



Technical Assistance

TAR: PRC 37633

Technical Assistance to the
People's Republic of China for
Alternative Energy Supply for Rural
Poor in Remote Areas (Financed by
the Poverty Reduction Cooperation
Fund)

September 2005

Asian Development Bank

CURRENCY EQUIVALENTS

(as of 15 July 2005)

Currency Unit	–	yuan (CNY)
CNY1.00	=	\$0.1208
\$1.00	=	CNY8.2767

Note: The exchange rate of the yuan is determined in relation to a weighted basket of currencies of the People's Republic of China's trading partners. A rate of \$1.00 = CNY8.30 is used in this report.

ABBREVIATIONS

ADB	–	Asian Development Bank
GIMAR	–	Government of Inner Mongolia Autonomous Region
IMAR	–	Inner Mongolia Autonomous Region
PRC	–	People's Republic of China
PRCF	–	Poverty Reduction Cooperation Fund
SWOT	–	strengths, weaknesses, opportunities, and threats
TA	–	technical assistance
W	–	watt
WTP	–	willingness to pay

TECHNICAL ASSISTANCE CLASSIFICATION

Targeting Classification	–	General intervention
Sector	–	Energy
Subsector	–	Renewable energy generation
Themes	–	Sustainable economic growth, environmental sustainability
Subthemes	–	Promote economic efficiency and enabling markets, fostering physical infrastructure development

NOTE

In this report, \$ refers to US dollars.

This report was prepared by a team consisting of A. Bhargava (team leader) and T. Oi.

I. INTRODUCTION

1. During the Country Program Update Mission in 2003, the Government of the People's Republic of China (PRC) requested the Asian Development Bank (ADB) for technical assistance (TA) to further promote alternative energy supply for the rural poor in remote areas—to support its economic development and poverty reduction efforts. The TA is included in ADB's 2005 TA program and the PRC *Country Strategy and Program Update 2005–2007*.¹ In April 2005, The TA was endorsed by the Department for International Development of the Government of the United Kingdom for funding by the Poverty Reduction Cooperation Fund (PRCF-PRC). A fact-finding mission visited the PRC on 19 June 2005 and reached an agreement with the Government on the impact, outcome, implementation arrangements, cost, financing plan, and terms of reference.² The TA design and monitoring framework is in Appendix 1.

II. ISSUES

2. About 70% of the PRC's 1.3 billion population lives in rural areas, which have experienced rapid development in the last 10 years in parallel with national economic growth. However, remote rural areas have weak transport services, which complicate delivery of modern fuels such as oil and gas. Providing access to reliable and efficient energy—especially electricity—is a great challenge in remote rural areas. The PRC has achieved more than 95% electrification at village and household level through (i) expansion of provincial electricity grids; (ii) development of local hydropower resources; and (iii) more recently, promotion of other alternative energy sources. Yet, about 70 million people in over 20,000 villages in remote rural areas do not have access to electricity. In rural areas of the northern and western provinces, far from the nearest grid, electricity provision through the extension of power grids is an expensive solution. But these areas are rich in alternative energy sources—wind, solar, and biomass—so decentralized electrification from alternative energy is often the most practical solution.

3. The Government has put priority on alternative energy-based rural electrification of remote households and communities, and began efforts with subsidies for small hydropower development. In the Ninth Five-Year Plan (1996–2000), two key programs were introduced to accelerate decentralized electrification of remote rural areas. First, the national “Brightness Program”, which aims to provide electricity to 23 million people in remote rural areas by 2010 through solar, wind, and solar-wind hybrid systems, was launched in 1996.³ It targets three provinces with adequate resources and sparse populations—Inner Mongolia Autonomous Region (IMAR), Gansu, and Tibet. Second, in 2002, the Government initiated the National Township Electrification Program, which is the world's largest alternative energy-based rural electrification program. By the end of 2004, 20 megawatts of solar power and 840 kilowatts of wind power were installed under the program to electrify the remaining 1,065 unelectrified townships in the country.

