in the PRC. It provides opportunities for polluters to buy or sell the permits for air emissions and effluent discharges to achieve compliance with environmental standards and meet legal and regulatory requirements. Polluters with high marginal abatement costs may buy rights from other firms with lower abatement costs, resulting in a cost-effective way of reaching environmental targets. Conversely, firms with low marginal pollution abatement costs will find opportunities to control pollution discharges below permitted amounts and sell the excess rights to polluters with higher costs. Compared with the traditional command-and-control approaches, MBIs including pollution permit trading improve the efficiency of pollution control and provide incentives to improve the environment.[21] In Shanxi Province, ADB is providing TA to facilitate the introduction of MBIs and develop a pollution permit-trading system.[22]

19. In addition to limiting pollution through trading of pollution permits, the PRC has considerable potential for trading green credits in the domestic and international markets. Under this new credit system, green credits will be issued for energy produced from renewable energy sources in an environment-friendly manner. The energy itself is traded and consumed locally while the environmental surplus value (green credits) is reflected in certificates, which are issued by recognized agencies. The issuance of the certificates allows the environmental benefits associated with a certain production of energy to be traded separately from physical energy. These certificates can be traded locally or internationally, thereby promoting development of renewable energy at the most productive and economic sites. The local trading can take place among local polluters who are required to meet a certain quota of energy production or use from cleaner energy.[23] International trading could take place in a similar fashion once the clean development mechanism (CDM) or comparable system is in place. The certificates also ensure that consumers have received the amount of green electricity from a particular supplier as reflected in their billing. The PRC is expected to begin implementing systems for trading of pollution permits and green credits under its tenth five-year plan (TFYP), 2001-2005. Internationally, the PRC has considerable potential for such trading as part of global efforts to reduce GHG emissions under the Kyoto Protocol and the CDM.[24]

6. Institutions and Legal Framework

20. During the past decade, the Government reorganized the energy sector. The objective was to improve governance by separating regulatory and operating responsibilities, and then corporatize the operating entities and use market forces to improve efficiency and promote energy conservation. First, the Ministry of Energy was disbanded and replaced with the Ministry of Electric Power (MEP), the Ministry of Coal Industry, and two corporations looking after petroleum and natural gas. Subsequent administrative reforms aimed at improving the operational efficiency of the power industry led to MEP restructuring with the establishment of the State Power Corporation (SP) in January 1997. In March 1998, MEP was abolished and SP designated as the agency responsible for power sector enterprise functions.[25] The sector's regulatory and policy functions are the responsibility of the State Economic and Trade Commission (SETC), which has similar responsibility for the petroleum and coal sectors, as well as the country's energy conservation program. Until the

[21] ADB. 1999. *Emissions Trading in the Energy Sector: Opportunities for the People's Republic of China*. Manila.
[22] TA 3325-PRC: *Shanxi Air Quality Improvement*, for $700,000, approved on 7 December 1999.
[23] Trading in green credits is under way in Denmark and the Netherlands and is expected to begin shortly in Germany.
[24] Assistance for such implementation is provided under TA 5861-REG: *Capacity Building for Implementation of the Kyoto Protocol and the Clean Development Mechanism*, for $200,000, approved on 1 September 1999.
[25] At the same time, the Ministry of Coal Industry was abolished and the State Administration of Coal Industry was made responsible for supervision of the coal sector.

mid-1990s, the power sector was governed by laws, administrative rules and regulations, and policy circulars, which were not well coordinated. To address this problem, the Electric Power Law was approved in December 1995 and became effective in April 1996. The law represents a major step in making the legal and regulatory framework for the sector more transparent.[26]

21. Under the PRC's State Council, four national agencies are actively involved in development of renewable energy in the PRC: SDPC, SETC, the Ministry of Science and Technology (MOST); and SEPA.[27] SDPC is responsible for evaluating and approving large renewable energy projects, and SETC for developing industries that can manufacture equipment required for the utilization of renewable energy. MOST carries out research and development activities for renewable energy utilization as well as technology transfer, including acquisition of foreign technology. SEPA is involved in renewable energy development programs to protect the local and global environment and assists the Ministry of Finance as the PRC focal point for GEF issues. SDPC, SETC, and MOST have representative offices in each province, which report both to the respective agencies and the provincial governments; each agency has also an associated research institute for renewable energy development.

B. Government Policies and Plans

1. Poverty Reduction Strategy

22. The Government has been making major efforts to reduce the imbalance in economic development between the increasingly prosperous coastal provinces and the poorer central and western regions. Poverty has traditionally been a rural phenomenon. By pursuing a strategy to raise living standards and incomes in the poorer rural areas through Government investments and subsidies in land development, rural works, and rural enterprises, the PRC has made commendable progress in reducing rural poverty from 260 million in 1978 to 34 million in 1999, using the PRC definition of rural poverty.[28] However, since 1997, concern about urban poverty has been growing. This reflects growing urban unemployment brought about by industrial enterprise reforms and government downsizing, in particular, retrenchment of excess employees of state-owned enterprises (SOEs). In 1998, 6.1 million industrial workers were laid off, most found other jobs. In 1999, layoffs increased by 3.0 million, with about 60 percent expected to be reemployed. The number of urban poor ranges from approximately 12 million to 15 million (about 4 percent of the urban population). Around 600 cities and 1,200 counties have established programs to ensure minimum living expenses. The Government has received assistance to develop an analytical framework for addressing increasing relative urban poverty.[29] ADB is also considering a loan to support the Government's Social Security Reform Program, which aims to improve pensioners income security, and the institutional capacity and administrative efficiency of the social safety net to protect urban and rural poor who are unemployed and need some minimum income support. In addition, reforms of the health insurance scheme under the program aim to reduce poverty through medical and community-based basic health care programs.

23. In 1999, the average annual per capita disposable incomes in urban areas of the two provinces and the autonomous region involved in the Project were lower than the national average of Y5,854 (i.e., Y5,320 for the Xinjiang Uygur Autonomous Region, Y4,595 for Heilongjiang

[26] The Company Law of 1994 covers the legal status, rights, and obligations of the power groups and companies, and promotes the use of solar, wind, geothermal, and biomass energy for power generation.

[27] In April 1998, the State Planning Commission became SDPC, the State Science and Technology Commission became MOST, and the National Environmental Protection Agency became SEPA.

[28] The PRC considers an annual income of Y635 per capita as the poverty line. ADB's definition of the poverty line includes an annual per capita income of Y1,000 for rural areas; an annual per capita income of Y2,000 for small or inland urban areas; and an annual per capita income of Y3,000 for coastal or large urban areas.

[29] TA 3377-PRC: *Urban Poverty Study*, for $410,000, approved on 27 December 1999.

Province, and Y4,899 for Liaoning Province). All three areas have developed programs to address urban poverty. The economic structure of the northeast part of the PRC, comprising the provinces of Heilongjiang, Liaoning, and Jilin, has been dominated by heavy industries and SOEs with relatively inefficient production processes. Many SOEs have become unsustainable in the context of market-oriented reforms, and the performance of most heavy industries and SOEs has deteriorated. As a result, growth of the region's per capita disposable income has been below that of other provinces, SOE-based social welfare is strained, and the number of laid-off workers has increased. The official unemployment rate in the various cities in the region is 3 percent, but would be close to 15 percent if all laid-off and underemployed workers are included. The average annual per capita disposable incomes in rural areas in the Xinjiang Uygur Autonomous Region and Heilongjiang Province were Y1,473 and Y2,166, lower than the national average of Y2,210, while the average annual per capita rural disposable income for Liaoning Province of Y2,501 was higher than the national average .

24. In January 1999, the Government issued a series of regulations specifying the establishment and administration of unemployment and social insurance funds for laid-off workers. The provincial and municipal governments in the three project areas are planning to address the growing urban poverty problem by (i) developing local economies and promoting private businesses offering employment opportunities; (ii) introducing preferential access policies in the form of fee exemptions or reductions for the urban poor in the areas of education, water, electricity, heating, and gas; (iii) providing preferential policies to private and nonstate enterprises that employ laid-off workers; (iv) developing physical infrastructure (especially roads and water supply) to promote economic development and employ laid-off workers for construction; and (v) providing microcredit, tax exemptions, and retraining to laid-off workers who show self-reliance and establish private businesses.

2. Environmental Strategy

25. The Government's environment sector objectives are to (i) bring environmental pollution under control, (ii) improve the quality of the environment in major cities, (iii) reduce degradation of natural ecological systems, and (iv) integrate environmental planning with economic and social development efforts. The Government's environmental objective for 2000 is to arrest environmental degradation environment by improving air and water quality in 52 major cities where pollution is most severe. The basic policies and guiding principles include pursuing a strategy of sustainable development by integrating environmental protection programs into national economic and social planning, and establishing an effective environmental regulatory framework and management systems in urban and rural areas. The aim is to contain the worsening trend of environmental pollution and ecosystem degradation, and improve the environment in some cities to demonstrate that rapid economic growth and a cleaner environment are compatible. To achieve these objectives, the Government aims to increase annual environment-related investments from 0.7 percent of GDP in the seventh five-year plan (1986-1990) to 1.3 percent during the ninth plan.[30]

26. According to the national policy statement of the State Council in 1996, air and water pollution are to be stabilized at 1995 levels, and all enterprises should comply with air emission and wastewater discharge standards by 2000. Meeting this goal will require reduction of pollution intensity (unit of pollution per unit of production) as industrial growth continues. Significant progress has been made in controlling pollution in some sectors, such as reducing emissions from power plants and closing small-scale polluting enterprises and power plants with a capacity of 50 MW or less. Meeting the State Council's goal requires massive investments in pollution prevention and control efforts. The Government has allocated $54.2 billion equivalent for direct environmental investments in the ninth five-year plan period. Of this, $25 billion (46 percent) is for prevention and

[30] This target has not yet been achieved; in 1999, environment-related investments were equivalent to about 1.0 percent of GDP.

control of air pollution, $22 billion (40 percent) for prevention and control of water pollution, $6 billion (11 percent) for control of solid wastes, and $1.2 billion (3 percent) for other categories of pollution prevention. Environmental improvement is focused on pollution related to power generation and heating systems; construction and building materials industry; water resources and water supply; and chemical, metallurgical, and pulp and paper industries.

27. Under the TFYP, the Government is expected to strengthen its control of pollutant discharge by issuing regulations on total pollutant control for selected cities and designated river basins and regions. Ecological protection will be given importance equal to pollution control, and environmental protection of agriculture will be strengthened.[31] Sustainable urban development will be strengthened by constructing centralized heating systems and sewage and solid waste treatment plants in large and medium-size cities. Air quality in cities is to be improved by substituting gas for coal, where feasible; modernizing and closing polluting industries; and increasing the use of technologies and fuels that minimize pollution from vehicular emissions. Also, automated air quality monitoring networks will be established in large and medium-size cities and continuous monitoring of water quality along stretches of several major rivers will begin. To achieve these objectives, the Government will strengthen institutional and regulatory frameworks and increasingly introduce MBIs for effective environmental management. In this context, the Government is planning to prepare and promulgate a law on environmental impact assessment, which will require that strategic environment assessments be made for all proposed national planning and policy development activities, and that possible environmental impacts be fully integrated in the decision-making process. ADB will assist SEPA in this regard.[32] Under the TFYP, the Government will promote the concept of a green civil society, emphasizing the benefits of sustainable environment-friendly development through green labeling of products, food, and energy that have been produced accordingly. The proposed Project will support the Government's efforts to increase the supply of such energy in the PRC.

3. Energy Sector Strategy

28. The Government's main objective for energy sector development up to 2020 is to reduce the growth of coal consumption and the environmental pollution that coal consumption causes. The Government is promoting (i) the introduction of clean coal technologies throughout the entire process of coal production, handling, transportation, and consumption; (ii) where possible, substitution of natural gas, hydropower, and renewable energy for coal; and (iii) demand-side management to decrease the growth rate in energy consumption. To increase natural gas consumption, the Government is planning to undertake (together with private investors) major gas infrastructure projects, including the construction of (i) long distance transmission pipelines to transport natural gas from known gas fields in the western part of the country to the coastal provinces in the east,[33] and (ii) a terminal and related facilities at Shenzhen in Guangdong Province for the importation of liquefied natural gas.[34] Natural gas consumption is projected to increase from about 25 billion m^3 per annum at present to about 100 billion m^3 per annum by 2010. This will require major investments of more than $50 billion in new gas infrastructure, and will increase the natural gas share in the primary commercial energy mix from 2.4 percent at present to 4 to 6 percent.

[31] Among others, development of highly efficient, low-pollution green fertilizers, organic fertilizers, and natural biological pesticides is to be promoted; use of biomass as fuel encouraged; and technologies for water efficient irrigation and control of water erosion improved.

[32] TA 3290-PRC: *Capacity Building in Ministerial Status Responsibilities in SEPA*, for $810,000, approved on 8 November 1999.

[33] Including pipelines (i) from Zhongxian in Sichuan Province to Wuhan in Hunan Province and Shanghai, (ii) from Shanganning in Shaanxi Province to Xinyang in Hebei Province and Shanghai, (iii) from the Qaidam basin fields in Qinghai Province to Lanzhou in Gansu Province, and (iv) from the Tarim basin fields in the Xinjiang Autonomous Region to Lanzhou in Gansu Province and Xi'an in Shaanxi Province. The pipelines are expected to be operational by early 2005.

[34] The terminal is expected to be able to receive and vaporize about 3 million tons of liquified natural gas per annum, providing about 4 billion m^3 per annum of natural gas for consumption in Guangdong Province.

Although the share of natural gas will still be modest, the planned 75 billion m^3 per annum increase in natural gas consumption will reduce coal consumption by about 155 million tons per annum, SO_2 emissions by about 2.2 million tons per annum, TSP emissions by about 0.7 million tons per annum, carbon dioxide (CO_2) emissions by about 52 million tons per annum, and solid waste by about 26 million tons per annum.

29. The Government's main objective in the power sector during the ninth five-year plan has been to increase investment in power facilities to support the country's economic growth and improve access to electricity. Given that the demand for additional power is largely being met, emphasis has shifted to (i) rationalizing power tariffs to reflect economic costs; (ii) improving efficiency and reducing emissions of existing power plants;[35] (iii) restructuring the sector to encourage competitive markets, and commercialization and corporatization of power utilities; (iv) improving power transmission and distribution, including rural electrification; and (v) diversifying financing for power development, including private sector participation through the build-own-operate and build-own-transfer approaches, shareholding, and other modes. ADB's operations in the PRC power sector are supporting this agenda.

30. The power sector is being transformed from a centrally administered and operated system to a decentralized system whereby more autonomy is given to the regional and provincial and municipal power utilities. The Government accepts the principle of full cost recovery in pricing electricity. To support these tariff reforms, ADB provided TA to enable the former MEP to assess the adequacy of tariff levels in relation to the long-run marginal cost of power supply and the financial requirements for sound utility management.[36] In processing power projects in Fujian, Henan, Hunan, and Yunnan provinces, and the Northeast Region,[37] ADB has, through policy dialogue with the Government, ensured that satisfactory tariff reforms are being introduced. Progress in achieving a more rational tariff structure at the provincial level will gradually lead to nationwide improvements and tariff levels based on the long-run marginal cost of power supply. The Government's role is also being transformed from direct administration and operation to management through legal and regulatory mechanisms. Power utilities are to operate on a commercial basis to make them more responsive to market forces. In line with its reform agenda, the Government has formed regional electric power group corporations and PPCs, and is transferring the management and operation of power facilities from regional network administrations and provincial electric power bureaus to these new entities. ADB has provided assistance to (i) study options for power sector restructuring, including the introduction of competitive markets in the different segments of the power sector; and (ii) develop sector structures to support such markets, using the East China and Northeast Power Region as the model system.[38] Pilot projects have been initiated in six provinces (Heilongjiang, Jilin, Shandong, Shanghai, Liaoning, and Zhejiang) to determine the optimum strategies for unbundling and separating power generation and transmission activities. The impact of power sector restructuring on wind-based power generation is expected to be minimal in view of the Government's plans to create a separate market for renewable energy during the TFYP. This will require producers and/or distributors of electricity to source a certain percentage of electricity from renewable energy resources, including wind-based power generation, and supply to consumers, thus separating this market from the reforms expected to be introduced in the conventional power market.

---

[35] In June 1999, the Government announced the closure of thermal power generating units with a capacity of 50 MW or less. As a result, about 30,000 MW of small coal-based plants will be decommissioned by 2003.

[36] TA 1922-PRC: *Support for Power Tariff and Financing Reforms*, for $450,000, approved on 3 August 1993.

[37] Loan 1318-PRC: *Yunan Lingjintan Hydropwer*, for $116 million, approved on 27 August 1983; Loan 1400-PRC: *Henan Power*, for $200 million, approved on 7 November 1995; Loan 1417-PRC: *Fujian Mianhuatan Hydropower*, for $170 million, approved on 14 December 1995; Loan 1582-PRC: *Northeast China Power Transmission*, for $150 million, approved on 25 November 1997; and Loan 1644-PRC: *Hunnan Dachaoshan Power Transmission*, for $100 million, approved on 27 November 1998.

[38] TA 2917-PRC: *Power Sector Restructuring*, for $804,700, approved on 24 November 1997. UNDP is also providing assistance for power sector reform; UNDP's assistance is focused on training, capacity building, and identification of issues while ADB's TA will recommend specific industry and market structures for the model region.

4. Renewable Energy Strategy

31. Traditionally, the Government has aimed to develop renewable energy to (i) diversify power generation, (ii) accelerate rural development, (iii) develop sustainable resources, and (iv) derive environmental benefits. However, compared with the available potential, the PRC's renewable energy program is relatively small. At present, only about 18.7 GW of renewable energy capacity (mostly in the form of small hydropower) has been harnessed out of an estimated potential of more than 350 GW. The Government's Program on New and Renewable Energy Development (para. 2), aims to improve the efficiency of renewable energy technologies, reduce production costs, and increase the use of renewable energy. Among other things, it targets the cumulative capacity of 400 MW of grid-connected wind farms by 2000, and 1,500 MW by 2010. Although the target for 2000 will not be met, that for 2010 will most likely be surpassed given the measures contemplated by the Government.[39] During the TFYP, the Government intends to gradually introduce the requirement that 5 percent of the electricity supplied to consumers be generated from renewable energy resources, thus maintaining their present share in the generation mix. Initially, this is expected to be introduced at the national level, and subsequently, passed on to provincial electricity grid levels. About 18 GW of new renewable energy capacity would need to be added until 2010 to achieve this target. Such a policy will create a secure long-term market for renewable energy resources, in which potential investors would be willing to invest.[40] The World Bank and GEF are planning to provide assistance to develop the policy and corresponding implementation guidelines under the Government's Strategic Partnership for Renewable Energy Development. However, several more years will likely be required before the appropriate regulatory and policy framework is established to meet the requirement that 5 percent of the electricity generated is produced from renewable energy. The Project supports many of these expected developments by addressing policy issues and barriers for renewable energy development at the provincial level within the envisaged strategic framework for the Government's Strategic Partnership for Renewable Energy Development (para. 48).

C. External Assistance to the Sector

32. Development of renewable energy resources in the PRC is being supported by GEF; UNDP; World Bank; bilateral agencies from Denmark, France, Germany, Japan, Netherlands, Spain, United Kingdom, and United States; and ADB (footnotes 2, 6, 7, and 8). The largest financial support has been provided by the World Bank under its renewable energy development project, which includes a wind-farm component for installation of 190 MW at various sites; a solar PV component for installation of 300,000-400,000 PV systems in various provinces for power generation; and a technology improvement component to provide financial assistance to local industries producing equipment for wind-based or PV power generation.[41]

33. Since 1979, UNDP and GEF have provided assistance for eight projects, totaling $9.8 million, to introduce wind-based power generation and geothermal and PV technologies. At present, UNDP and GEF are providing assistance for capacity building to promote demand-driven development of the PRC's renewable energy sector and facilitate rapid commercialization of

[39] In addition, under its Brightness Program, the Government aims to provide off-grid electricity to 23 million people by 2010 by installing small wind turbines with a capacity of 300 watts or less and PV systems.

[40] Required investments are estimated at more than $8 billion up to 2005 and at about $12 billion for 2005-2010; for financing the projected increase in wind-based power generation, more than $1.7 billion will be required until 2005, and about $3.0 billion from 2005 until 2010 (based on an estimated capital cost of $1,000 per kW).

[41] On 5 May 1999, the World Bank approved a $100 million loan for the project, which is also supported by a $35 million grant from GEF.

renewable energy technologies.[42] Activities supported by the UNDP-GEF project include establishment of a center for renewable energy industries association; development of demonstration projects for biogas production and wastewater treatment in livestock farms and alcohol distilleries, bagasse cogeneration plants in the sugar industry, and renewable energy systems for rural electrification; and capacity building for renewable energy resource assessment, investment promotion in renewable energy, and evaluation of renewable energy projects.

34. Bilateral assistance agencies have mainly focused on installing PV systems (sometimes in combination with diesel-fueled power generation), and developing grid-connected wind farms. Denmark, Germany, and Spain have sizable programs supporting installation of wind farms in the PRC. Germany, through mixed credits provided by the Kreditanstalt für Wiederaufbau, has provided financing for the construction of six wind farms with a total capacity of about 58 MW.[43] Through mixed credits, Denmark has financed the construction of nine wind farms with a total capacity of about 142 MW, and proposed financing for another four wind farms with a total capacity of about 120 MW over the next three years. Spain has approved mixed credits for the construction of seven wind farms with a total capacity of about 30 MW. In general, bilateral assistance is provided for construction of wind farms with an installed capacity of less than 20 MW each, with the assistance tied to procurement of wind turbines from the concerned country and with limited attention to policy issues.

D. Lessons Learned

1. Environmental Improvement Projects

35. ADB has provided 14 loans totaling $2.0 billion for urban environment improvement projects in the areas of water supply, wastewater treatment, air and water pollution control and management, clean forms of energy, and industrial relocation and pollution abatement. The projects have addressed environmental problems in nine major cities (Beijing, Chengdu, Dalian, Hefei, Qingdao, Shanghai, Tangshan, Tongchuan, Xi'an, and Xianyang, all of which are on the Government's list of 52 priority cities for pollution control), as well as energy efficiency and environmental improvement in key industry subsectors, by introducing advanced process technologies and management practices to reduce inefficiencies and waste. As part of the policy dialogue supporting the loans, ADB has promoted price reforms to ensure sustainable resource utilization.

36. Improving environment management has been a major focus of ADB's TA operations in the PRC. To date, ADB has provided about $62 million (or 36 percent of total TA funds provided to the PRC) for 100 TAs in areas such as environmental policy, regulatory measures, institutional building, economic incentives, replacement of obsolete technology with environment-friendly technologies, reduction of excessive reliance on coal, energy pricing and efficiency, water, natural resources, and hazardous waste management. ADB has also supported institutional strengthening of agencies involved in environmental management, and preparation and review of environmental impact assessments; improvement and enforcement of environmental standards; development of environmental legislation; and dissemination of information on environment-friendly technologies and equipment. The TAs have helped promote energy conservation, natural resource management, clean technology, renewable energy, and formulation of environmental policy on national and global issues.

[42] Foreign exchange financing mobilized for the project totals $14.3 million, comprising $8.8 million from GEF, $3.0 million from Australia, and $2.5 million from the Netherlands; implementation is from March 1999 until December 2003.

[43] Four wind farms with a total capacity of about 36 MW have already been completed.

