Economic & Social Affairs

Case Studies of Market Transformation

Energy Efficiency and Renewable Energy

United Nations

Case Studies of Market Transformation

Energy Efficiency and Renewable Energy

United Nations
New York • 2007

Acknowledgements

The United Nations wishes to acknowledge the contribution of the following individuals and organizations who contributed to this publication. They include Ms. Zhang Sainan, Ms. Zhao Xinhua, Mr. Ray Phillips, Mr. William Wallace, Mr. Mohan Peck and Winrock International.

Note

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of frontiers.

This publication has been issued without formal editing.

Contents

Abbreviations and Acronyms

AED	Academy for Educational Development
AQSIQ	State General Administration for Quality Supervision, Inspection and Quarantine (China)
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BTU	British thermal unit
CDM	Clean Development Mechanism
CFC	chlorofluorocarbon
CFL	compact fluorescent lamps
CLASP	Collaborative Labeling and Appliance Standards Program
CO_2	carbon dioxide
COP	coefficient of performance
CNCA	Certification and Accreditation Administration of China
CNIS	Chinese National Institute for Standardization
CREI	Commercializing Renewable Energy in India
CREIA	China Renewable Energy Industry Association
DFID, UK	Department for International Development (United Kingdom)
EDRC	Energy and Development Research Centre (new energy research centre)
ESCO	Energy Services Company
EU	European Union
FECO	Foreign Economic Cooperation Office
GEF	Global Environment Facility
GHG	greenhouse gas
IIEC	International Institute for Energy Conservation
IOF	Investment Opportunity Facility
IREDA	India Renewable Energy Development Agency
ISO	International Standards Organization
kWh/day	kilowatt-hour (10^3 watt-hours) per day
LBNL	Lawrence Berkeley National Laboratory
LCC	life-cycle cost
LPG	liquefied petroleum gas
MEPS	Minimum Energy Performance Standard
MNES	Ministry of Non-conventional Energy Sources (India)
MOP	Ministry of Power
NDRC	National Development and Reform Commission
NGO	non-governmental organization
NO_x	nitrogen oxides (also referred to as oxides of nitrogen)
PDF	Project Development Facility
PM	particulate matter
PV	photovoltaic

REEP	Renewable Energy and Energy Efficiency Partnership
RET	renewable energy technology
RMB	Renminbi or Yuan (People's Republic of China currency)
S&L	Standards and labelling
SEARI	Shanghai Electric Apparatus Research Institute
SEPA	State Environmental Protection Administration (China)
SHG	self-help group
SO_2	sulphur dioxide
SPV	solar photovoltaic
STQSB	State Technical Quality Supervision Board
TA	technical assistance
UNDESA	United Nations Department of Economic and Social Affairs
USDOE	United States Department of Energy
UNF	United Nations Foundation
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WI	Winrock International
WII	Winrock International — India

Transformation of the refrigerator market in China

Background

China represents the largest refrigerator market in the world, but during the 1990s the average energy efficiency of refrigerators on the market was quite low. At that time a demonstration project funded by the United States Environmental Protection Agency studied the refrigerator sector in China and identified a range of barriers to energy efficiency. The China Energy-Efficient Refrigerator Project was formulated to address those barriers and to assist China in introducing a range of policy and regulatory measures that could be implemented to improve the efficiency and competitiveness of refrigerators, and at the same time mitigate the environmental impacts due to high electricity consumption. The project received Global Environment Facility grants totalling US$ 9,860,000, leveraged by over US$ 31 million in other funding. The project began in December 1999 and was expected to be completed in June 2006.

From 1980 to 1995, residential power use rose from 3 to 12 per cent of total electricity consumption, growing at an annual rate of 16.3 per cent. This growth was driven by an explosive increase in household appliance use, as household income was rising. Within the residential sector, it is estimated that refrigerators alone, found in 70 per cent of urban households in 1999, account for approximately half of all residential electricity consumption. In 1992, there were a total of 39 million refrigerators in service, an increase from only 4 million in 1985, representing an average annual growth of 38 per cent. According to a business as usual scenario, refrigerators produced in China over the next decade would require an additional 601 billion kWh of electricity over their expected lifetimes. This would necessitate an estimated increase in annual power generation capacity of 5,700 MW, equivalent to an annual average of 60 million tons of additional CO_2 emissions. Excessive energy consumption by refrigerators thus was identified as an urgent issue that needed to be solved.

Prior to the China Refrigerator Project, Chinese refrigerators were significantly less energy-efficient than those produced in the European Union, the United States of America or Japan (e.g., the average refrigerator in China consumed up to 2.5 kWh/year per litre of volume compared to 1.5 kWh/year in Europe). There was a clear need to strengthen capacity in China to manufacture and utilize energy-efficient refrigerators. Domestic research demonstrated that the energy consumption by refrigerators in China could be reduced by as much as 40 per cent. However, there were many barriers to the widespread commercialization of energy-efficient refrigerators in China.

The China Refrigerator Project was developed in order to address this problem. The project began in 1989 as a bilateral cooperation project between the United States Environmental Protection Agency (USEPA) and the China State Environmental Protection Administration (SEPA).

From 1989 to 1995, work was conducted in the areas of chlorofluorocarbon (CFC) substitutes research, energy-efficient design options, prototype development, safety testing and field testing. A CFC replacement demonstration was funded through the Montreal Protocol Fund ($3.5 million) received in two parts in June 1993 and March 1995.

A key factor in ensuring the success of a comprehensive market transformation project is to carefully plan and coordinate activities, and to ensure that all stakeholders are involved in both project planning and execution. This was

particularly true with the China Refrigerator Project, which benefited greatly from active stakeholder involvement in the development and implementation of the project. Please see the box below for a list of key stakeholders.

Project goals

The project's main goal was to reduce energy consumption through promotion of improved refrigerator energy efficiency, contributing to protection of the global environment by reducing carbon dioxide and other greenhouse gas (GHG) emissions caused by household refrigerator energy use in China. An additional project goal was to take advantage of product and production line modifications through the CFC phase-out to introduce energy efficiency modifications.

Project participants

- Twenty-four Chinese refrigerator and compressor manufacturers
- China State Environmental Protection Administration (SEPA) — national executing agency, project Advisory Committee (AC) member
- United Nations Development Programme (UNDP) — Global Environment Facility (GEF) implementing agency, AC member
- China Ministry of Finance (MOF) — GEF country focal point, AC member
- SEPA Foreign Economic Cooperation Office — national implementing agency and home of Project Management Office (PMO)
- United Nations Department for Economic and Social Affairs (UNDESA) — international cooperating agency
- China National Development and Reform Commission (NDRC) — chief energy efficiency regulatory body, AC member
- China State General Administration for Quality Supervision, Inspection and Quarantine (AQSIQ) — issues energy efficiency and other product standards, AC member
- China National Institute of Standardization (CNIS) — provides market assessment, technology review and economic analysis support to AQSIQ in energy use standard development, and was lead participant in GEF project standards and labelling work
- China State Administration of Internal Trade (SAIT) — oversees retail sector; AC member
- China Household Electric Appliance Association (CHEAA) — lead participant in variety of project activities; liaison to industry; maintains project information centre and website
- China Household Electric Appliance Research Institute (CHEARI) — helped develop demo project prototype, provides project technical support and product testing capability
- China Certification Center for Energy Conservation Products (CECP) — responsible for China's endorsement level and will manage information label; key participant in mass procurement programme
- Collaborative Labeling and Appliance Standards Program (CLASP) — key participant in standards and labelling work
- University of Maryland Center for Environmental Energy Engineering (UMd CEEE) — intensive long-term refrigerator design training location
- National and international experts and contractors hired to support implementation of the project

It was originally estimated that in the 10 years following implementation of the project, refrigerators in China could reduce electricity consumption by about 120 billion kWh. If this electricity is all from coal-fired power stations, it would save 7.175 million tons of coal, resulting in emissions reductions of 143 million tons of CO_2. In addition to this significant global environmental benefit, corresponding reductions of SO_2 emissions and other local pollutants would lead to significant improvement of local environmental quality.

Project barriers

During project development, nine barriers were identified to adoption of energy-efficient refrigerators by households. These barriers were:

- *Lack of awareness of the life-cycle economic benefits of high-efficiency refrigerators*. Refrigerator purchasers in China were highly sensitive to the first costs of their purchases, and inappropriately preferred models with low purchase prices and higher electricity costs. They did not fully appreciate that total life-cycle costs, including electricity, could be much lower for high-efficiency models.
- *Lack of reliable, comparative information available to consumers about specific models*. Even where consumers wanted to purchase models with low life-cycle costs, they were unable to make comparisons between models because energy efficiency labels did not exist to provide this information in a consistent and easy-to-understand way.
- *Manufacturer uncertainty about market demand for high-efficiency models*. Manufacturers had access to few, if any, market research studies or data about the potential demand for high-efficiency models in the Chinese market. Due to historically low electricity prices and little emphasis on energy efficiency in the Chinese economy, both producers and consumers were uninterested in energy-efficient products.
- *Manufacturer uncertainty about cost-effectiveness of high-efficiency models.* Manufacturers were also uncertain about the costs of developing and producing high-efficiency models, and about the price premium in the marketplace that high-efficiency models might command. Therefore, manufacturers were reluctant to commit the resources to develop and produce high-efficiency models.
- *Lack of expertise in energy-efficient refrigerator design.* The majority of Chinese manufacturers lacked the engineering and design expertise to develop new energy-efficient refrigerator models or modify existing designs to make them more energy-efficient. As a result, manufacturers did not cultivate the skills and staff necessary for energy-efficient refrigerator design. Secondly, most domestic manufacturers had relied heavily on imported or licensed technology and were therefore at a further disadvantage in developing new energy-efficient product designs. Finally, many domestic manufacturers (and particularly second-tier ones) relied on a limited and unchanging product line for their sales, and therefore had extremely limited experience in product design and redesign. For these reasons, many manufacturers were uncertain of their ability to implement energy efficiency measures without targeted training to impart the necessary skill sets.
- *Higher-efficiency compressors not available domestically.* In order for a Chinese refrigerator manufacturer to design and produce a high-efficiency refrigerator, a higher-efficiency compressor must be utilized. Prior to the project, such compressors were not available in China, and the higher cost of imported high-efficiency compressors was a strong disincentive for domestic refrigerator manufacturers.

- *Dealer reluctance to stock or promote high-efficiency models.* Uncertainty about consumer demand, the need to educate their sales force, and fear of reduced sales due to higher prices on the shelves made dealers reluctant to stock high-efficiency models. Surveys conducted during project development also indicated that sales staff were unfamiliar with the benefits of energy efficiency and unable to provide consumers with reliable information.
- *Lack of an appliance recycling programme.* As China's refrigerator market matures, an increasing proportion of purchases involve replacement of an old refrigerator. Unlike most developed countries, where old appliances are scrapped or recycled, market research indicates that many new buyers in China have kept have their old refrigerators. Continued use of these old refrigerators has risked offsetting many of the efficiency gains from the purchase of new refrigerators.
- *Lax efficiency standards.* China's previous refrigerator efficiency standards, promulgated in the 1980s, were established in view of the needs of hundreds of small refrigerator producers. They allowed production of a large number of highly inefficient refrigerators and provided no incentive to manufacturers to increase the energy efficiency of their models.

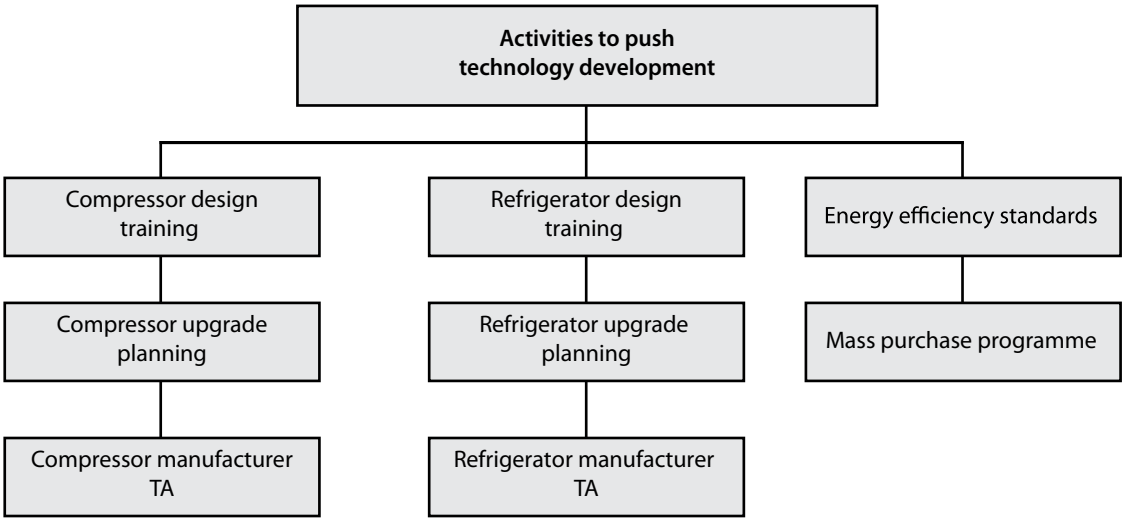
Project activities

A series of coordinated project activities were developed in order to eliminate or reduce these barriers so that a long-term, sustained transformation of China's refrigerator market could be accomplished. These activities can be grouped into two categories. One provided a "technology push" to increase the supply of energy-efficient refrigerators, including technical training, technical assistance, study tours, incentive programmes for refrigerator and compressor manufacturers, and revision of the national energy consumption standard. The other category created a "demand pull" to increase market demand for energy-efficient refrigerators by increasing retailer and consumer understanding of the benefits of energy efficiency and energy-efficient refrigerators.