4. IMAR's vast area and highly dispersed population present unique challenges to rural electrification and meeting rural energy needs in an efficient, environmentally sustainable manner. As one of the 12 western provinces, IMAR has benefited less than the east coast from economic growth and reforms. This is reflected in (i) lower incomes; (ii) more widespread

¹ ADB. 2004. *Country Strategy and Program Update (2005–2007): People's Republic of China*. Manila.

² The TA first appeared in *ADB Business Opportunities* (Internet edition) on 30 August 2004.

³ Formulated under the leadership of the National Development and Reform Commission, the Brightness Program targets an average of about 100 watts (W) per person.

poverty; (iii) lower health and education indicators; (iv) serious land degradation problems; and (v) weak physical infrastructure (including roads, railways, power, and telecommunications). About 74% of IMAR's 24 million inhabitants live in rural areas. In 2003, IMAR's average per capita gross domestic product was CNY8,734, below the national average of CNY9,046. Of the province's 101 counties, 31 are national poverty counties and 29 are provincial poverty counties. In 2003, about 1.3 million people—more than 10% of IMAR's rural population—lived on incomes below the official poverty line (CNY668 per capita/year) compared with the national rate of 3%. About 2.5 million people—18% of the rural population—had incomes below the international poverty line of \$1/day.

5. IMAR is the third largest province in the PRC, covering 1.18 million square kilometers. Most of the province is about 1,000 meters above sea level with low average rainfall, so it is poorly suited for agriculture, and is characterized by sparsely populated households (average distance of 2–5 kilometers apart). A large proportion of IMAR inhabitants do not have near-term prospects of access to grid electricity because of the (i) high cost of building transmission and distribution lines to remote locations, (ii) high service delivery cost because of low population density and dispersion over a large area, (iii) low demand, and (iv) low affordability because of variable income levels, with a large number of people living at or below the national poverty line.

6. IMAR has abundant conventional energy resources⁴ and exports electricity to neighboring provinces. It is also rich in alternative solar and wind energy resources.⁵ The Government of Inner Mongolia Autonomous Region (GIMAR) recognizes the techno-economic limitations of grid extension to electrify remote rural households and has promoted alternative energy-based decentralized electrification since 1986. GIMAR subsidizes two thirds of the wind and solar system cost for unelectrified households to promote basic electrification.⁶ It has also participated in both major national rural electrification programs (para. 3). Since 1995, wind-only household electrification has been considered less attractive, as it is unable to provide electricity during the low-wind summer. The household hybrid alternative energy system using complementary seasonal wind and solar resources, is now preferred.⁷ At the end of 2004, approximately 140,000 small wind systems, as well as a few solar systems, had been installed.

7. Basic electrification for IMAR households has achieved mixed results and faces many challenges, which can be classified as follows:

- (i) **Poor system configuration.** Current practice for system design is based on a set system configuration with little regard for local resources and unique requirements of specific users. This has led to dissatisfaction among end users who found them restrictive in meeting their energy needs.
- (ii) **Technical.** Variable quality of components, and poor system installation and maintenance⁸ have led to the development of certification standards and testing facilities but they lack proper coordination.

⁴ These include (i) 223 billion tons (t) of proven coal reserves and 1,200 billion t of prospective reserves; (ii) 700 million t of proven oil reserves and 4 billion t of estimated reserves; and (iii) 1 trillion cubic meters (m³) of proven natural gas reserves and 4.2 trillion m³ of prospective reserves.

⁵ Estimates indicate that IMAR has average solar radiation of 4.2 kilowatt-hours per square meter per day for more than 300 days a year and an average wind speed of 6.5 m/second for more than 3,000 hours/year.

⁶ Basic electrification includes households using the wind and solar system (300 W sets) powering light bulbs and small electrical appliances only.

⁷ Standard system configuration: 300 W wind turbine, 100–200 W photovoltaic panel, and 500 W inverter.