37. A comprehensive study prepared in 1998 found that ADB's strategic objectives for the energy and environment sectors in the PRC since 1991, as well as their evolution over time, have been appropriate.[44] ADB has played an effective role in assisting the PRC in the environment sector and has made advances in expanding its policies on social concerns.[45] The loan projects addressing environmental problems in several major cities have been generally successful. The Qingdao project is almost complete but the benefits are expected to be below appraisal estimates because the scope was reduced.[46] Most components of the Tangshan and Chengde project[47] have been completed, except for the recently approved wastewater treatment facilities that will be completed by the end of 2000. Full benefits are expected from this project. After experiencing an initial delay, the Beijing project is now proceeding smoothly—except for the components related to the disposal and treatment of hazardous wastes, which have been canceled as alternative arrangements have been made for the treatment—and will be completed in December 2000.[48]

38. The Anhui project[49] is proceeding well and is expected to be completed by the end of 2000. However, the implementation of the Xi'an-Xianyang-Tongchuan project[50] may incur some delay due to the need to review the fuel choice for some components. The Suzhou Creek Rehabilitation Project[51] became effective in February 2000 and is being implemented, while the Shanxi Environment Improvement Project[52] is expected to become effective shortly. Of the two industrial energy conservation projects that involved technological restructuring, the first, the Industrial Energy Conservation and Environment Improvement Project[53] was completed in 1997 and rated partly successful mainly because of some cost overruns and implementation delays.[54] The second is proceeding ahead of schedule and will be completed in 2000,[55] but lack of counterpart resources has led to the deletion of one of the six subprojects. Despite such implementation problems, the focus on energy efficiency and environmental issues has proved to be generally successful as savings in energy and other financial costs associated with environmental pollution are large enough to repay the loans on commercial terms. The contribution of ADB's substantial TA support in the environment sector is widely recognized in the PRC. This success was made possible by combining TA activities that demonstrate the benefits of investment in the environment, with lending to implement the strategies and projects outlined by the TAs.[56]

2. Energy Projects

39. ADB's experience in the PRC's energy sector is that projects are generally well-planned and implemented smoothly. EAs and IAs have personnel with good technical skills and make effective use of the training financed by loans to build their institutional capacity. Compliance with covenants

[44] CAP:PRC 98026: *Country Assistance Program Evaluation, People's Republic of China*, January 1999.
[45] Operations Evaluation Office. 1999. *Special Evaluation Study on Social and Environmental Impacts of Hydropower Projects*. Asian Development Bank, Manila.
[46] Loan 1205-PRC: *Qingdao Environment Improvement Project*, for $103 million, approved on 10 December 1992.
[47] Loan 1270-PRC:*Tangshan and Chengde Environment Improvement Project*, for $140 million, approved on 25 November 1993.
[48] Loan 1336-PRC: *Beijing Environment Improvement Project*, for $157 million, approved on 29 November 1994.
[49] Loan 1491-PRC: *Anhui Environmental Improvement Project for Industrial Pollution Abatement*, for $112 million, approved on 26 November 1996.
[50] Loan 1543-PRC: *Xi'an-Xianyang-Tongchuan Environment Improvement Project*, for $156 million, approved on 24 September 1997.
[51] Loan 1692-PRC, *Suzhou Creek Rehabilitation,* for $300 million, approved on 19 June 1999.
[52] Loan 1715-PRC, *Shanxi Environment Improvement,* for $102 million, approved on 7 December 1999.
[53] Loan 1178-PRC, *Industrial Energy Conservation and Environment Improvement* for $107 million, approved on 24 September 1992.
[54] PCR: PRC 25012: *Industrial Energy Conservation and Environment Improvement Project*, September 1999.
[55] Loan 1436-PRC: *Second Industrial Energy Efficiency and Environment Improvement Project*, for $178 million, approved on 9 May 1996.
[56] Operations Evaluation Office. 1997. TA Audit Report on *Selected TAs in the Environment Sector in the People's Republic of China*. Asian Development Bank, Manila.

is generally acceptable although greater efforts are required to implement the policy-related covenants, particularly those relating to diversification of enterprise ownership at the micro level in line with project commitments and policy directions. Rigorous Government screening of projects has a positive impact. Energy conservation projects have experienced some delays mainly because of their complex multicomponent nature involving several IAs in different provinces. Delays have also occurred for some projects in loan signing and loan effectiveness, as well as in procurement, construction, and commissioning. The Government is streamlining the multiple approval process to address these problems.

40. Commercial and financial management of power utilities has been found to be weak. Often, institutional strengthening is needed for organization structure, delegation of authority, management, information and control system, accounting and financial management, and personnel development and training. So far, 2 of the 13 power sector projects financed by ADB have been completed: the Fuel Conversion Project[57] and the Shanxi Liulin Thermal Power Project.[58] The project completion and project performance audit reports for these projects indicate that they were implemented smoothly and assessed them as generally successful. Some cost increases as well as minor delays were noted. Recommendations from the experience gained highlighted (i) the need to improve financial reporting; (ii) the need for more attention to environmental matters; (iii) the advisability of using larger boiler-turbine units; and (iv) the importance of capacity building not only for project preparation, but also for training staff in operational and managerial aspects of power utility operations. A recent reevaluation of the Fuel Conversion Project has revised the project rating downward to unsuccessful in economic terms, and concluded that ADB-financed projects in the energy sector should not be narrowly focused on expected economic gains that may not materialize, and should be rigorously screened to ensure they are in line with ADB's energy policy.[59] Recently, overall project implementation of some ongoing power projects in the PRC has deteriorated in terms of meeting procurement and construction deadlines. This appears to be mainly due to the ongoing restructuring of the power sector and consequent change in project ownership. Nevertheless, the overall implementation performance of ADB's energy portfolio in the PRC is satisfactory.[60]

41. These lessons were considered when designing the Project. Comprehensive feasibility studies were prepared for the three wind farms, and consulting services will be provided to assist with project implementation. Domestic commercial banks have committed their respective loans, which have been secured through guarantees from relevant provincial government agencies. Local currency financing has been structured to ensure an appropriate mix of debt and equity. Provision has been made for sufficient working capital requirements for each wind farm to be established. Sensitivity analysis of financial and economic performance has been undertaken. Power purchase agreements (PPAs), which govern the sale and dispatch of electricity to the grid, will ensure that the wind farms will be used for power generation whenever sufficient wind is available.

E. ADB's Sector Strategy

42. ADB's operational strategy in the PRC is aimed at helping the country achieve economic growth in an efficient, equitable, and sustainable manner. Accordingly, three strategic objectives—efficiency improvement, environmental protection, and promotion of growth in less developed inland provinces—provide the focus for ADB operations. In the energy sector, ADB's operational strategy supports the Government's two-pronged energy development program aimed at expanding energy

[57] Loan 880-PRC, *Fuel Conversion,* for $33.3 million, approved on 21 December 1987.
[58] Loan 1091-PRC, *Shanxi-Liuhin Thermal Power,* for $65 million, approved on 25 July 1991.
[59] The Audit Committee has noted among others that the financial and economic reevaluation could be carried out using different methodologies and assumptions, which could yield different results, and that the circumstances that made the project financially unattractive were largely exogenous to it.
[60] Of 17 loans currently under administration, 4 are rated as highly satisfactory, 9 as satisfactory, 3 as partially satisfactory, and 1 as unsatisfactory.

supplies and promoting energy conservation and end-use efficiency. ADB encourages private sector participation in the PRC's energy sector and is helping create the enabling environment for such private sector participation.[61] Energy projects are designed to assist in improving the efficiency of the economy in a sustainable manner, while protecting the environment and managing the country's natural resources.

43. ADB's energy sector operations in the PRC will focus on (i) promoting energy conservation and demand- and supply-side management; (ii) supporting improvements in transmission and distribution systems to promote system wide efficiency and reduce losses, including improvement of the reliability and affordability of rural electricity supply; (iii) developing cleaner energy sources such as hydropower, clean coal technologies, natural gas, methane gas, and renewable energy; (iv) renovating and retrofitting existing facilities to improve efficiency and reduce emissions; (v) promoting the corporatization and commercialization of power utilities; (vi) facilitating sector restructuring; and (vii) supporting pricing and tariff reforms. This is complemented by ADB's strategy for the environment sector, which focuses on (i) strengthening the legal, policy, and regulatory framework for sustainable environmental management; (ii) supporting institution- building programs in environmental monitoring and enforcement; (iii) supporting the utilization of economic, supply-side, and other measures to ensure sustainable utilization of natural resources; (iv) promoting the use of cleaner technologies for industrial production; (v) promoting market-based pricing and encouraging cost recovery; and (vi) implementing and monitoring agro-industrial pollution control mechanisms.

44. ADB's poverty reduction strategy for the PRC envisages a range of measures: (i) in the short term, providing goods and services directly to the most vulnerable members of society; (ii) in the medium term, improving health, education, and social security systems by supporting institutional reform and capacity building; and (iii) in the long term, promoting sustainable, pro-poor growth by improving infrastructure and creating jobs in areas with a high incidence of poverty. Because it does not have access to concessionary loans from ADB, the PRC has been reluctant to borrow for projects that address short- and medium-term poverty reduction measures. The Government and ADB therefore agree that poverty issues should be tackled from the following perspectives: (i) providing the necessary physical infrastructure in the poorer interior provinces, particularly in poverty counties, to stimulate economic growth; (ii) designing infrastructure projects to more broadly distribute project benefits in poor areas; (iii) encouraging natural resource management to sustain agricultural production of poor areas, and targeting agriculture and rural development projects to the poor; (iv) supporting social security reform and the development of a social safety net to offset the social costs related to SOE reform and ameliorate the increasing urban poverty; (v) ensuring that affordability by income level is considered during policy dialogue related to cost recovery (e.g., lifeline tariffs); (vi) ensuring that resettlement requirements of projects and environmental impacts do not result in worsened standards of living; (vii) paying special attention to the effects of projects on women and minority groups; (viii) looking more broadly at the poverty situation by working with the Leading Group on Poverty Alleviation of the State Council; and (ix) developing specific poverty reduction activities for financing by the Japan Fund for Poverty Reduction.

45. ADB's assistance in the PRC's energy sector will be aligned with the three pillars of ADB's poverty reduction strategy, i.e., pro-poor sustainable economic growth, social development, and good governance. Energy projects will be formulated and designed to support pro-poor growth, in

[61] In this regard, ADB provided TA 2730-PRC: *Changsha BOT Power Project*, for $597,000, approved on 23 December 1996, to help select the build-own-transfer operator and develop a project structure for a 2 x 350 MW coal-fired power plant near Changsha city in Hunan Province. ADB also provided financing of $50 million under its private sector operations to Fujian Pacific Electric Co. Ltd. of the PRC (Investment No. 1610/7144-PRC, approved on 26 February 1998, consisting of a loan of $40 million and an equity investment of $10 million) for Meizhou Wan BOT Power Project comprising a 720 MW coal-fired power plant in Fujian Province, which won two international awards for excellence.

particular in the poorer interior provinces, to achieve balanced regional development. The Project, with its emphasis on promoting the development of environment-friendly power generation that will help avoid air pollution, and with two wind farms located in areas with average annual incomes below the national average,[62] is in accord with ADB's strategy to promote pro-poor and environmentally sustainable economic growth in the PRC.

F. Policy Dialogue

46. Dialogue on the Project has focused on the supportive policies and measures, that the Government should undertake to accelerate the development of renewable energy projects, in particular grid-connected wind farms. A description of the issues discussed to promote renewable energy development and ensure the sustainability of the wind farms follows.

1. Promotion of Wind Power Development

47. As a result of the policy dialogue, the PPCs that distribute the electricity generated by the wind farms will be fully compensated for the cost of purchasing and distributing such electricity, and will be required at all times to dispatch the wind-based electricity when it is available. This will help eliminate the risk of nondispatch of relatively more expensive wind-based electricity when sufficient production from conventional sources is available. The Government has agreed to permit the PPCs to fully charge all consumers connected to their grids (who share in the environmental benefits of wind-based electricity) for its use and for this purpose, will consider requests made by the PPCs for retail tariff increases due to the purchase and distribution of the relatively more expensive electricity generated by the wind farms. Also, with assistance from the TA consultants, a mechanism will be developed to certify the electricity generated by the wind farms under the Project, allocating corresponding green credits to the wind-farm companies (WFCs) and informing consumers through their billings of the specific quantity of green electricity used. The potential for trading of green credits in both domestic and international markets is considerable (para. 19). The Project will help develop such markets; this approach is complementary to the pollution (emission) trading program promoted by ADB that aims to reduce air pollution by allocating maximum emission quotas to polluting sources.

2. Barriers to Renewable Energy

48. A major impediment for development of renewable energy sources in the PRC is the absence of a mandatory requirement that a certain percentage of the electricity supply is to be met from such sources. During the TFYP, the Government will introduce policies and mechanisms to ensure power producers gradually achieve 5 percent of their electricity generation from renewable energy, thus creating a separate market for renewable energy. Assistance for the development of such policies and mechanisms is expected to be provided by the World Bank and GEF through the Government's Partnership for Renewable Energy Development, which has as its main objective the reduction of harmful environmental emissions from coal-fired power generation by developing sustainable commercial markets for electricity from renewable energy. The strategic framework of the partnership is expected to comprise (i) policies, laws, and regulations for establishing a separate market for renewable energy and measures to make the market operational; (ii) actions to reduce the cost of renewable energy and make it competitive, including technology improvement to assist local manufacturers of good quality equipment to reduce cost; (iii) local capacity for project development and financing, as well as efficient operation and maintenance of facilities; and (iv) selected demonstration and investment projects that have strategic importance. However, World Bank-GEF assistance for the partnership will not likely become operational before June 2001 at the earliest, and several more years will probably be required before the appropriate regulatory and

[62] The wind farms in the Xinjiang Uygur Autonomous Region and Heilongjiang Province.

policy framework is established to make a separate market for renewable energy development and utilization viable. In the meantime, the installed capacity of grid-connected wind farms in the PRC needs to be steadily increased from its present level of about 265 MW by a minimum of 250-300 MW a year during the transitional phase to the separate market. This would meet the Government's target, increase the PRC's experience with the operation of large-scale wind farms, move to more market-based financing, and help promote localizing equipment assembly and manufacture, thereby reducing the capital costs of wind farms. The Project supports the envisaged partnership by providing momentum for wind-farm development in the PRC during the transitional period.

49. In this context, existing barriers to renewable energy development will be addressed in the project provinces and autonomous region. These include the absence of targets for renewable energy development at the provincial level, unavailability of wind data, absence of indicative site-specific cost ranges for wind-based electricity, and lack of interest in the nongovernment sector to invest in wind farms. In view of the global environmental benefits associated with the Project, ADB approached GEF for assistance in addressing these barriers and providing financial support for the construction of the three wind farms. The Project was accepted into the GEF formal pipeline in September 1999. On 2 November 2000, the GEF Council approved the proposed assistance as an intervention that supports the objectives of the GEF renewable energy partnership with the PRC. Given the magnitude of the investments required to develop additional renewable energy resources over the next 10 years to meet the 5 percent target, nongovernment funds must be mobilized for investment in wind farms. Under the Project, options will be studied to attract private investors and nongovernment investment funds. This will serve as a model for mobilizing such funds, which can be replicated in other parts of the PRC.

3. Power Sector Restructuring

50. Power sector restructuring to develop competitive electricity markets is expected to result in more efficient operations and a reduction in electricity tariffs for consumers. For the development of grid-connected, wind-based power generation, the creation of a separate market will be important for the usually more expensive electricity generated by wind farms. As the Government intends to create such a market during the TFYP by requiring that a minimum of 5 percent of electricity is generated from renewable energy, power sector reforms in Heilongjiang and Liaoning provinces are not expected to adversely affect the utilization of their wind-based power potential. ADB's continuing policy dialogue on power sector restructuring is expected to help the development of a green credit-trading system in the PRC. In particular, if progress is made in unbundling PPCs and corporatizing power generation plants, the number of parties that could participate and be interested in green credit trading would increase considerably and strengthen the viability of such a system.

IV. THE PROPOSED PROJECT

A. Rationale

51. The PRC's heavy reliance on coal as its primary fuel has led to serious national and global environmental problems, notably air pollution.[63] At present, annual coal production is about 950 million tons and coal consumption accounts for about 67 percent of total primary commercial energy use. The projected continuing dominance of coal in the energy sector implies increases in emissions of SO_2, nitrogen oxides (NO_x), TSP, and GHGs, i.e. CO_2 and methane. The annual economic losses due to adverse health impacts and agricultural loss associated with coal-related air pollution are considerable. Reducing environmental damage from coal use is a high priority for the Government. The PRC currently accounts for more than 10 percent of annual global energy-related GHG

[63] Air pollution also contributes to acid rain, which is causing increasingly serious damage to forests, crops, aquatic life, and archeological treasures.

emissions, mainly in the form of CO_2 and methane. Even with sharp declines in energy intensity, continued economic growth is likely to be accompanied by more than a three-fold increase in GHG emissions by 2020. Therefore the Government considers the development of noncoal energy alternatives essential for limiting the use of coal and hence the increase of GHG emissions and other types of pollutants. In particular, development of renewable energy, including wind power, offers an excellent alternative for the use of coal and deserves Government support.

52. In this context, the Government is promoting the development of grid-connected wind-based power generation, with the long-term objective of making medium- and large-scale wind farms (15 MW to 100 MW) competitive with the long-run marginal cost of electricity generation. At present about 13,500 MW of grid-connected wind power facilities have been installed worldwide.[64] By contrast, only 265 MW have been developed in the PRC (accounting for about 2 percent of the worldwide installed capacity), despite its wind power potential of 160 GW. As long as the environmental benefits of wind power or, conversely, the environmental costs of coal-based power generation are not internalized, the cost per kWh of wind power will be higher. To date, the development of grid-connected wind farms in the PRC has also not been carried out in a systematic and coordinated manner, and has been mainly by through bilateral grants and concessionary loans. Multilateral and bilateral support for the Government's efforts is essential to facilitate a breakthrough for grid-connected wind farms, and thereby promote the development of a domestic wind turbine industry resulting in lower manufacturing cost. Coordination of such assistance will likely be strengthened under the Government's Partnership for Renewable Energy Development (para. 48). The Project will accelerate the development of wind-based power generation in the Xinjiang Uygur Autonomous Region and in Heilongjiang and Liaoning provinces. It represents a bottom-up approach to the development of wind-based power generation at the provincial level within the framework of the Government's national policies and targets for renewable energy development, which are expected to be developed under the TFYP. GEF support will be provided under the Project to develop mechanisms for policy implementation in the two provinces and the autonomous region.

53. Over its lifetime, the Project will avoid emissions of about 11,000 tons of SO_2, 7,400 tons of NO_x, 5,000 tons of TSP, and 1.94 million tons of CO_2. In 1999 in the provincial capitals of the Xinjiang Uygur Autonomous Region and Heilongjiang Province, daily TSP pollution levels exceeded the PRC and World Health Organization standards for residential urban and rural areas (Appendix 4). The Project will help ensure the supply of electricity, given the plans of the respective PPCs to close down inefficient, and polluting coal-fired power plants with a capacity of 50 MW or less over the next five years. The Project is also expected to generate employment opportunities for skilled and semiskilled labor in the operation and maintenance of wind turbines and related facilities.

B. Objective and Scope

54. The principal objective of the Project is to produce electricity in an environment-friendly manner and increase the share of wind-based electricity in overall power generation through the establishment of three grid-connected wind farms in the Xinjiang Uygur Autonomous Region and Heilongjiang and Liaoning provinces, thereby avoiding emissions of SO_2, NO_x, TSP, and CO_2 associated with conventional thermal power generation.

55. The Project will establish three grid-connected wind farms with a total installed capacity of 78 MW and provide assistance for barrier removal and institutional strengthening for the development of wind power. The Project includes two components:

[64] Europe accounts for about 69 percent, North America for about 19 percent, the Asia and Pacific Region for about 11 percent, South and Central America for about 1 percent, and Africa for less than 1 percent.

1. Part A: Construction of Wind Farms

56. In the Xinjiang Uygur Autonomous Region, construction will include
(i) a 30 MW wind farm at Dabancheng No. 3 site, about 40 kilometers (km) southeast of the provincial capital, Urumqi;
(ii) a 2 x 20 megavolt-ampere (MVA), 110 kilovolt (kV) substation, and a 3 km double circuit 110 kV transmission line; and
(iii) consulting services for project implementation.

57. In Heilongjiang Province, construction will include
(i) a 24 MW wind farm about 32 km southwest of the city of Fujin;
(ii) a 2 x 16 MVA, 66/10 kV substation, and a 6 km double-circuit 66 kV transmission line; and
(iii) consulting services for project implementation.

58. In Liaoning Province, construction will include
(i) a 24 MW wind farm at Xiwaizi near Yingkou City, on the eastern shore of Liaoning Bay;
(ii) a 2 x 16 MVA, 66/10 kV substation, and a 7-km double circuit 66 kV transmission line; and
(iii) consulting services for project implementation.

2. Part B: Assistance for Barrier Removal and Institutional Strengthening

59. **Benchmarking of tariffs for wind-based power generation.** Activities include
(i) developing a methodology to determine appropriate tariffs for wind-based power generation taking into consideration site-specific conditions, investment costs, and required efficiency of operations and financial returns for investors;
(ii) consulting with key government agencies, potential investors, PPCs, and financial institutions to reach agreement on the methodology to be used for this purpose;
(iii) helping develop suitable PPAs for wind farms; and
(iv) training WFC staff and relevant provincial government staff of benchmarking methodology use and the preparation and use of PPAs.

60. **Commercializing the WFCs.** Activities include

(i) feasibility studies on options for attracting private investors and nongovernment investment funds to the project WFCs;
(ii) study on reorganizing existing wind farms in the two provinces and the autonomous region, including possible mergers and disinvestments, with the aim of improving efficiency of operations and attracting nongovernment investment funds in the future.

61. **Facilitating the implementation of national policy for renewable energy use at provincial level.** Activities include

(i) developing targets for renewable energy production and use for the two provinces and the autonomous region;
(ii) formulating an implementation plan to meet such targets;
(iii) incorporating wind power projects into regular power sector planning for the two provinces and the autonomous region;
(iv) identifying possible mechanisms to certify renewable energy production by issuing domestic trading of green credits; and

(v) within the framework of the national policy for renewable energy development, evaluating the suitability of non-fossil fuel obligation and other market mechanisms such as renewable portfolio standard to develop renewable energy in the two provinces and the autonomous region.

62. **Increasing wind measurement data in the Xinjiang Uygur Autonomous Region and Heilongjiang and Liaoning provinces.** Activities include

(i) wind measuring at about 25 promising sites for development of additional wind farms;
(ii) collecting and transfering of data to the national wind power data center, which is being established with UNDP support; and
(iii) preparing bid packages for wind farm development at specific sites.

63. **Capacity building and training.** Activities include

(i) training relevant staff of the PPCs, planning commissions, financing institutions, and commercial banks in planning, appraisal, and development of wind farm projects; and
(ii) training WFCs staff in business development and managerial skills.

64. **Assisting the project management office (PMO) and disseminating at a national level the experiences and achievements in the two provinces and the autonomous region.** Activities include

(i) preparing required background information and analysis policy development promote renewable energy utilization in the two provinces and the autonomous region;
(ii) holding national workshops and seminars to present and discuss the experiences and achievements of the two provinces and the autonomous region in the context of the Government's overall policies and objectives for renewable energy development; and
(iii) disseminating the findings and results.

C. Technical Justification

65. Over the years, using wind speed measurements, the PRC has identified various regions with strong average wind speeds (wind belts), in which wind farms can be developed. The first is the northern wind belt, which runs from north-northeast of Xinjiang Uygur Autonomous Region (near Urumqi) to the middle and northern part of Inner Mongolia, and then moves from the northeast of Inner Mongolia through the middle of Heilongjiang Province the People's Democratic Republic of Korea and the Russia Federation. The second wind belt is the coastal wind belt ranging from the coast near Hainan Island, through Fujian and Zhejiang provinces to Shanghai and the provinces of Heibei, Liaoning, and Shandong. The proposed sites for the three wind farms are situated in these two belts: the wind turbines and towers will be installed over areas ranging from 170 to 210 hectares.

66. The Xinjiang Uygur Autonomous Region has nine separate potential wind farm regions with adequate wind resources. One is in the Dabancheng area[65] where five sites in close proximity were identified with an estimated total wind-based power generation capacity of 1,000 MW. At sites No. 1 and No. 2, three grid-connected wind farms are operational with installed capacities of 12 MW and 57.5 MW. Site No. 3, which can accommodate up to 200 MW of wind-based power generation

[65] The area is easily accessible from the main highway and consists of a sparsely populated, wide open plain without much vegetation, flanked at two opposing sides by mountains, thus creating a corridor from the area around the city of Urumqi to the eastern part of the Xinjiang Uygur Autonomous Region.

capacity, has been identified for the installation of the 30 MW wind farm under the Project. The wind farm will be connected to an existing 220 kV transmission line that passes near the site. The average annual wind speed available for power generation is estimated at 8.4 meter per second (m/s).

67. The wind farm at Fujin in Heilongjiang Province will be located on a small range of hills named Bielanyinshan, on the Sanjiang plain. It will be the first wind farm in the province, which has four main wind zones. The area where the proposed wind farm is to be located has the highest wind resource of these four zones and is situated on the top of a mountain with an approximately 8 km long ridge line, which varies in height from 240 meters to 473 meters above sea level. The area around the site has good access and the equipment can be readily transported to the bottom of the hill site. Under the Project, an access road will need to be constructed to transport the wind turbines and related equipment and materials up to the site. The wind farm is to be connected to an existing 66 kV transmission line that is located about 5 km away from the site. The average annual wind speed available for power generation is estimated at 9.2 m/s.

68. The wind farm at Xiwaizi in Liaoning Province will be located near the eastern shore of Liaoning Bay. The topography of the site is relatively flat but there is a 20 - m high cliff near the location of the wind farm, which may introduce some turbulence effects that will need to be addressed during the design. Access to the site is good but will require some upgrading by strengthening several small bridges and widening several curves to allow long trucks to pass. The wind farm will be connected to an existing 66 kV transmission line that passes near the site. There are five operational wind farms in Liaoning Province with a total installed capacity of about 50 MW. The PPC is planning to increase the wind-based power generation capacity to about 195 MW by 2005. The average annual wind speed available for power generation is estimated at 6.9 m/s.

69. Analysis of design is based on the assumption that 660 kW wind turbines will be installed; however, this does not preclude the use of larger size turbines (850 kW to 1.5 MW). The 660 kW turbine size was selected as it is suitable for all sites. Larger wind turbines would yield similar amounts of energy; a decision on whether to use such turbines will be made during bid evaluation based on the micro siting of the turbines proposed by the bidders and the prices quoted by them.[66] Currently, companies in the PRC do not have the required technical capability and experience to manufacture the wind turbines.