Technology push

The project's "technology push" activities were focused on manufacturers: the "supply side" of the market transformation equation. First, given that an energy-efficient compressor is an integral component of energy-efficient refrigerators, the project included a range of activities aimed at compressor manufacturers. Through international design training, business planning, technical assistance and technology transfer, the project assisted compressor manufacturers in upgrading their products. Training provided manufacturers with the ability to design more efficient compressors, and an incentive programme provided them with the incentive and the incremental cost funding to make and market them.

Simultaneously, focused training activities aimed at the refrigerator manufacturers increased their capacity to design and manufacture energy-efficient refrigerators. Computer design modelling, international technology training, tours and exhibitions, technical assistance, and intensive energy-efficient design training provided refrigerator manufacturers with the tools to create new energy-efficient model designs. To provide them with the incentives and incremental cost funding to implement efficiency gains, manufacturers competed in a bidding process for incentive programme awards designed to both raise average efficiency levels for all manufacturers and promote development of super-efficient models.



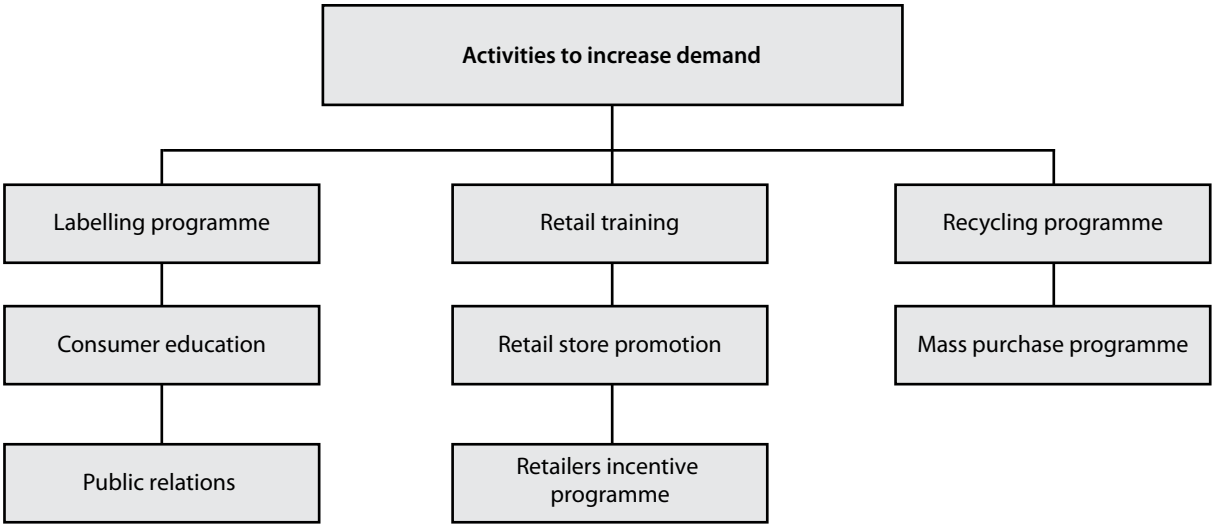
The project also strengthened energy efficiency standards with two rounds of standards revisions during both the Project Design Facility (PDF) and the GEF stages of the project. National standard-setting organizations and staff were also provided with assistance and training in the analytical tools for determining new efficiency standards in order to build national capacity for future standards revision.

Demand pull

The project's demand-pull activities included a number of programmes designed to reduce barriers to consumer acceptance and retailer understanding of energy-efficient refrigerators. During a market survey conducted during the PDF phase of the project, it was discovered that most refrigerators provided the same basic product functions. Instead of functions, other criteria were becoming increasingly important to consumers. The project's consumer awareness goal therefore became making energy efficiency one of those key factors.

In order to generate demand and increase consumers' understanding of the benefits of high-efficiency refrigerators, a consumer education campaign was designed, using television, newspapers, outdoor advertising, magazine advertisements and other media. Consumers were also targeted at retail locations with relevant educational and informational material. To complement this campaign, a public relations campaign was implemented in order to broadly educate the public about the benefits of energy efficiency. In addition, a nationally certified energy label was developed that provided comparable information across models to allow consumers to identify energy-efficient refrigerators easily.

Through the retail education activity, retail staff were trained in the benefits of energy efficiency, and a retail incentive programme was implemented to encourage stores and salespeople to market energy-efficient refrigerators actively in key target markets of China. A mass purchasing programme was designed and launched to promote the purchase of energy-efficient appliances by large-scale purchasers, particularly government agencies. Finally, a proposal was developed and third-party international funding is being sought for a recycle/



buy-back programme to provide financial incentives to consumers to return old refrigerators when they purchase new energy-efficient ones.[1] The project has also provided technical assistance to the National Development and Reform Commission (NDRC) in its development of new nationwide regulations for appliance recycling.

Please see table 1 below for a list of major project activities and budgets.

Table 1

Activity	GEF	Co-financing	Total
1. Compressor factory technical assistance	$352 500	$1 579 500	$1 932 000
2. Refrigerator factory technical assistance	$1 503 090	$24 265 000	$25 768 090
3. Incentive programmes	$3 595 000	$660 000	$4 255 000
4. Consumer education programme	$2 984 940	$4 450 000	$7 434 940
5. Project management, monitoring and evaluation	$1 181 470	$335 000	$1 516 470
Total	**$9 617 000**	**$31 289 500**	**$40 906 500**

Key project results

Overall energy efficiency gains

The China Refrigerator Project has achieved significant results in a variety of areas. First and foremost, the number of manufacturers producing energy-efficient refrigerators and the number of energy-efficient refrigerator models produced have significantly increased as a result of the project. As an intermediate indicator,

[1] No GEF funding was sought for the appliance recycling programme, which was designed as a parallel activity to be funded with third-party international funding.

annual production of energy-efficient refrigerators[2] went from about 1 million in 1999 to 10.7 million in 2004 and over 14 million in the 12 months ending in June 2005. The average refrigerator energy index[3] has improved from 0.794 in 1999 to 0.572 as of June 2005, for a gain of 28 per cent. Production of super-efficient refrigerators (those at least 60 per cent more efficient than the energy efficiency standard) has increased from 400 units in 1999 to 3.3 million during the 12 months ending in June 2005. There are currently 256 models of domestically manufactured energy-efficient refrigerators on the market that meet the energy efficiency requirement of grade 1 of the national standard for refrigerator energy consumption (superior to European grade A).

The project's original target was to promote sales of 20 million energy-efficient refrigerators over a 10-year impact period during and following the project after the project had achieved market transformation. Based on average efficiency gains of 40 per cent relative to the baseline, each energy-efficient refrigerator sold results in CO_2 emissions reductions of 5 tons over its lifetime, for total target estimated emissions reductions of 100 million tons CO_2 equivalent.[4] Based on sales of energy-efficient refrigerators (all of which are at least 40 per cent more efficient than the energy use standard) or 11.7 million units between 2000 and 2004, it appears that the project goal will be not only met, but also exceeded by twofold. If current sales levels of over 5 million energy-efficient refrigerators per year continue, emissions reductions due to market transformation achieved by the project could reach or exceed 250 million tons CO_2. Emissions reduction cost-effectiveness will likely be less than \$0.05/ton CO_2.[5]

Technical assistance

Under the technical assistance programme, engineers from eight Chinese compressor manufacturers participated in design training workshops, study tours and expert technical assistance. Engineers from 16 participating refrigerator manufacturers received training in international technology options, and modelling of energy efficiency measures, expert technical assistance and in-depth international design training. As shown in table 2, the project provided over 5,000 person-days of training.

Energy efficiency standards revision

China's refrigerator energy efficiency standard was introduced in 1989 (along with standards for washers, air conditioners, fans, rice cookers, televisions, radios and irons). It was revised in 1999 (effective date 1 January 2000) with support from the GEF during the project's PDF phase. The project also supported a second revision in 2003 (GB 12021.2-2003, test standard GB/T 8059.2-1995 = ISO 8187). This revision includes 10-15 per cent energy savings relative to the 1999 standard, with additional 10 per cent savings scheduled to take effect in 2007.

---

[2] Unless otherwise noted, "energy-efficient refrigerators" referred to here are those in the top two grades as defined by the new energy efficiency standard, consisting of refrigerators that are at least 40 per cent more efficient than the standard. Production refers to production by refrigerator manufacturers participating in the project.

[3] Average refrigerator energy use relative to the standard, so 0.572 in June 2005 means that, on average, refrigerators used 57 per cent of the energy allowed by the standard.

[4] Energy savings of 220 kWh/year per refrigerator = 5 tons CO_2 equivalent emissions reductions.

[5] Emissions reductions and energy savings are calculated as 40 per cent lower energy use for approximately 20 per cent of the projected market (2 million refrigerators/year) for a 10-year project impact period at the conclusion of and following the project and with an assumed 15-year average product life. A 40 per cent average efficiency gain for approximately 20 per cent of annual production represents an average fleet-wide efficiency gain of 8 per cent. Actual efficiency improvement achieved 1999-2004 was more than three times that amount, in addition to which greater numbers of energy-efficient refrigerators than projected are being sold.

Table 2

#	Description	Trainees	Person-days training
1	In-country compressor training programme (1)	29	174
2	In-country compressor training programme (2)	29	174
3	Overseas compressor study tour (1)	7	7
4	Overseas compressor study tour (2)	8	104
5	TA for compressor manufacturers (1)	54	149
6	TA for compressor manufacturers (2)	60	276
7	ERA design modelling training	38	418
8	Overseas training on refrigerator options for refrigerator manufacturer engineering staff	38	380
9	In-country intensive refrigerator design training	23	506
10	First group of refrigerator factories overseas training of intensive design at the University of Maryland	7	630
11	Second group of refrigerator factories overseas training of intensive design at the University of Maryland	6	546
12	Third group of refrigerator factories overseas training of intensive design at the University of Maryland	7	651
13	Fourth group of refrigerator factories overseas training of intensive design at the University of Maryland	7	651
14	TA for refrigerator manufacturers (1)[a]	110	348
15	TA for refrigerator manufacturers (2)	58	232
16	TA for refrigerator manufacturers (3)	64	243
	Total	**545**	**5 489**

[a] Manufacturer technical assistance consisted of individual visits to 4-6 factories per trip, with calculation of person-days taken into account by dividing by the number of factories visited.

Labelling

The GEF energy efficiency labelling programme is part of a joint effort funded by the GEF, the Energy Foundation and the UN Foundation.[6] The Collaborative Labeling and Appliance Standards Program (CLASP) is a technical partner. The GEF project's original intention was to include both endorsement and information label components, since both label types make different and important contributions to energy efficiency promotion. However, GEF funds for labelling were limited and China already had an energy efficiency endorsement label, so the decision was made to focus GEF support on development of the information label.

η ≤ 55%	1
55%< η ≤65%	2
65%< η ≤80%	3
80%< η ≤ 90%	4
90%< η ≤ 100%	5

Graphic design and market testing of the new information labelling were completed and a workshop held in March 2003 to announce and evaluate design options. The draft plan for management of the labelling programme was completed at the end of 2003. Regulations to create the energy efficiency label were approved on 13 August 2004 and took effect on 1 March 2005. Refrigerators are the first product to use the label, which will then be applied to other products as well, thus expanding the scope of its impact.

As shown by the illustration above, the information label is similar to the EU label, but with a number instead of letter scale. As shown in the table accompanying the illustration, energy use allowance for each label category is expressed as a percentage of the energy use standard.

Consumer education programme

The consumer education programme's purpose was to make consumers both aware of the advantages of energy-efficient refrigerators and more willing to purchase them. The programme's budget was approximately US$ 3 million, a significant portion of the GEF project budget and the first time that the GEF had funded a programme of this nature and scope.

Separate contracts for creative content development, media placement, public relations and consumer surveys were competitively bid and contracted. The advertising campaign began in November 2003 and was one year long. It included newspaper and magazine ads, outdoor advertising, in-store advertising, and two television ad pulses (November-December 2003 and June 2004, respectively) timed to coincide with peak buying seasons. The campaign featured the unified dual message that energy-efficient refrigerators protect the environment and save money, with imagery and themes to link those savings to the consumer's everyday life and protection of the environment.

