CAPACITY BUILDING FOR THE RAPID COMMERCIALIZATION OF RENEWABLE ENERGY IN CHINA

WORLD BANK – CASE STUDY
(1999 – 2005)

1. OVERVIEW

Issues of environment, energy security, and least-cost energy access for rural populations have all played a role in making renewable energy an integral component of China's national development strategy. Yet, China's high dependence on fossil fuels has remained firmly in place, and efforts to promote the widespread commercialization and adoption of renewable energy technologies is impeded by many challenges in capacity, financing, policy, technology, and information. This project was designed to strategically address a number of these challenges.

The overall objective of the project is to support the accelerated commercialization of key renewable energy technologies in promising market sectors. To achieve this objective, the project design integrated the following two main priorities throughout all project components:

• Capacity building - to develop the institutional capabilities to support commercial renewable energy development, and

• Commercialization - through lowering of technical, institutional, and policy barriers and introduction of international best practices for market-ready renewable energy technologies.

Project strategy utilizes a market sector approach, with activities focused on the technology application areas: biogas, grid-connected wind, solar water heaters, hybrid village power, and bagasse cogeneration. Additional cross-cutting focal areas are finance, business development and policy. Critical to the project's success has been its close coordination with the central government in support of the nation's renewable energy programs.

2. INSTITUTIONAL ARRANGEMENTS

The project was initiated in May 1999, and will have duration of six years. Co-funding was provided by UNDP-GEF ($8.8 million), Australian AusAid Program ($3 million), the Government of the Netherlands ($2.53 million), and the Government of China ($11.5 million). The Government of China also made significant in-kind contributions to set-up the Project Management Office (PMO) and provide support staff. The National Development and Reform Commission (NDRC) is the project's lead domestic

implementing agency, with implementation support also provided by the State Environmental Protection Agency (SEPA). A Project Advisory Group, including all project co-financiers, implementing and executing agencies, and other invitees, meets twice a year to review progress and provide advice and suggestions for future activities.

3. PROJECT ACTIVITIES AND ACCOMPLISHMENTS

CHINESE RENEWABLE ENERGY INDUSTRIES ASSOCIATION

The project supported the establishment of the Chinese Renewable Energy Industries Association (CREIA), one of the first completely business-led and self-financed associations in China. CREIA provides its members with the latest information on technology and market developments and acts as an organizer of industry training programs. From an informal base of 60 members in 2000, CREIA gained official status in 2003 and has grown to 160 members. Now considered the premier channel between

China's renewable energy companies and business and organizations in other parts of the world, CREIA will launch its Investment Opportunity Facility (IOF) in 2004 to link project implementers with investors.

RENEWABLE ENERGY MARKET SECTOR WORK

Demonstration projects, introduction of international best practices, capacity building (through training, workshops, and study tours), standards development, and promotion of business development have all been important elements of market sector work. Activities are summarized by sector below:

Industrial-Scale Biogas: The project has supported construction of three modern biogas plants in China, two on pig farms and one at a distillery. Building on these demonstrations, project workshops have been successful in catalyzing a substantial number of biogas business deals. The project is now supporting development of the biogas component of the Government's Biomass Strategy through 2020.

Solar Water Heaters: The project's solar water heater work has provided direct support to the Government in the areas of standards, testing, and certification. The project assisted in development of four new standards, which were approved in October 2003, serving to complete China's solar water heater standards framework. The project further supported the selection and equipping of three National Solar Water Heater Testing Centers, two of which have achieved official laboratory accreditation in China. The project has also supported the establishment of a National Solar Water Heater Certification Center in Beijing.

Wind Power: The project has supported wind resource assessment at ten sites, introducing international best practices and building capacity in local organizations. The sites have been incorporated into the Government's plans for wind power, directly feeding into an ambitious project development pipeline, with a target of 20 GW by 2020.

The project's resource assessment methods have also been adopted by the Government, which is planning to conduct 20 more site assessments by 2005.

Hybrid Village Power: The project has supported two pilot hybrid village power projects, a wind-PV-diesel system serving five remote sites in far western China and a wind diesel system serving an island fishing

community off of China's eastern seaboard. As the Chinese Government pursues the world's most extensive renewable energy-based rural electrification program, the project's emphasis on productive applications (e.g. microenterprises) will provide a model for promoting sustainability of village power installations.

Bagasse Cogeneration: The project aims to demonstrate the potential for cogeneration of heat and power (with sale of electricity to the grid) in sugar mills by using high pressure boilers to burn bagasse (the fibrous residue from crushing sugar cane). A pilot project is being constructed in Guitang, Guangxi Province. A study tour to Australia and Hawaii and a workshop were organized to build capacity for bagasse cogeneration in China and promote associated business development.