⁸ A survey by the US Department of Energy in 2004 found that only about 50% of the systems were in good condition after 5 years of operation, mainly due to poor manufacturing quality and inadequate end-user education.

- (iii) **Financial.** Developing innovative financing and marketing approaches to enable low income households to buy decentralized systems. GIMAR's subsidy scheme for household-owned systems, which ensures ownership by end users, has been successful but 70,000 households in 400 villages are still without basic electrification.
- (iv) **Institutional.** The institutional setup for system operation and maintenance is weak. Distribution and maintenance infrastructure should be expanded to provide service to remote dispersed households. Poor after-sales service, due to limited access to the remote rural areas, leads to frequent and prolonged breakdown of decentralized systems.
- (v) **Poor user knowledge base.** The end user has limited knowledge of how to operate the system properly, leading to frequent failures.

8. There is an urgent need to strengthen basic electrification in IMAR so that it can (i) support further social infrastructure development, (ii) promote income generation opportunities, and (iii) spur economic development of remote areas. GIMAR wishes to evaluate the performance of existing installations and their socioeconomic impact on remote rural households and communities so that it can identify and analyze options for further expansion and intensification of electrification. The existing 140,000 sets of alternative energy installations—including solar, wind, and solar-wind hybrid systems—provide a critical mass to evaluate and identify the most appropriate strategy to expand basic rural electrification into a sustainable rural energy model.

9. Operation and maintenance management capacity is a significant issue, which impacts the long-term sustainability of community based decentralized electrification. A comparative study of management approaches adopted in IMAR should be used to formulate an appropriate sustainable community-based power system. A rural energy service company or similar approaches, which have been successful under similar conditions in other countries, could integrate disparate decentralized systems. There is also a need to identify barriers (social, financial, and institutional), which have prevented 70,000 households in 400 villages from seeking basic electrification through government subsidies. The Government aims to evaluate the effectiveness of its subsidy scheme and target them at marginal and poor households.

10. ADB's operational strategy in the PRC aims to facilitate economic growth in an efficient, equitable, and sustainable manner. In the energy sector, ADB supports the Government's energy development program aimed at expanding energy supplies and promoting energy conservation and end-use efficiency. ADB's poverty reduction strategy for the PRC includes providing goods and services directly to the most vulnerable members of society, and promoting sustainable growth. The proposed TA is consistent with ADB's country strategies and government priorities.

11. ADB is providing assistance to GIMAR to formulate an energy development strategy,⁹ which aims to provide policy recommendations to develop IMAR as a national energy base, and harmonize energy sector development with overall economic and environmental development. The proposed TA will complement this study and provide policy and strategic recommendations on development of alternative energy to meet rural energy needs.

⁹ ADB. 2004. *Technical Assistance to the People's Republic of China for Energy Development Strategy for the Inner Mongolia Autonomous Region*. Manila (TA 4511-PRC).

III. THE TECHNICAL ASSISTANCE

A. Impact and Outcome

12. The impact of the TA will be improved economic development and better living standards in remote rural areas of IMAR. The outcome will be to assist GIMAR in formulating a strategy for expansion of alternative energy-based electrification in remote rural areas, including a strategy to improve sustainability of existing decentralized installations.

B. Methodology and Key Activities

13. The TA will (i) review the existing GIMAR approach and policies on basic electrification; (ii) short-list villages and households for socioeconomic assessment of basic electrification; (iii) undertake a socioeconomic survey to collect data on decentralized electrification systems; (iv) carry out analysis of the basic electrification approach; (v) analyze the impact of the ongoing subsidy scheme and recommend a mechanism to enhance the sustainability of rural electrification; (vi) compare and contrast community-based centralized systems and household-based decentralized systems to identify a structure for rural community and household electrification; (vii) identify mechanisms to promote community participation in design, and operation and maintenance of decentralized system; (viii) undertake rural energy resource assessment in short-listed villages to identify optimal energy mix for rural needs; (ix) evaluate and identify an appropriate rural energy business model; (x) analyze and recommend a strategic approach to expand and intensify alternative energy-based rural electrification; (xi) develop train-the-trainer program to extend maintenance services to remote dispersed households; (xii) identify a package of policy and regulatory initiatives to create enabling conditions for the proposed strategic approach; (xiii) examine possibilities of leveraging and integrating incentives through a clean development mechanism and global environmental facility mechanism; (xiv) develop a monitoring and evaluation framework for TA outcomes; and (xv) conduct workshops and seminars to disseminate TA results.