70. Availability of existing wind farms[67] in the PRC has been adversely affected by poor maintenance practices compounded by the debt-repayment type of PPA[68] commonly used. Improved availability is expected to be achieved for the wind farms to be established under the Project[69] because the wind turbine manufacturers will be responsible for the initial operation and maintenance, thus reducing potential risks related to the start-up problems. The initial involvement of the wind turbine manufacturers in the Project will also help establish inventory systems for spare parts. The manufacturers will train WFC personnel in operation and maintenance, enabling them to assume full responsibility about one year after project completion. The PPAs will also provide incentives for efficient operation and maximum availability of the wind farms.

71. Electrification ratios expressed as the number of households that have access to electricity are relatively high with 88.9 percent for the Xinjiang Uygur Autonomous Region, 99.5 percent for

[66] The installed capacity of each wind farm will differ slightly from the intended installed capacity if only 660 kW wind turbines are used.
[67] Defined as the period of electricity generation over the period of adequate wind speeds for electricity generation.
[68] The debt repayment type of PPA provides a certain tariff only to wind farms as long as required to meet estimated annual expenditures including debt repayment; once in a given year the required estimated income is thus generated as a much lower tariff is applied to the remainder of the year.
[69] The 57.5 MW wind farm at Dabancheng's site No. 2 achieved an availability of 95 percent in 1999.

Heilongjiang Province, and 99.0 percent for Liaoning Province. The provinces have ongoing programs for further rural electrification. Although just a fraction of the total power distributed in each province,[70] the power to be generated by the project wind farms will help meet the demand for electricity and stabilize the power distribution systems during expansion and restructuring of the respective power generation base, which includes the closure of old, inefficient, and polluting coal-fired power plants.

72. The present tariff structures in the two provinces and the autonomous region are relatively complex, do not fully reflect the structure of supply costs, and do not provide adequate incentives for energy conservation. The industrial consumers, who usually take electricity at higher voltage levels (hence at lower costs) are paying a tariff that is higher than the tariff for residential consumers. Within the same consumer category, consumption at the lower voltage level is charged at a higher tariff, but the difference is small compared with the difference in supply costs. The tariff structures involve economic subsidies but are being modified to remove these deficiencies and promote the efficient use of electricity.

73. Programs to eliminate rural surcharges and increase rural electrification that began in 1998 have resulted in a substantial reduction of rural tariffs in the two provinces and the autonomous region. However, the current rural residential tariffs are still about 1.5 to 2 times the urban residential tariffs, amounting to Y0.60/kWh for Dabancheng, Y0.76/kWh for Fujin, and Y0.70/kWh for Xiwaizi. The PPCs have been (i) increasing urban residential tariffs, (ii) increasing the capacity charge for large industrial consumers, and (iii) increasing the number of consumers with time-of-day tariffs. Tariff reforms required to make electricity affordable to poor rural consumers will be discussed further with the Government on the basis of the findings of an ongoing TA.[71]

D. Cost Estimates

74. The total project cost including taxes, physical and price contingencies, and other charges during construction, is estimated at $98.0 million equivalent, comprising a foreign exchange cost of $69.0 million and a local currency cost of $29.0 million equivalent (Table 1). Part A accounts for $93.2 million, and Part B for $4.8 million. Detailed cost estimates are given in Appendix 5.

Table 1: Project Cost
($ million)

Item	Foreign Exchange	Local Currency	Total Cost
Part A: Wind Farms			
Dabancheng Wind Farm	20.1	9.5	29.6
Fujin Wind Farm	16.8	7.9	24.7
Xiwaizi Wind Farm	16.8	7.2	24.0
Subtotal (Base Cost)	53.7	24.6	78.3
Contingencies	4.4	2.4	6.8
Interest During Construction[a]	7.1	1.0	8.1
Subtotal Part A	**65.2**	**28.0**	**93.2**
Part B: Barrier Removal and Institutional Strengthening	**3.8**	**1.0**	**4.8**
Total	**69.0**	**29.0**	**98.0**

[a] Includes a 1 percent front-end fee on the Asian Development Bank loan.
Source: Staff estimate.

[70] About 1.4 percent of the electricity distributed through the Urumqi power grid, and about 0.2 percent of the electricity distributed through the Heilongjiang and Liaoning power grids.
[71] TA 3369-PRC: *Rural Electricity Supply Study*, for $700,000, approved on 26 December 1999.

E. Financing Plan

75. The entire foreign exchange cost of Part A of the Project of $65.2 million is proposed to be financed by an ADB loan of $58.0 million, a $6.0 million contingent interest-free loan from GEF (that is to be repaid after 10 years if the Project is successful), and $1.2 million from the GEF grant to meet the foreign exchange costs of the consulting services for project implementation. The GEF contingent loan will be provided under joint cofinancing arrangement with ADB. Both the GEF contingent loan and the GEF grant will be administered by ADB. The local currency cost of Part A of $28.0 million equivalent will be financed by the PPCs by mobilizing equity participation in the respective wind farms from their own and other sources ($18.6 million) and from loans from domestic banks and/or financial institutions ($9.4 million equivalent). The entire cost of Part B of the Project of $4.8 million for barrier removal and institutional strengthening in the two provinces and the autonomous region will be financed by GEF on a grant basis. The GEF Council approved the Project on 2 November 2000 (para. 49). The proposed use of the GEF contingent loan is an innovative tool that is to be provided to share perceived performance risks associated with the wind farms with the WFCs and build confidence in the new technology. These performance risks comprise lower than expected wind speeds (i.e., wind resource risk[72]) and wind turbine reliability (i.e., technology risk). Experience in the PRC shows that operation and maintenance of wind farms have not always been up to international standards and that wind farms have been constructed on the basis of overly optimistic assumptions about expected wind speeds. This has resulted in losses to the operators due to energy outputs lower than projected in the feasibility studies. The GEF contingent loan is to be repaid after 10 years following project completion if the Project is successful. The Project is considered successful if during the three years prior to repayment all three WFCs have achieved an availability of more than 95 percent, complied with the financial covenants, and made a reasonable profit. If the Project is not successful, repayment of the GEF contingent loan will not be required only if the Project is unsuccessful due to wind resource and technology deficiencies that were beyond the control of the WFCs. Table 2 presents the proposed financing plan for the Project.

76. The ADB loan will be from ADB's ordinary capital resources. The loan will carry a front-end fee of 1 percent, an interest rate to be determined in accordance with ADB's pool-based variable lending rate system for US dollar loans, and a commitment charge of 0.75 percent per year. The loan will have a repayment period of 20 years, including a grace period of 3 years.[73]

[72] Given the range of estimated average annual wind speeds at the three sites, a 10 percent reduction of the average annual wind speeds is expected to result in 20-35 percent lower electricity production.

[73] The blending of the GEF contingent interest-free loan with the ADB loan provides a total of $64 million at an estimated net effective interest rate of 5.9 percent, which is equivalent to the estimated weighted average cost of capital for the EAs and close to the present interest rate on long-term domestic borrowings (around 6.2 percent).

Table 2: Financing Plan
($ million)

Item	Foreign Exchange	Local Currency	Total	Percent of Total
Equity				
XEPC	0.0	7.0	7.0	7.2
HEPC	0.0	5.9	5.9	6.0
LEPC	0.0	5.7	5.7	5.8
Total Equity	0.0	**18.6**	**18.6**	**19.0**
Loans				
ADB	58.0	0.0	58.0	59.2
GEF	6.0	0.0	6.0	6.1
Domestic Banks		9.4	9.4	9.6
Total Loans	**64.0**	**9.4**	**73.4**	**74.9**
Grant (GEF)				
Part A	1.2	0.0	1.2	1.2
Part B	3.8	1.0	4.8	4.9
Total GEF Grant	**5.0**	**1.0**	**6.0**	**6.1**
Total Project	**69.0**	**29.0**	**98.0**	**100.0**

ADB= Asian Development Bank; GEF= Global Environment Facility, HEPC= Heiliongjiang Electric Power Company Ltd; LEPC= Liaoning Electric Power Company Ltd; XEPC= Xinjiang Electric Power Company Ltd.
Source: Staff estimates.

F. Implementation Arrangements

1. Project Management

a. Part A

77. The EAs for Part A of the Project will be the respective PPCs: the Xinjiang Electric Power Company Ltd (XEPC) for the wind farm at Dabancheng, the Heilongjiang Electric Power Company Ltd (HEPC) for the wind farm at Fujin, and the Liaoning Electric Power Company Ltd (LEPC) for the wind farm at Xiwaizi. They will be responsible for the timely mobilization of all project financing, including obtaining any foreign exchange required in addition to the funds made available by ADB and GEF. XEPC, HEPC, and LEPC will also be responsible for procurement, preparation of legal agreements for the respective wind farms including PPAs and land lease agreements, and disbursement of funds. For this purpose, the PPCs have established project implementation offices, staffed with a project manager, an accountant, and a procurement specialist. Overall coordination of the activities will be undertaken by SDPC, as the national coordinating agency.

A.

78. To operate the wind farms, three WFCs will be established under the PRC Company Law. The establishment of separate WFCs is in line with the Government's policy to corporatize power generation activities. It will also facilitate attracting nongovernment funds to the wind farms in the future and allow the wind farms to operate as independent entities in a separate market for renewable energy, which the Government plans to establish during the TFYP. Each WFC will be the IA responsible for the construction and the operation and maintenance of its respective wind farm. The concerned PPC will be the majority shareholder in each WFC, (with possible additional shareholdings by PPC-related organizations) during the initial period of commercial operations. The WFCs will be responsible for site preparation, construction supervision, and liaison with the concerned PPC. They will be staffed adequately, initially for implementation of the Project and, subsequently, for its operation and maintenance.

b. Part B

79. The EA for Part B of the Project will be SDPC. SDPC will establish a PMO, which will include representatives from the Ministry of Finance and SP, to coordinate, at the national level, the various project activities and disseminate the experiences and results. The PMO will also coordinate the implementation of the various activities with the concerned PPCs and provincial planning commissions. At the provincial level, working groups will be established involving provincial stakeholders in renewable energy development to provide feedback on the consultants' proposals and recommendations. Consultants will provide support to the PMO on policy development, coordination of provincial activities, and the nationwide promotion and dissemination of the findings of the provincial activities. The supervision and administration of the activities to be undertaken under Part B will be carried out by ADB.

2. Procurement

80. All goods and services to be financed by the ADB loan and the GEF contingent loan will be procured in accordance with ADB's *Guidelines for Procurement.* The wind turbines and towers will be procured on the basis of an engineering, procurement, and construction (EPC) contract for each wind farm following international competitive bidding among prequalified contractors.[74] Under the EPC contracts, manufacturers of the wind turbines will be contractually responsible for the operation and maintenance of the wind turbines for one year following the completion of the wind farms, and during this period will be required to train WFC staff in operation and maintenance. Auxiliary equipment will be financed from ADB and GEF funds and will be procured in accordance with international shopping procedures. Civil works and all other goods, including substations and transmission facilities, will be financed by the EAs and procured through local competitive bidding. All goods to be financed under the Project will be insured against hazards associated with their transport, delivery, and installation, while the wind turbines and blades will be insured against damage risk during maintenance from the second year of commercial operations onward following the turnover of operation and maintenance by the manufacturers of the wind turbines. The proposed procurement packages are shown in Appendix 6. Since LEPC is planning to award the EPC contract by June 2001, prequalification of contractors needs to begin by late 2000 prior to loan effectiveness. LEPC therefore requested the Appraisal Mission for advanced procurement action for this component. This request is being endorsed by the Government and when received by ADB will be processed for ADB approval. Advance procurement action has been approved for the prequalification and selection of the EPC contractors.

3. Consulting Services

81. The consultants, all of whom will be financed by the GEF grant, will be selected and engaged in accordance with ADB's *Guidelines for Use of Consultants* and other arrangements for the selection and engagements of domestic consultants. For Part A, about 30 person-months of international consulting services will be needed to help (i) the project implementation offices will prepare bidding documents for procuring and installing the wind turbines and towers under the EPC contracts, and (ii) the WFCs supervise construction of the wind farms.

82. For Part B, about 70 person-months of international and about 190 person-months of domestic consulting services will be recruited to provide assistance for the barrier removal and institutional strengthening activities in the two provinces and the autonomous region. The budget allocations and terms of reference for all consulting services are in Appendix 7.

[74] A sufficient number of qualified manufacturers of wind turbines in the range of 600 kW to 1.5 MW are available to ensure competition.

4. Implementation Schedule

83. Implementation of Part A is expected to begin with site preparation work[75] to be undertaken by the WFCs, after the Government has formally approved the project feasibility studies and the WFCs are established. Site preparation will take 5-6 months. Concurrently, the procurement process for each wind farm will begin, i.e., the prequalification and selection of the EPC contractor and the procurement of the components not included in the EPC contract, such as transmission lines, substations, cranes, and other auxiliary equipment. Construction and commissioning of the wind farms will require 16-17 months. All wind farms are expected to be physically completed by the end of 2002. During 2003 the wind turbine manufacturers will be responsible for operation and maintenance, and provide training to WFCs staff. Part B of the Project will be implemented from early 2001 until late 2003. The implementation schedule is given in Appendix 8.

5. Governance and Anticorruption

84. During project processing, ADB's anticorruption policy was explained to central and local government officials. Attention was drawn to the section on fraud and corruption that was added to ADB's *Guidelines for Procurement*, particularly the need for bidders, suppliers, and contractors to observe the highest standards of ethics in procuring and implementing ADB-financed contracts, and the sanctions to be applied if fraud and corruption are discovered. Similarly, the anticorruption provisions added to ADB's *Guidelines on the Use of Consultants* were discussed.

85. The Government is increasingly concerned with governance issues and has conducted well-publicized campaigns against official corruption. ADB's country assistance program for the PRC includes support to the Government in improving governance and providing incentives to reduce the incidence of corruption in the longer term. In 1997, ADB also provided TA to draft procurement regulations and standard bidding documents.[76] The six sets of draft regulations and the three sets of sample bidding documents produced under the TA contain provisions related to avoidance of corrupt or fraudulent practices, in accordance with ADB's anticorruption policy. This assistance culminated in the promulgation of the Law on Tendering and Bidding, which became that became effective on 1 January 2000. The law, which covers key state-funded construction projects and all externally funded projects, stipulates in Article 5 that bidding activities will follow the principles of openness, fairness, impartiality, and good faith. Article 6 stipulates that "no organizations or persons shall, by any means, limit or exclude legal persons or other organizations from other regions or systems from participating in the bidding procedure. No illegal interference in any form is permitted in the bidding process." Article 32 specifically prohibits bribes and collusion, while articles 49 to 64 specify appropriate sanctions for all abuses of the law, including substantial fines and criminal prosecutions. ADB is providing TA for implementation of the law.[77]

86. In 1998, ADB provided TA related to the consulting industry and auditing that will also help address the main elements of ADB's anticorruption policy. Under the first TA,[78] detailed guidelines were developed for selecting and engaging consultants, which take account of the principles of ADB's anticorruption policy, increase transparency, and provide for equal opportunity competition. Under the second TA, consultants are helping strengthen the Government's auditing system to conform with the requirements of the Audit Law and, as far as practicable, international auditing

[75] Construction of access roads, power and water supply facilities, and site leveling.
[76] TA 2845-PRC: *Establishment of National Procurement Regulation for the Public Sector, for* $565,000, approved on 20 August 1997.
[77] TA 3457-PRC: *Implementation of the Tendering and Bidding Law on Related Regulations*, for $565,000, approved on 14 June 2000. ADB is also planning to provide TA for *Preparation of a Government Procurement Law*, for $578,000.
[78] TA 3138-PRC: *Regulatory Framework for the Engagement of Consultants*, for $700,000, approved on 22 December 1998.

standards.[79] In particular, this TA is helping (i) formulate government auditing standards and procedures; and (ii) design and implement an audit-training program to promote full and consistent adherence to such auditing standards and procedures by government auditors. When completed, this work should strengthen the Government's ability to detect fraud and corruption.

G. Executing Agencies

1. Organization

87. XEPC, HEPC, and LEPC are all limited liability companies, wholly owned by SPC. They are responsible for undertaking the generation, transmission, and distribution functions related to the heating and electric power industry in their respective areas. Day-to-day operations of each company are the responsibility of a general manager who is assisted by seven officers of deputy general manager rank, including a chief engineer and a chief accountant. Each company has a network of wholly owned subsidiaries and controlled shareholding companies that include power generating plants, power distribution offices, research organizations, power-related educational institutions, construction offices, and noncore business that are not related to the performance of the power utility functions. Each also has investments in other companies. The organization structures of the three companies are presented in Appendix 9.

2. Accounting and Financial Management

88. In each EA, a finance department is responsible for accounting and financial management. The finance department is under the overall supervision of the chief accountant or deputy general manager for finance and planning. Separate sections are responsible for tariffs, cost and management accounting, capital assets, head office accounting, and internal finance. The financial management functions of all the subsidiaries are supervised by the head office. The EAs use accounting systems that are in accordance with internationally accepted accounting principles. Accounts are maintained at the level of the individual business units and are consolidated for the EA as a whole. The operating budget is prepared annually and reviewed twice a year.

89. The financial statements of each EA and its subsidiaries are audited by independent external auditing firms. The financial statements are submitted to Ministry of Finance and SP for approval. Each EA has its own internal audit division. Under the Project, the EAs and IAs will prepare annual financial statements consisting of income statements, sources and application of funds, and balance sheets. They will also maintain records adequate to identify goods and services financed from the proceeds of the ADB and GEF loans. Each will have its financial statements audited in accordance with generally accepted auditing standards by external auditors acceptable to ADB, and will submit to ADB, not later than nine months after the close of each fiscal year, certified copies of financial statements, audited accounts, and the auditor's report in English.

3. Past Financial Performance

90. From 1997 to 1999, XEPC earned net profits and generated annual rates of return on net fixed assets of 4 to 7 percent. As of the end of 1999, its total assets amounted to Y8.9 billion and its debt to equity ratio was 66:34.

91. From 1997 to 1999, HEPC's returns on net fixed assets ranged between 2 and 4 percent. As of the end of 1999, its total assets amounted to Y23.1 billion. Financial indicators were satisfactory, including a debt to equity ratio of 33:67 and a debt service coverage ratio of 1.3 times.

[79] TA 3103-PRC: *Strengthening the Government Auditing System,* for $700,000, approved on 26 November 1998.

92. LEPC was officially established only in 1999 following the reorganization of the North East Power Group. Estimates are available for 1998, and consolidated accounts for 1999. In these two years, LEPC's financial performance was satisfactory. Net profits were realized during both years and its return on net fixed assets ranged between 4 and 6 percent. As of the end of 1999, its total assets amounted to Y44.7 billion. Financial indicators were satisfactory, including a debt to equity ratio of 29:71 and a debt service coverage ratio of 4.0 times.

4. Financial Projections

93. A summary of the past and projected financial performance of the three EAs is given in Table 3 while the detailed financial projections are in Appendix 10. Figures for 1998 and 1999 are based on actual financial performance. The projected energy sales are based on likely load forecasts. The major assumptions used in the projections include the maintenance of average revenues to enable a yield of around 8.0 percent on net fixed assets by the time the Project is commissioned, and thereafter. The debt to equity ratio is to be maintained at below 75:25.

Table 3: Summary of Actual and Projected Financial Performance of the EAs

Indicator	Unit	1998	1999	2000	2001	2002	2003	2004	2005
A. Xinjiang Electric Power Company Ltd									
Energy sales	GWh	6,399	6,892	7,400	7,900	8,400	8,900	9,400	10,000
Increase in energy sales	%	11.4	7.7	7.4	6.8	6.3	6.0	5.6	6.4
Average revenue	Y/kWh	0.276	0.350	0.385	0.435	0.492	0.556	0.628	0.691
Increase in average revenue	%	5.9	26.7	10.0	13.0	13.0	13.0	13.0	10.0
Net income	Y mln	13	8	433	394	451	548	595	712
Net fixed assets	Y mln	4,223	4,373	7,682	10,785	12,754	15,387	18,449	20,262
Capital expenditures	Y mln	1,043	940	3,149	4,248	3,596	3,790	2,395	2,463
Operating ratio	%	89	90	65	69	68	66	67	67
Return on net fixed assets	%	4.2	4.5	11.2	8.3	8.2	8.6	8.2	8.3
Debt service ratio	times	1.1	1.0	2.9	2.0	1.4	1.4	1.2	1.2
Debt/debt-plus-equity ratio	%	60	66	65	67	68	63	60	55
B. Heilongjiang Electric Power Company Ltd									
Energy sales	GWh	27,766	28,162	28,800	29,500	30,300	31,200	32,100	33,200
Increase in energy sales	%	-1.8	1.4	2.3	2.4	2.7	3.0	2.9	3.4
Average revenue	Y/kWh	0.299	0.359	0.412	0.446	0.481	0.506	0.531	0.552
Increase in average revenue	%	1.8	20.0	14.7	8.2	8.0	5.0	5.0	4.0
Net income	Y mln	41	21	494	634	790	1,067	1,301	1,405
Net fixed assets	Y mln	12,793	11,572	15,388	17,088	18,693	20,146	19,713	19,152
Capital expenditures	Y mln	0	0	4,616	2,527	2,584	2,568	823	784
Operating ratio	%	99	99	92	90	90	89	88	89
Return on net fixed assets	%	3.3	1.8	8.2	9.0	9.5	10.8	11.7	12.0
Debt service ratio	times	1.8	1.3	1.5	1.7	1.6	1.4	1.4	1.4
Debt/debt-plus-equity ratio	%	40	33	41	48	52	53	52	51
C. Liaoning Electric Power Company Ltd									
Energy sales	GWh	49,739	50,236	51,400	53,000	54,800	56,500	58,300	60,300
Increase in energy sales	%		1.0	2.3	3.1	3.4	3.1	3.2	3.4
Average revenue	Y/kWh	0.342	0.356	0.410	0.439	0.469	0.502	0.537	0.559
Increase in average revenue	%		4.1	9.0	7.0	7.0	7.0	7.0	4.0
Net income	Y mln	316	722	2,073	2,618	3,023	3,449	3,740	3,872
Net fixed assets	Y mln	13,765	16,757	21,297	25,395	29,583	31,979	32,982	33,546
Capital expenditures	Y mln		277	6,140	5,956	6,291	4,850	3,835	3,683
Operating ratio	%	98	98	91	88	87	86	86	86
Return on net fixed assets	%	5.2	4.5	12.0	12.8	12.4	11.8	11.4	11.3
Debt service ratio	times		4.0	3.0	2.0	1.8	1.7	1.6	1.5
Debt/debt-plus-equity ratio	%	21	29	32	35	37	37	35	32

GWh= gigawatt-hour, kWh= kilowatt-hour; mln= million, Y= Yuan.
Source: Staff estimates and estimates of Xinjiang Electric Power Company Ltd, Heilongjiang Electric Power Company Ltd, and Liaoning Electric Power Company Ltd.

H. Implementing Agencies

94. During the construction period and the initial years of operation, the respective PPCs will be the majority owners of the WFCs. Each WFC will have a PPA for the sale of its electricity to the concerned PPC. For the first year of full operations of the wind farms, the tariffs, including value-added tax, are based on those included in the feasibility studies. They are Y0.531/kWh for the wind farm at Dabancheng, Y0.679/kWh for the wind farm at Fujin, Y0.741/kWh for the wind farm at Xiwaizi. The tariffs will be reviewed and adjusted annually to reflect inflation to ensure a levelized annual rate of return on equity of at least 15 percent.[80] Taking into account the wind conditions at

[80] The calculation takes into account (i) operating costs, (ii) repair and maintenance costs, (iii) administrative and personal costs, (iv) depreciation, (v) interest charges to the extent that they exceed depreciation, and (vi) taxes on operation and revenues, including income tax and value added tax.

each site, the plant factors[81] are estimated at 43.5 percent at Dabancheng, 44.7 percent at Fujin, and 28.3 percent at Xiwaizi. Based on these assumptions, the electricity purchase prices for the PPCs are expected to be more than the PPC's self-generation costs of Y0.37-Y0.40/kWh. As agreed by the Government, the higher costs of wind power will be passed on by the PPCs to electricity consumers. Because of the low share of wind power in the generation mix of the PPCs (footnote 69), the impact will be negligible (about Y0.0002/kWh or less than 0.05 percent of their present average electricity tariff).

95. The financial projections (Appendix 11) indicate that WFC operations will be able to yield a levelized annual rate of return on equity of at least 15 percent using the tariffs in the range of Y0.531-Y0.741/kWh with annual inflation adjustment. Each company will be able to service the loan repayment requirements as they become due; the debt-service ratios are maintained over 1.3 times (except the year of GEF contingent loan repayment). In the third year of full operation and onward, the debt-equity ratio of the three WFCs will at no time be more than 75:25.