BUSINESS DEVELOPMENT AND FINANCING

The project has held a series of training programs and workshops on business development and financing for renewable energy. These activities have sought to enhance the business skills of managers and entrepreneurs and to raise awareness and understanding of renewable energy among the financial community.

POLICY SUPPORT

In addition to direct support of government programs and strategic planning in the market sectors of biogas, solar water heaters, grid-connected wind, and village power, the project has also provided cross-sector policy support to the Chinese Government in the formulation of its Promotion Law for Renewable Energy Development and Utilization.

4. VILLAGE HYBRID POWER PROJECTS

BACKGROUND

China has made great progress in rural electrification over the past 20 years. However, more than 20 million people, mainly in western and northern China, still have no access to electricity. The cost of grid extension to many of China's un-electrified regions is prohibitive, and stand-alone renewable power systems, such as solar, wind, hydro, and biomass, often provide the most cost-effective option. Recognizing the suitability of renewables to electrification needs, the Government of China has recently embarked upon the world's largest and most aggressive renewable energy-based rural electrification program with a focus on western China.

The National Township Electrification Program, authorized in 2001 and administered by the National Development and Reform Commission (NDRC), has provided $US 250 million to cost share with local governments to install a total of 17 MW of renewable power systems in 1,066 townships. The upcoming National Village Electrification Program is even more ambitious and aims to electrify as many of China's 20,000 remaining un-electrified villages as possible.

In spite of successes achieved, the National Township Electrification Program raised several issues related to the long-term sustainability of installations. The majority of systems installed are photovoltaic (PV)/battery storage systems, with no diesel back up, which are sized so that availability of power is

limited in duration each day. These systems provide electricity for household needs, but do not address the possibility of productive applications, which offer the potential of generating household and village income. Other key issues, revolving around ownership, tariff setting, and O&M of the systems need to be addressed to insure sustainability of system performance.

SUPPORT FOR RENEWABLE VILLAGE POWER

The aim of the project's village power component is to support the Government efforts to enhance the effectiveness of its rural renewable electrification program. The project emphasizes hybrid systems, which combine more than one power source (generally wind and PV), with battery storage, and in many cases include diesel or gas generators as backup. Activities center on:

• Technical demonstration of international best practices for the design, system integration, and installation of hybrid village power systems.

• Development of business models for ownership, operation, and management of systems, and for rational setting of electricity tariffs.

• Training of Renewable Energy Service Companies (RESCOs) and other types of village power management organizations.

• Identification and promotion of productive uses of electricity both to increase people's incomes and to support the sustainability of renewable village power systems, including consideration of micro-credit/finance.

Pilot Projects: The project has co-financed with local governments, two hybrid pilot projects to demonstrate sustainable deployment principles. One project consisting of a total of 80 kW of wind and 10 kW of PV with battery storage and back-up diesel generators is installed at five sites (four villages and a tourist site) that are typical herdsman communities in Western China. The second project consisting of a 70 kW wind/diesel village power system is installed on Bei Long Island off the coast of Zhejiang Province. These pilot projects incorporate several productive uses of electricity, such as seafood processing, tourism, retail village enterprises and gem polishing, as well as improved social services in the areas of health and education.

Business Development: The project is making use of the Xinjiang pilot as a "RESCO laboratory," in which experiences are gained and business models developed to improve future training for companies operating village power systems. The RESCO is testing whether partial commercialization is achievable through small, self-sustaining businesses that operate multiple village power systems. Models tested in the RESCO lab emphasize not only "hardware," but also "software," including abilities such as customer relations. For example, it has been found that the RESCO can raise productive power demand and thus promote its own sustainability by providing customers with information on machines used in productive applications.

Capacity Building: The project has also conducted technical and business training for companies marketing and installing village power systems and has supported solar and wind resource assessment at remote village sites, to build a resource assessment capacity.

The project has conducted village power market studies, surveys of existing village power systems, and has published the Village Power Project Development Guidebook.

IMPACTS

The project's village power component has achieved success both in providing models for more sustainable renewable village power systems and in raising awareness of these options among relevant government agencies and Chinese engineering companies.

• Recognizing the project's achievements and potential for additional contributions, the NDRC has asked the project to provide direct input to its National Village Electrification Program in the following areas: 1) conducting a baseline survey of systems installed through the National Township Electrification Program to create a database for the program and enumerate lessons learned, 2) conducting business and management training for RESCOs, and 3) training expert teams responsible for developing the National Village Electrification Program in three pilot provinces.