In addition to GEF funds, participating refrigerator manufacturers were required to invest 10 per cent of their advertising budget in promoting energy-efficient products. An expert group site visit to participating manufacturers found that manufacturers met or exceeded that requirement.

---

[6] Labelling funding US$ 145,000 GEF funding, US$ 178,000 others.

Refrigerator manufacturer incentive programme

For the refrigerator manufacturer incentive programme, basic awards of US$ 60,000 or US$ 120,000 (depending on manufacturer size) were awarded to each of the 16 participating manufacturers (exceeding the project's original target of 12 participants) to cover incremental costs of project participation for each manufacturer. These costs included: (*a*) participation in all training and technical transfer programmes; (*b*) increasing average energy efficiency by at least 10 per cent; (*c*) development of at least one new, top-rated energy-efficient product; and (*d*) investing at least 10 per cent of the refrigerator advertising budget in energy-efficient products. All participants met or exceeded these requirements, some significantly.

The refrigerator principal award was a total award of US$ 1 million (including the basic award) and was given to the manufacturer who committed to and achieved the greatest total energy savings (relative to the energy efficiency standard) over a 12-month period for a single new energy-efficient model refrigerator freezer. The winner, Kelon, committed to producing and selling 1 million super-efficient refrigerators during the contest period. The model proposed, the BCD-209, uses only 0.42 kWh/day (67 per cent lower than the energy use standard), making it one of the most energy-efficient refrigerators in the world.[7]

The refrigerator principal award was carefully timed to follow the technical training, and allow for large-scale production and sales of new, energy-efficient refrigerators to benefit from the simultaneous consumer education campaign and issuance of the energy efficiency label. However, intense competition between leading manufacturers over the principal award resulted in a political battle, which (along with concerns related to the amount of money involved) delayed finalization of the award contract for several months and reduced some of these benefits.

Three supplemental awards of US$ 60,000 each were also awarded to manufacturers that committed to and achieved the greatest energy savings relative to their base-year energy efficiency. The three supplemental award recipients (Haier, Xinfei and Kelon) are moving towards completing them.

Compressor manufacturer incentive programme

The compressor manufacturer incentive programme consisted of two awards of US$ 400,000 and US$ 100,000, respectively, to the manufacturers that committed to developing and commercializing the most energy-efficient compressor technologies (awards could be split in the event of a tie). For both the principal and secondary awards, proposals were evaluated and scored as follows:

Coefficient of performance (COP) of compressor – baseline COP of 1.4 multiplied by the potential market for compressor(s) of that size range.

Potential awardees for the secondary award received an efficiency bonus of 0.05 if the substitute refrigerant technology proposed differed from the one proposed by the principal award winner in order to encourage development of compressors using a variety of refrigerants.

---

[7] In order to account for shipments of energy-efficient refrigerators to retailers that have not yet been sold to final consumers, Kelon and the backup award recipients will receive up to a 15 per cent credit for the delta between wholesale and final consumer sales, such that if Kelon meets its 1 million unit target for sales to retailers, up to 150,000 refrigerators may still be in retailer hands and not yet sold to final consumers. In order to encourage further promotion by Kelon of energy-efficient refrigerators and long-term sales gains, Kelon may receive another 5 per cent sales credit if at least 50 per cent of its advertising during the promotional period is energy-efficiency-related, and another 5 per cent if consumer awareness is raised by at least 10 percentage points during that period.

Three winning manufacturers were selected and committed to developing new lines of more energy-efficient compressors. Huangshi Dongbei won the US$ 400,000 main prize with a package of 18 highly efficient compressors. Wanbao and Jiaxipera split the secondary prize. Based on site visits and data collected from the bid winners, manufacturer commitments to increase compressor energy efficiency have been met or exceeded. According to independent test results, Huangshi's top model reached COP 1.9; Wanbao's and Jiaxipera's top models reached 1.8 and 1.76 respectively, compared to average efficiency of COP 1.0 in 2000 for all compressor company project participants. All three of the bid winners had met commercialization goals, with significant sales by Jiaxipera and Huangshi (331,000 and 755,000 high-efficiency units, respectively).

Retailer incentive programme

Through the retailer incentive programme, cash payments of over US$ 250,000 were awarded on a competitive basis to winning stores and individual salespeople. Additional funding of about US$ 200,000 went for programme administration, an award workshop, retailer education, purchaser awards and in-store consumer education materials.

In addition to the retailer and salesperson awards, the retailer incentive programme also included a lottery-style award for purchasers. This award was designed to give purchasers an additional incentive to buy energy-efficient refrigerators, and to collect additional information (a total of 12,892 information forms were submitted).

A total of 57 top nationwide retailers were recruited to participate in the programme, all of whom signed contracts committing themselves to achieving programme goals. A sales data collection system was established and in-store advertising materials were sent to each retailer. Retailer education was completed in April 2004 (200 salespeople received training by project staff). The retailer incentive programme contest was conducted from 1 May to 31 October 2004, after which the awards workshop was held to issue incentive funding awards. The first-place retailer award was won by the Shanghai Commercial Center. The first-place salesperson award was won by Ma Haiming from Beijing.

Participating stores and salespeople achieved sales of over 35,000 top-rated energy-efficient refrigerators. While this amount is small compared to total nationwide refrigerator sales, the programme was able to achieve a per-refrigerator incentive cost (approximately $7 per refrigerator) that was significantly lower than that achieved in comparable rebate programmes in other countries.

Project management and monitoring

In addition to technical and substantive project activities, the China Refrigerator Project established a structure to monitor achievement of project results and manage project activities. An information centre was established (managed under subcontract by CHEAA) to collect product and other technical and financial data from participating manufacturers. A testing centre was established at the China Household Electric Appliance Research Institute (CHEARI) to perform scheduled and random testing of new refrigerators and compressors in order to provide independent test results confirming efficiency gains. A project website

(*www.r-gefchina.org.cn/news/en/admin.asp*) was constructed and managed by CHEAA in order to provide project- and product-related information to project participants and the public.

Through participation in the project, the project management abilities of project executor SEPA/FECO, the Project Management Office (PMO) and its subcontractors have grown steadily, and good, productive relations have been established among national and international experts and other project stakeholders. The principal structure for interaction among project stakeholders is the Advisory Committee (AC), which includes representatives from all relevant government agencies and NGOs, and which has been invaluable in providing management, guidance and coordination for the project.

PMO staff have also benefited by collaborating with national and international experts in organizing and implementing technical training workshops, as well as participating in project management–related training specifically undertaken to familiarize key PMO staff with project management techniques and practices.

The GEF implementing agency is UNDP. The domestic executing agency is the China State Environmental Protection Administration (SEPA); and the United Nations Department for Economic and Social Affairs (UN-DESA) is supporting the project as an international cooperating agency.

Stakeholder involvement

SEPA and FECO have also worked closely with representatives of the key government agencies involved in the appliance sector in order to ensure the success and sustainability of project activities, in particular the China National Development and Reform Commission (NDRC), the China State General Administration for Quality Supervision, Inspection and Quarantine (AQSIQ), the China National Institute of Standardization (CNIS), the China Certification Center for Energy Conservation Products (CECP), and others.

Most importantly, the project has been successful in working with its most important stakeholders: refrigerator and compressor manufacturers. The strong interest that manufacturers showed in the project and the sustained commitments they made in order to participate are evidence of this success. A total of 16 refrigerator manufacturers (four more than the 12 originally targeted) and 12 compressor manufacturers (double the six originally targeted) requested participation in the project, and made the necessary commitments to participate. In addition to meeting or exceeding their commitment to develop new, energy-efficient products, these manufacturers also invested significant resources in undertaking and completing project activities. Through 2004, participating manufacturers invested co-financing of over US$ 100 million in conjunction with their participation in project activities. This figure is far more than the committed funds (US$ 30 million) estimated in the project document. Why did these manufacturers, profit-seeking entities, participate to this extent? Because the project was designed in order to provide incentives for and maximize this participation, and ultimately because manufacturers were convinced (in no small part by project organizers and the technical and marketing research conducted during the project's PDF phase) that participation in the energy efficiency market transformation programme was in their own interest and vital to their competitive positions. This strong level of manufacturer involvement is both a major success indicator and, as a major leverage of GEF funds, a significant success in itself.

Experience and lessons learned

The China Refrigerator Project provides a variety of beneficial experiences and lessons learned for future implementation of other projects. First, during the process of project implementation, great attention was paid to

cooperation and establishment of good relations with government agencies, NGOs and donors, which greatly benefited project implementation. Close coordination with other key project stakeholders, particularly refrigerator and compressor manufacturers and government agencies relevant to the appliance sector, was essential. Coordination requires strong and constant communications with project participants, as well as ongoing monitoring of the progress of project activities, needs and requirements.

The successful implementation of the China Refrigerator Project has shown that project design is very important. As a market transformation project, the project included many more activities and was significantly more complex than a traditional highly focused project, but it was therefore able to achieve larger and more sustainable gains. Moreover, the design proved that the private sector can become fully engaged when it perceives that its marketable products as well as its production capacity can be enhanced through project participation.

The market development of energy-efficient refrigerator products includes two aspects: "pushing" efficient refrigerator production and "pulling" efficient refrigerator sales. In order to promote market development, the project adopted a wide variety of voluntary, mandatory and capacity-building measures. The combination of these measures created the conditions for long-term, sustainable transformation of the market in favour of energy-efficient compressors and refrigerators.

Finally, it is also crucial to conduct international exchange and cooperation. Many countries have significant experience with energy-efficient compressors and refrigerators. Through international exchange, research and cooperation, China was able to draw on that experience, jump-start progress in China and avoid mistakes by organizing a series of international and domestic workshops, study tours and training programmes.

Information sources

General project information is available from the China Refrigerator Project website *www.r-gefchina.org.cn/news/en/admin.asp*. The demonstration project technical report *Sino-US CFC-Free Super-Efficient Refrigerator Project Progress Report: Prototype Design & Testing, Summer 1997* and technical information regarding the prototype are available at *www.epa.gov/appdstar/appd* or from the project organizers. Copies of the project proposal, the project document and periodical status reports are available at *www.gefweb.org*.

Rapid commercialization of renewable energy in China

Introduction

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, including its extensive coal reserves (63 per cent of primary energy in 2003), petroleum (26 per cent of primary energy in 2003, with imports accounting for 31 per cent of crude oil consumption) and natural gas (3 per cent of primary energy in 2003), has remained firmly in place. Efforts to promote renewable energy in China have intensified in recent years, with several domestically and internationally supported initiatives, but the widespread commercialization and adoption of associated technologies are impeded by many challenges in capacity, financing, policy, technology and information. The project described in this brief is meant to address strategically a number of these challenges.

Project implementation, financing and time line

China's National Development and Reform Commission (NDRC) is the project's lead domestic implementation agency, with implementation support also provided by the State Environmental Protection Agency (SEPA). The United Nations Development Programme (UNDP) is the international implementing agency. The United Nations Department of Economic and Social Affairs (UNDESA) is the executing agency. A project Advisory Group (AG), including all project co-financiers and implementing and executing agencies, meets twice a year to review progress and provide advice and suggestions for future activities.

The project's overall budget is US$ 25.8 million, including funding from UNDP-GEF ($8.8 million), Australia ($3 million), the Netherlands ($2.53 million) and the Government of China ($11.5 million). The Government of China has also made significant in-kind contributions, including setting up the Project Management Office and providing support staff. The project was initiated in April 1999, will have a duration of six years and is projected to close in 2006.

Project objectives and strategy

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 combines emphasis on two main priorities throughout all components:

- Capacity-building (for the identification, development and implementation of commercial renewable energy projects);
- Commercialization (through lowering of technical, institutional and policy barriers and introduction of international best practice for market-ready renewable energy technologies).

Project strategy is based on a market sector approach, with activities focused on the technology application areas of: (*a*) biogas, (*b*) grid-connected wind, (*c*) solar water heaters, (*d*) hybrid village power and (*e*) bagasse; additional cross-cutting focal areas are (*f*) finance and (*g*) policy. Finally, critical to the project's success has been its close coordination with the central Government in support of the nation's various programmes for renewable energy.

Establishment of the Chinese Renewable Energy Industries Association

The project has supported establishment of the China Renewable Energy Industry 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 programmes. From an informal base of 60 members in 2000, CREIA gained official status in 2003 and has grown to 180 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 practice, capacity-building (through training, workshops and study tours), standards development, and promotion of business deals 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.[8] Building on these demos, project workshops have been successful in catalysing a substantial number of biogas business deals. The project is now supporting development of the biogas component of the Government's Biomass Strategy to 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 centres, two of which have achieved official laboratory accreditation in China. The project has also supported the establishment of a national solar water heater certification centre in Beijing. These efforts have all received an enthusiastic response from industry.