I. Environmental and Social Measures

1. Environment

96. ADB has classified the Project as environmental category B. Each wind farm is an integral part of the environmental investment plans of the two provinces and the autonomous region. As part of the feasibility study, initial environmental examinations (IEEs) and summary IEEs, prepared by the TA consultants (footnote 2) concluded that detailed environmental impact assessments were not required. The wind farms will generate benefits to the national and global environments in terms of avoided air pollution from coal-fired power plants and reduced GHG emissions. Disturbances to the immediate surroundings will be minor during construction and operation of the wind farms. The IEEs indicate that such adverse environmental impacts can be easily mitigated by following standard norms of civil and construction engineering practices. Environmental management, mitigation, and monitoring plans were prepared as a part of the IEEs, and will be carried out to ensure sound environmental practices during construction and operation of the wind farms. In particular, care will be taken to prevent groundwater contamination at Dabancheng as the site is located on gravel sediments that are the main source of potable water for the city of Urumqi. Environmental clearances from the concerned local environmental bureaus have been obtained for all sites. During the loan disbursement period, the Government will provide ADB with an annual report containing copies of all safety and environmental quality monitoring reports and, in the event the Project has been cited for violations of any safety and environmental rules and regulations, a certification from the relevant government authorities that the violation has been corrected or an acceptable plan to correct the deficiency has been approved.

2. Social Measures

97. Land acquisition for the wind farms under the Project will be done in accordance with the Land Administration Law of 1998. The sites are not occupied by any settlements and hence, no people will be relocated. With regard to the Xiwaizi wind farm, only the area used for foundations of the wind turbines, roads, buildings, and related equipment will be leased by the WFC from the Government for 30 years. For this purpose, only about 2.5 percent of the area of about 167 hectares required during installation of the wind turbines and construction of related facilities will have to be leased.[82] The land not leased by the wind farm will continue to be used for agriculture. Adequate

[81] The number of units generated in a year divided by the plant capacity and the number of hours in a year (8,760).
[82] The area required during construction is relatively large because for the installed capacity of 24 MW at Xiwaizi, about 36 adequately spaced wind towers with turbines of 660 kW each will have to be erected.

compensation will be paid to the original users of the land.[83] For the Fujin wind farm, a similar arrangement will be made with the exception that the land will be leased for an indefinite period and the owner of the site, the Forest Bureau, will receive compensation for replanting of some 100 trees to substitute for those cut in connection with wind farm construction. Growing of trees, which do not reach a height of more than 10 m, will continue in the area not required for wind farm operations.

98. Kazakh ethnic minority herders have been using the proposed site of the wind farm at Dabancheng for cattle grazing during the seasons when grass is available. The rights to use the grassland are guaranteed under a 50-year agreement with the Government in accordance with the 1985 Grassland Law. The construction of the wind farm will reduce the grass available to them. In accordance with the ADB's Policy on Indigenous Peoples, an assessment of the wind farm's impact on these herders was carried out, and confirmed that the Project will have no significant adverse impacts. About 3 to 4 families will lose their seasonal grazing rights for the site where the wind farm will be constructed. However, the affected families will be given a compensation package through the local township, which they can use for leasing a plot of agricultural land and settling down in the township under the Government's regular agricultural settlement scheme. Land acquisition plans and the compensation packages for affected people at all sites were included in the Project's feasibility studies. Finalization of compensation packages for the 3 to 4 affected families at Dabancheng and the farmers at Xiwaizi is a condition for loan effectiveness. Adequate financial compensation will be paid according to national and provincial laws, and the Government will ensure that all affected parties are at least equally well off after the Project as before.

V. PROJECT JUSTIFICATION

A. Financial and Economic Analyses

1. Financial Analysis

99. Financial sustainability of the wind farms will be ensured by the cost recovery mechanism built into the PPAs between the WFCs and the respective PPCs. Appendix 11 describes the analysis carried out to determine the financial viability of each wind farm. Given the provisions in the PPA, annual returns on equity will be at reasonable levels and significantly higher than the estimated weighted average cost of capital of the WFCs. The financial internal rate of return for the Project is 11.0 percent (10.3 percent for the wind farm at Dabancheng, 13.4 percent for the wind farm at Fujin, and 9.4 percent for the wind farm at Xiwaizi). These are all above the estimated WACC of the Project at 5.9 percent. Sensitivity analysis tested the impact of adverse conditions on the viability of the wind farms. The results indicate that even under adverse conditions, the financial internal rate of return of the individual wind farms would remain above weighted average cost of capital, (Table 4). The tariff-setting mechanism allows the PPCs to recover all costs including operating costs and debt-service requirements, and to earn a reasonable rate of return on net fixed assets.

[83] Equivalent to about 10 times the average annual crop yield of the area that can no longer be used for agriculture.

A. Table 4: FIRR Sensitivity Analysis of the Wind Farms

Case	Change	Dabancheng FIRR (%)	Dabancheng SI[a]	Dabancheng SV[b]	Fujin FIRR (%)	Fujin SI[a]	Fujin SV[b]	Xiwaizi FIRR %	Xiwaizi SI[a]	Xiwaizi SV[b]	Overall Project FIRR (%)	Overall Project SI[a]	Overall Project SV[b]
1. Base case		10.3			13.4			9.4			11.0		
2. Capital cost overrun	+10%	9.2	1.9	52.1	12.1	1.1	87.9	8.3	2.4	41.0	9.9	1.7	60.6
3. Lower benefits	-10%	8.9	3.2	31.3	11.8	2.3	43.6	8.2	3.7	27.2	9.7	2.9	35.0
4. Implementation delay	1 year	9.0			11.6			8.2			9.6		
5. Combination of (3) and (4)		7.8			10.3			7.2			8.5		
6. Devaluation of Yuan	-20%	8.4	1.7	57.3	11.2	1.0	99.4	7.6	2.2	45.1	9.1	1.5	67.3

FIRR= financial internal rate of return.
a Sensitivity indicator (ratio of percentage change in the net present value(NPV) to the percentage change in the selected variable).
b Switching value (percentage change in a variable for the project decision to change, that is for the NPV to become zero or the financial internal rate of return to fall to the cut-off rate).
Source: Staff estimates.

2. Economic Analysis

a. Least-Cost Analysis

100. Least-cost generation expansion plans for the three provincial power systems were carried out by SP's Power Economic Research Center with the assistance of the PPCs. The input data and assumptions were reviewed by the TA consultants and the Mission, and found appropriate. The analysis covered 1999-2022, and used constant 1999 prices and a discount rate of 12 percent. Tradable commodities were valued at border prices at the prevailing exchange rate. Nontradable commodities were valued at shadow prices, using a mix of standard and specific conversion factors. The base case consisted of expansion of power generation including the proposed wind farms under the Project. The least-cost analysis shows that this base case is superior in terms of the present value of supply costs to alternative additional power generation options for all three power systems if the environmental benefits are taken into account (Appendix 12). The results of the least-cost analysis are also supported by the outcome of a levelized cost analysis, under which the investment and operation costs of run-of-river hydropower stations with similar environmental benefits are compared with the costs of the wind farms under the Project. The levelized costs[84] are Y0.32/kWh for the wind farms at Dabancheng and Fujin, and Y0.49/kWh for the wind farm at Xiwaizi, i.e., below the levelized costs of run-of-river hydropower stations with the same level of environmental benefits at Y0.37/kWh, Y0.52/kWh, and Y0.52 /kWh for the two provinces and the autonomous region.[85]

b. Economic Internal Rate of Return

101. In the economic internal rate of return (EIRR) calculation, the same conversion factors; investment costs for generation, transmission, and distribution; and fuel, operation, and maintenance costs, where applicable, were used as in the least-cost analysis. The main benefits will be the incremental supply of electricity and environmental benefits. The former were valued based on avoided costs of supplying an equal amount of electricity as the wind-based electricity to be produced under the Project. On this basis, the EIRRs were calculated at 12.9 percent for the Project (11.4 percent for the wind farm at Dabancheng, 14.8 percent for the wind farm at Fujin, and 12.7 percent

[84] Net present value of all future costs per unit of electricity produced.
[85] Originally, a 24 MW wind farm at Taizili in Liaoning Province was included in the project scope; however, during processing, the wind farm was deleted because it did not represent the least cost-option for expanding of the power system.

for the wind farm at Xiwaizi). If no environmental benefits are included, the EIRR of the Project decreases to 9.3 percent (Appendix 12).

102. Sensitivity analyses tested the impact of variations of some parameters (Table 5). Capital cost increases, benefit reductions, and implementation delays do not affect the viability of the proposed wind farms. Changes in foreign exchange rates would not constitute a major risk to the viability of the proposed wind farms.

Table 5: EIRR Sensitivity Analysis of the Wind Farms

Case	Change	Dabancheng			Fujin			Xiwaizi			Overall Project		
		EIRR (%)	SI [a]	SV [b]	EIRR (%)	SI [a]	SV [b]	EIRR (%)	SI [a]	SV [b]	EIRR (%)	SI	SV
1. Base case		11.4			14.8			12.7			12.9		
2. Capital cost	+10%	10.1	26.3	-3.8	13.3	5.1	19.6	11.3	21.1	4.7	11.5	16.1	6.2
3. Benefits	-10%	9.9	26.7	-3.8	13.5	4.6	21.8	11.6	15.8	6.3	11.2	18.2	5.5
4. Implementation delay	1 year	9.8			13.0			11.0			11.2		
5. Combination of (2), (3) and (4)		7.2			10.5			8.6			8.4		
6. Devaluation of Yuan	-20%	9.6	17.9	-5.6	12.8	3.5	28.9	10.7	14.7	6.8	11.1	11.1	9.0

EIRR= economic internal rate of return.

[a] Sensitivity indicator (ratio of percentage change in the economic net present value (NPV) to the percentage change in the selected variable).

[b] Switching value (percentage change in a variable for the project decision to change, that is for the economic NPV to become zero or the EIRR to fall to the cut-off rate).

Source: Staff estimates.

103. To complement the sensitivity analyses, a probabilistic risk analysis was performed using the Monte Carlo simulation technique (Appendix 12). The expected EIRR for the Project based on the weighted average of all simulated combinations, is 12.7 percent, 0.2 percent lower than the base case value without consideration of project risks. Under the assumed distribution of the five main variables, the probability that the Project EIRR will be less than 10.0 percent is 13.0 percent.

B. Environment

104. The Project's main environmental benefit will be the avoidance of air emissions that would take place if the same amount of electricity were produced in coal-fired power plants (Appendix 13). The avoidance of air pollutants has been valued on the basis of its positive impacts on human health and welfare in accordance with the approach outlined in ADB's Guidelines for the economic evaluation of environmental impacts. The estimated net present value of the environmental benefits from avoided air pollution at the national level is about $15.4 million, while the net present value of the global environmental benefits from avoided GHG emissions is estimated at $13.9 million (low case) to $31.2 million (high case) in net present value terms.

C. Impact on Poverty

105. The Project will create a minimum of 25 jobs for operation and maintenance of the wind farms. Clean energy projects such as wind farms contribute to poverty reduction by avoiding environmental pollution, which disproportionately affects the poor, and by creating new job opportunities. Since the Project will help accelerate the establishment of grid-connected wind farms in the PRC by removing impediments to their development and providing institutional strengthening to promote such development, it will be instrumental in transferring international wind turbine manufacturing technology to the PRC and increasing domestic manufacturing of wind turbines. Apart

from reducing the cost of wind turbines, this is expected to generate about 17 job-years for each MW manufactured in the PRC.[86] Local manufacture of wind turbines is also promoted under the Government's Ride the Wind program, which was approved in March 1996 and aims to (i) promote joint ventures between local and foreign companies, (ii) develop large wind turbines with a local content of a minimum of 60 percent, and (iii) carry out research and development activities in large wind turbine technologies.

D. Risks

106. Although the Project is based on proven design and the technology is generally successfully being used worldwide, experience in the PRC shows that its successful application is relatively sensitive to the use of appropriate handling, installation, and operation and maintenance procedures, as well as the timely availability of spare parts. The PRC is still in the process of developing such procedures. Because of the present limited market size for wind turbines in the PRC, adequate local service and support facilities have not yet been developed by international manufacturers of wind turbines. Since it is also a relatively new technology for the PRC, wind farm developers in the PRC, which are usually PPCs, consider wind farm projects to have a higher technical risk than conventional power generation projects. For the Project, no significant technical risks are anticipated in the detailed design of the equipment[87] as the EAs will be using the services of project implementation consultants who will help prepare of the technical specifications for the wind turbines, evaluate the received bids for the EPC contracts, and provide the technical certification of the delivered wind turbines. The use of the EPC contracts will also help ensure that appropriate handling and installation procedures are applied for the wind turbines. Together with the requirement that the bids for the EPC contracts can be called only after land acquisition for each site has been completed, the completion risk will be reduced. The initial operation risk has been addressed by requiring that the wind turbine manufacturers be responsible, under the EPC contracts, for operation and maintenance during the first year of operations and that during that year they will also provide training for staff of the WFCs. Overall, however, the higher technical performance risk of wind farm projects, will be eliminated only after the PRC develops a larger market for wind turbines, has become more familiar with the technology, and gains adequate experience with operation and maintenance of wind farms. The wind resource risk under the Project has been minimized by using long-term wind measurement data for the design, nevertheless, during certain years the average annual wind speed could be less than assumed (footnote 71).

107. The marketing risk for the electricity produced by the wind farms has been substantially reduced by the adoption of the PPAs, which will allow for the sale of wind-based electricity whenever sufficient wind speeds are prevalent. The PPA tariffs will be subject to periodic review to ensure that the WFCs receive a reasonable return on their investment, while taking into account the efficiency achieved in the operation of the wind farms. With regard to the distribution of the relatively more expensive wind-based electricity, the Government has agreed to full compensation of the PPCs through appropriate tariff increases for consumers; this will provide an incentive for the PPCs to maximize distribution of wind-based electricity, given their investments in the WFCs.

[86] Based on recent European studies, published in *Renewable Energy World* magazine, November 1999. It is also estimated that a minimum demand for wind turbines in the PRC in the range of 40-60 MW per annum would induce foreign manufacturers to establish manufacturing facilities in the PRC.

[87] At present, the largest turbine size in use in the PRC is 600 kW; however, larger sizes up to 1.5 MW based on the same technology are available worldwide and are not expected to pose any additional technical risk.

VI. ASSURANCES

A. Specific Assurances

108. The Government has given the following assurances, in addition to the standard assurances, which have been incorporated in the legal documents:

(i) Construction and operation of all facilities under the Project will take place in accordance with national environmental standards and the ADB's environmental guidelines, and will include all the mitigating measures identified in the IEEs.

(ii) For the Dabancheng wind farm, the land lease and compensation arrangements set forth in the assessment of the wind farm's impact on the ethnic minority herders will be implemented in a timely manner during project implementation;

(iii) Based on the findings and recommendations of the consultants under Part B of the Project, the Government will take the necessary actions to increase public awareness of the benefits of wind-based electricity;

(iv) The PPCs will be able to recover all costs of purchasing and distributing wind-based power from consumers;

(v) In Xinjiang Uygur Autonomous Region and Heilongjiang and Liaoning provinces, a wind power development plan and a feasibility study on attracting nongovernment investment funds will be prepared with assistance from the consultants recruited under Part B of the Project;

(vi) The tariffs for the WFCs will be sufficient to allow them to earn a minimum 15 percent rate of return on equity on a levelized annual basis;

(vii) Each WFC will maintain a debt service coverage ratio of not less than 1.3 times (except in the year of repayment of the GEF contingent loan); and

(viii) From the third year of full operations onward, the WFCs will not exceed a debt-equity ratio of 75:25.

B. Conditions for Loan Effectiveness

109. Effectiveness of the Loan Agreement will be subject to satisfaction of the following conditions:

(i) arrangements acceptable to ADB for the lease of all land required for the Project and for the payment of the compensation due to the present users of the land at Dabancheng and Xiwaizi have been finalized;

(ii) PPAs acceptable to ADB have been finalized and executed;

(iii) joint cofinancing agreements relating to the GEF contingent loan and the GEF grant have been executed; and

(iv) subsidiary loan agreements acceptable to ADB have been executed.

VII. RECOMMENDATION

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

(i) the loan of $58,000,000 from ADB's ordinary capital resources to the People's Republic of China for the Wind Power Development Project, with a term of 20 years, including a grace period of 3 years, and with interest to be determined in accordance with ADB's pool-based variable lending rate system for US dollar loans, and such other terms and conditions as are substantially in accordance with those set forth in the draft Loan and Project Agreements presented to the Board;

(ii) ADB administering a contingent loan of $6,000,000 to be provided by the Global Environment Facility to the Government of the People's Republic of China for the Wind Power Development Project; and

(iii) ADB administering a grant of $6,000,000 to be provided by the Global Environment Facility to the Government of the People's Republic of China for the Wind Power Development Project.

TADAO CHINO
President

29 November 2000

APPENDIXES

Supplementary Appendixes

PROJECT FRAMEWORK

Design Summary	Performance Targets	Monitoring Mechanism	Assumptions and Risks
A. Goals			
Avoid adverse environmental impacts of the power sector Increase availability of electricity Increase use of renewable energy for power generation through barrier removal and institutional strengthening	Emission levels within prescribed limits Sufficient supply to meet power demand Increased electrification of households Share of renewable energy in power generation mix of 5 percent over the next five years Lower coal consumption per kWh generated	National power sector and environmental reports and statistics Country and sector consultation missions Reports and statistics from the State Power Corporation Reports and statistics on certification of renewable energy and trading of renewable energy certificates	Funding constraints Slowdown in reform process and postponement of closure of old inefficient power plants Economic slow down and decreasing growth in energy consumption Implementation of suitable policies for renewable energy development
B. Purpose			
Increase clean power supply Reduce coal consumption Avoid provincial air pollution Remove barriers to wind power development in the two provinces and the autonomous region including the adoption of appropriate policies to promote renewable energy development Promote development of a domestic market for large-scale wind turbines	Addition of clean renewable power capacity as follows: 30 MW in the Xinjiang Uygur Autonomous Region; 24 MW in Heilongjiang Province and 24 MW in Liaoning Province Establishment of database for wind measurement in the two provinces and the autonomous region and setting targets for wind-based power generation over the next five years Increased investments in wind-based power generation and domestic assembly and manufacture of large-scale wind turbines	New wind farm companies and provincial power companies annual reports Air quality indicators Dated loan covenants for establishing and implementing. Renewable energy policies Provincial statistical yearbooks	Slow power demand growth Inability of the three provinces to mobilize the required counterpart funds Inability to create an increasing annual demand for development and utilization of renewable energy
C. Outputs			
30 MW wind farm at Dabancheng, including 2 x 20 MVA, 110 kV substation, and 3 km of 110 kV transmission line	• Operation of new wind farms and sale of wind-based power to provincial power companies by 2002 • Provincial officials involved in energy development trained as scheduled	• Project progress reports and ADB review missions • Project completion report	Use of agreed power purchase agreements and continued commitment by the provincial power companies to purchase and distribute all output from the wind farms

ADB= Asian Development Bank, KV= kilovolt, MVA= megavolt-ampere, MW= megawatt.

Design Summary	Performance Targets	Monitoring Mechanism	Assumptions and Risks
24 MW wind farm at Fujin including 2x16 MVA, 60/10 kV substation and 6 km of double circuit 66 kV transmission line 24 MW wind farm at Xiwaizi, including 2x16 MVA, 60/10 kV substation and 7 km of double circuit 66 kV transmission line New wind measurement data of 25 sites in the two provinces and the autonomous region Training in capacity building for wind power projects Identification of options for nongovernment investment in wind farms and preparation of bid packages to attract such investments Development of new policies at the concerned provincial level to accelerate the use of the wind energy in the two provinces and the auto-nomous region	New policies for renewable energy resources development and use at the concerned provincial level are being implemented Increased nongovernment investments in development of grid-connected wind farms		Inefficient operation of the wind farms Ineffective implementation of the provincial policies for promoting and accelerating the use of wind energy
D. Inputs			
Equipment Civil works Training Consultants for (i) project implementation, and (ii) barrier removal and institutional strengthening to accelerate development of grid-connected wind farms	• Project cost of $98.0 million • Funding sources as follows ADB loan $58.0 million GEF loan $ 6.0million stic bank $ 9.4million GEF grant $ 6.0million Equity $18.6million	Project implementation progress reports Project accounts	Good performance by local contractors and consultants Counterpart budget is available on a timely basis Coordination and cooperation among the various Government organizations involved is satisfactory

MW = megawatt; MVA = megavolt-ampere; kV = kilovolt; km = kilometer.

PRODUCTION AND CONSUMPTION OF PRIMARY COMMERCIAL ENERGY VERSUS GDP GROWTH

Item	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Production (million tons of standard oil equivalent)	411	423	417	414	437	467	510	560	577	598	627	665	680	686	702	727	777	844	868
Proportion (%)																			
Coal	70.3	70.2	69.4	70.2	71.3	71.6	72.4	72.8	72.4	72.6	73.1	74.1	74.2	74.1	74.3	74.0	74.6	75.3	75.2
Crude oil	23.7	23.5	23.8	22.9	21.7	21.3	21	20.9	21.2	21.0	20.4	19.3	19.0	19.2	18.9	18.7	17.6	16.6	17.0
Natural gas	2.9	3.0	3.0	2.7	2.3	2.3	2.1	2	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	2.0
Hydropower	3.1	3.3	3.8	4.2	4.7	4.8	4.5	4.3	4.3	4.4	4.5	4.6	4.8	4.7	4.8	5.3	5.9	6.2	5.8
Consumption (million tons of standard oil equivalent)	374	384	395	389	406	432	464	502	529	567	609	634	646	679	715	759	803	859	909
Proportion (%)																			
Coal	70.7	71.3	72.2	72.7	73.7	74.2	75.3	75.7	75.8	76.2	76.2	76.0	76.2	76.1	75.7	74.7	75.0	74.6	74.7
Crude oil	22.7	21.8	20.7	20	18.9	18.1	17.4	17.1	17.2	17.0	17.0	17.1	16.6	17.1	17.5	18.2	17.4	17.5	18
Natural gas	3.2	3.3	3.1	2.8	2.5	2.4	2.4	2.4	2.3	2.1	2.1	2.0	2.1	2.0	1.9	1.9	1.9	1.8	1.8
Hydropower	3.4	3.6	4.0	4.5	4.9	5.3	4.9	4.8	4.7	4.7	4.7	4.9	5.1	4.8	4.9	5.2	5.7	6.1	5.5
GDP Index (constant prices)	100.0	107.6	116.0	122	133.3	148.2	170.9	193.5	209.9	234.1	260.5	271.5	283	308.8	352.2	398.4	448.7	489.1	536.8
Energy Intensity Index (consumption/GDP)	100.0	95.4	91.0	85.3	81.6	78	72.7	69.4	67.5	64.8	62.5	62.5	61.1	58.9	54.3	51	47.9	47.0	45.3

GDP = gross domestic product

Notes: 1. Excluding bio-energy, solar, geothermal and nuclear energy.

2. All fuels are converted into standard oil with thermal equivalent of 10,700 kilocalories(kcal) per kilogram (kg).
The conversion factors are

1 kg of coal (5,000 kcal)	=	0.467 kg of standard oil
1 kg of crude oil (10,000 kcal)	=	0.935 kg of standard oil
1 cubic meter of natural gas (9,310 kcal)	=	0.870 kg of standard oil

3. The conversion of hydropower is based on the specific consumption of standard coal for thermal power generation of the year.

4. The data on energy consumption in 1999 were estimated figures.

Source: China Statistical Yearbook 1999.

Appendix 3

INSTALLED CAPACITY, ELECTRICITY GENERATION, AND ELECTRICITY CONSUMPTION IN THE PEOPLE'S REPUBLIC OF CHINA

A. Installed Capacity and Electricity Generation

Year	Installed Capacity			Electricity Generation			Annual Growth (%)	
	Total (MW)	Thermal (%)	Hydro (%)	Total (GWh)	Thermal (%)	Hydro (%)	Electricity Generation	GDP
1980	65,869	69.2	30.8	300,627	80.6	19.4		7.8
1981	69,002	68.2	31.8	309,269	78.8	21.2	2.9	5.0
1982	72,360	68.3	31.7	327,678	77.3	22.7	6.0	8.6
1983	76,440	68.4	31.6	351,440	75.4	24.6	7.3	9.6
1984	79,920	68.0	32.0	376,987	77.0	23.0	7.3	15.3
1985	86,493	69.8	30.2	410,689	77.5	22.5	8.9	13.3
1986	93,818	70.6	29.4	449,571	79.0	21.0	9.5	8.5
1987	102,897	70.7	29.3	497,321	79.8	20.2	10.6	11.4
1988	115,497	71.7	28.3	545,065	80.0	20.0	9.6	11.3
1989	126,630	72.7	27.3	584,675	79.7	20.3	7.3	4.1
1990	137,894	73.9	26.1	621,318	79.7	20.3	6.3	3.9
1991	151,473	75.0	25.0	677,494	81.6	18.4	9.0	9.5
1992	166,533	75.6	24.4	754,189	82.6	17.4	11.3	14.0
1993	182,911	75.6	24.4	836,429	82.0	18.0	10.9	13.3
1994	198,700	74.9	25.1	927,800	82.0	18.0	10.9	11.6
1995	217,200	75.0	25.0	1,007,000	80.2	19.8	8.5	11.5
1996	236,542	75.6	24.4	1,079,358	81.4	18.6	7.2	9.7
1997	254,230	76.5	23.5	1,134,204	83.1	16.9	5.1	8.8
1998	277,289	76.5	23.5	1,157,697	82.4	17.6	2.1	7.8
1999	298,768	75.6	24.4	1,233,141	82.7	17.3	6.5	7.1
Average Annual Growth Rate (%)		**8.3**			**7.8**		**9.8**	

B. Electricity Consumption by Consumer Category

Year	Total Consumption (TWh)	Share of Consumption (%)						
		Industry			Agriculture	Resident	Transport	Public and Commerce
		Heavy	Light	Subtotal				
1985	411.7	63.8	15.9	79.7	7.7	5.4	1.5	5.7
1986	456.7	64.9	15.8	80.7	7.1	5.5	1.5	5.2
1987	498.5	64.0	16.4	80.4	7.2	5.7	1.5	5.2
1988	546.7	62.8	17.0	79.8	6.9	6.3	1.6	5.4
1989	586.5	63.0	16.2	79.2	7.0	6.7	1.7	5.4
1990	623.0	62.2	16.0	78.2	6.9	7.7	1.7	5.5
1991	680.4	61.2	16.2	77.4	7.1	8.0	1.7	5.8
1992	745.5	61.2	15.9	77.1	6.8	8.5	1.8	5.8
1993	820.1	61.2	15.4	76.6	6.3	8.9	1.9	6.3
1994	904.6	60.3	15.1	75.4	6.3	9.7	1.9	6.8
1995	986.8	59.8	15.1	74.9	6.2	10.2	1.8	6.9
1996	1057.0	59.3	14.8	74.1	6.1	10.7	1.9	7.2
1997	1103.9	59.3	14.6	73.0	6.2	11.4	1.9	7.5
1998	1134.7	57.6	14.2	71.8	5.9	12.2	1.9	8.2
1999	na	na	na	na	na	na	na	na

GDP = gross domestic product, GWh = gigawatt-hour, MW = megawatt, TWh = terawatt-hour.

