

**CASE STUDY:
UNDP/GEF PROJECT FOR COMMERCIALIZATION
OF RENEWABLE ENERGY IN CHINA**

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Background

The UNDP/GEF China project “Capacity Building for the Rapid Commercialization of Renewable Energy” began in March 1999 and by 2002 was mid-way through implementation. Designed to promote renewable energy development and a commercial renewable energy industry, the project provides training, workshops, demonstration installations, business development, policy facilitation, equipment standards, company and product certification, and overall industry support. The project focuses on five sectors: (1) village-scale power for household electrification and rural industry using hybrid wind and solar PV systems with battery storage and diesel backup generators, (2) biogas from industrial and agricultural organic waste effluents, (3) solar hot water heating for buildings, (4) wind power for grid-based power generation, and (5) bagasse cogeneration for grid-based power generation. The project has been financed with \$8.8 million from the GEF, \$3.0 million from the Australian AusAid Program, \$2.5 million from the Netherlands Government, and \$11.5 million from Chinese sources of co-financing.

When the project was approved by the GEF Council in 1997, the Chinese renewable energy industry had been growing slowly since the early 1990s. Many technologies were still in the R&D stage or supported primarily through government or donor aid programs. However, growth of the commercial industry since the mid-1990s has greatly accelerated. According to the 2001 book “New and Renewable Sources of Energy—Technologies and Projects,” published by the China Renewable Energy Industries Association (CREIA), there are now extensive commercial activities for many renewable energy applications:

Technology production. Seven manufacturers produced 4.5 MWp of PV cells in 2001, which represented a doubling of production from 2.1 MWp in 1998. Many other firms produce ancillary equipment such as PV pumping systems, inverters, charge controllers, DC lights, and test equipment (CREIA features 25 firms and 8 research institutes in its book). There are over 1000 enterprises manufacturing solar hot water heaters, with 6 million m² produced in 2000—the largest manufacturing capacity of any country in the world. Over 25 firms now produce small-scale (up to 10 kW) wind turbine generators, with over 10,000 turbines produced in 2000—also the largest production volume in the world. The small hydropower industry, by far the largest in the world, has been well developed for many years. Production of biogas digesters at household scales is also well developed and more than ten bioengineering companies are now recognized as leading design and construction firms for industrial scale biogas digesters in China. Five companies in China manufacture grid-connected wind turbines in the range 250 kW to 750 kW.

Village and household power. In 2001 there were an estimated 150,000 solar home systems, 140,000 wind household-scale systems, and 70 village-scale hybrid power systems (wind and/or PV combined with battery storage and many using backup diesel generators, ranging in size from 5-200 kW), and 80 solar school systems installed in China.

Power generation. Over 40,000 small hydro power stations, for both grid-based and isolated village-power systems, total 25,000 MW in capacity have been installed in China. There is about 2,200 MW of installed geothermal power generation. The large-scale wind industry has yet to flourish, for reasons related to cost, power sector policy, donor aid, and tariff issues, but by 2002 the installed capacity of grid-connected wind power in China was 470 MW (located at 32 separate wind farm sites).

Solar hot water and cooking. As of 2000, 26 million m² of solar hot water heaters were installed (serving an estimated 10-15 million households). This market has grown by 25% or more per year for the past several years. Over 300,000 solar cookers are in use.

Industrial-scale biogas. Industrial and animal wastewater streams are treated with both anaerobic and aerobic technologies to produce biogas at about 400 industrial and agricultural sites, with annual gas production estimated at 1 billion m³ (energy equivalent to 7 million barrels of oil). Development plans call for greatly increasing these applications. New national standards for wastewater effluents should increase demand for biogas-based means of effluent reduction.

In 1998, China launched an ambitious “Brightness Program” that targets household and village-scale applications of solar PV and wind in off-grid regions, particularly in western China. In 2002 the Chinese Government started a major new rural electrification initiative called the Song Dian Dao Xiang program (National Township Electrification Program). This program is directed at electrifying approximately 1000 townships in seven provinces in western China and is funded at 2 billion RMB (\$240 million) to subsidize the installation of about 17 MW of village-scale hybrid systems (mainly PV, with some wind, combined with batteries and diesel back-up systems) Funding is used to subsidize 50% of capital costs (100% in Tibet) of village power systems. “China is becoming the international community’s laboratory for village-scale power,” asserted one project participant.

Project Experience

By mid-point, the project had resulted in demonstration installations, training activities, policy facilitation, financing studies, business models, national institutions, national standards, market information, resource assessments, international best practice guides, and a new renewable energy industry association. Most of the progress so far has related to the village-scale power components, the industrial-scale biogas components, establishment of a National Testing and Certification Program for the solar water heating industry, establishment of a national wind resource measurement program, and the establishment, support, and operation of the China Renewable Energy Industries Association (CREIA).