Wind power. The project has supported wind resource assessment at 10 sites, introducing international best practice 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 MW by 2020. The project's resource assessment methods have also been adopted by the Government, which was 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 China's eastern seaboard. As the Chinese Government pursues the world's most extensive renewable energy–based rural electrification programme, the project's emphasis on productive applications (e.g., microenterprises) will provide a model for promoting sustainability of village power installations.

Bagasse. The project aims to demonstrate the potential in sugar mills for cogeneration of heat and power (and sale of electricity to the grid) by burning fibrous processing wastes. A pilot project is being constructed at Guitang, Guangxi Province. A study tour to Australia and Hawaii and an upcoming workshop aim to build capacity for bagasse cogeneration in China and promote associated business development.

---

[8] Biogas plants create a substitute for natural gas, through anaerobic fermentation processes, at the same time breaking down polluting organic compounds.

Business Development and Financing

The project has held a series of training programmes 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 programmes and strategic planning in the market sectors of biogas, solar water heaters, grid-connected wind and village power, the project is also providing cross-sector policy support to the Chinese Government in the formulation of its Renewable Energy Development and Utilization Law.

China Renewable Energy Industries Association (CREIA)

Efforts to increase the use of renewable energy in China have, to date, relied primarily on technology demonstrations. Today, with several renewable energy technologies on the brink of commercialization, the nation's decision makers have recognized the potential of market mechanisms as a more effective means for promoting growth in the sector. Thus, they are exploring avenues for catalysing business deals and ensuring sound market development.

To strengthen the position of the renewable energy industry during this period of critical potential, the National Development and Reform Commission (NDRC)/UNDP-GEF project has supported the establishment of the Chinese Renewable Energy Industries Association (CREIA). As an independent, industry-led association, CREIA aims to provide networking and business development opportunities to its members; act as an industry advocate; raise awareness internationally of renewable energy investment opportunities in China; and provide the Government with policy advice on key issues. A target of financial self-sufficiency has been set for CREIA, so that the association will continue to thrive beyond the project's lifetime.

Within China, CREIA serves as a bridge between regulatory authorities, research institutes and industry professionals. It provides a forum for the discussion of renewable energy development issues at the national level. Based on input gathered, it advises the Government on the formulation of strategic policies.

CREIA is a window through which domestic and international project developers and investors are brought together. It promotes technology transfer and foreign investment in the sector through online approaches, regional meetings and training activities.

The association provides a network for Chinese renewable energy companies, which, in the past, have lacked access to timely information and a medium to communicate across subsectors. CREIA further provides them with a platform to voice their concerns collectively.

CREIA was established in January 2000, temporarily taking on company status. It was formally registered in March 2002 as a non-profit autonomous subsidiary of the China Comprehensive Resource Utilization Association. CREIA's membership consists primarily of domestic renewable energy companies, and its chief objective is to act on their behalf. The association's initial membership strategy has been selective, focusing on the strongest renewable energy companies across all subsectors, so as to build a solid foundation and reputation as a provider of high-value services for its members. CREIA has also invited a number of distinguished domestic experts from government and industry to become individual members, thus enhancing its networking and advisory base. CREIA operates under the guidance of a five-year business plan and an annual operating plan approved by the Board of Directors.

CREIA offers a wide range of services and support, including but not limited to:

- Web-based services, such as the Investment Opportunity Facility (IOF);
- Networking, training events, and study tours for industry;
- Policy and other support for the Government;
- Information and market support for members, provided through various channels, including key media outlets.

CREIA is currently working to upgrade its web-based services, of which the IOF will be a key component. CREIA created the IOF to promote business development and financing for renewable energy companies and projects in China. Databases will be available in both English and Chinese, providing the international audience (developers and investors) with information on domestic companies and government programmes and the domestic audience (Chinese companies) with information on international programmes and financing schemes. The Chinese and English versions of the IOF can be accessed at *www.creia.net*. CREIA's upgraded website will also provide members with training materials, resource assessments and updated information about CREIA activities and events around the world.

Since January 2000, CREIA has offered over 40 workshops and study tours on behalf of the Chinese renewable energy industry. These activities have provided extensive networking opportunities and offered a wide range of training curricula, including advanced business and project development, technology transfer, courses in specific technologies, and marketing. CREIA has been especially active in organizing financing events. Most recently, it has established cooperation with the World Wildlife Fund to provide training for CDM project development.[9]

CREIA has supported Government policy formulation through provision of sector analyses on solar water heaters, photovoltaics, wind and biogas. It is also involved in ongoing work for the development of specific policy recommendations. The association has further supported the Government through standards work in renewable energy subsectors. Finally, CREIA has provided critical assistance in implementation of the Government bond-financed wind programme, which, aiming to stimulate domestic production, resulted in the installation of 80 MW of high-domestic-content wind turbines.

Impacts and successes of CREIA

In its four years of existence, CREIA has developed a strong reputation for providing valued services to its members. It has played an active role in international cooperation and has generally succeeded in stimulating the industry through its multifaceted activities. Evidence of its success is given below:

- From an informal base of about 60 companies in 2000, CREIA has grown to a membership of 120. Companies are attracted by the business development opportunities, information channels and consultation offered. Despite the existence of other associations in some subsectors, CREIA is seen by members as the most effective forum for the industry to exchange information and collectively express its opinion.

---

[9] CDM refers to the Clean Development Mechanism, the mechanism that emerged in 1997 from the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) to enable developed countries to gain credit for emissions reductions through cooperation in projects implemented in developing countries.

- In a short time, CREIA has achieved the goal of financial self-sufficiency. In addition to a growing paid membership base, CREIA has been successful in landing contract work with a number of domestic and international organizations.
- CREIA has developed a reputation as the premier channel between China's renewable energy companies and businesses and organizations in other parts of the world. Reflecting growing recognition by the world renewable energy community, the association has recently been chosen as the East Asian Secretariat of the Renewable Energy and Energy Efficiency Partnership (REEEP). Emerging from the World Summit on Sustainable Development in Johannesburg in 2002, REEEP is increasingly seen as an important vehicle for expanding the global market for renewable energy and energy efficiency technologies through international cooperation.
- CREIA is playing an increasingly important role in promoting the latest information and marketing approaches in China. The association secured China's first "Emission Reduction Purchase Agreement" (signed with the Netherlands Government) under the CDM framework for one of its member companies and is well positioned to play a leading role in CDM project development in China.

Wind power programme

Current status

With its vast wind resources, escalating demand for power and growing environmental concerns, China represents a major, untapped opportunity for wind energy development. The nation's wind endowment is estimated to represent a potential of up to 250 GW of power generation, equivalent to 65 per cent of China's current total power generation capacity.[10] Yet, the installed capacity of China's 40 wind farms (containing 1,042 wind turbines) in 2003 was only 567 MW — less than one GW. India, an example of a developing country taking a more aggressive stance on wind power, had 3.7 times this capacity in 2003.

Most of China's existing wind capacity was built using bilateral assistance and soft loans tied to equipment imports, though the industry is now in the midst of a transition to commercial project development. Analysts agree that China's wind sector currently has at most only one successful, fully commercial project. To attract more commercial investment to the sector, the Government of China has recently adopted a concession approach with guaranteed power purchase prices. In 2003, the country's National Development and Reform Commission (NDRC) granted the first two contracts for such wind concession projects to domestic investors.[11]

Indeed, after an extended moratorium on approval of wind projects, recent Government activity presages a potential take-off. NDRC's new and ambitious plans for the sector are outlined in its national wind development programme, which calls for:

- By 2005, 30 potential wind farm sites' wind resources measured and characterized;
- By 2010, 4 GW of installed capacity, through both concessions and other business models;
- By 2020, 20 GW installed (over 30 times 2003 capacity).

---

[10] A gigawatt (GW) is a billion (1,000 million) watts, while a megawatt (MW) is a million watts. Thus, 1,000 MW are equivalent to one GW.

[11] NDRC is a product of government restructuring in 2004. Its predecessor was the State Development and Planning Commission (SDPC).

In addition to this programme, the Government has promulgated a series of incentive policies to promote investment in wind power and is in the midst of formulating the Renewable Energy Promotion Law, which should further enhance the business environment in China's wind sector.

UNDP-GEF project support for wind power in China

All of the UNDP-GEF project's wind power activities are fully integrated into the national wind development programme, and work is carried out in close cooperation with NDRC. The aim of the project's wind power component is to facilitate the Government programme's ambitious pace and ensure that past shortcomings in upstream aspects of wind project development are ameliorated so as to yield bankable projects with high success potential.

In the past, a critical weakness of wind projects in China has been the quality of resource assessment work; projects have, as a result, often not delivered the power expected. To address this issue, the UNDP-GEF project is supporting a series of activities directed at characterizing new wind sites with high potential for commercial development. These activities combine capacity-building with direct support of NDRC's project pipeline, by engaging both domestic and international entities to work together in performing assessment work and by providing training in international best practices.

Working with the Longyuan Power Company (China's top holder of wind farm assets following power sector restructuring), the project supported installation of approximately US$ 1 million of wind resource monitoring equipment in 2002 at 10 sites distributed throughout China. Wind development potential of each site is at least 100 MW and often much larger—up to 1,000 MW or more. A typical site configuration includes one 70-metre tower and three 40-metre towers for data collection. Longyuan coordinates 10 local field organizations responsible for data acquisition and site maintenance; and the project further supports these groups by an extensive training programme.

Data from the 10 field sites will soon be validated and analysed through cooperation with the China Hydropower Engineering Consulting Group. China Hydropower will work with RISO in Denmark to utilize the latter's WASP model in wind flow analysis. The British company Garrad Hassan has been retained to cross-check results and work closely with banks and other investors to ensure that the assessments achieve credibility with the financial sector.

Impacts and successes of the UNDP-GEF project in China's wind sector

The project has been remarkably successful in achieving its goal of supporting the Government of China in the development of wind power, with key indicators as follows:

- Project activities have been fully incorporated into NDRC's strategic planning process for China's national wind development programme. Specifically, NDRC has included all 10 of the project's wind sites under evaluation into its national programme for investigating 30 new, high-potential wind sites by 2005 for near-term development.
- NDRC has directly adopted the project's field installation and data acquisition methods for all of its future wind resource assessments and has already begun to apply these to numerous other sites.
- Chinese organizations (e.g., Longyuan, China Hydropower and local field organizations) have developed increased capacity for wind resource assessment. Policy formulation has also been enhanced through the project's contributions to overall planning and the concession strategy.

Indeed, given the substantial lead times necessary for wind resource assessment (generally at least two years), project activities are playing a critical role in supporting the rapid pace targeted by the Government programme and feeding its project pipeline. Wind site characterization conducted through the project is at the level of commercial pre-feasibility studies; NDRC plans to use this work in pursuing commercial development by competitive bidding. Sites characterized by the project potentially represent at least 1,000 MW of the 4,000 MW NDRC has targeted for development by 2010.

Aside from direct catalytic impacts on the wind power project pipeline in China, the UNDP-GEF project can also be seen to have had broader, "multiplier" effects. Now fully convinced of the critical importance of high-quality and extensive resource assessment, NDRC has adopted the project's field installation and data acquisition procedures and protocols for wind resource monitoring to enhance the bankability of projects. While short-term official Government plans call for 20 more site assessments by 2005, recent reports that Longyuan has purchased a total of 200 additional data-collection towers indicate that the advance towards wind power is on an even faster track. This purchase represents a potential for assessment of 50 more sites, an immediate multiplier effect of five times for the project in the short term alone.

Building on these positive impacts, further assistance targeted to stimulate the project pipeline and attract the involvement of a range of industry and financial players is being considered. Potential cooperation would focus on the establishment of innovative financing mechanisms for both wind farms and a national turbine industry.

Industrial-scale biogas programme

Current status

China's extensive biomass resources (estimated at 5 billion tons annually) include substantial animal wastes and organic industrial effluent, appropriate raw materials for the production of biogas. While most biomass resources used as energy in China today are not converted into modern energy carriers, biogas can be used as a substitute 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 quality organic fertilizer.[12]

While China has extensive experience with biogas at the household level (with roughly 2 million rural household digesters in operation), industrial-scale production, appropriate for medium- to large-scale livestock farms and for manufacturing operations in such sectors as liquor, beer, pharmaceuticals and food starch, lags far behind potential. Indeed, as meat consumption continues to rise in China, water pollution from animal manure produced at livestock and poultry farms has emerged as a key environmental problem, creating both a treatment necessity and a sizeable biogas production opportunity. Estimates place manure generated at such farms at over 900 million tons annually, with an electric power potential of over six gigawatts (GW).[13] Industrial organic wastewater effluent, also on the rise as China's economy grows, has reached 2.8 billion m^3. 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 advanced CHP (combined-heat-power) technologies.

---

[12] In anaerobic fermentation processes, bacteria break down organic compounds in the absence of oxygen, while aerobic processes take place in the presence of oxygen.

[13] A gigawatt (GW) is equivalent to 10^9 watts or 1,000 megawatts (MW). For comparison, a typical scale for a modern coal-fired power plant is 100 MW.