Source: State Power Corporation of China.

POLLUTION LEVELS IN ROVINCIAL CAPITALS: URUMQI, HARBIN, AND SHENYANG

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
A.	Daily Average SO_2 Concentrations ($\mu g/m^3$)										
	Urumqi	222	207	301	210	111	60	73	68	104	146
	Harbin	28	27	29	22	26	23	25	26	23	35
	Shenyang	111	137	131	117	120	105	108	82	71	72
B.	Daily Average TSP Concentrations ($\mu g/m^3$)										
	Urumqi	716	433	424	538	504	515	496	481	504	463
	Harbin	441	373	345	409	379	359	342	310	269	260
	Shenyang	438	358	398	425	497	374	422	369	332	304
C.	Daily Average NO_x Concentrations ($\mu g/m^3$)										
	Urumqi	13	164	152	147	105	74	74	78	87	92
	Harbin	39	40	55	71	49	30	34	43	45	48
	Shenyang	78	91	76	80	84	74	75	73	66	65

NO_x = nitrogen oxide, SO_2 = sulphur dioxide, $\mu g/m^3$ = micrograms per cubic meter, TSP = total suspended particulates.

PROJECT COST ESTIMATES AND FINANCING PLAN

($ million)

Component/ Item	Project Cost FE	Project Cost LC	Project Cost Total	Financing Plan ADB/GEF FE	ADB Loan FE	GEF Loan FE	GEF Grant FE	LCF Loans LC	LCF Equity LC
Part A: Construction of Wind Farms									
1. Wind Farm at Dabancheng									
Base Cost									
Land	0.00	0.19	0.19	0.00	0.00	0.00	0.00	0.00	0.19
Civil Works	0.00	3.77	3.77	0.00	0.00	0.00	0.00	0.00	3.77
Equipment	19.60	5.20	24.80	19.60	19.60	0.00	0.00	3.12	2.08
Consultancy Services	0.39	0.08	0.47	0.00	0.00	0.00	0.39	0.00	0.08
Preoperating Costs	0.15	0.28	0.43	0.15	0.15	0.00	0.00	0.00	0.28
Subtotal (Base Cost)	20.14	9.51	29.65	19.75	19.75	0.00	0.39	3.12	6.40
Physical Contingencies	0.99	0.46	1.44	0.97	0.97	0.00	0.02	0.16	0.30
Price Contingencies	0.51	0.51	1.44	0.50	0.50	0.00	0.01	0.17	0.34
Interest During Construction	2.66	0.39	3.05	2.66	2.66	0.00	0.00	0.39	0.00
Total	**24.29**	**10.87**	**35.58**	**23.87**	**23.87**	**0.00**	**0.42**	**3.83**	**7.04**
Percent of Total	68.3	30.6	100.0	67.1	67.1	0.0	1.2	10.7	19.8
2. Wind Farm at Fujin									
Base Cost									
Land	0.00	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.04
Civil Works	0.00	4.03	4.03	0.00	0.00	0.00	0.00	0.00	4.03
Equipment	16.30	3.52	19.82	16.30	16.30	0.00	0.00	2.50	1.02
Consultancy Services	0.39	0.08	0.47	0.00	0.00	0.00	0.39	0.00	0.08
Preoperating Costs	0.13	0.25	0.37	0.13	0.13	0.00	0.00	0.00	0.25
Subtotal (Base Cost)	16.81	7.91	24.72	16.42	16.42	0.00	0.39	2.50	5.41
Physical Contingencies	0.82	0.33	1.16	0.80	0.80	0.00	0.02	0.12	0.21
Price Contingencies	0.43	0.41	0.84	0.42	0.42	0.00	0.01	0.13	0.28
Interest During Construction	2.23	0.32	2.55	2.23	2.23	0.00	0.00	0.32	0.00
Total	**20.29**	**8.97**	**29.26**	**19.87**	**19.87**	**0.00**	**0.42**	**3.07**	**5.90**
Percent of Total	69.3	30.7	100.0	67.9	67.9	0.0	1.4	10.5	20.2
3. Wind Farm at Xiwaizi									
Base Cost									
Land	0.00	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.17
Civil Works	0.00	3.15	3.15	0.00	0.00	0.00	0.00	0.00	3.15
Equipment	16.28	3.56	19.84	16.28	16.28	0.00	0.00	2.03	1.53
Consultancy Services	0.39	0.08	0.47	0.00	0.00	0.00	0.39	0.00	0.08
Preoperating Costs	0.13	0.25	0.37	0.13	0.13	0.00	0.00	0.00	0.25
Subtotal (Base Cost)	16.80	7.20	24.00	16.41	16.41	0.00	0.39	2.03	5.17
Physical Contingencies	0.82	0.34	1.16	0.80	0.80	0.00	0.02	0.10	0.24
Price Contingencies	0.43	0.38	0.80	0.42	0.42	0.00	0.01	0.11	0.27
Interest During Construction	2.23	0.26	2.48	2.23	2.23	0.00	0.00	0.26	0.00
Total	**20.27**	**8.18**	**28.45**	**19.85**	**19.85**	**0.00**	**0.42**	**2.49**	**5.69**
Percent of Total	71.2	28.8	100.0	69.8	69.8	0.0	1.5	8.7	20.0

ADB= Asian Development Bank, FE= foreign exchange, GEF= Global Environment Facility
LC= local currency, LCF=local cost financing.

Component/ Item	Project Cost FE	LC	Total	Financing Plan ADB Loan FE	GEF Loan FE	GEF Grant FE	LCF Loans LC	LCF Equity LC
Total Part A								
Base Cost								
Land	0.00	0.40	0.40	0.00	0.00	0.00	0.00	0.40
Civil Works	0.00	10.95	10.95	0.00	0.00	0.00	0.00	10.95
Equipment	52.17	12.28	64.45	46.67	5.50	0.00	7.64	4.63
Consultancy Services	1.17	0.23	1.40	0.00	0.00	1.17	0.00	0.23
Preoperating Costs	0.40	0.77	1.17	0.36	0.04	0.00	0.00	0.77
Subtotal (Base Cost)	53.74	24.63	78.37	47.03	5.54	1.17	7.64	16.98
Physical Contingencies	2.63	1.13	3.76	2.29	0.28	0.06	0.38	0.75
Price Contingencies	1.78	1.30	3.08	1.57	0.18	0.03	0.40	0.89
Interest During Construction	7.11	0.97	8.08	7.11	0.00	0.00	0.97	0.00
Total Part A	65.26	28.03	**93.29**	58.00	6.00	1.26	9.40	18.63
Percent of Total	70.0	30.0	100.0	62.2	6.4	1.3	10.1	20.0
Part B. Assistance for Barrier Removal and Institutional Strengthening								
Base Cost	3.51	0.88	4.38			4.38		
Physical Contingencies	0.18	0.04	0.22			0.22		
Price Contingencies	0.10	0.04	0.14			0.14		
Total Part B	**3.78**	**0.96**	**4.74**	**0.00**	**0.00**	**4.74**	**0.00**	**0.00**
Percent of Total	79.7	20.3	100.0	0.0	0.0	100.0	0.0	0.0
Total Project Cost								
Base Cost								
Land	0.00	0.40	0.40	0.00	0.00	0.00	0.00	0.40
Civil Works	0.00	10.95	10.95	0.00	0.00	0.00	0.00	10.95
Equipment	52.17	12.28	64.45	46.67	5.50	0.00	7.64	4.63
Consultancy Services	1.17	0.23	1.40	0.00	0.00	1.17	0.00	0.23
Preoperating Costs	0.40	0.77	1.17	0.36	0.04	0.00	0.00	0.77
Institutional Strengthening	3.51	0.88	4.38	0.00	0.00	4.38	0.00	0.00
Subtotal (Base Cost)	57.25	25.50	82.75	47.03	5.54	5.55	7.64	16.98
Physical Contingencies	2.80	1.18	3.98	2.29	0.28	0.28	0.38	0.75
Price Contingencies	1.88	1.34	3.22	1.57	0.18	0.17	0.40	0.89
Interest During Construction[5]	7.11	0.97	8.08	7.11	0.00	0.00	0.97	0.00
Total	**69.04**	**28.99**	**98.03**	**58.00**	**6.00**	**6.00**	**9.40**	**18.63**
Percent of Total	70.4	29.6	100.0	59.2	6.1	6.1	9.6	19.0

Notes:

1. Base costs are in July 2000 prices. An exchange rate of Yuan 8.28 to US dollar 1.00 was used.
2. Physical contingencies are estimated at 5.0 percent.
3. Price escalation is estimated for foreign exchange costs at 2.4 percent a year and for local currency costs at 2.0 percent in 2001, 3.0 percent in 2002, 4.0 percent in 2003, and 5.0 percent per year thereafter.
4. The GEF zero-interest loan for $6.00 million is allocated as follows: $2.308 million for the wind farm at Dabancheng , $1.846 million for the wind farm at Fujin , and $1.846 million for the wind farm at Xiwaizi.
5. Interest during construction includes front-end fee of 1 percent on the ADB loan.

Appendix 6

PROPOSED PROCUREMENT PACKAGES

Component/ Package	Base Cost ($ million) 2000 prices	Procurement Method
Dabancheng 30 MW Wind Farm		
Major Packages (ADB/GEF Financing)		
EPC for wind turbines	19.60	ICB
Equipment (mobile crane; car)	0.15	IS
Other Major Packages (Local Financing)		
Civil Works	3.80	LCB
Substation and transmission	4.40	LCB
Xiwaizi 24 MW Wind Farm		
Major Packages (ADB/GEF Financing)		
EPC for wind turbines	16.30	ICB
Equipment (mobile crane; car)	0.13	IS
Other Major Packages (Local Financing)		
Civil Works	4.03	LCB
Substation and transmission	2.91	LCB
Fujin 24 MW Wind Farm		
Major Packages (ADB/GEF Financing)		
EPC for wind turbines	16.28	ICB
Equipment (mobile crane; car)	0.13	IS
Other Major Packages (Local Financing)		
Civil Works	3.15	LCB
Substation and transmission	3.01	LCB

B= Asian Development Bank, EPC= engineering, procurement, and construction,
= international competitive bidding, IS= international shopping, LCB= local competitive bidding,
'= megawatt.

TERMS OF REFERENCE
FOR CONSULTING SERVICES

A. Construction of Wind Farms

1. Consulting Services for Project Implementation

1. Thirty person-months of international consulting will be provided to undertake the following:

(i) Review the available technical and wind resource data for the sites where the three wind farms will be constructed.

(ii) Review the overall implementation schedules prepared by the Executing Agencies (EAs); if required, suggest modifications to strengthen them; and prepare an appropriate monitoring plan for measuring progress of the implementation schedule.

(iii) Review the schedules for civil works construction, procurement, wind farm construction and commissioning, construction and commissioning of substations and transmission lines, and startup operations as prepared by the EAs and if required, suggest modifications to strengthen the same.

(iv) As required, provide the EAs with the technical information that is relevant for the construction of the concerned wind farm.

(v) Assist in preparing the basic technical design of the three wind farms and the bidding documents for the selection of a contractor for the manufacturing and construction of the wind turbines, towers, and related facilities through a separate engineering, procurement, and construction (EPC) contract for each wind farm.

(vi) As required, help the EAs evaluate applications for prequalification and bids received for the three EPC contracts.

(vii) Review the actual responsibilities of the EAs , the provincial power companies, and the wind farm companies (WFCs) for the construction of the wind farms; the working relationships between the EAs and the WFCs; and the coordination of their activities for each site. If required, suggest possible action to strengthen coordination of activities.

(viii) As required, assist the EAs with implementating and monitoring procurement activities, and the WFCs with their construction and commissioning supervision activities, and assist the EAs with other procurement activities as may be required.

(ix) Assist the WFCs prepare detailed operation and maintenance plans as well as training programs for technicians to be implemented by each EPC contractor during the first year of wind farms operation.

(x) Provide training to the WFCs in planning for future expansion of the concerned wind farm.

(xi) Following each visit prepare a progress report on the activities carried out and the status of the Project, and during 2001 assist the provincial power companies prepare quarterly progress reports as required by the Asian Development Bank.

Table A7.1: Cost Estimates

($)

Item	Foreign Exchange	Local Currency	Total Cost
Consultants			
a. Remuneration and Per Diem	810,000	120,000	930,000
b. International and Domestic Travel	40,000	10,000	50,000
c. Reports and Communications	10,000		10,000
Computers and Software	10,000		10,000
Contract Negotiations	5,000		5,000
Contingencies	180,000	15,000	195,000
Total	**1,055,000**	**145,000**	**1,200,000**

B. Barrier Removal and Institutional Strengthening

1. Benchmarking of Tariffs for Wind-Based Power Generation

2. Ten person-months of international and ten person-months of domestic consulting services and domestic training courses will be provided. The consultants will have the following responsibilities:

(i) Collect the necessary data and background information in the relevant agencies in the three areas on the mechanisms and methodologies for tariffs setting for power purchase agreements (PPAs) for wind farms that take into account site-specific conditions, investments costs and risks, required efficiency of operations, and financial returns to investors.

(ii) Identify the essential requirements for benchmarking of wind power tariffs in the three areas, including institutional arrangements for the benchmarking, data on the volume of the benchmarking, technical aspects of the benchmarking, and the basis for determining wind power tariffs and the tariff approval procedure.

(iii) Examine the evaluation and benchmarking practice for wind-farm tariffs in the three areas and develop a standard evaluation and benchmarking methodology for wind power tariffs. Based on the proposed evaluation and benchmarking methodology, design appropriate ranges for wind power tariffs for specific regions with sufficient background information. The proposed mechanism for determining wind power tariffs should take into account the economic costs of wind power and should be transparent.

(iv) In developing the evaluation and benchmarking methodology and in designing the wind power tariffs, the consultant will analyze (a) historical trends of wind power tariff; (b) economic subsidies (cross-subsidies) based on the estimated economic cost of wind power; (c) the impact of tariff adjustments on tariff levels in the three provinces; (d) the impact of tariff adjustments on the financial performance of provincial power companies; and (e) affordability of consumers under the recommended wind power tariffs.

(v) Analyze variations in wind power tariffs in the three project areas compare the wind power tariffs with the average costs of supplying electricity, and identify the optimum mechanism for setting specific consumer tariffs for wind power.

(vi) Review the arrangements for recovery of the incremental costs of wind power by the provincial power companies. In view of the envisaged increased supply of wind power recommend, if appropriate, steps to be taken by the Government to improve these arrangements and ensure continued recovery of the incremental costs by the provincial power companies. Take into account the supply costs as well as the willingness and ability of consumers to pay. Where subsidies are suggested, clearly identify the subsidy and rationale in accordance with ADB criteria on subsidies of the Asian Development Bank.

(vii) Evaluate whether incentives are required for wind farm development in the three areas; if so, design appropriate incentive mechanisms and evaluate whether additional measures are required to address the constraints for wind power development; if so, identify them.

(viii) Conduct wide consultations with key government agencies and other parties involved in wind farm development and operations including State Development and Planning Commission; State Economic and Trade Commission; Ministry of Science and Technology; State Power Corporation; investors; and provincial power companies, planning commissions, and financial institutions to reach agreement on the evaluation and benchmarking methodology, tariff design, and incentive mechanisms.

(ix) Based on the proposed cost recovery mechanisms and the tariff, design and develop a general standard PPA to be used for developing new wind farms, and train the provincial power companies and pricing bureaus in the three provinces in the PPA implementation and their periodic review.

(x) Prepare interim, draft final, and final reports on the activities carried out, findings, and recommendations.

Table A7.2: Cost Estimates

($)

Item	Foreign Exchange	Local Currency	Total Cost
Consultants			
a. Remuneration and Per Diem			
i. International Consultants	220,000	40,000	260,000
ii. Domestic Consultants		50,000	50,000
b. International and Local Travel	30,000	10,000	40,000
c. Reports and Communications	5,000		5,000
Training Courses	40,000	10,000	50,000
Computers and Software	10,000		10,000
Contract Negotiations	5,000		5,000
Contingencies	110,000	20,000	30,000
Total	**420,000**	**130,000**	**550,000**

2. Commercializing of the Wind-Farm Companies (WFCs)

3. Ten person-months of international and ten person-months of domestic consulting services and workshops will be provided. The consultants will have the following responsibilities:

(i) Review the progress and objectives of the capacity building assistance provided by the United Nations Development Programme (UNDP) for the rapid commercialization

of renewable energy in the People's Republic of China (PRC) and assess the status of commercialization of WFCs in the country.

(ii) Review the operations of the Chinese Renewable Energy Industries Association (CREIA) with regard to promoting market-based sustainable renewable energy business development and market expansion, and identify the most likely scenario for commercializing renewable energy in the context of the Government's plans to create a separate market for renewable energy under its 10th five-year plan (TFYP).

(iii) Discuss with stakeholders and nongovernment parties interested in the development of wind farms in the PRC, their expectations and views on commercializing and increasing competitiveness of wind farm investments and operations during the TFYP and assess the potential for commercialization of WFCs in the three project areas.

(iv) Discuss with the concerned provincial power companies their plans for increasing grid-connected wind farms under the TFYP and the financing arrangements required for this.

(v) Assess the overall financing requirements for grid-connected wind farm development in the three areas under the TFYP assuming that mandatory shares for renewable energy will gradually be established and national trading of green credits will commence.

(vi) Identify options for mobilizing the required financing for new wind farms to be established in the provinces during the TFYP, identify the options with the highest probability of success, and prepare action plans to mobilize the required funds.

(vii) Review the present ownership structures in the existing WFCs in the three areas and evaluate if a reorganization of the WFCs would increase the efficiency of their operations and/or the availability of funds for development of new wind farms; if so, prepare a course of action for such reorganization.

(viii) Within the context of the Government's plans for developing a separate market for renewable energy under its TFYP evaluate the potential for stand-alone net-metered wind turbines, and if viable, identify the requirements for promoting the installation of such facilities.

(ix) Propose an action plan for each area to attract the required financing for their envisaged wind farm development plan and to increase competitiveness in wind farm investments and operations for the next five years.

(x) Prepare interim, draft final, and final reports on the activities carried out, findings, and recommendations.

Table A7.3: Cost Estimates

($)

Item	Foreign Exchange	Local Currency	Total Cost
Consultants			
a. Remuneration and Per Diem			
i. International Consultants	220,000	40,000	260,000
ii. Domestic Consultants		50,000	50,000
b. International and Local Travel	30,000	10,000	40,000
c. Reports and Communications	5,000		5,000
Workshops	40,000	10,000	50,000
Computers and Software	10,000		10,000
Contract Negotiations	5,000		5,000
Contingencies	110,000	20,000	130,000
Total	**420,000**	**130,000**	**550,000**

3. Facilitating the Implementation of National Policy for Renewable Energy Use at Provincial Level

4. Fifteen person-months of international and fifteen person-months of domestic consulting services, workshops, and domestic training courses will be provided. The consultants will have the following responsibilities:

(i) Review national, provincial, and local renewable energy, in particular wind-based power, generation policy options based on economic, social, technical, environmental, and political factors.

(ii) Prepare an analysis highlighting the policy strengths and weaknesses of the existing regulatory framework, and identify possible modifications to promote introduction of market-based new renewable energy promotion policy tools.

(iii) Document general patterns of energy generation from various sources in three provinces to meet the compliance requirements stipulated in the tenth five-year plan.

(iv) Develop renewable energy development plans, in particular for wind-based power generation in all three project areas.

(v) Identify potential for green credit trading within and among the grids, provinces and any other suitable energy units based on socioeconomic information, wind measurements, consequences of local environmental benefits, and energy resource utilization characteristics.

(vi) Assess the potential for establishing green credit-trading markets at different levels such as power producers or distributors based on strengths and weaknesses of each level.

(vii) Assess the potential economic gains of green credit trading for all possible sources documenting power tariff, national and provincial energy targets, reduced emission levels from these sources, and documenting potential environmental benefits.

(viii) In consultation with the Ministry of Finance; the State Development and Planning Commission; the State Power Corporation; and local power companies, establish maximum renewable energy loads for the identified grids.

(ix) Using selected market systems, demonstrate that green credit-trading systems can enhance environmental quality at a faster rate and at a lower cost.

(x) Prepare an appropriate legal and institutional mechanism, and submit it for Government's approval for the actual conduct of green energy-credit trading.

(xi) Define requirements for a compliance monitoring system and performance indicator systems to support the proposed green energy credit-trading systems.

(xii) Document all potential incentives that can be harnessed from proposed green credit-trading systems for power companies, government, and consumers; and provide such information during the public awareness component of the assistance.

(xiii) Develop a web site that will facilitate actual green credit trading, providing information for buyers and sellers and interagency information exchange.

(xiv) Prepare training programs and carry out the training of officers from relevant agencies, particularly from power companies and environmental and planning agencies, on procedures for designing, implementing, and maintaining an effective green credit-trading system. The training will include identification of potential trading units, assessment of possible renewable energy sources; establishment of maximum energy loads from various sources; data requirements and gathering relevant data for market establishment; price determination process; legal and institutional requirements; and performance monitoring.

(xv) Prepare interim, draft final, and final reports on the activities carried out, findings, and recommendations.

Table A7.4: Cost Estimates

($)

Item	Foreign Exchange	Local Currency	Total Cost
Consultants			
a. Remuneration and Per Diem			
i. International Consultants	330,000	58,000	388,000
ii. Domestic Consultants		75,000	75,000
b. International and Local Travel	30,000	10,000	40,000
c. Reports and Communications	10,000		10,000
Workshops and Domestic Training Courses	120,000	20,000	140,000
Training Materials	40,000		40,000
Computers and Software	25,000		25,000
Contract Negotiations	5,000		5,000
Contingencies	130,000	22,000	152,000
Total	**690,000**	**185,000**	**875,000**

4. Increasing Wind Measurement Data in the Xinjiang Uygur Autonomous Region and Heilongjiang and Liaoning Provinces

5. Fifteen person-months of international and fifteen person-months of domestic consulting services, domestic training courses, and wind measurement towers will be provided. The consultants will have the following responsibilities:

(i) Review available wind and other meteorological data available in the three areas.

(ii) Review the plans of the provincial power companies and planning commissions to increase the number of wind farms, and obtain additional wind data for this purpose, and evaluate the suitability of the areas identified.

(iii) Consult the United Nations Development Programme (UNDP) on the status of the national wind power database being developed with UNDP assistance, the types of data input and output used, and the programs and requirements for expansion of the database.

(iv) In consultation with the provincial power companies and planning commissions, identify priority areas where additional wind power could be developed, and prepare a program to obtain the required wind data to enable the preparation of the basic design of such additional wind farms and an estimate of the required investments.

(v) Help determine about 25 preferred locations for the wind measurement towers to record the additionally required wind data during 2001 and 2002, and carry out procurement and installation of the wind measurement towers.

(vi) Help process data produced by the wind measurement towers, and prepare and update of wind maps for the concerned areas.

(vii) Assist with the processing of data for transfer to the national wind power database, and train staff from the provincial power companies in this processing.

(viii) In consultation with the provincial power companies and planning commissions, prepare the technical background information for investment packages that could be offered to parties interested in wind farm development in the concerned province.

(ix) Prepare a plan for additional wind resource measurements in the three provinces over the next three years taking into account the envisaged expansion of grid-connected wind farms in each area.

(x) Review existing wind data for remote areas that are unlikely to be connected to the electricity grid over the next 10 years, and assess the need for additional wind measurements to determine where off-grid small-scale wind power projects would be viable.

(xi) If appropriate, prepare a program for wind measurements in such remote areas, including the installation of appropriate wind measurement towers and processing of data by the relevant authorities.

(xii) Prepare interim, draft final, and final reports on findings and recommendations.