Demonstration installations. Two biogas plants at pig farms in Hangzhou and Beijing became operational in 2001. A third plant at an alcohol distillery in Qingdao became operational in October 2002. A 100-kW wind/diesel hybrid village power plant was under construction in 2002 in Zhejiang (Bei Long Dao). A second hybrid system consisting of 80 kW of wind and 20 kW of PV power became operational in Xinjiang in December of 2002. A bagasse cogeneration plant at a sugar mill in Guangxi completed installation in 2002.

Training activities. The project has supported a number of training events for government officials, renewable energy business managers, bank officers, engineers, and researchers. By October 2002, the Project had conducted more than 27 training events, including 20 workshops and targeted training forums and 7 international study tours. Particularly notable were three regional workshops on biogas plant development for livestock farms that provided a focused forum for business development between bioengineering companies and livestock farm owners and managers. These workshops have facilitated project plans for more than 30 new biogas facilities for livestock farms; construction of several of these facilities was completed during 2001 and 2002.

Policy facilitation. The Chinese Renewable Energy Industries Association (CREIA) prepared a renewable energy policy white paper in 2001. This white paper, which included international renewable energy best practices, fed into a major renewable energy policy review and development initiative by the State Economic and Trade Commission (SETC) for wind, solar, biomass, and geothermal. The white

paper provided recommendations for national action plans for industrial-scale biogas and solar water heater industry. In particular, the project was helping SETC develop a “National Action Plan for Industrial-Scale Biogas Development,” which will offer a blueprint for improving domestic policies supportive of biogas power projects in industrial applications. In addition, the Project and the SETC presented policy recommendations to the China Council for International Cooperation on Environment and Development (CCICED). The project has also supported the State Environmental Protection Administration (SEPA) in promulgating wastewater discharge standards for livestock farms and industrial plants in conjunction with biogas development, and in creating a regulatory and enforcement plan for the standards, which should result in greater market demand for biogas technologies.

Financing studies. The project is facilitating information exchange and commercial financing for wind power investment projects.

Business models. Business models have been investigated for village power, including strategies for linking economic development with village power systems. A business model is being promoted for the commercial operation and management of village power systems for village clusters consisting of several village power systems within a county or township territory, including the sustainable operation of village power systems by collecting fees sufficient to cover operation, maintenance and replacement costs.

National testing institutions. Three national testing centers for solar hot water equipment have been established in Kunming, Yunnan Province, in Wuhan, Hubei Province and in Beijing. In addition a national center for equipment certification is being established in Beijing. The testing and certification program and institutions are expected to have a major impact on the solar hot water industry and its rapid development, given that China is the world’s largest market for solar hot water systems, but that there is considerable consumer confusion about product quality and economic merits.

National standards. The project has developed four new solar hot water industry standards and for product quality assessment, which have been submitted for government approval. These standards will be used for the national solar hot water testing and certification program. This process has been greatly facilitated by a European study tour to learn about international best practices.

Market information. Market surveys produced have included a survey of existing village power systems, including the performance of some 70 separate systems, and a solar water heating industry market report. Additional reports are being produced for the biogas and bagasse cogeneration markets.

Resource assessments. Solar and wind resource assessments for village power and for large scale wind farms were initiated in 2002. Forty meteorological towers that are 40-meters and 70-meters in height have been installed at 10 prospective sites for wind farm characterization and development in the 50-100 MW range. The measurement program follows international best practices for wind resource measurement and site-specific wind flow modeling at the ten sites. GIS databases were developed and three GIS and resource assessment training courses were completed. Workshops focused on transferring international best practices for installation of monitoring equipment, data acquisition, and data analysis.

Best practice guides. A Village Power Project Development Guidebook was published in August 2002. This guidebook is being used by the State Development and Planning Commission’s training program for the ambitious 1000-village “National Township Electrification Program.”