14. Major assumptions and risks that need to be considered for successful implementation of the TA include (i) a change in GIMAR's priorities, (ii) lack of adequate, in-time data provision, (iii) delay in submission of required studies, (iv) delay in selection of consultants, and (v) poor performance of consultants. Efforts will be made by ADB to ensure that competent consultants will be recruited on time. GIMAR agrees to provide adequate counterpart support and data when needed. Close coordination among the consultants, executing and implementing agencies, and ADB will further mitigate these risks.

C. Cost and Financing

15. The total cost of the TA is estimated at \$700,000 equivalent, of which \$345,000 is the foreign exchange cost and \$355,000 equivalent is the local currency cost. ADB will finance \$500,000 equivalent, which includes the entire foreign exchange cost and \$155,000 equivalent of the local currency cost. The TA will be financed on a grant basis from the Poverty Reduction Cooperation Fund, administered by ADB. The Government will finance the remaining local currency cost of \$200,000 through in-kind contributions, including office accommodation and facilities, counterpart staff, data, and other information needs. Detailed cost estimates are in Appendix 2.

D. Implementation Arrangements

16. GIMAR will be the Executing Agency and will provide a TA coordinator for day-to-day implementation management. GIMAR will set up a steering committee or lead group consisting of key stakeholders and relevant GIMAR departments (Finance, Development and Reform Commission, Poverty Reduction, etc.) within 2 weeks of commencement of the TA to oversee and guide implementation and help disseminate results.

17. The TA will be implemented over 9 months from December 2005 to August 2006. The TA will require 10 person-months of international and 22 person-months of domestic consulting services. The consultant will procure office equipment in accordance with ADB's *Guidelines for Procurement*, and deliver it to the Executing Agency at the conclusion of the TA.

18. ADB will engage the international and domestic consultants using quality- and cost-based selection procedures in accordance with its *Guidelines on the Use of Consultants*, and simplified technical proposals will be requested. The following experts will be required: (i) alternative energy development specialist, (ii) institutional development specialist, (iii) financial analyst, (iv) economist, and (v) social/poverty specialist. Outline terms of reference for consulting services are in Appendix 3.

19. The consultant will submit an inception report within 1 month after TA commencement, a midterm report after 4 months, and a draft final report after 8 months. The final report will be submitted within 9 months of TA commencement. TA activities will be undertaken using a participatory approach—stakeholder participation will be encouraged through workshops and seminars to progressively discuss and share TA results. Tripartite meetings will be held between ADB, GIMAR and the consultants after the submission of the inception and the draft final reports. The recommendations of the TA will be disseminated through a provincial level seminar with broad participation from all stakeholders. A national level seminar will be organized at the final stages of the TA to disseminate TA results to poorer provinces of PRC, who are facing similar challenges in meeting the energy needs of the remote rural areas.