Table A7.5: Cost Estimates

($)

Item	Foreign Exchange	Local Currency	Total Cost
Consultants			
a. Remuneration and Per Diem			
i. International Consultants	330,000	58,000	388,000
ii. Domestic Consultants		75,000	75,000
b. International and Local Travel	15,000	5,000	20,000
c. Reports and Communications	5,000		5,000
Domestic Training		15,000	15,000
Wind Measurement Towers	215,000		215,000
Contract Negotiations	5,000		5,000
Contingencies	130,000	22,000	152,000
Total	**700,000**	**175,000**	**875,000**

5. Capacity Building and Training

6. Twenty person-months of international and forty person-months of domestic consulting services, workshops, domestic training courses, and information materials, will be provided. The consultants will have the following responsibilities:

(i) Review the qualifications, skills, and professional experience of staff who are involved in developing renewable energy projects in provincial power companies and planning commissions.

(ii) Review the renewable energy programs in the provincial power companies and planning commissions, and make an assessment of the staffing and professional skills required to carry out the programs.

(iii) Evaluate the awareness and understanding of the potential of renewable energy development and its benefits among key decision makers in the provincial power companies and the planning commissions.

(iv) Review the general operations of the main local banks and financing institutions in the three provinces, and make an assessment of their views and interest in providing financial assistance for renewable energy development projects including the construction of wind farms.

(v) Evaluate the capacity of interested local banks and financial institutions in the three project areas to appraise the technical feasibility and financial viability of new wind farm projects.

(vi) Discuss with the provincial power companies, planning commissions, and interested banks and financial institutions the staff training requirements for these organizations to evaluate and develop renewable energy projects, and develop related training programs for each type of organization as required.

(vii) Conduct pilot training programs in each organization as needed, evaluate the results, and adjust and modify the training programs as needed.

(viii) Discuss and finalize with the concerned organizations comprehensive training programs that would be carried out over one year, prepare the materials required under each training program, and implement the training programs.

(ix) Assess the longer-term training requirements of staff of concerned organizations involved in renewable energy development, and prepare a program to address these training needs; include domestic and international training and study tours.

(x) Evaluate options for increasing awareness of the potential and benefits of renewable energy development among the general public in the three provinces and recommend the preferred course of action for provincial policy makers.

(xi) Evaluate the training requirements of staff in the wind farm companies in the areas of financial evaluation of wind farm operations, business development, and managerial skills.

(xii) As required, prepare and conduct training programs for such staff in these areas.

(xiii) Prepare interim, draft final, and final reports on training programs carried out, findings, and recommendations.

Table A7.6: Cost Estimates

($)

Item	Foreign Exchange	Local Currency	Total Cost
Consultants			
a. Remuneration and Per Diem			
i. International Consultants	440,000	78,000	518,000
ii. Domestic Consultants		200,000	200,000
b. International and Local Travel	30,000	15,000	45,000
c. Reports and Communications	20,000		20,000
Seminars, Domestic Training Courses, Study Tours	150,000	20,000	170,000
Training Materials	50,000		50,000
Information Materials	50,000		50,000
Contract Negotiations	5,000		5,000
Contingencies	172,000	70,000	242,000
Total	**917,000**	**383,000**	**1,300,000**

6. Assisting the Project Management Office and Disseminating at the National Level the Achievements of the Three Project Areas

7. One hundred person-months of domestic consulting, seminars, workshops, information materials, publications and promotional activities will be provided. The consultants will have the following responsibilities:

(i) Review the organizational arrangements and responsibilities of the Project Management Office (PMO) for implementing the assistance for Barrier Removal and Institutional Strengthening in the Xinjiang Uygur Autonomous Region and the provinces of Heilongjiang and Liaoning.

(ii) Discuss with the PMO requirements for assistance in such areas as preparation of background information, data collection and analysis, modeling, policy impact evaluation, economic evaluation, environmental impact assessment, and scenario development; prepare a program for carrying out the required tasks; and identify suitable domestic consultants to be engaged for this purpose.

(iii) Discuss with the PMO and the provincial parties involved the proposed timing and implementation arrangements for all consulting services for barrier removal and institutional strengthening in the areas and in consultation with the PMO prepare a detailed implementation plan.

(iv) Assist the PMO with coordinating the assistance with all parties directly involved, as well as with other relevant assistance in the area of renewable energy development financed from other sources.

(v) Prepare concise progress reports on the various activities being implemented, prepare and implement a monitoring and evaluation plan for the assistance, and assist the PMO in scheduling and arranging meetings with the Asian Development Bank (ADB) to officially review the various inputs.

(vi) Prepare reports summarizing the findings and recommendations of the consultants and in consultation with the PMO prepare a workshop schedule to disseminate and discuss results with relevant stakeholders in renewable energy development and assistance agencies involved in the sector.

(vii) Within the framework of the Government's partnership for renewable energy and in consultation with the PMO, arrange for the conduct of two national seminars (tentatively about one and two years following the start of the consulting services) to present and discuss the experiences and achievements of the three project areas, involving national policymakers, domestic international experts, and assistance agencies.

(viii) Evaluate possible options and the most cost effective means for disseminating the findings and results of the assistance to the general public so as to promote renewable energy in the PRC.

(ix) In consultation with the PMO prepare a campaign for this purpose and arrange for the preparation of the necessary information, documentation, and materials.

(x) In consultation with the PMO and ADB arrange for the preparation of a book summarizing the main results of all assistance provided.

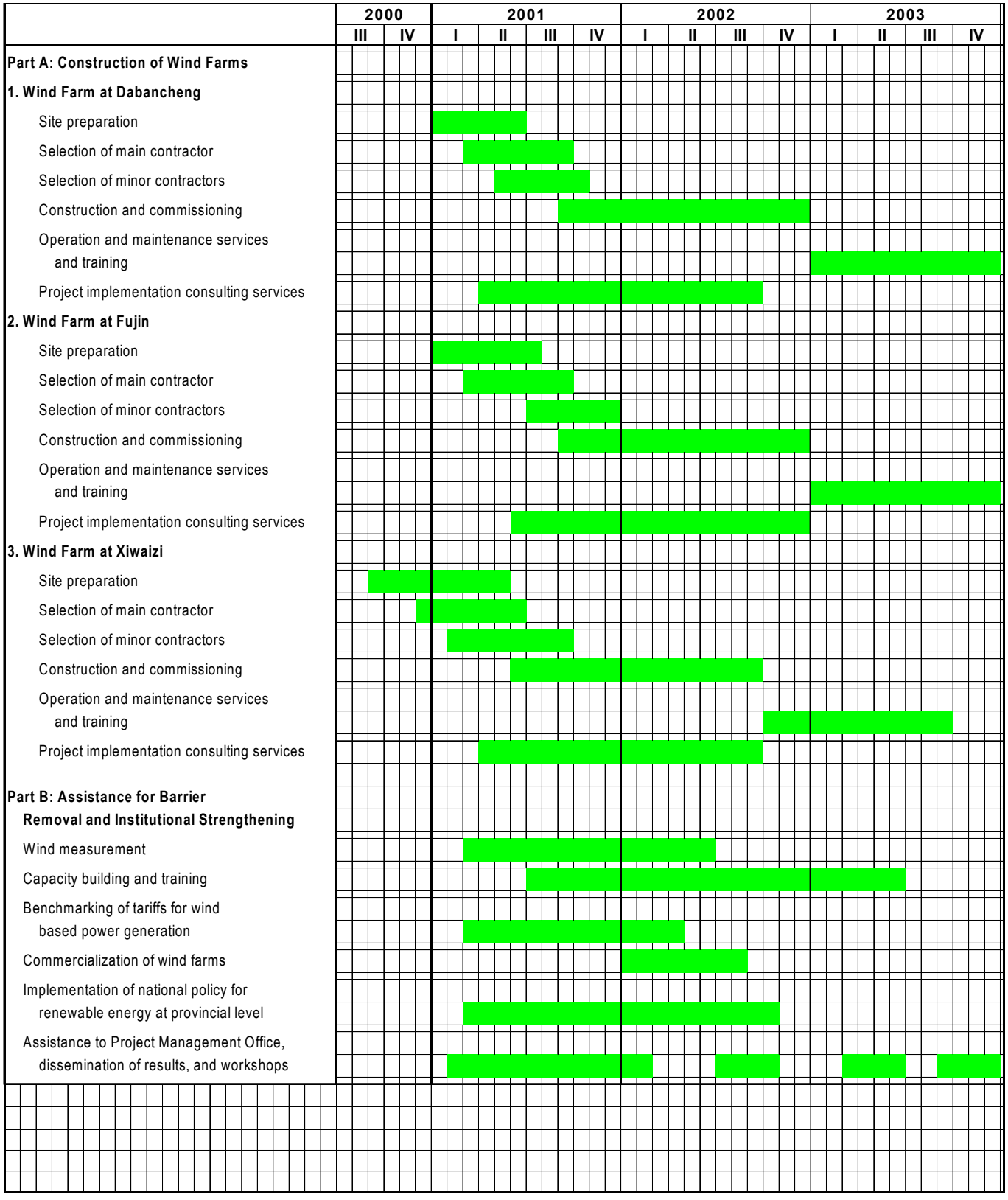
Table A7.7: Cost Estimates

($)

Item	Foreign Exchange	Local Currency	Total Cost
Consultants			
a. Remuneration and Per Diem			
i. Domestic Consultants		500,000	500,000
b. Local Travel		10,000	10,000
c. Reports and Communications		5,000	5,000
Seminars and Workshops		20,000	20,000
Information Materials and Publications		10,000	10,000
Promotional Activities		10,000	10,000
Contingencies		95,000	95,000
Total		**650,000**	**650,000**

Appendix 8

Project Implementation Schedule



ORGANIZATION OF THE EXECUTING AGENCIES

Figure A9.1: Organization of Xinjiang Electric Power Corporation

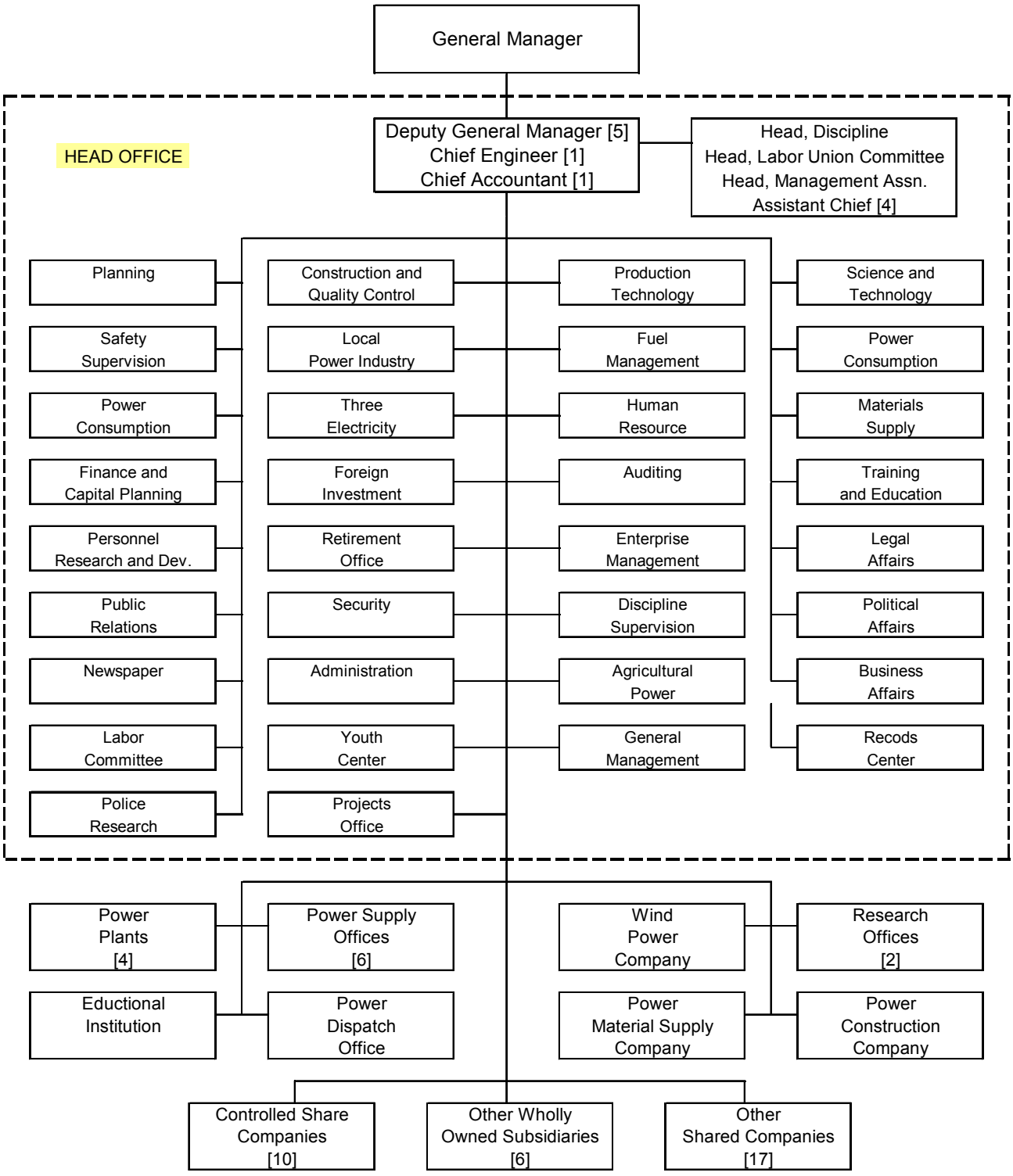


Figure A9.2: Organization Chart of Heilongjiang Electric Power Company

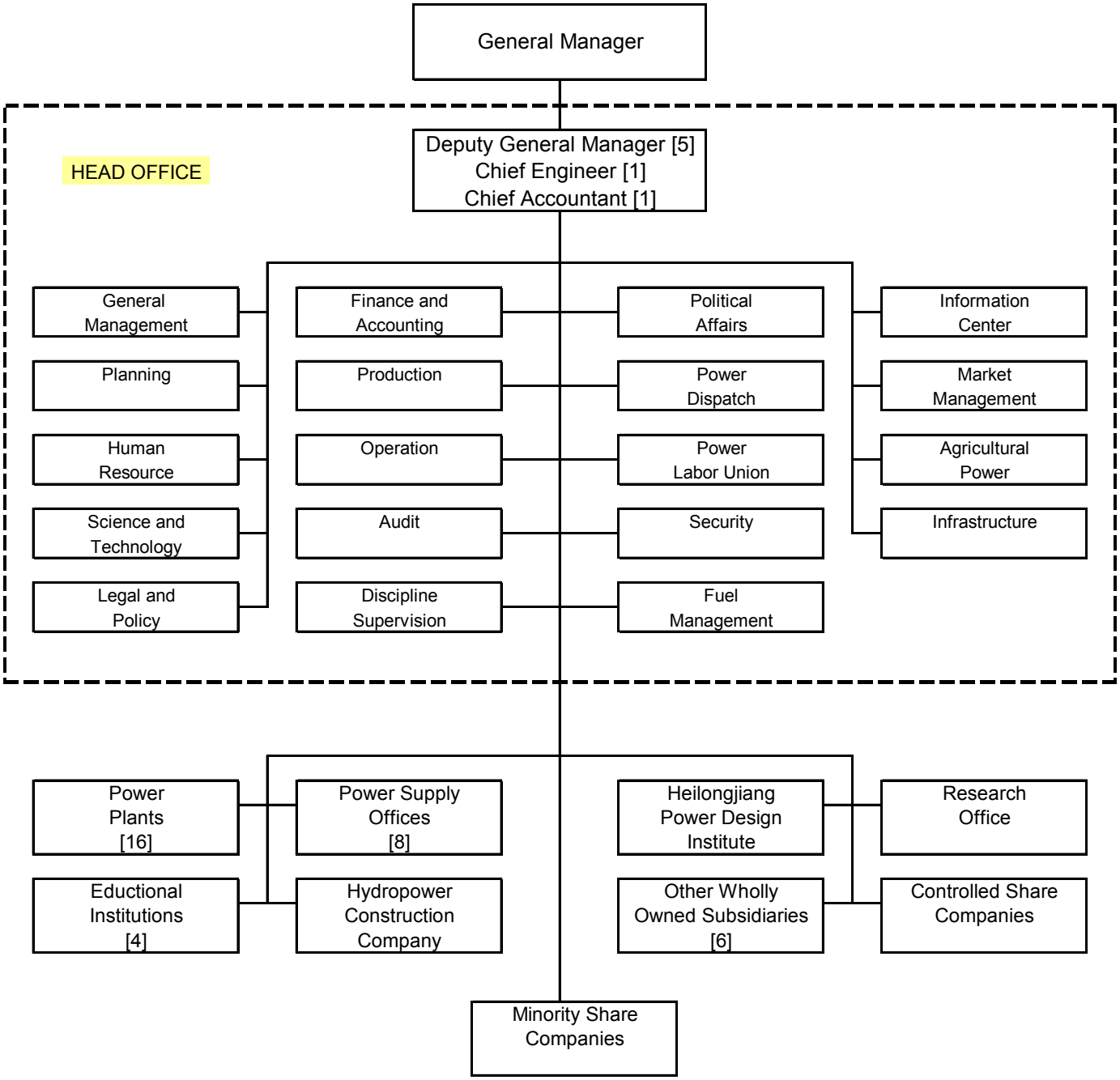
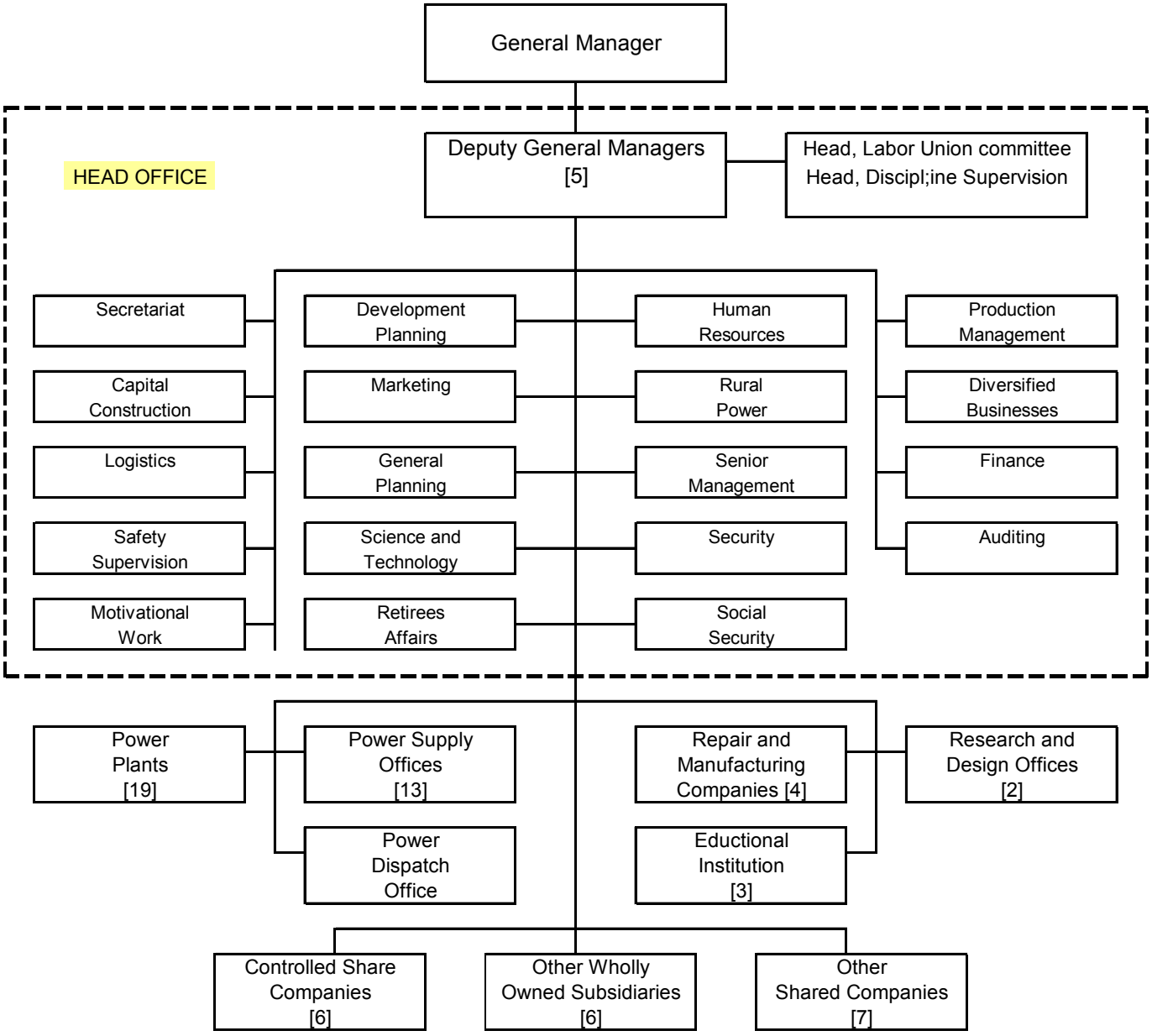


Figure A9.3: Organization Chart of Liaoning Electric Power Company



FINANCIAL PROJECTIONS OF THE EXECUTING AGENCIES

1. The financial operations of the three Executing Agencies, the Xinjiang Electric Power Company Ltd (XEPC), Heilongjiang Electric Power Company Ltd (HEPC), and Liaoning Electric Power Company Ltd (LEPC) were projected for 2000-2009 as shown in tables A10.1-A10.3 based on major assumptions described here.

A. General

1. Capital investment Program

2. The capital investment programs of three companies are based on the least-cost power development plans for the two provinces and the autonomous region.

2. Demand Forecast

3. The energy sales projections are based on the load growth forecast prepared by the three utilities with the assistance of domestic consultants.

3. Prices, Inflation, and Exchange Rate

4. Foreign exchange costs are estimated to increase at about 2.4 percent a year over the projection period. Local currency costs' annual escalation rates are estimated at 2 percent in 2001, 3 percent in 2002, 4 percent in 2003, and 5 percent thereafter. The projections use an exchange rate of Y8.28 to $1.00.

B. Income Statements

1. Revenues

5. Revenues are calculated from the energy sales and the average tariffs per kilowatt-hour (kWh) of electricity. The tariff rates are based on the tariff schedule prevailing in 2000 and are adjusted regularly to yield a return on net fixed assets of about 8.0 percent in 2000 increasing gradually to about 9 percent by 2005.

2. Cost of Coal

6. Average consumption of standard coal (7,000 kilocalories per kilogram) is based on actual experience of the companies. Standard coal prices are projected to increase with inflation.

3. Purchase of Power

7. Power purchases are based on estimated requirements to make up for the shortage between user demand and the utilities' own generating capacities. Power purchase prices are based on actual contracts.

4. Other Operating Expenses

8. Other operating costs include personnel, distribution, administration, and other expenses, and are projected to increase in accordance with increase in energy generation and distribution operations.

5. Depreciation

9. Depreciation is calculated on a straight-line basis using estimated remaining life of the fixed assets.

6. Other Income

10. Investments are estimated to earn interest at the short-term interest rate of 8 percent.

7. Interest on Long-term Debts

11. Interest expenses on existing long-term debts are calculated at the given loan terms. Interest on external loans to be incurred is calculated at 6.53 percent; those for local loans are at 6.00 percent.

8. Taxes

12. Taxable income of the utilities is subject to 33 percent income tax. Value-added tax for electricity sales is 17 percent. Additional sales tax of 9 percent of value-added tax is levied.

C. Balance Sheets and Cash Flow Statements

1. Fixed Assets

13. The projections are based on the historical values of the fixed assets.

2. Accounts Receivable

14. Accounts receivable are estimated at about five weeks' sales, considering the experience of the companies.

3. Accounts Payable

15. Accounts payable are estimated to amount to about five weeks' operating expenses.

D. Financial Indicators

16. Indicators of financial performance and condition have been calculated as follows:

(i) Operating ratio: total operating expenses as a percentage of total revenues,
(ii) Return on net fixed assets: net income before financial expenses as percentage of average net fixed assets,
(iii) Current ratio: ratio of current assets to current liabilities,
(iv) Debt/equity ratio: ratio of long-term debt to long-term-debt plus equity,
(v) Debt service ratio: ratio of internal cash generation to debt service requirement, and
(vi) Self-financing ratio: net internal cash generation as a percentage of the three-year moving average capital expenditures.