In contrast to the European Union's 1.8 GW (2002) of mainly profit-driven installed capacity, the major driver of China's industrial-scale biogas projects has been compliance with environmental regulations. In 2002, China's State Environmental Protection Agency (SEPA) issued 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. Aerobic fermentation is often used for second-stage treatment in order to fully meet national discharge standards, as compared to Europe, where first-stage effluent is used in irrigation. China has more than 700 small to mid-size industrial-scale biogas plants, but increased deployment and incorporation of international best practice to promote commercial viability are needed.

UNDP-GEF project support for industrial-scale biogas in China

The project has co-financed three pilot industrial-scale biogas projects, representing advanced international best practice in design and construction of commercial facilities and covering the two key market sectors (industry and livestock). Table 3 provides details on the characteristics of these projects, which include two pig farms (one formerly the largest in the world) and a distillery.

Table 3. Characteristics of pilot biogas facilities

Characteristics	Dengta Pig Farm (Hangzhou, Zhejiang Province)	Shunyi Pig Farm (Shunyi, Beijing Municipality)	Jiuchang Distillery (Qingdao, Shandong Province)
Scale	200,000 pigs	60,000 pigs	10,000 t/year alcohol
Wastewater	3,000 tons/day	600 tons/day	10,000 m^3/day
Biogas produced	8,500 m^3/day	2,200 m^3/day	10,000 m^3/day
Biogas application	Electricity, some heat	Electricity, some heat	Boiler fuel for processing heat
Generating capacity	230 kW	100 kW	N/A
Use of electricity	Sold to grid	Used on site	N/A
Other output	142 tons fertilizer/day	8 tons fertilizer/day	Solids recycling

Business and industry development work aims to catalyse deals among developers, end-users and the financial sector and introduce international best practice. 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 about potential projects. To further introduce international best practice, the project has financed preparation of a detailed guidebook, *International Biogas Best Practices Report*, which will soon be published in Chinese.

Current project work is focused on (*a*) facilitating a transition from environmental compliance–driven to profit-motivated biogas projects and (*b*) supporting policymakers 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 thus have greater potential for selling electricity to the grid. In the policy arena, the project is assimilating experience and preparing a draft Biogas Action Plan. The plan is to 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.

Impacts and successes of UNDP-GEF project in China's industrial-scale biogas sector

The project has already achieved a number of notable successes to date, suggesting a substantial impact on the development of industrial-scale biogas in China:

- The project has achieved concrete results in catalysing the spread of biogas development projects in China. A limited survey of bioengineering companies indicates that 34 new biogas projects at livestock farms have been developed, with deals resulting directly from discussions held at the project's first three workshops. Ongoing multiplier effects are likely much greater. Already, third-party investors have begun to get involved in biogas projects.
- The pilot projects have been shown to provide China with easily replicable designs, as demonstrated when the local government shut down the Dengta Pig Farm, requiring that its biogas plant be reconstructed outside the city limits. The new plant was constructed with great efficiency, in only six months.
- Project outputs are having a direct impact on policymaking. The project's *China Biogas Project Development Guidebook* is already being used by the National Development and Reform Commission (NDRC) in preparation of the biogas component of its Biomass Strategy through 2020. NDRC has also indicated that it will make use of the project's Biogas Action Plan as a key input to the biogas portion of its Biomass Strategy. In addition, the project has had an impact on local governments, such as Hangzhou, which took action to implement new standards once the project demonstrated the potential of biogas solutions.
- 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.

Solar water heater programme

Current status

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 m^2 or US$ 1.28 billion, compared to 900,000 m^2 in the European Union, the world's second largest market. China's 2002 production was 10 million m^2; and cumulative installed capacity reached 40 million m^2 (compared to 10.8 million m^2 in the European Union). Recently, sales in China have grown rapidly, more than tripling between 1998 and 2003.

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.

Despite recent growth, the sound expansion of China's solar water heater industry has been impeded by the highly variable quality of products on the market. With over 3,000 often small-scale Chinese companies involved in manufacture 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 a handful of companies used to dominate sales, the market share of small manufacturers has grown in recent years.

Since the second half of the 1980s, the Chinese Government has been supporting the sector through funding for research and development and technical upgrading loans. 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 programme to ensure that solar water heaters regain and maintain their reputation among households as a reliable alternative to electric and gas water heaters.

UNDP-GEF project support for solar water heaters in China

Working in close partnership with China's National Development and Reform Commission (NDRC) and other relevant agencies, the project has provided critical support to the development of the nation's solar water heater programme in three areas: (*a*) standards, (*b*) testing and (*c*) certification. An aggressive promotion and media campaign has also been undertaken to ensure that industry stakeholders will participate in the programme. In the standards area, the project has addressed the problem of an incomplete and outdated standards system and collaborated with the Chinese National Institute for Standardization (CNIS) to develop a full framework of requirements for component and system performance.

In the area of testing, the project cooperated with CNIS and the State Technical Quality Supervision Board (STQSB) in 2002 to conduct competitive selection of three national test centres. Given China's large and highly dispersed solar water heater production base, an institute in each of north, central and south-west China was selected as follows:

- Institute of Air Conditioning, China Academy of Building Research, Beijing (north China);
- Hubei Product Quality Supervision and Testing Institute (central China);
- Solar Energy Research Institute of Yunnan Normal University (south-west China).

The project has emphasized the introduction of international best practice in building up collector and full system test capabilities and has arranged for the Netherlands' Ecofys and Australia's University of New South Wales to work with the test centres. In addition, as preparation for finalizing the design and construction of testing equipment and facilities supported by project cost-sharing, the project sponsored visits by test centre staff to test centres in Greece, Portugal, Switzerland and the Netherlands.

Finally, in the area of certification, the project has worked with the Certification and Accreditation Administration of China (CNCA) in setting the stage for a solar water heater certification system. In October 2003, CNCA established the national solar water heater certification centre at Beijing Jianheng, an organization under the China National Institute of Measures. With support from the project and input gained through exchange with Europe's Solar Keymark programme, the centre is now working to develop a certification and labelling programme for solar water heater products in China, which it will eventually oversee. It will also be responsible for coordination and final approval of procedures and protocols used at the three national test centres. Once certification and labelling 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 labelling and quality issues.

Impacts and successes of UNDP-GEF project in China's solar water heater sector:

From the start, the project's solar water heater component has been highly integrated with the Government's work, so that project activities in essence have been equivalent to the Government programme for completing its standards framework and establishing testing and certification. Highlights of specific project successes include the following:

- Four new standards were developed with CNIS and approved, accomplishing (as of October 2003) the updating and completion of China's standards framework for solar water heaters and their components. The new standards form the basis for a national testing system and are consistent with the ISO and European EN systems.
- Two of the three test centres (Beijing and Wuhan) established by the project received laboratory accreditation from the STQSB and were formally designated national solar water heater testing centres by the Chinese Government in March 2004.
- Promotion work and efforts to involve industry have met with considerable success: industry has expressed strong enthusiasm for the new standards and plans for testing. These have also gained substantial coverage in the media.

Beyond accomplishments to date, the national solar water heater testing and certification programme facilitated by the project has enormous potential impacts. In short, it is poised to play a critical role in promoting the strong and continued growth of the world's largest solar water heater market by increasing the confidence of Chinese consumers in the sector's products.

UNDP-GEF support for China's national rural electrification programmes

From 2002 to 2004, the Chinese Government supported the installation of ~15 MW of PV in hybrid village power systems in rural areas in a major programme designed to electrify the remaining 1,065 unelectrified townships in 10 provinces in western China. Known as the Song Dian Dao Xiang or the National Township Electrification Programme, by the end of 2004 approximately 660 townships were electrified with PV/battery hybrid storage systems (~15 MW) and by the end of 2005 an additional 300 townships will be electrified with small hydropower stations (~275 MW). At present, planning for a follow-on programme, known as Song Dian Dao Cun, is directed at the 20,000 remaining smaller unelectrified natural villages, located mainly in the remote western regions of China. The UNDP-GEF has been providing support to the National Development and Reform Commission to address some of the key issues affecting sustainability of the township programme, including performing surveys and assessments, providing training support, exploring business models for managing township systems, and developing recommendations for national policies. With the passage of the Renewable Energy Law in China in February 2005, national policies are now being developed to provide a sustainable support basis for China's national rural energy development programmes.

Background

China has extensive historical experience with the development of renewable energy systems for rural electrification. From the late 1970s through the 1980s, system integrators and equipment manufacturers underwent a period of capacity-building, developing experience with Government-supported demonstration programmes and a commercial market for remote telecommunications systems and other industrial applications. Starting in 1996, the Chinese Government initiated the "Brightness Program", representing a domestic programme for pilot village power projects using small wind systems, solar home systems and hybrid village power systems, with a particular focus on Tibet, Inner Mongolia and Gansu. Examples of projects include: 5,500 hybrid PV/wind/battery hybrid household systems

installed in Inner Mongolia in 2003; 10,000 solar home systems installed in Gansu in 2002; and 30 PV/battery village power systems and 11,000 solar home systems installed in Ali in Tibet in 2001.

International bilateral and multilateral programmes have also provided access to international experience and best practices for rural electrification using renewable energy technologies. Examples include: a 21 million euro Shell Solar and Sun Oasis solar home system project in Xinjiang targeting the installation of 78,000 household systems in 2000-2006; a 20 million euro GTZ/KFW project in four provinces to install and monitor village power systems; and capacity-building programmes supported by the World Bank, UNDP, the United States Department of Energy etc. in general having a significant business and commercialization focus.

China's national programme

With the extensive foundation laid during the more than 15 years of experience with rural energy systems, in 2001 China began preparation of a major national rural electrification programme authorized by the State Council. The National Township Electrification Programme (Song Dian Dao Xiang) was initiated in 2002 with the goal of electrifying the remaining 1,065 administrative townships in rural western China. The programme was funded with 2 billion RMB (US$ 240 million) from the central Government and 2.7 billion RMB (US$ 330 million) from local provincial and township governments. The programme was executed with competitive bidding at the provincial level, and most systems were installed during the mid-2002 to 2004 time frame.

To date, approximately 662 community-scale village power systems have been installed in townships (an additional 49 systems have been installed at military posts), consisting primarily of PV/battery systems, with a cumulative installed capacity of about 15.7 MW. These township systems have been installed in Tibet, Qinghai, Xinjiang, Inner Mongolia, Gansu, Sichuan and Shaanxi provinces and autonomous regions in western China. One hybrid system containing 210 kW of wind and 90 kW of PV has been installed at Ma Zhong Shan in Gansu. All systems contain battery storage, but not all systems contain backup diesel generators. Small hydropower systems have been targeted for an additional 302 townships with a cumulative capacity of ~274 MW in 10 provinces/autonomous regions and Chongqing. Approximately 15,000 solar home systems have also been installed in the programme to date.

Institutional development

The execution of the National Township Electrification Programme was extremely rapid, focusing on the bidding, contracting and installation of systems. The National Development and Reform Commission (NDRC), which is responsible for the implementation of the programme, is now in the process of developing an infrastructure to ensure the long-term sustainability of the township systems. The UNDP-GEF project Capacity-building for the Rapid Commercialization of Renewable Energy in China, along with other international organizations, is assisting NDRC to address the following issues:

Ownership. The Chinese Government is accelerating the transfer of ownership of the township systems from the national Government to the local provincial and township authorities.

Tariff regulation. At present, electricity tariffs charged for customers of the township systems vary greatly from province to province and from system to system (a range of 0 to 2.0 RMB based on surveys conducted by the UNDP-GEF project). NDRC is in the process of establishing uniform tariff regulations for the township systems.

Financial support. It is known that the long-term financial requirements of township systems, such as battery replacement etc., will not be covered by electricity tariff revenues alone. The Renewable Energy Law, which was passed in February 2005 by the National People's Congress, will provide a financing mechanism to provide continuing

government cost-sharing for the township systems. The details of the cost-sharing system will be established by the end of 2005. NDRC is currently assessing the detailed cost requirements for maintaining the township systems over a 15-year operating period as input into this process.

Management. Four models are under investigation for management of the township systems (see table 4). To the extent possible, the management of systems will be structured as a small business.

Table 4. Four management models

Utility ownership	Provincial utility companies in Shaanxi and Sichuan will own and operate township systems
Lease contract	Established in Tibet with GTZ assistance for small hydropower systems; village owns system and leases to a professional management company
Community-owned and -operated	Department of township government owns and operates system
System integrator company as RESCO	System integrator establishes a company to manage systems under contract to township

Training. The training requirements for the township programme are substantial and must be addressed on several levels (engineering training for system operators, management training, training for system integrators and equipment manufacturers etc. based on planned future expansion of the national programme). NDRC is in the process of determining the requirements of a continuous training system to be conducted in a network of existing provincial institutions.

UNDP-GEF project assistance

Working in cooperation with the National Development and Reform Commission, the UNDP-GEF project in China has provided support in the following areas:

Capacity-building and information exchange. The project has published the *Village Power Project Development Guidebook* and has executed several workshops emphasizing sustainable development principles for rural energy development, working directly with government decision makers and the system integrator community.