IV. THE PRESIDENT'S DECISION

20. The President, acting under the authority delegated by the Board, has approved ADB administering technical assistance not exceeding the equivalent of \$500,000 to the Government of the People's Republic of China to be financed on a grant basis by the Poverty Reduction Cooperation Fund for the Alternative Energy Supply for Rural Poor in Remote Areas, and hereby reports this action to the Board.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets/Indicators	Data Sources/Reporting Mechanisms	Assumptions and Risks
<p>Impact Improved economic development and better living standards in remote rural areas in Inner Mongolia Autonomous Region (IMAR)</p>	<p>Lower level of poverty in rural areas^a</p> <p>Increased electricity supply to households and communities—85% of the remaining households without power supply to obtain electricity by 2010</p>	<p>IMAR statistics</p>	<p>Assumptions</p> <ul style="list-style-type: none"> • Government of Inner Mongolia Autonomous Region (GIMAR) sustains priority and resources for economic development of remote rural areas • Technical Assistance (TA) recommendations are implemented effectively
<p>Outcome Strategy developed to expand alternative energy-based electrification in remote rural areas of IMAR</p>	<p>Memorandum of understanding of final tripartite meeting signed by GIMAR and Asian Development Bank (ADB)</p>	<p>Consultant's final report</p> <p>Memorandum of understanding</p> <p>Back-to-office report of final TA review mission</p>	<p>Assumption</p> <ul style="list-style-type: none"> • Effective stakeholder participation and ownership developed <p>Risk</p> <ul style="list-style-type: none"> • Key stakeholders do not follow strategy
<p>Outputs</p> <p>1. Technical assessments completed</p> <p>2. Socioeconomic impact assessment completed</p> <p>3. Strategy for improving decentralized system sustainability and further expansion agreed</p>	<p>Inception report: week 4</p> <p>Midterm report: week 16</p> <p>Draft final report: week 30</p> <p>Final report: week 34</p> <p>Government, development partners, and nongovernment organizations endorse socioeconomic impact assessment</p> <p>Government, development partners, and nongovernment organizations endorse strategy</p>	<p>Project reports</p> <p>TA reviews: week 6, 18, and 32</p> <p>Project reports</p> <p>TA reviews: week 18 and 32</p> <p>Project reports</p> <p>TA reviews: week 18 and 32</p>	<p>Assumptions</p> <ul style="list-style-type: none"> • No restriction on availability and access to timely information and personnel • No restriction on access to geographical sites

Activities with Milestones	Inputs: \$700,000
<ol style="list-style-type: none"> 1.1 Review existing provincial and national policies and approaches, and prepare inception report (weeks 1–4). 1.2 Carry out stakeholder workshop (week 6). 2.1 Identify criteria for socioeconomic assessment and prepare short list of villages and households (weeks 5–8). 2.2 Complete socioeconomic survey (week 9–16). 3.1 Carry out SWOT analysis of alternative energy-based electrification approaches and prepare the mid-term report (week 9–16). 3.2 Carry out stakeholders' workshop to discuss survey findings and SWOT assessment (week 18). 3.3 Carry out financial and institutional analysis and recommend financing mechanism and organization structure for decentralized electrification (weeks 16–24). 3.4 Evaluate and identify rural energy business model (week 16–32). 3.5 Develop strategic approach to expand and intensify alternative energy-based rural electrification in IMAR (week 16–32). 3.6 Assess training needs and formulate train-the-trainer program for selected technicians in system operation and maintenance (week 16–32) 3.7 Analyze and recommend a set of policy and regulatory measures to enhance enabling conditions for alternative energy in IMAR (week 16–32). 3.8 Prepare draft final report (week 28–32). 3.9 Carry out stakeholders' workshop to discuss key recommendations and output of TA activities (week 34). 3.10 Prepare final report addressing stakeholders' comments on TA recommendations and output (week 36). 	<p>ADB: \$500,000</p> <ul style="list-style-type: none"> • Consultants—\$389,000 <ul style="list-style-type: none"> International (10 person-months) Domestic (22 person-months) • Equipment—\$20,000 • Socio-economic Survey—\$16,000 • Trainings and Seminars—\$30,000 • Contingencies—\$45,000 <p>Government: \$200,000</p> <ul style="list-style-type: none"> • Personnel—\$80,000 • Transport and Office Accommodation—\$80,000 • Logistics—\$40,000

ADB = Asian Development Bank, IMAR = Inner Mongolia Autonomous Region, SWOT = strengths, weaknesses, opportunities and threats, TA = technical assistance.

^a The consultant will develop the target for lowering poverty in rural areas in consultation with the Government of Inner Mongolia Autonomous Region.