Table A10.1: Projected Financial Operations, Xinjiang Electric Power Company Ltd
(Yuan million)

Item	Actual	Projected									
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Operating Data											
Energy Sales (GWh)	6,892	7,400	7,900	8,400	8,900	9,400	10,000	10,600	11,200	11,900	12,600
Increase in Energy Sales (%)	7.7	7.4	6.8	6.3	6.0	5.6	6.4	6.0	5.7	6.3	5.9
Average Tarif (Y/kWh)	0.350	0.385	0.435	0.492	0.556	0.628	0.691	0.711	0.711	0.711	0.711
Increase in Tariff (%)	26.7	10.0	13.0	13.0	13.0	13.0	10.0	3.0	0.0	0.0	0.0
Income Statements											
Net Revenues	1,745	2,321	2,800	3,364	4,028	4,807	5,626	6,142	6,490	6,895	7,301
Cash Operating Expenses	1,234	1,220	1,404	1,570	1,775	2,134	2,436	2,699	2,861	3,218	3,509
Depreciation	335	284	525	702	867	1,083	1,340	1,537	1,597	1,645	1,650
Operating Profit	175	817	871	1,092	1,386	1,590	1,850	1,906	2,032	2,032	2,142
Financial costs	180	244	372	509	657	791	876	847	778	667	605
Other Income	13	73	89	89	89	89	89	89	129	179	219
Taxable Income	8	646	588	673	818	889	1,063	1,148	1,383	1,545	1,756
Income Tax	0	213	194	222	270	293	351	379	456	510	580
Net Income	**8**	**433**	**394**	**451**	**548**	**595**	**712**	**769**	**927**	**1,035**	**1,177**
Balance sheets											
Assets											
Net Fixed Assets	5,422	8,287	12,010	14,904	17,827	19,139	20,262	19,362	18,978	18,561	18,197
Other Assets	893	893	893	893	893	893	893	1,293	1,793	2,193	2,993
Current Assets	2,589	2,406	2,785	2,905	3,365	3,581	3,917	3,956	4,043	4,168	4,182
Total Assets	**8,904**	**11,586**	**15,688**	**18,702**	**22,085**	**23,612**	**25,072**	**24,611**	**24,813**	**24,921**	**25,372**
Equity and Liabilities											
Equity	2,393	3,235	4,286	5,208	6,439	7,452	8,482	9,381	10,506	11,740	13,121
Long-term Debt	4,590	6,720	9,402	11,415	13,137	13,480	13,588	12,251	11,118	10,149	9,233
Other Liabilities	0	0	0	0	0	0	0	0	0	0	0
Current Liabilities	1,921	1,631	2,000	2,079	2,509	2,681	3,002	2,979	3,190	3,033	3,019
Total Equity and Liabilities	**8,904**	**11,586**	**15,688**	**18,702**	**22,085**	**23,612**	**25,072**	**24,611**	**24,813**	**24,921**	**25,372**
Cash Flow Statements											
Sources											
Internal Cash Generation	524	961	1,291	1,662	2,072	2,469	2,928	3,153	3,302	3,347	3,432
Borrowings	1,455	2,452	3,344	2,798	2,974	1,787	1,896	451	897	914	967
Other sources	121	409	657	471	683	417	318	130	198	199	204
Total Sources	**2,100**	**3,822**	**5,292**	**4,931**	**5,729**	**4,673**	**5,142**	**3,734**	**4,397**	**4,460**	**4,603**
Applications											
Capital Expenditures	940	3,149	4,248	3,596	3,790	2,395	2,463	637	1,213	1,228	1,286
Debt Service	531	319	619	1,171	1,442	2,043	2,320	2,635	2,566	2,697	2,488
Change in Working Capital	440	43	66	67	82	88	88	39	38	12	39
Others	(55)	282	0	0	0	0	0	400	500	400	800
Total Applications	**1,856**	**3,793**	**4,933**	**4,834**	**5,314**	**4,526**	**4,871**	**3,711**	**4,317**	**4,337**	**4,613**
Net Cash Flow	**244**	**29**	**359**	**97**	**415**	**148**	**271**	**24**	**80**	**123**	**(11)**
Cash, Beginning	430	674	703	1,062	1,159	1,574	1,722	1,993	2,017	2,097	2,220
Cash, Ending	**674**	**703**	**1,062**	**1,159**	**1,574**	**1,722**	**1,993**	**2,017**	**2,097**	**2,220**	**2,209**
Ratios											
Operating Ratio (%)	90	65	69	68	66	67	67	69	69	71	71
Return on Net Fixed Assets (%)	4.5	11.2	8.3	8.2	8.6	8.2	8.2	8.2	8.9	9.4	10.2
Current Ratio	1.3	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.4
Debt/Equity Ratio (%)	66	68	69	69	67	64	62	57	51	46	41
Debt Service Ratio	0.2	2.9	2.0	1.4	1.4	1.2	1.2	1.2	1.3	1.2	1.4
Self-financing Ratio	0	22	17	11	17	12	28	33	68	51	108

Table A10.2: Projected Financial Operations, Heilongjiang Electric Power Company Ltd
(Yuan million)

Item	Actual	Projected									
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Operating Data											
Energy Sales (GWh)	28,162	28,800	29,500	30,300	31,200	32,100	33,200	34,300	35,500	36,700	38,100
Increase in Energy Sales (%)	1.4	2.3	2.4	2.7	3.0	2.9	3.4	3.3	3.5	3.4	3.8
Average Tarif (Y/kWh)	0.359	0.392	0.424	0.458	0.480	0.504	0.525	0.538	0.554	0.582	0.611
Increase in Tariff (%)	20.0	9.0	8.2	8.0	5.0	5.0	4.0	2.5	3.0	5.0	5.0
Income Statements											
Net Revenues	8,745	9,391	10,395	11,517	12,445	13,438	14,449	15,300	16,308	17,695	19,280
Cash Operating Expenses	7,847	8,309	8,978	9,888	10,503	11,152	12,200	12,756	13,987	15,337	16,822
Depreciation	784	800	827	979	1,115	1,256	1,345	1,421	1,470	1,521	1,574
Operating Profit	114	282	590	651	828	1030	903	1123	851	836	883
Financial costs	181	400	550	612	655	665	618	539	456	372	298
Other Income	110	374	374	550	782	886	1070	1230	1230	1230	1230
Taxable Income	43	256	414	589	955	1251	1356	1814	1625	1695	1815
Income Tax	22	85	137	194	315	413	447	599	536	559	599
Net Income	**21**	**172**	**278**	**395**	**640**	**838**	**908**	**1215**	**1089**	**1135**	**1216**
Balance sheets											
Assets											
Net Fixed Assets	11,572	15,388	17,088	18,693	20,146	19,713	19,152	18,551	17,941	17,320	16,688
Other Assets	4,516	4,516	6,716	9,616	10,916	13,216	15,216	15,216	15,216	15,216	15,216
Current Assets	6,974	5,960	6,200	6,012	6,109	6,295	6,730	6,848	6,854	6,868	7,779
Total Assets	**23,062**	**25,864**	**30,004**	**34,321**	**37,171**	**39,224**	**41,098**	**40,615**	**40,011**	**39,404**	**39,683**
Equity and Liabilities											
Equity	11,931	12,265	12,702	13,257	14,057	15,055	16,123	17,499	18,748	20,043	21,420
Long-term Debt	5,951	8,772	12,369	15,669	17,586	18,546	19,324	17,474	15,556	14,001	12,870
Other Liabilities	0	0	0	0	0	0	0	0	0	0	0
Current Liabilities	5,180	4,827	4,933	5,395	5,528	5,623	5,651	5,642	5,708	5,360	5,394
Total Equity and Liabilities	**23,062**	**25,864**	**30,004**	**34,321**	**37,171**	**39,224**	**41,098**	**40,615**	**40,011**	**39,404**	**39,683**
Cash Flow Statements											
Sources											
Internal Cash Generation	986	1,372	1,655	1,986	2,410	2,759	2,871	3,175	3,015	3,028	3,088
Borrowings	(1,130)	3,572	4,395	4,629	3,468	2,684	2,563	0	0	0	424
Other sources	911	162	160	160	160	160	160	160	160	160	160
Total Sources	**767**	**5,106**	**6,210**	**6,775**	**6,038**	**5,603**	**5,594**	**3,335**	**3,175**	**3,188**	**3,672**
Applications											
Capital Expenditures	(1,426)	4,616	2,527	2,584	2,568	823	784	820	860	900	942
Debt Service	381	559	1,142	1,410	1,984	2,216	2,342	2,324	2,306	2,290	1,853
Change in Working Capital	488	833	65	51	63	58	20	39	(1)	25	33
Others	1,581	0	2,200	2,900	1,300	2,300	2,000	0	0	0	0
Total Applications	**1,024**	**6,008**	**5,934**	**6,945**	**5,915**	**5,397**	**5,146**	**3,183**	**3,165**	**3,215**	**2,828**
Net Cash Flow	**(257)**	**(903)**	**276**	**(170)**	**123**	**207**	**449**	**152**	**10**	**(27)**	**844**
Cash, Beginning	2,684	2,407	1,504	1,780	1,609	1,733	1,939	2,388	2,540	2,550	2,523
Cash, Ending	**2,427**	**1,504**	**1,780**	**1,609**	**1,733**	**1,939**	**2,388**	**2,540**	**2,550**	**2,523**	**3,367**
Ratios											
Operating Ratio (%)	99	97	94	94	93	92	94	93	95	95	95
Return on Net Fixed Assets (%)	1.8	5.3	6.3	6.8	8.1	9.0	9.1	10.6	9.7	9.9	10.3
Current Ratio	1.3	1.2	1.3	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.4
Debt/Equity Ratio (%)	33	42	49	54	56	55	55	50	45	41	38
Debt Service Ratio	1.3	1.0	1.4	1.4	1.2	1.2	1.2	1.3	1.3	1.3	1.6
Self-financing Ratio	0	-1	14	20	18	35	63	99	83	79	196

Table A10.3: Projected Financial Operations, Liaoning Electric Power Company Ltd
(Yuan million)

Item	Actual	Projected									
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Operating Data											
Energy Sales (GWh)	50,236	51,400	53,000	54,800	56,500	58,300	60,300	62,100	64,200	66,500	68,900
Increase in Energy Sales (%)	1.0	2.3	3.1	3.4	3.1	3.2	3.4	3.0	3.4	3.6	3.6
Average Tarif (Y/kWh)	0.356	0.388	0.416	0.445	0.476	0.509	0.530	0.551	0.559	0.573	0.587
Increase in Tariff (%)	4.1	9.0	7.0	7.0	7.0	7.0	4.0	4.0	1.5	2.5	2.5
Income Statements											
Net Revenues	15,509	16,488	18,169	20,078	22,127	24,407	26,237	28,086	29,460	31,265	33,189
Cash Operating Expenses	13,701	14,166	15,038	16,351	17,680	19,342	20,780	22,399	23,844	26,491	28,839
Depreciation	1,563	1,600	1,858	2,103	2,454	2,832	3,119	3,323	3,378	3,406	3,435
Operating Profit	245	722	1,273	1,624	1,993	2,233	2,338	2,363	2,238	1,367	915
Financial costs	(91)	(582)	(753)	(924)	(1,102)	(1,188)	(1,171)	(1,055)	(834)	(642)	(507)
Other Income	487	888	888	864	840	822	828	828	952	1,184	1,480
Taxable Income	823	2,192	2,913	3,411	3,934	4,243	4,337	4,246	4,024	3,193	2,902
Income Tax	101	339	464	516	571	616	658	705	777	630	623
Net Income	**722**	**1,853**	**2,449**	**2,895**	**3,363**	**3,627**	**3,679**	**3,541**	**3,246**	**2,563**	**2,279**
Balance sheets											
Assets											
Net Fixed Assets	16,757	21,297	25,395	29,583	31,979	32,982	33,546	30,717	27,850	24,974	22,711
Other Assets	7,642	12,342	12,342	12,342	12,342	12,342	12,342	12,342	13,442	16,042	19,742
Current Assets	20,306	15,741	15,706	15,627	15,785	15,831	15,857	15,921	15,267	14,241	12,392
Total Assets	**44,705**	**49,380**	**53,443**	**57,552**	**60,106**	**61,155**	**61,745**	**58,980**	**56,559**	**55,257**	**54,845**
Equity and Liabilities											
Equity	25,145	25,834	26,777	27,824	28,984	30,234	31,571	33,002	34,581	35,860	37,125
Long-term Debt	10,145	12,456	15,113	17,578	18,421	17,962	17,062	13,599	11,024	8,946	7,292
Other Liabilities	0	0	0	0	0	0	0	0	0	0	0
Current Liabilities	9,415	11,090	11,553	12,150	12,701	12,959	13,112	12,378	10,954	10,451	10,428
Total Equity and Liabilities	**44,705**	**49,380**	**53,443**	**57,552**	**60,106**	**61,155**	**61,745**	**58,980**	**56,559**	**55,257**	**54,845**
Cash Flow Statements											
Sources											
Internal Cash Generation	4,100	4,937	3,573	4,070	4,644	5,220	5,645	5,918	5,966	5,639	5,428
Borrowings	4,403	4,584	4,795	5,429	4,568	3,684	3,563	400	0	0	424
Other sources	16	0	0	0	0	0	0	0	0	0	0
Total Sources	**8,519**	**9,521**	**8,368**	**9,499**	**9,212**	**8,904**	**9,208**	**6,318**	**5,966**	**5,639**	**5,852**
Applications											
Capital Expenditures	277	6,140	5,956	6,291	4,850	3,835	3,683	494	511	530	1,172
Debt Service	791	1,470	2,138	2,662	3,266	3,813	4,314	4,518	4,297	3,217	2,585
Change in Working Capital	953	1,033	10	(2)	(36)	(25)	9	54	88	156	110
Others	2,420	4,700	0	400	800	1,100	1,000	1,000	1,500	2,600	3,700
Total Applications	**4,441**	**13,343**	**8,104**	**9,351**	**8,880**	**8,723**	**9,006**	**6,066**	**6,396**	**6,503**	**7,567**
Net Cash Flow	**4,078**	**(3,822)**	**265**	**148**	**332**	**181**	**202**	**251**	**(430)**	**(864)**	**(1,716)**
Cash, Beginning	3,317	7,395	3,573	3,838	3,986	4,318	4,499	4,701	4,953	4,523	3,659
Cash, Ending	**7,395**	**3,573**	**3,838**	**3,986**	**4,318**	**4,499**	**4,701**	**4,953**	**4,523**	**3,659**	**1,943**
Ratios											
Operating Ratio (%)	98	96	93	92	91	91	91	92	92	96	97
Return on Net Fixed Assets (%)	4.5	8.1	9.2	9.0	8.7	8.3	8.1	8.3	8.8	7.9	8.2
Current Ratio	2.2	1.4	1.4	1.3	1.2	1.2	1.2	1.3	1.4	1.4	1.2
Debt/Equity Ratio (%)	29	33	36	39	39	37	35	29	24	20	16
Debt Service Ratio	4.0	2.7	1.7	1.5	1.4	1.4	1.3	1.3	1.4	1.7	2.1
Self-financing Ratio	0	59	23	25	28	35	49	86	309	307	482

FINANCIAL ANALYSIS OF THE PROJECT

1. Detailed financial analysis was conducted on the Project. Below are described the notes and assumptions used in the financial evaluation. All the costs and prices are expressed in constant 2000 prices.

1. Benefits

2. All the wind turbines will be installed by the end of 2002 and commercial operations are expected to begin by 1 January 2003. The wind farms will operate with the following plant factors: 43.5 percent for the wind farm at Dabancheng, 44.7 percent for the wind farm at Fujin, and 28.3 percent for the wind farm at Xiwaizi. During periods with sufficient wind the average generation availability is estimated at 97 percent and own use of electricity by the wind farms is about 1 percent of the generated electricity. The tariffs (including value-added tax) are based on the feasibility studies for the wind farms as prepared by the respective provincial power companies and approved by the Government. They are: Y0.531/kilowatt-hour (kWh) for the wind farm at Dabanchang; Y0.679/kWh for the wind farm at Fujin; and Y0.741/kWh for the wind farm at Xiwaizi. The tariffs will be reviewed and adjusted annually to reflect inflation to ensure a levelized annual rate of return on equity of at least 15 percent. The project life is estimated at 20 years. The financial projections for the three wind farm companies are shown in Table A11.1.

2. Costs

a. Capital Costs

3. The capital costs include physical contingencies but exclude interest charges during construction. The construction period will be about two years. The salvage value at the end of 20 years is estimated at 10 percent of capital costs.

b. Operating Costs

i. Operation and Maintenance Costs

4. Annual operation and maintenance costs are estimated at Y0.04/kWh in 2000 prices.

ii. Fixed Cost

5. Fixed costs are estimated at about 1 percent of net fixed assets.

iii. Interest Expenses

6. Financial expenses are the interest on loans incurred in Project implementation. Interest on foreign exchange loans is calculated at 6.53 percent and on local borrowings at 6.21 percent.

iv. Income Tax

7. The Project's taxable income is subject to 33 percent income tax.

3. Financial Internal Rate of Return

8. The financial internal rates of return of the three wind farms and the overall Project are calculated as shown in Table A11.2.

Table A11.1: Financial Projections of the Wind Farm Companies

	2003	2004	2005	2006	2007	2014	2022
Wind Farm Company at Dabancheng, 30 MW							
Installed Capacity (MW)	30	30	30	30	30	30	30
Plant Factor (%)	43.5	43.5	43.5	43.5	43.5	43.5	43.5
Generation (GWh)	113.2	113.2	113.2	113.2	113.2	113.2	113.2
Net Electricity Sales (GWh)	108.7	108.7	108.7	108.7	108.7	108.7	108.7
Network Transfer Tariff (Y/kWh)	0.531	0.531	0.531	0.531	0.531	0.531	0.531
Return on Equity (%)	37.9	13.4	14.0	15.4	16.1	22.5	29.9
Debt Service Ratio (%)		1.6	1.6	1.6	1.6	1.0	
Debt/Debt-plus-Equity Ratio (%)	73	76	75	74	73	51	
Wind Farm Company at Fujin, 24 MW							
Installed	24	24	24	24	24	24	24
Plant Factor (%)	44.7	44.7	44.7	44.7	44.7	44.7	44.7
Generation (GWh)	93.9	93.9	93.9	93.9	93.9	93.9	93.9
Net Electricity Sales (GWh)	90.1	90.1	90.1	90.1	90.1	90.1	90.1
Network Transfer Tariff (Y/kWh)	0.679	0.679	0.679	0.679	0.679	0.679	0.679
Return on Equity (%)	38.1	24.2	24.8	25.4	26.0	31.6	38.1
Debt Service Ratio (%)		2.0	2.0	1.9	1.9	1.1	
Debt/Debt-plus-Equity Ratio (%)	70	66	61	57	52	18	
Wind Farm Company at Xiwaizi, 24 MW							
Installed Capacity (MW)	24	24	24	24	24	24	24
Plant Factor (%)	28.3	28.3	28.3	28.3	28.3	28.3	28.3
Generation (GWh)	59.6	59.6	59.6	59.6	59.6	59.6	59.6
Net Electricity Sales (GWh)	57.2	57.2	57.2	57.2	57.2	57.2	57.2
Network Transfer Tariff (Y/kWh)	0.741	0.741	0.741	0.741	0.741	0.741	0.741
Return on Equity (%)	29.5	11.1	11.8	12.6	13.4	20.6	29.5
Debt Service Ratio (%)		1.5	1.5	1.5	1.5	1.7	
Debt/Debt-plus-Equity Ratio (%)	78	76	73	71	68	36	

GWh= gigawatt hour, kWh= kilowatt-hour, MW= megawatt, Y= Yuan.

Table A11.2: Financial Internal Rates of Return of the Wind Farms and Overall Project

(Yuan million)

	2001	2002	2003	2004	2005	2006	2007	2008	2022
A. Wind Farm at Dabancheng									
Cash Flow									
Revenues			44.5	44.5	44.5	44.5	44.5	44.5	44.5
Capital Costs	113.8	143.6	0.0						
Cash Operating Costs			8.0	8.0	8.0	8.0	8.0	8.0	8.0
Salvage Value									66.6
Income Tax			10.0	3.5	3.7	4.0	4.2	4.4	7.9
Net Cash Flow	**-113.8**	**-143.6**	**26.6**	**33.0**	**32.8**	**32.5**	**32.3**	**32.1**	**95.3**
FIRR		**10.2**							
B. Wind Farm at Fujin									
Cash Flow									
Revenues			46.7	46.7	46.7	46.7	46.7	46.7	46.7
Capital Costs	96.8	117.5	0.0						
Cash Operating Costs			6.8	6.8	6.8	6.8	6.8	6.8	6.8
Salvage Value									55.4
Income Tax			9.5	6.0	6.2	6.3	6.5	6.7	9.5
Net Cash Flow	**-96.8**	**-117.5**	**30.4**	**33.8**	**33.7**	**33.6**	**33.4**	**33.2**	**85.8**
FIRR		**13.4**							
C. Wind Farm at Xiwaizi									
Cash Flow									
Revenues			32.7	32.7	32.7	32.7	32.7	32.7	32.7
Capital Costs	94.1	114.2	0.0						
Cash Operating Costs			5.5	5.5	5.5	5.5	5.5	5.5	5.5
Salvage Value									53.9
Income Tax			5.4	2.0	2.2	2.3	2.5	2.6	5.4
Net Cash Flow	**-94.1**	**-114.2**	**21.8**	**25.2**	**25.0**	**24.9**	**24.7**	**24.6**	**75.7**
FIRR		**9.6**							
D. Overall Project									
Cash Flow									
Revenues	0.0	0.0	123.9	123.9	123.9	123.9	123.9	123.9	123.9
Capital Costs	304.7	375.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash Operating Costs	0.0	0.0	20.2	20.2	20.2	20.2	20.2	20.2	20.2
Salvage Value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	175.9
Income Tax	0.0	0.0	24.9	11.6	12.0	12.7	13.2	13.7	22.8
Net Cash Flow	**-304.7**	**-375.3**	**78.7**	**92.0**	**91.6**	**90.9**	**90.4**	**89.9**	**256.8**
FIRR		**11.1**							

FIRR= financial internal rate of return.

ECONOMIC ANALYSIS OF THE PROJECT

A. Least-Cost Analysis

1. The least-cost generation expansion analysis covering 2000-2022 (planning period) for the Heilongjiang Power Grid (HPG); the Liaoning Power Grid (LPG); and the Xinjiang Power Grid (XPG) were carried out by Beijing Economic Research Institute of Water Resources and Electric Power (BERI) using the GESP II model.[88] The input data and assumptions were reviewed by the Mission and found appropriate. The analysis used constant 1999 prices and a discount rate of 12 percent. Tradable commodities were valued at border prices at the prevailing exchange rate (Yuan [Y]8.3/$1.0). Nontradable commodities were valued at shadow prices, using a mix of standard and specific conversion factors.[89] The least-cost analyses confirmed the robustness of the proposed wind farms.

2. The results of the least-cost analysis are supported by levelized cost (LC) analysis. In the LC analyses, run-of-river hydropower stations with similar environmental benefits will replace wind farms. The analyses compare the investment and operation cost of wind farms with that of run-of-river hydropower stations. The main assumptions for the candidates, including the cost and generation, were found to be appropriate. The data were obtained from local design institutes and power companies.

1. Wind Farm at Dabancheng

3. The wind farm at Dabancheng will be required by year 2003, with the projected annual demand growth in the Xinjiang Uygur Autonomous Region of 2.4 percent during 1999-2001, 3.4 percent for 2002-2012, and 3.4 percent for 2011-2022. Two least-cost generation expansion alternatives for UPG were considered. Alternative I is the basic case, which includes the construction the 30 MW wind farm at Dabancheng. In alternative II, the wind farm at Dabancheng will not be constructed. The present values of cost flows for alternative I and II are Y55,551 and Y55,564 million. The results indicate that the least-cost generation expansion scenario including the wind farm at Dabancheng compares favorably with the one without the wind farm at Dabancheng. The LC of the wind farm at Dabancheng is Y0.32/kilowatt-hour (kWh), lower than the LC of run-of-river hydropower with environmental benefits (Y0.37/kWh).

2. Wind Farm at Fujin

4. The wind farm at Fujin will be required by 2003, with the projected annual electricity demand growth in Heilongjiang Province of 2.2 percent for 1999-2001, 3.3 percent for 2002-2010, and 3.2 percent for 2011-2022. Two least-cost generation expansion alternatives for HPG were considered. Alternative I is the basic case, which includes the construction the 24 megawatt (MW) wind farm at Fujin. In alternative II, the wind farm at Fujin will not be constructed. The present values of cost for alternative I and II are Y218,078 and Y218,118 million. The results indicate that the least-cost generation expansion scenario including the wind farm at Fujin compares favorably with the one

[88] The computer model GESP II (Generator of Electric System Planning) has been used for similar analysis in more than 10 power projects financed by the World Bank and the Asian Development Bank.

[89] A standard conversion factor of 0.93 was used. Border prices were used for all import items. Local costs were shadow priced using group and specific conversion factors: 1.0 for equipment, 1.51 for steel, 0.69 for cement, 0.63 for timber, 2.0 for skilled labor, and 0.67 for unskilled labor. Taxes and duties were excluded.

without the wind farm at Fujin. The LC of the wind farm at Fujin is Y0.32/kWh, lower than the LC of run-of-river hydropower with similar environmental benefits (Y0.52/kWh).

3. Wind Farm at Xiwaizi

5. The wind farm at Xiwaizi will be required by year 2003, with the projected annual demand growth in Liaoning Province of 2.4 percent during 1999-2001, 3.4 percent for 2002-2012 and 3.4 percent for 2011-2022. Two least-cost generation expansion alternatives for LPG were considered. Alternative I is the basic case, which includes the construction the 24 MW wind farm at Xiwaizi. In alternative II, the wind farm at Xiwaizi will not be constructed. The present values of cost flows for alternative I and II are Y310,056 and Y310,063 million. The results indicate that the least-cost generation expansion scenario including the wind farm at Xiwaizi compares favorably with the one without the wind farm at Xiwaizi. The results show that the LC of the wind farm at Xiwaizi is Y0.49/kWh, lower than the LC of run-of-river hydropower with environmental benefits (Y0.52/kWh).