• As evidence of initial successes gained with the RESCO model, the project's Xinjiang pilot has given rise to the only operating company in China that manages multiple renewable village power installations. The project's RESCO manages ten systems, five associated with the Xinjiang pilot and five associated with NDRC's National Township Electrification Program.

• Initial successes in productive applications are also evidenced by the Xinjiang pilot project, where the hybrid electrification system has stimulated small-scale enterprises in tourism, gem polishing, weaving, and electronics repair.

Electrification has also had a positive impact on social services, with the local hospital expanding its capabilities.

• The project's Village Power Project Development Guidebook is in its second printing. The book has not only been well received in China, but is also being used as a guide in other countries.

5. INDUSTRIAL SCALE BIOGAS PROJECTS

China's extensive biomass resources (estimated at five billion tons annually) include substantial industrial and livestock farm organic wastewater effluents that are appropriate raw materials for the production of biogas (predominantly methane).

Biogas can be used as an alternative to natural gas, providing process heat, electricity, and/or gas for local distribution. Biogas production, achieved through anaerobic fermentation processes, also serves the important purpose of treating organic pollutants in the waste stream and can yield a high-quality organic fertilizer.

The Challenge: While China has extensive experience with biogas at the household level (with roughly two million rural household digesters in operation), industrial-scale production, appropriate to medium to large-scale livestock farms and to industrial processes including breweries, alcohol distilleries, pharmaceuticals, and food products, lags far behind the potential. Indeed, as meat consumption continues to rise in China, water pollution from animal manure produced at more than 10,000 livestock and poultry farms has emerged as a key environmental problem, creating both a treatment necessity and sizable biogas production opportunity.

However, less than 10% of livestock farms at present have treatment facilities for wastewater processing. Industrial organic wastewater effluent, also on the rise as China's economy grows, has reached 2.8 billion m3 per year. China's industrial sector holds particularly high promise for profitable biogas installations, given its suitability to cogeneration of heat and power and the availability of efficient combined heat and power technologies.

The Opportunity: The major driver of China's industrial-scale biogas projects has been compliance with environmental regulations. In 2002, SEPA promulgated new standards for industrial wastewater discharge and stepped up enforcement, stimulating greater interest in biogas. The use of anaerobic fermentation technology for wastewater treatment is well-developed in China. There are more than 700 small to midsize industrial-scale biogas plants, but proper incentives and incorporation of international best practices to promote commercial viability can greatly increase the deployment potential for biogas technologies and their effectiveness for pollution mitigation.

The Strategy: Project activities are based on several synergistic elements, including:

i) Use of pilot projects as a visible demonstration of advanced commercial technology,

ii) Well-constructed regional workshops having a strong business focus to promote project development, and

iii) Strong policy promotion in partnership with NDRC and other key stakeholders.

Pilot Projects: The project has co-financed three pilot industrial-scale biogas projects, representing advanced international best practices in design and construction of commercial facilities and covering two key market sectors (livestock farms and distilleries). Table 1 provides details of the characteristics of these projects, which include two pig farms and a distillery representative of two of the largest of these market sectors in China.

Regional Workshops: Business and industry development work aims to catalyze deals among developers, end users, and the financial sector and introduce international best practices. The project has aggressively pursued these goals through a series of four workshops, each held near one of the pilot sites or a similar facility for demonstration of economic and technical performance. Workshops focused on end users and were held in partnership with SEPA, with input from international and domestic experts. Breakout sessions gave end users an opportunity to hold discussions with bioengineering companies and to pursue business discussions.

Commercial Viability: Current project work is focused on facilitating a transition from environmental compliance-driven to profit-motivated biogas project development, and supporting policy makers in promoting biogas. As part of its commercialization strategy, the project is supporting feasibility studies for large-scale centralized biogas digesters, which will each serve several industrial end users and have greater potential for selling electricity to the grid. In the policy arena, the project is assimilating experience to support preparation of the National Action Plan for Industrial Biogas Development in China in cooperation with NDRC. The plan will utilize stakeholder input in identifying roles and action items for various groups associated with the technical, business development, financing, environmental, and policy aspects of biogas commercialization.

The project has achieved a number of notable successes to date, including:

• At least 34 new biogas projects at livestock farms have been developed based on the project's first three regional workshops.

• Project outputs are having a direct impact on changing the paradigm for biogas technology deployment in China, influencing bioengineering companies to consider more commercially viable technologies and project development strategies.

• NDRC has indicated that it will use the project's National Action Plan for Industrial Biogas Development as the biogas component of its Biomass Strategy through 2020.