COST ESTIMATES AND FINANCING PLAN
(\$)

Item	Foreign Exchange	Local Currency	Total Cost
A. Poverty Reduction Cooperation Fund Financing^a			
1. Consultants			
a. Remuneration and Per Diem			
i. International Consultants	220,000	0	220,000
ii. Domestic Consultants	0	110,000	110,000
b. International and Local Travel	35,000	10,000	45,000
c. Reports and Communications	5,000	3,000	8,000
2. Equipment ^b	20,000	0	20,000
3. Training, Seminars, and Conferences	25,000	5,000	30,000
4. Surveys	1,000	15,000	16,000
5. Miscellaneous Administration and Support Costs	4,000	2,000	6,000
6. Contingencies	35,000	10,000	45,000
Subtotal (A)	345,000	155,000	500,000
B. Government Financing			
1. Office Accommodation and Transport	0	80,000	80,000
2. Remuneration and Per Diem of Counterpart Staff	0	80,000	80,000
3. Others	0	40,000	40,000
Subtotal (B)	0	200,000	200,000
Total	345,000	355,000	700,000

^a Administered by the Asian Development Bank.

^b Including 4 Pentium computers, 2 photocopiers, 2 laser printers, 1 LCD projector, 1 digital camera, and 1 fax machine. The equipment will be transferred to the Executing Agency at technical assistance completion.
Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

1. The technical assistance (TA) will be implemented in consultation with relevant stakeholders, including the Government of Inner Mongolia Autonomous Region (GIMAR), local communities, and other development agencies. The team of international consultants (10 person-months) will coordinate with the domestic consultants (22 person-months). The consulting team comprising international and domestic consultants will have the following expertise: (i) alternative energy development, (ii) institutional development, (iii) financial analysis (iv) economics, and (v) social/poverty issues. The international alternative energy development specialist will be the team leader and will allocate tasks among other consulting team members. The team leader will be responsible for overall coordination of TA activities.

A. International Consultants

1. Alternative Energy Development Specialist (5 person-months)

2. The alternative energy development specialist will undertake the following activities:

- (i) Review all previous alternative energy studies, ongoing studies, and government plans and policies for alternative energy development in rural areas of Inner Mongolia Autonomous Region (IMAR);
- (ii) Prepare an inventory of household-based basic electrification units, according to geographical dispersion and equipment rating;
- (iii) Prepare criteria (representative of the inventory above) in consultation with key stakeholders to select short list of villages and households for socioeconomic impact assessment of basic electrification in remote rural areas of IMAR;
- (iv) Visit short-listed villages, prepare an inventory of alternative energy technologies currently in use and possible new technologies that could be used, and compare them with villagers' needs to identify optimal energy mix;
- (v) Identify key challenges threatening sustainability of stand-alone household-based basic electrification model;
- (vi) Undertake strategic analysis—strengths, weaknesses, opportunities and threats (SWOT)—of the ongoing program for basic electrification in remote rural areas; recommend the way forward to expand and intensify off-grid rural electrification in IMAR;
- (vii) Examine possibility of leveraging and integrating incentives through a clean development mechanism and global environmental facility;
- (viii) Develop a rural energy business model in association with the institutional development specialist;
- (ix) Present strategic analysis and recommendation at provincial level workshop; and organize village, township, and city level workshops to disseminate TA findings and community awareness of alternative energy technologies;
- (x) Prepare a monitoring and evaluation framework for TA outcomes and stipulate how improvements in supply/services should be monitored after 2 years;
- (xi) Prepare project reports and liaise with GIMAR for smooth TA implementation.