B. Economic Internal Rate of Return (EIRR)

6. The economic analysis used the conversion factors;, investment costs for generation, transmission, and distribution; fuel costs; and operation and maintenance (O&M) costs that are consistent with those used in the least-cost analysis. For economic internal rate of return (EIRR) calculations, the benefits of energy output were valued based on avoided power supply cost. The economic benefits of wind turbines in EIRR calculations begin with the operation of each individual wind turbine. The results of the EIRR analysis show the generation and environmental benefits as the major benefits. The costs include (i) capital investments of wind farms, and (ii) incremental O&M costs calculated at 1.0 percent of the capital costs. EIRR calculation used a conservative approach that does not include the benefit of improved quality of supply. The environmental benefits were valued based on the benefits transfer method, using (i) methodology adopted in ADB's Workbook on Economic Evaluation of Environmental Impacts (1996) to determine an adjusted estimate of the monetary damages caused by air pollution during the study period, taking into account the location of the power plant, the emission level, and the population affected; and (ii) estimates of average annual climate change for carbon emissions to evaluate the monetary damages caused by greenhouse gas emissions. Sensitivity analyses on the EIRR were also performed for each wind farm.

1. Wind Farm at Dabancheng

7. The EIRR for the wind farm at Dabancheng is 11.4 percent (Table A12.1). The sensitivity analysis showed the EIRR would decrease to (i) 10.1 percent if the Project experiences a cost overrun of 10 percent; (ii) 9.9 percent if the benefits reduced by 10 percent; (iii) 9.8 percent if the Project experiences a commissioning delay of one year; and (iv) 7.2 percent if all (i), (ii), and (iii) happen. Without the environmental benefits, the EIRR would decrease to 11.1 percent. Local currency depreciation of 20 percent will reduce EIRR to 9.6 percent.

2. Wind Farm at Fujin

8. The EIRR for the wind farm at Fujin is 14.8 percent (Table A12.2). The sensitivity analysis indicates the EIRR would decrease to (i) 13.3 percent if the Project experiences a cost overrun of 10 percent; (ii) 13.5 percent if the benefits are reduced by 10 percent; (iii) 13.0 percent if the Project experiences a commissioning delay of one year; and (iv) 10.5 percent if all (i), (ii), and (iii) happen. Without the environmental benefits, the EIRR would decrease to 9.4 percent. Local currency depreciation of 20 percent will reduce the EIRR to 12.8 percent.

3. Wind Farm at Xiwaizi

9. The EIRR for the wind farm at Xiwaizi is 12.7 percent (Table A12.3). The sensitivity analysis indicates the EIRR would decrease to (i) 11.3 percent if the Project experiences a cost overrun of 10 percent; (ii) 11.6 percent if the benefits are reduced by 10 percent; (iii) 11.0 percent if the Project experiences a commissioning delay of one year; and (iv) 8.6 percent if all (i), (ii), and (iii) happen. Without the environmental benefits, the EIRR would decrease to 6.9 percent. Local currency depreciation of 20 percent will reduce the EIRR to 10.7 percent.

4. The Project EIRR

10. The EIRR for the overall Project is 12.9 percent (Table A12.4). The sensitivity analysis showed the EIRR would decrease to (i) 11.5 percent if the Project experiences a cost overrun of 10 percent; (ii) 11.2 percent if energy sales are reduced by 10 percent; (iii) 11.2 percent if the Project experiences a commissioning delay of one year; and (iv) 8.4 percent if all (i), (ii), and (iii) happen. Without the environmental benefits, the EIRR would decrease to 9.3 percent. Local currency depreciation of 20 percent will reduce the EIRR to 11.0 percent.

[71]

C. Project Risk Analysis

11. To complement this deterministic analysis, risk analyses was undertaken using a probabilistic approach to the perceived risk factors that affect Project viability. Four broad categories of risk were considered:

(i) Demand Risk. Demand risks are related to lower peak-load demand growth than expected and/or breach of contract by the purchaser. A low load growth and/or an important reduction in electricity off-take could jeopardize the economic viability of the Project.

(ii) Price Risk. Price risk is related to the willingness and ability of consumers to pay for electricity and charges. Recent experience in the PRC shows that the power producer could also be confronted with unexpected price changes in both inputs and outputs.

(iii) Project Cost Risk. Higher-than-estimated project costs usually result from (a) higher equipment prices. Although the major equipment items will be purchased through international competitive bidding, their prices could be affected by market fluctuations; (b) implementation delays. For infrastructure projects these are usually caused by construction delays that are due to interfacing problems between different suppliers, unforeseen site conditions, and inadequate construction management; and (c) exchange rate fluctuations. Also, a depreciation of the local currency, the Yuan, could result in a major increase in project cost. Although the Yuan, has been stable for a considerable period, it could depreciate because of more stringent macroeconomic conditions resulting from the Asian financial crisis.

(iv) Operational Performance Risk. Poor operational performance could be caused by the low quality of generating equipment and facilities and inadequate O&M and management supervision.

12. Risk analysis was carried out for the EIRR to ensure the economic viability of the wind farms. Based on the foregoing considerations and sensitivity analyses, five variables for EIRR analysis were selected as the crucial risk variables, because of their significant impact on the

project economic viability. The risk analysis was carried out using the Monte Carlo simulation technique.[3] The inputs for the risk analysis are taken from the base case benefit-cost analysis. The correlation between risk variables is explicitly considered before the simulation to avoid generation of unrealistic project scenarios. The probability distributions attached to the selected variables are based on past ADB experience in power projects in general, and the PRC in particular, and extensive discussion with the Executing Agencies and relevant agencies in the PRC. Table A12.5 presents the selected variables including generation, plant capital cost, avoided power supply cost, implementation delay, and currency depreciation, the assumed value ranges and the assumed probability distributions. The results were based on 3,000 simulations.

13. The expected EIRR for the Project (Table A12.5), based on the weighted average of all simulated combinations is 12.7 percent (with a standard deviation of 2.4 percent), about 0.2 percent lower than the base case EIRR of 12.9 percent (without consideration of project risks). The probability for the EIRR to be below the considered discount rate of 10 percent is 13.0 percent the (cumulative distribution of EIRR is also in Table A12.5).

[3] The simulation was carried out using the Risk Master computer software. Monte Carlo simulation works by generating a series of random numbers following the distribution of probability of each risk variable. For each simulation, which represents a combination of different state of risk variables, EIRRs are calculated and recorded. The results of 3,000 simulations are averaged.

Table A12.1: Economic Internal Rate of Return of the Wind Farm at Dabancheng

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Costs (Yuan million)																	
Capital Cost	0.0	109.2	139.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O&M Cost	0.0	0.0	0.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Total	0.0	109.2	139.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Benefits (Yuan million)																	
Annual Generation (GWh)	0.0	0.0	0.0	113.2	113.2	113.2	113.2	113.2	113.2	113.2	113.2	113.2	113.2	113.2	113.2	113.2	113.2
Plant Use (%)	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Availability (%)	0%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%
Net Electricity Sales (GWh)	0.0	0.0	0.0	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7
National Environmental Benefit	0.0	0.0	0.0	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9
Avoided Supply Cost (Without Env. Benefits)	0.0	0.0	0.0	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4
Net Benefit (Without Env. Benefits)	0.0	-109.2	-139.0	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
Net Benefit (With National Env. Benefits)	0.0	-109.2	-139.0	33.4	33.5	33.5	33.6	33.6	33.7	33.7	33.7	33.7	33.8	33.8	33.8	33.8	33.8
EIRR(No Env.)	11.1%																
Base Case - EIRR(National Env. Bene.)	11.4%																

EIRR=economic internal rate of return, GWh = gigawatt-hour, kWh = kilowatt-hour, MW = megawatt, NPV = net present value, O&M = operation and maintenance, SI = sensitivity indicator, SV = switching val

Notes:
(i) Discount Rate 12%
(ii) Standard Conversion Factor 0.93

Sensitivity Analysis of EIRR	**Change in Variable**	**NPV (Y million)**
Base Case		(6.3)
(i) Capital Cost Overrun	10%	(22.9)
(ii) Benefit Reduction	-10%	(23.1)
(iii) Implementation Delay	1 year	(26.2)
(iv) Combination of (i), (ii) and (iii)		(61.6)
(v) Yuan (Exchange Rate) Depreciation	20%	(28.9)

Table A12.2: Economic Internal Rate of Return of the Wind Farm at Fujin

Item	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Costs (Yuan million)																							
Capital Cost	0.0	93.2	113.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O&M Cost	0.0	0.0	0.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Total	0.0	93.2	113.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Benefits (Ymillion)																							
Annual Generation (GWh)	0.0	0.0	0.0	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9
Plant Use (%)	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Availability (%)	0%	0%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%
Net Electricity Sales (GWh)	0.0	0.0	0.0	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2
National Environmental Benefit	0.0	0.0	0.0	7.6	8.8	6.1	9.9	13.7	14.1	14.6	15.0	13.9	12.8	11.6	10.5	9.4	9.6	9.8	10.1	10.3	10.5	10.5	10.5
Avoided Supply Cost (Without Env. Benefits	0.0	0.0	0.0	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Net Benefit (Without Env. Benefits)	0.0	-93.2	-113.9	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.3
Net Benefit (With National Env. Benefits)	0.0	-93.2	-113.9	31.9	33.0	30.3	34.2	38.0	38.4	38.8	39.3	38.1	37.0	35.9	34.8	33.7	33.9	34.1	34.3	34.5	34.7	34.7	34.7
EIRR(No Env.)	9.4%																						
Base Case - EIRR(National Env. Benefits)	14.8%																						

EIRR=economic internal rate of return, GWh = gigawatt-hour, kWh = kilowatt-hour, MW = megawatt, NPV = net present value, O&M = operation and maintenance, SI = sensitivity indicator, SV = switching value.

Notes:

(i) Discount rate 12%

(ii) Standard conversion factor 0.93

Sensitivity Analysis of EIRR	Change in Variable	NPV (Y million)	EIRR (%)	SI
Base Case		27.3	14.8%	
i. Capital Cost Overrun	10%	13.4	13.3%	5.1
ii. Benefit Reduction	-10%	14.8	13.5%	4.6
iii. Implementation Delay	1 year	10.6	13.0%	
iv. Combination of (i), (ii) and (iii)		(17.4)	10.5%	
v. Yuan (Exchange Rate) Depreciation	20%	8.4	12.8%	3.5

Table A12.3: Economic Internal Rate of Return of the Wind Farm at Xiwaizi

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Costs (Yuan million)																							
Capital Cost	0.0	90.5	110.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O&M Cost	0.0	0.0	0.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total	0.0	90.5	110.6	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Benefits (Yuan million)																							
Annual Generation (GWh)	0.0	0.0	0.0	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6	59.6
Plant Use (%)	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Availability (%)	0%	0%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%
Net Electricity Sales (GWh)	0.0	0.0	0.0	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2	57.2
National Environmental Benefit	0.0	0.0	0.0	28.0	5.7	6.2	7.0	7.9	8.2	8.5	8.9	8.9	9.0	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.7	9.7
Avoided Supply Cost (Without Env. Benefits)	0.0	0.0	0.0	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4
Net Benefit (Without Env. Benefits)	0.0	-90.5	-110.6	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3
Net Benefit (With National Env. Benefits)	0.0	-90.5	-110.6	47.3	25.0	25.5	26.4	27.2	27.5	27.9	28.2	28.3	28.3	28.4	28.4	28.5	28.6	28.7	28.8	28.9	29.1	29.1	29.1
EIRR(No Env.)	6.9%																						
Base Case - EIRR(National Env. Benefits)	12.7%																						

EIRR=economic internal rate of return, GWh = gigawatt-hour, kWh = kilowatt-hour, MW = megawatt, NPV = net present value, O&M = operation and maintenance, SI = sensitivity indicator, SV = switching value.

Notes:

(i) Discount Rate 12%

(ii) Standard Conversion Factor 0.93

Sensitivity Analysis of EIRR	**Change in Variable**	**NPV (Y million)**	**EIRR (%)**	**SI**
Base Case		6.4	12.7%	
I. Capital Cost Overrun	10%	(7.1)	11.3%	21.1
ii. Benefit Reduction	-10%	(3.7)	11.6%	15.8
iii. Implementation Delay	1 year	(9.8)	11.0%	
iv. Combination of (i), (ii) and (iii)		(35.0)	8.6%	
v. Yuan (Exchange Rate) Depreciation	20%	(12.4)	10.7%	14.7

Table A12.4: Economic Internal Rate of Return of the Overall Project

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015	2020	2021	2022	NPV
Costs (Yuan million)																
Fujin	0.0	93.2	113.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	148.5
Xiwaizi	0.0	90.5	110.6	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	144.3
Dabancheng	0.0	109.2	139.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	177.8
Total	0.0	292.8	363.4	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	470.6
Benefits (Yuan million)																
Local Environmental Benefit	0.0	0.0	0.0	36.1	15.0	12.9	17.6	22.3	23.1	23.9	24.7	19.5	21.2	21.2	21.2	103.6
Generation Benefit	0.0	0.0	0.0	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	394.4
Net Benefit (No Env.)	0.0	-292.8	-363.4	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	-76.2
Net Benefit (National)	0.0	-292.8	-363.4	112.6	91.6	89.4	94.1	98.8	99.6	100.4	101.2	96.0	97.7	97.7	97.7	27.4
EIRR(No Env.)	9.3%															
Base Case - EIRR(National Env. Bene.)	12.9%															

EIRR=economic internal rate of return, GWh = gigawatt-hour, kWh = kilowatt-hour, MW = megawatt, NPV = net present value, O&M = operation and maintenance, SI = sensitivity indicator, SV = switching value.

Notes:

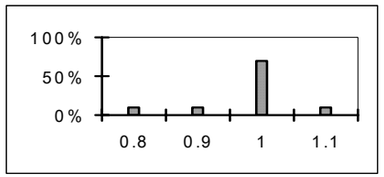
(i) Discount Rate 12%

(ii) Standard Conversion Factor 0.93

Sensitivity Analysis of EIRR	Change in Variable	NPV (Y million	EIRR (%)	SI	SV (%)
Base Case		27.4	12.9%		
i. Capital Cost Overrun	10%	(16.6)	11.5%	16.1	6.2
ii. Benefit Reduction	-10%	(22.4)	11.2%	18.2	5.5
iii. Implementation Delay	1 year	(25.4)	11.2%		
iv. Combination of (i), (ii) and (iii)		(124.4)	8.4%		
v. Yuan (Exchange Rate) Depreciation	20%	(33.3)	11.0%	11.1	9.0

Table A12.5. Risk Analysis

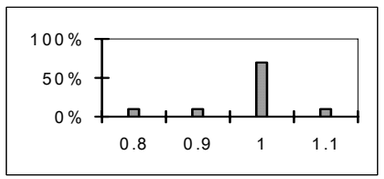
I. Risk Variables Report



Risk Variable No. 1

Capital Cost

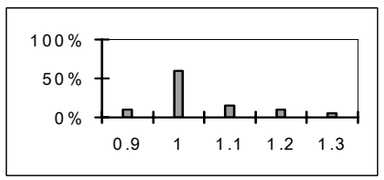
Probability distribution:			DISCRETE
10%	10%	70%	10%
0.8	0.9	1	1.1



Risk Variable No. 2

Generation

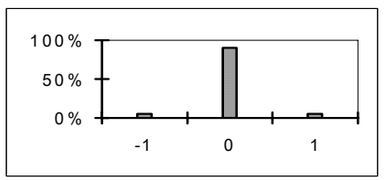
Probability distribution:			DISCRETE
10%	10%	70%	10%
0.8	0.9	1	1.1



Risk Variable No. 3

Foreigh E. Rate

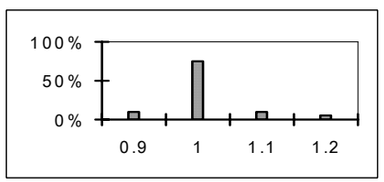
Probability distribution:				DISCRETE
10%	60%	15%	10%	5%
0.9	1	1.1	1.2	1.3



Risk Variable No. 4

Comm. Date

Probability distribution:			DISCRETE
5%	90%	5%	
-1	0	1	



Risk Variable No. 5

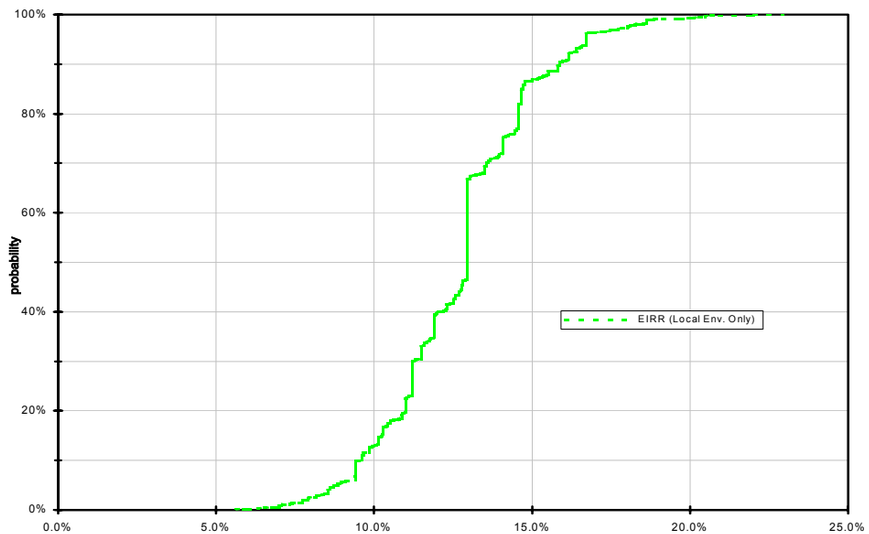
Avoided Cost

Probability distribution:				DISCRETE
10%	75%	10%	5%	
0.9	1	1.1	1.2	

II. Expected EIRR and Variance

	EIRR (Local Env. Only)
Expected value	12.7%
Standard deviation	2.4%
Minimum	5.6%
Maximum	22.9%
Coefficient of variation	0.189
Probability of negative outcom	0.0%

Cumulative Distribution



ECONOMIC ANALYSIS OF ENVIRONMENTAL IMPACT

A. Introduction

1. The economic analysis of environmental impact requires an evaluation of avoided environmental costs as a result of the Project, which are taken as environmental benefits. In the least-cost analysis, two cases (with and without the proposed wind farm) were studied to identify its environmental benefits (costs) with regard to the selected power grids: the Xinjiang power grid, the Heilongjiang power grid, and the Liaoning power grid. The economic analysis of environmental impact is carried out in four steps: step 1: major stressors or polluters are identified; step 2: impact screening is carried out for each stressor; step 3: if the impacts are major, effort is made to place monetary valuation; and step 4: the benefits (costs) flows are quantified for integration with the economic analysis of the Project.

B. Identification and Screening of Environmental Stressors

2. Air pollution emissions mainly come from the coal-fired power plants in each power grid. Table A13.1 provides a summary of the avoided emissions of the major environmental stressors as a result of the Project.

3. In step 2, these environmental stressors are screened for their potential impacts on four major groups, human health, human welfare, environmental resources, and global systems. Of the various impacts, the following are significant.

4. **Human Health Impacts: Increased Morbidity and Mortality from Conventional Air Emissions.** Health studies currently focus on airborne particles that are small enough to be inhaled deeply into the lungs (called PM_{10}). PM_{10} aerosols resulting from the combustion of fossil fuels include sulfate and nitrate aerosols, acid aerosols, and other chemical constituents. Their impacts include both premature mortality and chronic acute respiratory disease.

5. **Human Welfare Impacts**: **Reduced Visibility and Materials Damage from Air Emissions of PM_{10}, SO_2, and NO_x.** Particulate matter (less than 2.5 micrometers in diameter) that is emitted directly from industries or is formed in the presence of sulfur dioxide and nitrogen oxide gas emissions can reduce the visual range.

6. **Building and Materials Impacts.** Particulate matter and acid deposition from sulfur dioxide emissions can damage materials. Materials damage can include surface soiling, surface erosion, blistering, paint discoloration, corrosion and tarnishing of metals and electronic components, fading, reduction of fabric tensile strength, and spalling of buildings and monuments.

7. **Global Impact.** Environmental impacts are not confined to the immediate location or within country limits but can involve global impacts. The economic value of CO_2 was assessed using ADB's Workbook estimates.

C. Economic Assessment of Environmental Impacts

8. Once the major environmental impacts and their influence on human health, human welfare, and socioeconomic activities are properly identified, the impacts are valued economically. In step 3, the environmental impact of the major environmental stressors are evaluated in three ranges in terms of distances to the load center: local (within 30 km), regional (beyond 30 km and within 100 km), and distant (beyond 100 km and within 500 km). Information on population density and per capita gross domestic product in each region is given in Table A13.2.

9. Various methods are available for impact valuations, some require a substantial amount of primary data, time, and field investigations. Thus the benefit transfer method (BTM) was used for this assessment. The BTM allows using results from similar valuations conducted in different parts of the world with proper adjustments for any particular project. While adjusting the data from the results of original research in the United States (US) to the People's Republic of China (PRC), three major adjustments were carried out for (i) GDP differentials between the US and the PRC, (ii) updating price levels to 1999 constant prices, and (iii) medical cost level differentials between the US and the PRC. For inflation adjustments, a GDP deflator was used. The period of environmental impact is assumed to be the same as the economic life of the Project.

10. In step 4, an average value was used for the economic valuation of environmental impacts. The environmental cost differences (avoided environmental cost) between the base case and the alternative case are taken as the environmental benefits of the Project. The results are given in Table A13.3. Other environmental impacts were not evaluated due to methodological difficulties or lack of data. The estimated net present value of the environmental benefits from avoided air pollution at the national level is about $15.4 million, and from avoided green house gas emissions at the global level is estimated at $13.9 million (low case) to $31.2 million (high case).

A. Table A13.1: Environmental Stressors and Average Annual Emissions
('000/year)

Location	CO_2	SO_2	NO_x	PM_{10}
Dabancheng	84.9	0.58	0.37	0.10
Fujin	95.3	0.29	0.28	0.08
Xiwaizi	52.1	0.47	0.22	0.05

CO_2= Carbon Dioxide, SO_2= Sulfur Dioxide, NO_x= Nitrogen Oxides, PM_{10}= Particulate Matter (with a diameter of less than 2.5 micrometers).
Source: Staff estimates.

Table A13.2: Population Density and Per Capita GDP in Affected Areas (1999 prices)

Item		Xinjiang Uygur Autonomous Region			Heilongjiang Province			Liaoning Province		
		Local	Regional	Distant	Local	Regional	Distant	Local	Regional	Distant
Population Density	Persons/km^2	111.4	51.1	10.2	505.8	81.0	279.0	705.8	279.0	279.0
Population	Persons (1,000)	315	731	3,857	1,429	1,158	10,5127	1,995	3,987	10,5146
Per Capita GDP	Yuan/person	5,400.0	5,400.0	5,400.0	6,444.6	6,444.6	6,444.6	7,671.7	7,671.7	7,671.7

km^2= square kilometer, GDP= gross domestic product.
Source: Staff estimates.

Table A13.3. Economic Benefits from Avoided Emissions by Wind Farm ($'000)

Year	Wind Farm at Dabancheng			Wind Farm at Fujin			Wind Farm at Xiwaizi		
	National	Global		National	Global		National	Global	
		Low	High		Low	High		Low	High
2002	-	-	-	-	-	-	-	-	-
2003	24	250	562	512	358	805	281	140	316
2004	98	738	1660	1402	1049	2359	988	418	939
2005	110	728	1636	1549	1029	2315	3146	532	1197
2006	110	725	1630	512	835	1878	781	440	990
2007	73	732	1646	524	124	280	866	441	991
2008	73	732	1646	537	124	280	927	441	991
2009	73	782	1759	561	882	1983	976	442	994
2010	85	782	1759	585	882	1983	1012	442	994
2011	85	782	1759	610	882	1983	1037	442	994
2012	85	783	1761	634	901	2027	1073	443	996
2013	73	807	1815	768	928	2089	1085	456	1027
2014	73	807	1815	902	928	2089	1098	456	1027
2015	73	807	1815	1037	928	2089	1110	456	1027
2016	73	807	1815	1171	928	2089	1122	456	1027
2017	73	703	1581	1305	912	2053	1134	455	1024
2018	73	703	1581	1268	912	2053	1159	455	1024
2019	73	703	1581	1220	912	2053	1171	455	1024
2020	73	703	1581	1183	912	2053	1183	455	1024
2021	73	703	1581	1146	912	2053	1207	455	1024
2022	85	729	1641	1098	906	2040	1220	453	1020
NPV	586	5,162	11,612	6,440	5,590	12,574	8,369	3,099	6,971

National	**($ Million)**	15.40
Global	**Low NPV ($ Million)**	13.85
	High NPV ($ Million)	31.16

Note: Discount rate = 12 percent