Baseline survey and training. In 2005 the project was conducting a field survey of the installed systems in collaboration with the Energy Research Institute in Beijing to develop a database to provide information for current planning purposes and future evaluation. In collaboration with the Institute of Electrical Engineering in Beijing, the project developed a curriculum and management training programme for future renewable energy service companies complementing an engineering training programme for system operators that was developed with the support of GTZ.

RESCO model. The project established a rural energy service station model for management of village power systems in Bulunkou township in Xinjiang, which was managing 10 hybrid wind/PV/diesel/battery systems during 2002-2005. This project contains characteristics of and is a precursor for RESCO companies operating as a small business to manage large numbers of village power systems. In the near future, NDRC plans to establish RESCO pilot projects in Qinghai, Xinjiang and Tibet with the assistance of the GEF/World Bank renewable energy development programme in China.

China has made a commitment to expand the national rural electrification programme to some 20,000 un-electrified natural villages and a large number of remote rural households in western China, known as the Song Dian Dao Cun programme. Ultimately, this programme could be financed at a level of US$ 5 billion over 10-15 years. A 20 million RMB pilot phase for Song Dian Dao Cun has been approved by NDRC to be conducted in three provinces in 2005.

Bagasse cogeneration programme

Background

The sugar industry is one of the main economic industries in southern China. In 1997/98, total planted area of sugar cane was 1.30 million hectares and produced an output of 79 million tons of sugar cane. The sugar cane, used as raw material for production of sugar, produced 19.75 million tons of bagasse, which is equivalent to 4.95 million tons of coal when used as boiler fuel.

Sugar refining consumes a great amount of steam and electricity. For this reason, sugar refineries generally have their own power station. They use bagasse as fuel for boilers, producing steam to drive turbine generators. The generated power is used by the sugar refinery itself and is usually not provided to external electric networks. The back-pressure steam is used for sugar and alcohol production.

Due to historical reasons, sugar refineries in China are typically small-scale, with daily milling less than 2,500 tons, although some consolidation is under way. These sugar refineries usually have smaller-capacity boilers and turbine generators, which are of lower thermal efficiency. For example, the designed efficiency for boilers with 75 tons/hour is 87 per cent, while that for boilers with 20 tons/hour is 75 per cent. The large difference in their efficiencies leads to a great waste of primary energy.

In order to obtain higher utilization efficiency of primary energy, to control environmental pollution and to reduce emission of greenhouse gases, efforts are needed to replace old boilers and turbine generators having low performance and small capacity with medium-pressure boilers and turbine generators of higher performance and larger capacity. This will improve energy efficiency. Based on this background, the GEF sought to enhance the technical level of energy utilization in sugar refineries and to change their management mode through a demonstration project.

After a study conducted by the Government, it was agreed to take the Guangxi Guitang Group Company as the demonstration refinery because it is the largest sugar refinery of China and leads in comprehensive utilization. In addition, Guitang agreed to fund all technical innovations proposed by the project.

The milling capacity at Guitang is currently 10,000 tons/day, and it can treat more than 1 million tons of sugar cane annually, producing about a quarter million tons of bagasse. The proportion of pith from self-produced bagasse is 40 per cent, which means 100,000 tons of pith from the bagasse can be used as fuel for each year. The remainder is used as input for paper production. The proportion of pith from purchased bagasse is 15 per cent and 30,000 tons of pith can be obtained each year.

In the process of its expansion and technical alteration, most equipment for heat power in Guitang has been updated. Nevertheless, it still cannot satisfy the demand for electricity. A paper production line with output of 40,000 tons per year is in construction and will consume 7,500 kW of electricity and 40 tons/hour of steam. The new paper production line will require more electricity and steam than the old refinery could produce. Therefore,

the demonstration project not only satisfied the demand of expanding production but also enhanced the technical level of power generation and economic efficiency, as well as protecting the environment.

Technical scheme and implementation

The demonstration project installed a 12 MW turbine generator and its auxiliary devices and a new 75 tons/h boiler. In addition to bagasse, the boiler could also burn pulverized coal. Total investment for the project was RMB ¥ 34,936,100.00, excluding interest in construction period and current capital. Project evaluation was performed by the Guangxi Institute of Electricity.

As a result of the completion of the project in December 2004, energy efficiency and environmental conditions improved. The energy savings are shown in table 5.

Table 5

Coal consumption	New 12MW turbine generator	Old 12MW turbine generator
For steam	115.8 kg/t	117 kg/t
For electricity	401 g/kWh	560 g/kWh

The price of electricity if purchased from the grid is RMB 0.50/kWh. The cost of the project was RMB 0.274/kWh. As a result, Guitang will save RMB 18,790,000 a year from the project.

Emerging lessons learned

Industrial-scale biogas investments are feasible by the soundest Chinese firms. The biogas workshop series and the subsequent biogas investments by industry, which were facilitated by the workshops, demonstrated that the top 20 per cent 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. At the same time, the project is supporting the development of a national action plan for industrial-scale biogas development, which will offer a blueprint for improving the domestic policy environment for creating favourable investment-grade biogas power projects that will further stimulate the deployment of biogas technologies for industrial applications.

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 15 cents/kWh) seems to be about the maximum that can be collected. Households are willing to pay higher amounts for solar home systems, but as soon as grid extensions arrive, people compare themselves to those paying urban tariffs of 0.5 RMB/kWh or less.

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".

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.

New national rural development programmes offer challenges and opportunities. The village-scale power programme was restructured to accommodate the reality of the Chinese Government's National Township Electrification Programme in western China. The project has refocused its efforts in support of this bold Chinese initiative, which represents the most aggressive international programme yet launched for rural electrification using renewable energy–based technologies. In the future, the project will provide training support to SDPC to introduce new ideas for business models for operation and management of village power systems and make linkages between village power systems and income generation, through use of productive applications and support of village enterprise development.

Information sources

General project information is available at the China Renewable Energy Industries Association website *www.creia.net.* Copies of the project proposal, the project document and periodical status reports are available at *www.gefweb.org*.

Market transformation through energy efficiency standards and labelling

Introduction

Worldwide, building energy use accounts for 34 per cent of energy consumption and about 25-30 per cent of energy-related carbon dioxide CO_2 emissions, as well as substantial amounts of sulphur dioxide (SO_2), nitrogen oxides (NOX), carbon monoxide (CO), particulate matter (PM) and other energy-related local pollutants.[14] Energy use in the building sector (principally household appliances, heating, cooling, lighting, and other energy-consuming household equipment) is a large and growing share of total energy use.

Due to economic growth and the increasing standard of living, growth in building energy use is particularly strong in developing countries. For example, in some Asian countries energy use in commercial sector buildings is growing by as much as 8.9 per cent annually. Without focused efforts to reduce the energy consumption by appliances and equipment, residential and commercial building electricity demand will continue to grow rapidly, taxing energy supply and delivery systems, restraining economic growth, and resulting in significant global and local environmental damage.

An energy efficiency standard is a regulation that prescribes minimum energy performance (that is, the maximum energy use) of an energy-using product (most commonly, household appliances, lighting products and other energy-consuming equipment). Energy efficiency labels are information labels attached to manufactured products indicating the product's energy efficiency rating or estimated annual energy use in order to provide consumers with the data necessary to make an informed purchase. Appliance energy efficiency labelling and standards can be a primary force in the creation of stronger markets for energy-efficient goods and services. By gradually eliminating low-cost, inefficient appliance models and by stimulating the development of more efficient technologies, labels and standards increase a country's overall energy efficiency.

Energy standards and labelling (S&L) programmes are often a highly cost-effective way to improve the building of energy efficiency. In the United States, each $1 of taxpayer money spent by the Government on existing standards will, over the life of those standards, result in $350 to $440 investment by consumers in energy efficiency and $610 to $760 net savings from fuel reductions. The United States experience with S&L programmes dramatically demonstrates the enormous energy savings that can be achieved with these policies. By the year 2020, standards will reduce annual residential energy consumption in the United States by a projected 8 to 9 per cent compared to the levels expected without any standards, saving a cumulative total of 25 to 30 quads of energy and 422 million metric tons of carbon by 2015 and 60 quads of energy and 964 metric tons of carbon by 2030.[15]

Based on programme results to date, successful implementation of appliance labelling and efficiency standards in the developing world can yield similar if not more significant results. Experts estimate that in some developing countries the adoption of comprehensive appliance labelling and efficiency standards could help shave electricity

---

[14] *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting*, 2nd edition, CLASP, February 2005.

[15] CLASP phase 2 project document.

consumption by as much as 10 to 20 per cent over the next 25 years, with concomitant reductions in greenhouse gas (GHG) emissions and consumer energy bills.

The project's goal was to promote the cost-effective adoption of energy efficiency standards and labels in the developing world, with particular focus on China, India and Brazil. In each of these countries, the project worked closely with government authorities and other stakeholders to develop and strengthen country-based and country-owned standards and labelling programmes. The focus of this work was to build national capacity and strengthen national and regional networks through technical assistance, training and provision of informational, technical and financial resources.

The project also conducted targeted country or regionally based activities in Ghana, South Africa, Mexico and Poland and in the South Asia region. Finally, the project developed a variety of informational and analytical tools and other materials, which were made available to interested parties via conferences, training workshops and the Internet, in particular the CLASP standards and labelling *Guidebook*, the CLASP website, the policy analysis calculator and model survey forms.

This case study describes and presents the results and findings of a United Nations project that sought to transform markets to higher levels of energy efficiency through implementation of a global programme on energy standards and labelling. The project technical counterpart is the Collaborative Labeling and Appliance Standards Program (CLASP), which is a World Summit on Sustainable Development (WSSD) partnership and non-profit corporation that seeks to serve as the primary international voice and resource for policymakers and practitioners of energy efficiency standards and labelling. The project is being implemented by the United Nations Department of Economic and Social Affairs (UNDESA).

The project's goal was to promote energy efficiency by providing technical assistance and/or informational tools to help developing countries develop and implement minimum energy performance standards and energy efficiency labels for appliances, lighting, motors and other energy-using products. CLASP was funded in two phases by the United Nations Foundation (UNF) and other donors.[16] Phase 1 was implemented from April 2000 to the end of 2001 with seed funding of $1.61 million from UNF and approximately $1.4 million from the Energy Foundation (EF), the International Copper Association (ICA), the Global Environment Facility (GEF), the United States Environmental Protection Agency (USEPA), the United States Agency for International Development (USAID) and the United States Department of Energy (USDOE). Phase 2 was implemented from the end of 2002 to the end of 2005, with funding of $1,250,000 from UNF (including a $750,000 pass-through from USAID), with parallel funding of $872,000 from USEPA, the Climate Technology Initiative and the Energy Foundation.

Each of these activity areas is discussed in detail in the following sections.

China country programme

The project's China programme is the largest and most comprehensive programme component. Activities included work on four energy efficiency standards, endorsement labels for three energy-efficient products, development of a new energy informational label, technical training, and a product prioritization study for future labelling work.

---

[16] Project code ESA/GLO/99/095 for phase 1 funding and ESA/GLO/02/236 for phase 2.

The project collaborated with seven major in-country institutions, the key Chinese institutions responsible for standards and labelling policy. These included the National Development and Reform Commission (NDRC), which oversees all standards and labelling work; the National Commission for Standardization Management (formerly part of the State Bureau of Quality and Technical Supervision), which is responsible for approval and implementation of energy efficiency standards; the China National Institute of Standardization (CNIS), responsible for analysis, proposals and stakeholder involvement in the standard-setting process; the China Center for the Certification of Energy Conservation Products (CECP), responsible for the development of energy efficiency criteria for the nationally certified energy efficiency label; the China Institute of Metrology and the China Energy Conservation Association, responsible for oversight and management of China's certified national testing laboratories; and the Shanghai Electric Apparatus Research Institute (SEARI), the only internationally certified motor testing laboratory in China.

The programme's goal was to support and build on national activities that were planned or already in process in China, but for which international assistance was needed. For example, China was already developing new minimum efficiency standards, but with a budget of only US$ 1,200 per standard, and without engineering simulation, national impact analysis, financial analysis, and other key elements of standard development. The programme therefore focused on training Chinese staff to use these new analytical techniques for each standard under development.

The same approach was adopted with energy efficiency labelling. At the project's inception, China had a voluntary endorsement label in place, but no tools with which to evaluate potential energy savings of labelled products or the cost/benefit impact of the label criteria. The project therefore focused on providing those tools and training Chinese staff in their use.

New standards development for fluorescent lamps

Support for development of fluorescent lamp standards comprised training and support for stakeholder meetings. Six Chinese technical experts were trained in development of fluorescent lamp standards. This training included support for development of the technical support document for the standards, which includes the results of the techno-economic analysis and provides direct input to the development of the draft standards. Support was also provided to CNIS for the organization of three stakeholder meetings involving government, industry and academic experts to review the draft, revised and final standards for fluorescent lamps. These meetings preceded the final release and implementation of the standards. As a result of the training and stakeholder support, new mandatory fluorescent lamp standards were enacted at the end of 2002, yielding estimated carbon savings of 3 million tons in year 10 of operation and additional annual savings thereafter.