2. Institutional Development Specialist (1 person-month)

3. The institutional development specialist will undertake the following activities:

- (i) Coordinate with the team leader to assess training needs of users, local government units, community level organizations, and provincial planners to enhance the sustainability of ongoing remote rural area electrification plan in IMAR;
- (ii) Compare and contrast community-based organizational setup against household setup and recommend organizational setup to manage decentralized alternative energy sets to meet rural needs. Consider possible use of market intermediaries such as rural energy supply companies;
- (iii) Identify institutional and human resource requirements for a self-sustaining energy service organization that can design, install, operate, and maintain alternative energy system in rural areas;
- (iv) Assess training needs and formulate train-the-trainer program for selected technicians closer to the remote areas in decentralized system installation and maintenance;
- (v) Prepare business plan to establish locally-owned commercial energy service provider, including (a) legal requirements for registration, (b) staffing needs, (c) market development, and (d) initial capitalization and ongoing financial management;
- (vi) Identify package of policy and regulatory initiatives to create enabling conditions for alternative energy supply;
- (vii) Assist team leader in developing a replicable rural energy business model.

3. Financial Analyst (1 person-month)

4. The financial analyst will undertake the following activities:

- (i) Assist team leader and institutional development specialist in preparing a replicable rural energy business model;
- (ii) Assess impact of ongoing subsidy scheme on sustainability of rural electrification and suggest way forward toward more market-oriented approach;
- (iii) Design and recommend innovative financing mechanism to make off-grid electrification more affordable to poorest people in IMAR;
- (iv) Prepare a projected financial model for the life of the TA based on rural energy business model and IMAR plans. Establish tariff levels, subsidy levels, alternative revenue sources, and phasing-out period for subsidies (which should be incorporated into model) in accordance with willingness-to-pay (WTP) and affordability surveys;
- (v) Determine net present value, weighted average cost of capital, and financial internal rate of return for the TA investment (and any defined subprojects) based on base case financial model developed above. This should take account of all TA financial costs and benefits. Identify all risks to TA revenues and costs and conduct relevant sensitivity analyses;
- (vi) Prepare cost estimates and potential financing plans for the business model, including innovative financing mechanisms and sources.

4. Power Economist (1 person-month)

5. The power economist will undertake the following tasks:

- (i) Review IMAR's plans to develop alternative energy in view of energy needs, resource endowments, development goals, and status of economic development;
- (ii) Assist team leader in formulating appropriate survey forms for socioeconomic survey of short-listed villages;
- (iii) Assess WTP for electricity by population in short-listed villages in consultation with the social/poverty specialist, based on sample survey of energy consumed and price paid by households. Survey should also assess household incomes;
- (iv) Construct a demand function from survey data;
- (v) Assess economic impact of ongoing off-grid rural electrification program and measures to maximize economic benefits from future interventions;
- (vi) Ensure that the selected option for electrification is the least-cost option; the economic benefits of electricity supply should adequately exceed the economic costs of its provision;

5. Social/Poverty Specialist (2 person-months)

6. The social/poverty specialist will undertake the following activities:

- (i) Assess poverty impact of off-grid electrification in short-listed villages;
- (ii) Ensure that all abovementioned analyses are gender disaggregated, paying attention to gender division of labor within the community, and that women are actively involved in socioeconomic surveys and community/stakeholder consultation workshops;
- (iii) Recommend mechanisms to maximize community participation in off-grid rural electrification;
- (iv) Assist economist in social survey to identify WTP;
- (v) Assist institutional development specialist in formulating an innovative organizational setup to manage centralized and decentralized alternative energy sets for community.

B. Domestic Consultants

7. The domestic consultants (22 person-months) will be engaged to assist the international consultants in their tasks. The domestic consultants will have extensive knowledge of the alternative energy related issues in IMAR and the People's Republic of China. The domestic consultants will include (i) two alternative energy experts (6 person-months each); (ii) an institutional development expert (2 person-months); (iii) a financial analyst (2 person-months); (iv) a power economist (2 person-months); (v) a social/poverty expert (4 person-months). One of the domestic alternative energy experts will have extensive knowledge of ongoing off-grid electrification plans and issues associated with its implementation in IMAR.

8. The domestic consultants will assist international consultants in quickly becoming familiar with their tasks by reviewing relevant reports, analytical data, policies and regulations, and translating relevant documents into English.