• The capacity of biogas project developers has clearly been increased by the project. For example, the Hangzhou Bioengineering Company, which developed the Dengta pilot, has reported substantial expansion of its business, including cooperation with multinationals in China and contracts for projects abroad.

TABLE 1: CHARACTERISTICS OF PROJECT'S THREE BIOGAS FACILITIES

CHARACTERISTICS	DENGTA PIG FARM	SHUNYI PIG FARM	JIUCHANG DISTILLERY
SCALE	200,000 pigs	60,000 pigs	10,000 t/year alcohol
LOCATION	Hangzhou, Zhejiang	Shunyi, Beijing	Qingdao, Shandong
WASTEWATER	3,000 tons/day	600 tons/day	Up to 1,500 tons/day
BIOGAS PRODUCED	8,500 m3/day	2,200 m3/day	10,000 m3/day
BIOGAS APPLICATION	Heat for farm use	Heat for farm use (electricity in the future)	Boiler fuel for process heat
OTHER OUTPUT	142 tons fertilizer/day	8 tons fertilizer/day	Solid recycling

6. SOLAR WATER HEATING

Already the world's largest solar water heater market and manufacturing base, China represents expansive growth potential for the industry. In 2002, sales of solar water heaters in China (by collector area) were 9.6 million m2 or US$1.28 billion. China's 2002 production was 10 million m2; and cumulative installed capacity reached 40 million m2 (compared to 10.8 million m2 in the EU).

A number of factors suggest the possibility of continued rapid growth of this market, including the large numbers of Chinese households in small towns and rural areas that do not have bathing facilities at home; the low life-cycle costs of solar water heaters (achieved through fuel savings); the existence of abundant solar resources in many parts of China; and the Government's growing emphasis on energy security and environmental concerns.

The Challenge: In spite of recent growth, the expansion of China's solar water heater industry has been impeded by the highly variable quality of products in the marketplace.

With over 1,000 mostly small-scale companies involved in manufacturing and distribution in the sector, it is not surprising that quality problems have begun to damage the reputation of the industry among Chinese consumers. While 19 companies dominate sales, the market share of small manufacturers has grown in recent years.

The Solution: Since the second half of the 1980s, the Chinese Government has been supporting the sector through funding for research and development and loans for plant upgrading. In the early 1990s, the Government began establishing standards for the industry and more recently has begun developing its National Solar Water Heater Testing and Certification Program to ensure that solar water heaters regain and maintain their reputation among households as a reliable option to electric and gas water heaters.

The Objective: The focus of all project work in the solar water heater sector has been to provide a sound foundation for market development through the establishment and support of the National Solar Water Heating Testing and Certification Program. Working in close partnership with NDRC and other relevant agencies, the project has provided critical support in the areas of standards, testing, and certification. An aggressive promotion and media campaign was also undertaken to ensure that industry stakeholders participate in the program.

Standards: Working with the Chinese National Institute for Standardization (CNIS), the project has supported the creation of four new standards to complete the standards framework in China for the performance and qualification testing of solar water heater components and systems. All standards have received formal approval by the Chinese Government.

Test Centers: Working with the State Technical Quality Supervision Board (STQSB) in 2002, the project assisted the Chinese Government in the competitive selection of three National Test Centers. Given China's large and highly dispersed solar water heater production base, three institutes, one each in North, Central and Southwest China were selected.

Capacity Building: The project has emphasized the introduction of international best practices in building up collector and full system test capabilities working with Ecofys in the Netherlands and the University of New South Wales in Australia. In addition, during preparation for finalizing the design and construction of testing equipment and facilities, supported by project cost-sharing, the project sponsored a study tour by test center staff to advanced test centers in Greece, Portugal, Switzerland, and the Netherlands.

Certification: For certification, the project has worked with the Certification and Accreditation Administration of China (CNCA) in establishing a solar water heater certification program. In October 2003, CNCA established the National Solar Water Heater Certification Center at Beijing Jianheng, an organization under the China National Institute of Metrology. With support from the project and input gained through exchange with Europe's Solar Keymark Program, the center is working to develop a certification and labeling program for solar water heater products in China, which it will oversee. It will also be responsible for coordination and final approval of procedures and protocols used at the three national test centers. Once certification and labeling are officially launched, the project will support Jianheng in managing an extensive publicity campaign to promote, in cooperation with industry, awareness of solar water heating labeling and quality issues.

Recognition: From inception, the project's solar water heater component has been coordinated with the appropriate Government agencies, industry has expressed strong enthusiasm for the new standards, testing and certification programs, and media coverage has been extensive.