Development of new "reach" standard for motors

The Chinese Government approved a new policy approach to standards development that will result in significantly tighter minimum efficiency standards, combined with a longer lead-in time for manufacturers to prepare for changes in the standards and thus improve predictability and reduce compliance costs. In the past, energy efficiency standards in China were developed in small step increments for immediate implementation, resulting in manufacturers' inability to plan for longer-term changes.

Technical assistance was provided to CNIS in the establishment of new mandatory minimum efficiency standards for small and medium low-voltage air conditioner motors. This also included support for outreach for the involvement of motor manufacturers and other stakeholders in the review of proposed motor minimum efficiency standards (130 individual stakeholders, including manufacturers, users, research institutes,

universities and government agency staff contributed comments, more than 60 persons provided their feedback on the standards, and more than 30 persons participated in the review meetings).

The project conducted a manufacturers' survey and a consumer survey on the motor sector and motor efficiency levels. It also analysed international motor standards.

A stakeholder workshop was then held, which decided to propose for China the "Efficiency 1" level of motor efficiency as currently in use in the European Union, with a further move to the "Efficiency 2" level in 4 to 5 years as the "reach" part of the standard. A new mandatory motor standard for small and medium motors was approved and issued in 2002. The new "reach" motors standard was completed and then formally adopted in December 2004.

Other standards work

The project provided support for initial data collection and analysis by CNIS for a new central air conditioner standard. This included organization of a technical committee of government, industry and research institution stakeholders, development of a database of central air conditioning energy and market data; and preparation of a draft central air conditioner standard for review by stakeholders. The Government is implementing a new reach standard approach for room air conditioners, in parallel with and similar to the approach being taken for motors. Work also focused on training in technical and economic analysis for development of a washing-machine standard. Eight Chinese technical staff received training, and a draft new washing-machine standard was completed in 2002.

Endorsement efficiency labelling of office equipment

In 2002, the Government approved the research and analysis needed to develop a new mass procurement programme for energy-efficient products. A policy proposal for pilot implementation in government buildings (including central and local government, universities, schools and hospitals) was completed in December 2003. The programme includes labelling of the most standard office equipment, including computers, monitors, fax machines, printers, scanners, copiers and televisions. Prior to the project, none of these products had been certified for energy efficiency labelling. Work under this task included:

- Analysis of the market, usage and technical performance of each of these products in the China market;
- Development of an energy savings model for each product;
- Preparation of draft efficiency criteria for each product;
- Stakeholder meetings to discuss proposed efficiency levels;
- Certification of each office equipment product for inclusion in the government procurement programme.

All covered products were certified by December 2003. Projected savings from office equipment certification are expected to reach 420 kilotons carbon equivalent per year beginning in 2012. Building on and partially in response to the certification programme, the Ministry of Finance announced a new government policy for mandatory energy efficiency procurement of labelled products, which began in early January 2005.

Standby power losses have also been identified by the Government as a key concern, and this has led to development of plans for comprehensive standby power management. Results included: implementation of a first-ever survey of Chinese household standby energy use; participation by China in international standby power initiatives; and preparation of a plan for labelling standby power products, beginning with DVDs.

Development of China's energy information label

China decided to pursue the preparation of an energy information label as a further means of educating consumers about life-cycle energy costs for major appliances. The refrigerator was selected to be the first labelled product, and project support for this effort was extensive. First, an analysis was made of the product's current market and technical options. Then technical staff of CNIS were trained in the development of a criteria-setting model. A market research study was undertaken to test consumer reactions to various label designs and to determine the most effective message on labels. Subsequently, stakeholder meetings were organized and an implementation plan was finalized. Finally, the new information label was launched.

Energy efficiency information and endorsement labelling integration

China is one of relatively few countries that have both an endorsement label and an information label. The endorsement label is managed by CECP and is a voluntary one. The endorsement label was initially developed prior to commencement of the project, but the project supported the endorsement label's further development and the addition of new products to the labelling programme. The information label was developed through the project and is mandatory.

Because of the overlapping, yet in some cases differing, requirements of each of these label types, there are a number of technical and programmatic challenges to simultaneous adoption, promulgation and promotion of endorsement and information labels. This task therefore focused on clarifying potential technical and programmatic approaches to managing the two labels in an integrated fashion in order to achieve the greatest combined impact and to ensure consistency, uniformity and consumer appeal. An international survey of labelling issues (including labelling coordination) was completed during the first quarter of 2005 in order to support Chinese research and decision-making. The information label was subsequently launched in March 2005, and the integration report completed during the second half of 2005.

Other capacity-building

The CLASP *Guidebook* to energy standards and labelling and other international regulatory and policy-related materials regarding information labelling development and implementation were translated into Chinese. These publications and materials were widely distributed at the national, provincial and local levels.

Institutional capacities for appliance testing were also strengthened. Engineers from China's certified testing laboratories (China Institute of Metrology and China Energy Conservation Association) undertook international training on operation, management, procedures, quality assurance and testing conformity. A study was prepared that made recommendations for reforms at China's nationally certified testing laboratories, which resulted in improved testing accuracy.

Finally, an analytical study was prepared identifying the next tranche of products that should be targeted for endorsement labelling. This included organization of a training programme at the Lawrence Berkeley National Laboratory (LBNL) on analytical tools for use in the study. Fifteen products were identified for inclusion in future programmes; they included: compact fluorescent lamps (CFLs), adapters, gas water heaters, water cookers, motors, washing machines, transformers, personal computers, lampblack machines, computer monitors, fax machines, printers, scanners, VCD/DVD players and copiers.

India country programme

In 2002, the Indian Government passed a landmark Energy Conservation Act creating the Bureau of Energy Efficiency (BEE), a department of the Ministry of Power (MOP), and directing it to collaborate with the Bureau of Indian Standards (BIS) in energy efficiency standards and labelling development. CLASP international experts conducted several missions to India in order to meet with BEE and other officials and develop the project plan.

Concurrent with this planning process, the International Institute for Energy Conservation (IIEC) (one of the CLASP implementing partners) established and staffed offices in India and signed a memorandum of understanding (MOU) with BEE. The MOU established a public-private partnership between IIEC and BEE and called for IIEC to provide national and international experts to advise BEE in the implementation of energy conservation programmes in seven target areas: demand-side management, transmission and distribution, standards and labelling, special projects, building codes, ESCO finance, and water/energy efficiency. Standards and labelling is identified as one of the priority activities for implementation of the Energy Conservation (EC) Act and the MOU. IIEC's India office has therefore acted as the in-country partner for the CLASP project.

Baseline and market assessment for S&L target products

Based upon preliminary discussions with stakeholders, India identified refrigerators, air conditioners, water heaters and motors as the priority products for initial S&L development. Work under this task was conducted to verify the validity of that initial prioritization through analysis of data on the energy efficiency of existing products in the marketplace, comparative analysis of Indian product efficiency with international levels, and projections of GHG reduction potentials for the selected products.

During the work, it was discovered that efficiency data for air conditioners were not available because no testing labs were capable of performing the required testing in accordance with the selected International Standards Organization (ISO) testing procedure. As a result, the data analysis focused on refrigerators (a partial baseline analysis of air conditioners was completed). Collection of baseline refrigerator data from manufacturers was a significant achievement, since manufacturer associations in India do not generally share this information.

Assessment of testing capacity for priority products and expansion needs

CLASP subsequently worked with BEE to evaluate existing testing facilities, the number of new testing laboratories required, and options for upgrading current facilities. The most appropriate test procedures for the climate and use conditions in India were also evaluated and determined. Finally, training was conducted on procedures for certification and licensing.

A total of five refrigerator and air conditioner test facilities were evaluated. Draft test procedures for refrigerators and air conditioners were developed, along with an international comparison of local, ISO and Australian test procedures. A training workshop was conducted in May 2004 to provide an overview of international experience with refrigerator testing and hands-on experience with test procedures, methodology and reporting. Modified and improved test procedures were developed and submitted to the Ministry of Power for approval. All deliverables have been completed. Technical support to independent and manufacturers' test facilities is ongoing.

Development of at least one new minimum efficiency standard

Refrigerators were selected by the Government to be the first product to receive a revised standard. The project supported the work of committees in BEE and BIS charged with proposing, reviewing and setting a time frame

for finalizing minimum efficiency standards. It also provided technical assistance in the dialogue among consumers, manufacturers and other stakeholders to review the draft, revised and final standards and labelling criteria for target products. Support was then provided in the drafting and finalization of the standard prior to approval.

In October 2004, CLASP organized a training workshop for standard-setting analysis with the help of experts from LBNL and the Indian Institute of Technology (IIT). The refrigerator technical committee members from BEE, BIS, independent test labs, industry and consumer organizations attended the workshop. The purpose of organizing the training workshop was to build capacity within the refrigerator technical committee in conducting energy efficiency analysis for refrigerators using state-of-the-art software. As per standards and labelling programme implementation procedures, the technical committee will be engaged in future energy efficiency labelling and standard-setting activities. Providing hands-on training to the committee members was very beneficial for programme development and implementation.

The three-day training agenda covered the most pertinent issues related to refrigerator energy efficiency in India (see *http://www.iea.org/Textbase/work/workshopdetail.asp?id=196*).

In July 2005, MOP advanced a new draft refrigerator standard, representing a significant success for the project. Previously, MOP had proposed a single set of 5-star rating categories for frost-free refrigerators only. In the revised draft, four increasingly stringent sets of draft 5-star label thresholds have been proposed for both frost-free and direct cool refrigerators, and a draft minimum energy performance standards (MEPS) level corresponding to the 1-star minimum threshold applies. The draft standard has been distributed to manufacturers for comment. If adopted, the new standard would lead to improvement of almost 50 per cent for a typical no-frost 250-litre refrigerator (722 kWh/year in 2005 to 370 kWh/year in 2012). In addition, a new draft standard has been completed for air conditioners, exceeding the workplan requirement of one revised standard.

Preparation of energy information labelling for one product

Refrigerators were selected by BEE as the initial target for energy-efficient labelling. Technical support from the project assisted in (*a*) analysing the current market and technical options, (*b*) training BEE in the development of a criteria-setting model, and (*c*) establishing new efficiency criteria for labelling the selected product. Support was given to stakeholder meetings for the promotion of labels (consumer groups, manufacturers, BIS, BEE), as well as for consensus-building around their roles in implementation. BEE was also assisted in designing a process to test the proposed labels in various regions in India, with help from a consumer marketing organization in India. After preparation of a media campaign, the new energy information label was launched.

Brazil country programme

Project assistance to Brazil focused on project scoping and strategic planning for a multi-year programme of technical assistance. Brazil is the project's priority country in South America, for two reasons. First, Brazil is the largest economy on the continent. Second, Brazil is currently facing a severe energy crisis. To avoid blackouts, the Government has issued emergency measures aimed at reducing electricity consumption by 20 per cent. Businesses and consumers that do not comply with this target face stiff financial penalties. In response to the crisis and the need to reduce energy consumption in both the long and short terms, a strong political consensus exists for energy efficiency standards and labelling, as evidenced by enaction of a new mandatory programme into law in October 2000 (prior to that time, Brazil had only a voluntary standards and labelling programme).

In January 2002, the Brazilian Government passed a decree elucidating how the new standards and labelling programme would be implemented. A technical committee will be responsible for coming up with the procedures that will govern how standards will be set for each category of end-use equipment. The committee responsible for each category of end-use equipment will be led by the Ministry of Mines and Energy (MME) and composed of representatives from other relevant ministries, the National Electric Regulatory Commission (ANEEL), a representative from an energy efficiency research university and a citizen representative with energy expertise.

Under the previous voluntary regime, standards and labels in Brazil were the result of political compromises between industry and government. International experience has shown that this approach results in less than optimum standard levels and/or labelling categories in comparison to a mandatory system. The project's goal was therefore to work with the Brazilian Government and industry to ensure that the procedure for setting standards and labels relies on sound technical and economic analysis. In addition, the CLASP project set a goal of providing technical assistance support for preparation of at least one mandatory standard or label in Brazil.

