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EXPANDING RENEWABLE ENERGY-BASED ELECTRIFICATION IN INNER MONGOLIA, PEOPLE'S REPUBLIC OF CHINA

Due to an urgent need to strengthen basic electrification in Inner Mongolia Autonomous Region, a technical assistance was designed to assist the Government of IMAR in formulating a strategy for expansion of renewable energy-based electrification in remote rural areas.

The People's Republic of China (PRC) is the second largest producer of electricity in the world and its power demand growth is among the world's highest.[1] At present, 70% of PRC's energy comes directly from coal that produces harmful gases such as sulfur dioxide and carbon monoxide. Since the last decade of the 20th century, the country has produced about 3 billion tons of sulfur dioxide every year, and that figure continues to grow with time.[2]

During the past 20 years, the PRC has achieved more than 95% electrification at village and household levels mainly through the extension of power grids and the use of small or micro hydropower schemes.

However, rapid economic growth and the absence of an electric grid in large areas of the rural countryside have created a need for new energy sources, both in urban centers and in rural areas in the PRC. About 70 million people in over 20,000 villages in remote rural areas do not have access to electricity; one fifth of whom are in the western PRC.[3]

Providing electricity in the rural areas of the northern and western provinces, far from the nearest grid, through the extension of power grids is an expensive solution. These areas are rich in alternative and renewable energy sources such as wind, solar, and biomass. Therefore, decentralized electrification from alternative and renewable energy is often the most practical solution.

The PRC Government has made targeted efforts to expand electricification to these remote rural areas. The use of biomass for energy supplies in rural areas—mostly biogas power generation—has already exceeded 250 million tons of standard coal or about half of the total consumed energy of rural residents in their daily life. By the end of 2003, PRC had 30,000 megawatts of small-scale hydropower, which was equivalent to one and a half of the Three Gorges Dam project.[4]

With the aim of generating at least 10% of the nation's electricity by wind, hydropower, solar energy, biomass, and geothermal technology by 2020, the Government is firmly committed to its long-term strategy of developing alternative energy sources.

But converting to alternative and cleaner power is complicated by the low cost of coal in the PRC. In Inner Mongolia, for example, wind-produced power costs about $.06 per kilowatt hour, more than twice that of conventional coal power.[5] For other renewable energy, such as solar energy, the price gap is even larger. Moreover, a renewable energy project tends to require a huge investment.[6]

Renewable Energy in Inner Mongolia

The Inner Mongolia Autonomous Region (IMAR)[7] is located along the PRC's northern border and it is the third largest province. Its climate is characterized by warm, dry summers and very cold, dry winters. Winds in the province can be fierce and are steady from fall to spring, presenting an excellent opportunity to develop wind power.

Because Inner Mongolia is primarily rural, with households dispersed far from urban centers and often very distant (2–5 kilometers) from one another, extending the electrical grid to individual households was never an option. Thus, experts and officials in the PRC and Inner Mongolia took note when western countries began to research and to utilize renewable energy in the 1970s. The Government began pilot projects to test wind turbines on local herdsmen. In 1986, the provincial government was offering subsidies to livestock breeders who wanted to buy a renewable (usually wind) energy system. During the mid-1980s,

small solar panels (20–50 watts [W]) also began to be used, but to a much lesser extent.[8]

By the 1990s, many families were beginning to feel that wind-only or the occasional solar-only systems were insufficient. Moreover, the PRC was transitioning to a market economy; many new commodities were becoming popular, while houses of livestock breeders were becoming larger and more modern.[9] The household hybrid alternative energy system using complementary seasonal wind and solar resources was then preferred.

Now, there is an urgent need to strengthen basic electrification in IMAR to support further social infrastructure development, promote income generation opportunities, and spur economic development of remote areas.[10]

Technical Assistance 4649: The PRC's Alternative Energy Supply for Rural Poor in Remote Areas[11]

Technical assistance (TA) 4649 was designed to assist the Government of IMAR (GIMAR) in formulating a strategy for expansion of renewable energy-based electrification in remote rural areas, including a strategy to improve sustainability of existing decentralized installations. The TA focused on the use of wind and solar energy for electrification purposes for the rural poor in remote areas of IMAR.[12]

Assessments[13] were made on electrification activities using renewable energy technologies, including a study of the contrast of the two approaches—household-based versus community-based systems. Relevant documents were reviewed and stakeholders' consultations were conducted to have an overview of past electrification activities using renewable energy technologies. Among the main findings were:

- A number of different government departments were involved with previous renewable energy programs (such as the Ministry of Agriculture and the Ministry of Science and Technology), leading to a wealth of expertise in this area.
- Since the 1970s and 1980s, there had been a number of electrification programs using renewable energy in IMAR. The latest of these, the Brightness Program, was suspended in 2005. IMAR has no active program apart from the World Bank-assisted Renewable Energy Development Program that started in late 2001. Users were offered a total system package, not just individual components. For the earlier programs, appliances such as DC-powered television (TV) sets were included with the package.
- Many technical problems had occurred. During the early years of wind turbine deployment, effective feedback loops involving the service centers ensured that problems regarding the reliability of wind turbines were addressed and rectified. However, some technical problems persist.
- Battery disposal and recycling has been a continuing issue. The high rate of battery replacement resulted in a large number of disused batteries. No proper facilities to recycle old batteries are available. Often, disused batteries are left with the wind/PV (photovoltaic) system, which is possibly still being used occasionally. A way of collecting old batteries and returning them to manufacturers for recycling should be developed.

An extensive socioeconomic survey was also undertaken i) on the use of renewable energy systems, satisfaction with systems, and their impact on rural households; and ii) on energy usage, potential for similar renewable energy installations in remote areas, and ability and willingness to pay by rural households.