China Renewable Energy Industries Association (CREIA). The development of CREIA began during early project implementation. By 2002, CREIA was officially registered and had increased to five full-time professional staff and 20 associated staff. In 2002, CREIA membership rose to over 80 companies and 40 individuals, which represented a doubling of its membership base over 2001. CREIA is notable among Chinese organizations for its strong market orientation. A five-year business plan is in place, and

staff have been trained. CREIA is starting to supplement its core income through contracts with government agencies and NGOs, and through membership dues. By 2003, CREIA had achieved a level of financial strength sufficient to sustain its operations from membership fees and contract revenues. Among some of CREIA's notable early activities:

- Published in 2002 a photo-illustrated 300-page book on China's renewable energy industry, including detailed information on markets, products, and firms.
- Organized more than 20 workshop and training events that benefited corporate membership.
- Established a web-based "investment opportunity facility" (IOF) that matches potential projects, investors, and financiers to support project development.
- Published bimonthly newsletters and engaged in many forms of information exchange, with both domestic and foreign companies, on a daily basis.
- Helped several renewable energy firms to develop business plans and to better understand technologies and market opportunities.
- Facilitated bilateral and multilateral projects.
- Organized meetings and workshops on renewable energy CDM projects.
- Participated in more than 7 international exhibitions and conferences.

The president of CREIA, Zhu Junsheng, said that "all the companies consider CREIA services to be excellent...they trust us and are interested enough in our services that they would be willing to pay for them in the future." For the next stage of development, CREIA is looking to broker financing and to help domestic enterprises develop their capabilities and services to "international levels."

Project Impacts

Since the project is still mid-way through implementation, impacts are in the process of being judged. However, early project activities are resulting in some significant impacts. The formation, national recognition, and industry support of CREIA is certainly a major outcome. One of the most significant policy impacts has been the project's indirect influence on the successful introduction of renewable energy policy targets in the national Tenth Five Year Plan. These targets call for 5% of new power generation to come from renewables by 2010. The research for the Village Power Project Development Guidebook and interactions with the SDPC has provided support and guidance for the development of training programs for the National Program for Remote Township Electrification started in late 2001. The Project's interaction with the Poverty Alleviation Office in Beijing and its local offices in several provinces has encouraged the PAO to incorporate renewable energy into its program development process for rural energy support. Business activity indirectly linked to the industrial-scale biogas workshops is resulting in new investment and construction (about 30 new projects stimulated so far). The solar hot water market has now reached 6 million m² per year and the project is accelerating the growth of this market through its support of major firms in the industry. CREIA has played a major role in managing a 80-MW wind power development program being supported by SETC as a means to stimulate domestic manufacturing of large wind turbine generators. Overall, the project is expected to facilitate "new thinking" in China on entrepreneurial-based development, stronger links between energy programs and poverty programs, and innovative forms of business incentives for operation and management of village-scale power systems, industrial-scale biogas plants, bagasse co-generation facilities, and wind farms.

Emerging Lessons Suggested by Experience

1. *Industrial-scale biogas investments are feasible by the soundest Chinese firms.* The biogas workshops, and subsequent biogas investments by industry facilitated by the workshops, demonstrated that the top 20% of financially sound firms in the large-scale livestock and industrial sectors are able to finance such investments themselves and see these investments as a necessary and acceptable cost of doing business.

2. *Village-scale power continues to be one of the biggest challenges.* Early project experience suggests that village power applications are going to require government assistance for some time, due to economics, the challenges of management arrangements, and the need for local regulatory and tariff frameworks. Most village-scale power systems managed by traditional utilities have not been successful in China. Other operating and management models are needed. Even collecting tariffs high enough to cover operating and maintenance costs can be a challenge—about 1 RMB/kWh (US 12 cents/kWh) seems to be about the maximum. Households are willing to pay higher tariffs for solar home systems, but once grid extensions arrive, people compare themselves to those paying urban tariffs of 0.5 RMB/kWh or less.

3. *Bottom-up village-scale power development works.* Bottom-up development of village power schemes, done by local village organizations and business firms, seems to invoke a greater chance of success by coordinating mutual interests at the earliest stage of development, generating commitment through face-to-face communications with working level people, and following a rigorous process for clarifying the interests, roles, and responsibility of all parties.

4. *Greater attention to capacity building for resource assessment is needed.* Resource assessment training activities have shown that potential Chinese capabilities for performing assessments are strong, but that a large training gap exists to bring these capabilities up to international best practices.

5. *Project flexibility to adapt to changing policy circumstances is important.* The village-scale power program was restructured to accommodate the government's National Township Electrification Program in western China. The project refocused its efforts to support this new initiative, which represents the most aggressive international program yet launched for rural electrification using renewable energy technologies. In the future, the project expects to provide training support for new business models for operation and management of the village power systems, and to make linkages between village power systems and income generation, productive applications, and village enterprise development.

Sources of Information

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“New and Renewable Sources of Energy—Technologies and Projects,” China Renewable Energy Industries Association (Beijing, 2001).

Further information is available from the project web site, <http://www.ccre.com.cn>, and from the CREIA web site, <http://www.creia.net>.