Key survey results included:[14]

- The renewable energy systems in use were mostly used for lighting, TV, and charging mobile phones. For lighting, some respondents also used candles. While most households that owned renewable energy systems used 2–3 CFL (compact fluorescent) lamps, lighting was often found to be lower in preference to watching TV or charging mobile phones.
- Income was found to be low, health and education costs are high, and herder families find it difficult to buy wind systems, especially those larger than 300 W system. This is clearly seen from the nonelectrified household respondents that had fewer livestock, lived in remoter areas, and for whom paying an upfront cost for a wind system was a problem.
- Men were normally responsible for buying and maintaining the systems.

A technical evaluation of a sample of systems[15] was carried out. The general conclusion was that systems work reasonably well. However, the technical survey also indicated that the quality of electrical installation, loose or dangling wires, broken-off wind turbine blade, damaged or perished insulation, corrosion of battery terminals that can lead to poor contacts and thus to system inefficiencies, were problem areas.

Following a review of the findings from the review and socioeconomic survey, a number of conclusions and recommendations have been proposed for future rural electrification projects in IMAR. A number of different deployment models (e.g., cash sales, credit sales, and fee-for-service models) were also reviewed and their applicability for IMAR determined.

Development of Pilot Program[16]

A pilot program was developed for the models suggested by the TA. This could then be replicated on a larger scale. The pilot program could be implemented in all 13 of the banners[17] surveyed; however, it focused only on a few after the banners were prioritized and selected based on relative poverty, lack of benefiting from previous programs, and geographical spread. The program addressed nonelectrified households. It was suggested to test the fee-for-service model in at least two selected areas.

Three standard system sizes were proposed to provide choices to the users:
1) The standard system that is available in two configurations; appropriate for the majority of households; and able to power

lights, a colored TV, a small freezer, and various miscellaneous loads;
2) The basic system that is designed for the poorest 10–25% of the population. It is a low-cost system to provide power for lights and colored TV; and
3) The deluxe system—designed for the richest 10–20% of the population—allows for additional appliances such as a computer, refrigerator, or washing machine.

A monitoring and evaluation framework has also been prepared for the project outcomes.

TA Recommendations[18]

TA 4649 forwarded a number of recommendations to ensure GIMAR's goal of 100% electrification. Among these are:

- GIMAR continues the current strategy of a parallel approach of grid extension and electrification using renewable energy since the grid is unlikely to reach the remote households in the foreseeable future;
- Two different approaches could be used to ensure that even the most remote as well as the poorest people are reached with electricity: a new subsidy program, along similar lines to the past Brightness Program, (but with a number of improvements including a higher level of subsidy) and that the power company acts as an energy service company for the areas served by off-grid renewable energy and owns and operates renewable energy systems in these areas;
- A significant level of external subsidy for renewable energy electrification is needed, but it is essential that end users also significantly contribute to achieve longer-term sustainability; Existing standards should be updated to require renewable energy system components to be of sufficiently high quality.

Endnotes

[1] Available: web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPENERGY/0,,contentMDK:20502907~pagePK:34004173~piPK:34003707~theSitePK:574015,00.html

[2] Available: http://english.people.com.cn/200608/21/eng20060821_295374.html

[3] Asian Development Bank (ADB). 2005. *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). Manila.

[4] Available: www.chinadaily.com.cn/china/2006-04/27/content_577961.htm

[5] Available: www.climateark.org/shared/reader/welcome.aspx?linkID=45262

[6] Available: www.chinadaily.com.cn/english/doc/2005-03/17/content_425775.htm

[7] Autonomous regions are provincial-level divisions distinguished by a designated ethnic minority. They have a chairperson instead of a governor, and the chairperson must be an ethnic minority.

[8] Available: www.nrel.gov/docs/fy05osti/37678.pdf

[9] Available: www.nrel.gov/docs/fy05osti/37678.pdf

[10] ADB. 2005. *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). Manila.

[11] Technical Assistance 4649 (PRC Alternative Energy Supply for Rural Poor in Remote Areas); executing agency – Government of Inner Mongolia Autonomous Region (GIMAR); TA amount – $500,000 was financed by the Poverty Reduction Fund (contributed by the United Kingdom Department for International Development Fund and administered by ADB) and $200,000 from the PRC Government; approval date – September 2005; and completion date – June 2007.

[12] Biomass/biogas, solar water heating, and grid extensions were outside the scope of the TA.

[13] Oldach, Rolf, Rebecca Gunning, and Zhou Wei. 2007. Final Report TA 4649-PRC Alternative Energy Supply for Rural Poor in Remote Areas of Inner Mongolia.

[14] Endnote 13.

[15] Analyzed in detail were 21 household-based systems. These included different renewable energy technologies such as wind-only, PV-only and PV–wind hybrid systems, as well as systems of various sizes.

[16] Endnote 13.

[17] A banner is an administrative division of the Inner Mongolia Autonomous Region in the People's Republic of China.

[18] Endnote 13.

This case study was written by Social Development Direct (RETA Consultant) under the Regional TA 6270: Facilitating Knowledge Management for Pro-Poor Policies and Projects with inputs from Ashok Bhargava, Project Officer of TA 4649, and Sonomi Tanaka, Senior Social Development Specialist, ADB. The views and assessments contained herein do not necessarily reflect the views of ADB or its Board of Directors or the governments they represent. ADB does not guarantee the accuracy of the data and accepts no responsiblity for any consequences of their use.

For any queries, contact:

NPRS-PRF Secretariat
nprs-prf@adb.org