Institutional capacity and data needs assessment

An assessment was conducted through interviews with PROCEL, CEPEL and other laboratories, INMETRO and key industry groups (Eletros, ABINEE and ABNT). The assessment evaluated existing staff and institutional capacity to develop, implement and maintain S&L programmes based on sound technical and economic analysis. The project also reviewed the technical expertise that exists to evaluate and process the data as they are gathered. Finally, CLASP determined whether the number of lab and public policy staff is adequate for maintaining a solid mandatory standards and labelling regime. Results included:

- Report on existing institutional roles for standard-setting in Brazil and recommendations on possible changes that may facilitate the development of more effective minimum efficiency standards;
- Report on existing data-collection requirements that support the standards and labelling regime, and recommendations on what additional data may be needed, how they should be collected, by whom they should be collected and how they should be monitored.[17]

At the request of the Ministry of Mines and Energy and the Ministry of Science and Technology (MCT), a number of additional tasks were also undertaken, including: (*a*) an appliance market analysis and data collection for a specific appliance; (*b*) an inventory and comparison of international experience of standard-setting methodologies; (*c*) an evaluation of implementation and effectiveness of new mandatory standards for tri-phase motors (small commercial motors up to 250 hp); and (*d*) preparation of a two-year workplan in line with MME and MCT priorities.

Assessment of current levels of efficiency of end-use equipment in Brazil

Working with local partners, CLASP assessed pre-project levels of equipment energy efficiency to serve as a baseline for calculating the impact of the mandatory standards and labelling programme. Data gathered on end-use appliances included current and forecast efficiency levels, level of efficiency politically and technically possible, characteristics and numbers of domestically manufactured products, characteristics and numbers of

[17] Modifications were made to the original workplan at the request of the Ministry of Mines and Energy and the Ministry of Science and Technology.

imported products, annual sales volumes, sales prices, production volumes, distribution channels, retail and manufacturing sector characteristics, engineering data for technical and energy characteristics for individual product models available on the market, appliance usage data, consumer behaviour data, related data on energy prices, and other national energy statistics. Results included:

- Analysis of available data;
- Protocol for how to gather necessary information not available;
- Official assessment of current level of efficiency of end-use equipment in Brazil;
- Comparison of Brazil's efficiency levels for common products with other similar countries.

Technical capacity-building for at least one standard or label

This task incorporated the results of the preceding tasks to help Brazil develop the in-country technical expertise necessary to support preparation of at least one mandatory standard or label. That expertise includes the economic and statistical capability for data collection and analysis, as well as the technical capability for appliance testing. By training Brazil in both the full techno-economic analysis approach used by the United States and the life-cycle cost (LCC) approach used by some European countries, the goal was to allow Brazil to be fully equipped to decide which approach it wanted to use given the data it had available. The result was a completed draft report on development of minimum energy performance standards (MEPS) levels, comparison with international levels and test procedures, industry impacts and financial benefits to consumers.

Evaluation of effectiveness of new mandatory standards for tri-phase motors

A team of local and international experts conducted a preliminary impact assessment of the first MEPS for small commercial motors (up to 250 hp) passed in Brazil in December 2002. COPPE worked with the project to prepare a motor study with recommendations for the motor standard implementation. The study compared the MEPS with those used internationally. It also estimated the operating cost savings potential from the establishment of new MEPS as well as the costs and the cost/benefit ratio from the standpoint of the user and the Brazilian Interconnected Power System. In addition, the study assessed the potential for expansion of the range of motors covered by MEPS to 500 hp, as well as the technical advances towards high efficiency in induction motors, comparing these technologies and their impacts on motor design and fabrication. Finally, the study made specific recommendations regarding the appropriateness, additional preparatory work and timing of standards.

Ghana country programme

Work in Ghana was undertaken with the goal of developing at least three standards and one label. The project worked with the Ghana Standards Board (GSB), the Ministry of Energy, the Ghana Customs and Excise Police Service (CEPS), and several parliamentary select committees, including the Committees on Mines and Energy, Trade and Industry, and Finance. The Ghana Standards Board houses and staffs the S&L programme. CLASP also worked with the Ghana Energy Foundation, which provided co-funding for the Ghana programme.

As of the end of the programme, Ghana had one standard (for room air conditioners) in place and had completed market assessment and baseline work for at least two additional standards (refrigerators and motors). The estimated savings projected from the room air conditioner standard are energy savings of at least US$ 8 million, reduced emissions of 132,000 tons of CO_2 and power generation capacity savings of approxi-

mately 29 MW by 2010. Impacts from the commercial sector are expected to be even higher. Furthermore, the project's support in training Ghanaian staff in life-cycle cost and net impacts analysis led to a higher standard level for room air conditioners than local analysis (based on a statistical approach) had suggested.

CLASP built capacity in Ghana to allow the country's programme to succeed in implementing a comprehensive S&L programme. Without project intervention, market research with stakeholders (e.g., consumers) would not have been conducted. Because of the market research that did take place, Ghana has a much more effective labelling programme.

South Africa country programme

During the project lifetime, CLASP worked with South Africa to develop and launch an S&L programme for appliances and equipment, in the following areas.

Development of advocacy tools

CLASP worked with key institutions in South Africa including, in particular, the South African Standards Board, ESKOM, EDRC, and such government ministries as the Department of Environmental Affairs and Tourism. Outputs under this task included a preliminary S&L impact assessment and a preliminary S&L product prioritization. To support AED's efforts, CLASP attended workshops in February, July and November 2003, and provided such tools as CLASP's recruitment screener, moderator topic guide, label rating forms and comparison labels for use in the focus group survey. CLASP provided commentary on the focus group questionnaire, the labels selected for use by the focus group, the selection criteria for focus group members, and technical assistance on the questions raised prior to the focus group survey.

A workshop was organized in which focus group receptivity was cited, label design preferences noted and consumer behaviours discussed, as presented by CASE, the local consultants charged with conducting the survey. After this meeting, CLASP held meetings with other government agencies involved in the S&L process and subsequently reviewed technical data prior to final design of the label and formulation of the government implementation strategy. The project also produced the report "Public Understanding and Participation in South Africa", prepared using the data gained from the national telephone and omnibus surveys.

South Asia Regional Initiative

The South Asia Regional Initiative (SARI) was a cooperative activity carried out in conjunction with the Academy for Educational Development (AED). In December 2001, AED completed a training course for policymakers in the SARI/Energy region (Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka) on standards and labelling using the CLASP S&L *Guidebook* (discussed under "CLASP Toolkit", below) as the basis for the training course. Under phase 2 of the project, CLASP built on that earlier training workshop to provide training and stakeholder support of a more specific and problem-solving nature. The follow-on training's goals were to achieve: (*a*) regional consensus at the political level on potential for harmonization and (*b*) mobilization of individual country institutional resources within the SARI/Energy region towards similar S&L development. The programme was also coordinated with the activities under USAID's SARI/Energy technical assistance programme.

Based on country and regional needs determined through communication and relationships with S&L experts in the SARI region, two of the four new course concepts described below were developed into training courses and delivered in conjunction with AED via two workshops in the SARI region in 2003.

The first course, on effective S&L programme development, included analysis of legal, policy, regulatory and institutional frameworks required for harmonization of standards and labelling in the region. The results of the meeting were (*a*) draft framework legislation for each SARI/Energy country with recommendations on steps to finalization, and (*b*) a regional coordination plan for legislation implementation with recommendations on mechanisms and steps for official agreement.

The second course was on setting energy performance standards, including analysis of the costs and benefits of a standards and labelling programme for each of the SARI countries as well as regional trade-offs. This course made use of CLASP's policy analysis calculator, a modelling tool that aids in-country partners in producing detailed and accurate estimation of efficiency costs and benefits of appliance efficiency standards programmes. The results of the meeting were (*a*) a draft cost/benefit analysis for one standard for each SARI country with recommendations on steps to finalization, and (*b*) a regional coordination plan for standard-setting and assessment throughout the SARI region with recommendations on mechanisms and steps for official agreement.

A third course covered designing and managing energy efficiency test facilities and protocols, including analysis of test facilities and procedures for various kinds of appliances such as lighting, refrigerators, air conditioners and other electrical consumer durables to evaluate the potential of using existing facilities on a regional basis and avoiding duplication. Discussion on how enforcement is accomplished in other countries was addressed, particularly key variances in approach such as whether or not testing is performed at manufacturers', private third-party or government test facilities. The results of the meeting were: (*a*) a recommended test protocol for each SARI/Energy country; and (*b*) a regional plan for coordinated use and management of test facilities throughout the SARI region including recommendations for expansion of test capacity and mechanisms for official agreement.

Finally, a fourth course on designing and promoting labels, including establishment of uniform metrics, development of label concepts, and effective stakeholder engagement, promotion and marketing strategies, was developed. Results included: (*a*) research design plans for all countries without an existing label; (*b*) integrated marketing plans for all countries to implement labelling; and (*c*) a regional coordination plan for promotion of labelling throughout the SARI/Energy region.

The two courses selected were on designing and managing energy efficiency test facilities and on protocols and effective S&L programme development and were held in October 2003 (one week each) in Sri Lanka and Bangalore, India, respectively. The Sri Lanka workshop was attended by 24 officials from Bangladesh, Bhutan, India, Nepal, Sri Lanka and the Maldives. In addition to the two key technical trainers assigned by CLASP, three guest speakers from the region were invited to provide regional and local perspectives to the participants. The Bangalore course was attended by 22 officials from Bangladesh, Bhutan, India, Nepal and Sri Lanka, and included a total of five guest speakers from SARI member countries, AED and CLASP.

CLASP Toolkit

In addition to the country and regional activities outlined in the section above, CLASP has developed a series of analytical tools for dissemination to country programme participants, as well as for broad distribution to other developing (or even developed) country energy efficiency officials and other interested parties. This has allowed CLASP to greatly increase the project's impact.

Standards and labelling Guidebook

The CLASP *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting* was first released in February 2001, and an updated second version was issued in early 2005. The *Guidebook* is a 321-page document chock-full of information and analysis. It is distributed free of charge to project participants and partners, at workshops that CLASP is involved in, and is available for download from *www.clasponline.com.* The English version of the *Guidebook* has been distributed to over 1,000 people in 60 countries. The *Guidebook* has also been translated into Spanish, Korean and Chinese, and distributed in those languages to more than 300 representatives from 21 countries.

Policy analysis calculator

The purpose of the CLASP policy analysis modelling tool is to assist developing countries in estimating the costs and benefits of appliance efficiency standards programmes. The tool is an Excel-based spreadsheet program designed to aid in-country partners in producing detailed and accurate estimation of efficiency costs and benefits. In addition, the tool is meant to make these calculations easier and less costly (in particular relative to the high cost of international consultants) for developing country officials and other stakeholders to prepare preliminary high-quality, detailed analyses. Ghana, for example, selected a candidate room air conditioner standard based on a statistical approach (which requires a minimum of technical analysis) without using the calculator and had initially picked an EER for air conditioners of 2.5. By working with LBNL to apply and utilize the policy calculator, the Ghanaian/LBNL team was able to perform a more detailed analysis within only three days that showed that Ghana receives at least an additional $50 million in net economic benefit by improving the standard to an EER of 2.75.

CLASP was then able to test the calculator in other countries, perfect spreadsheet and web-based tools, develop technical manuals and evaluation documents, and develop a plan for further dissemination of the calculator. The goal was to achieve use of the calculator by at least three country partners, which has been significantly exceeded. Moreover, preliminary regional analyses were performed for Asia and South America. The policy calculator is available at *http://www.clasponline.org/policy.php3*, along with full user instructions.

Model survey forms

In most developing countries where there is a shortage of data, there is often a need to conduct surveys to collect new data in order to ensure proper analysis in the standard-setting process. This is an impediment to policymakers deciding to undertake S&L programmes, since it increases the cost of developing an S&L programme. In order to reduce this cost and simplify the survey process, the project developed a standardized survey form that addresses basic saturation and end-use questions. CLASP developed two model survey forms, one for residential and one for commercial use, each with sections for the following technologies: indoor and outdoor lighting, heating, air conditioning, refrigeration and hot water heating. These forms and instructions for their use are available on the CLASP website, *http://www.clasponline.org/survey.php3*. An initial draft of the forms was field-tested in Ghana with data gathered from about 3,000 residential surveys conducted throughout the country. The resulting data were used to further improve the forms.

CLASP website

CLASP launched its website (*www.CLASPonline.org*) in July 2000. The website contains information on S&L programmes worldwide, current research on issues in planning and implementing S&L programmes, presen-

tations, training materials, papers, downloadable sample labels and the full gamut of other tools that CLASP makes available free of charge to all interested parties (more than 150 documents are available on the website, and new documents are added regularly). The website also includes a webmaster e-mail address to which technical enquiries can be addressed and answered by CLASP S&L experts. Since its launch, the website's average monthly activity includes over 82,000 hits and 1.6 gigabytes of downloads from more than 100 countries.

Commercializing renewable energy in India

Background

The Commercializing Renewable Energy in India (CREI) project is aimed at strengthening local entrepreneurial capacity for sustained commercial operation of rural energy enterprises that harness renewable energy technologies to service productive use applications in selected areas of southern Andhra Pradesh (AP), India. The distinguishing feature of this project is that it links the commercialization of enterprises that match renewable energy technology to productive use applications with the substantial ongoing efforts to develop enterprise capacity in rural areas of India by the rural development trusts of two major national banks, Syndicate Bank and Canara Bank, and with the ongoing efforts of the United Kingdom's Department for International Development (DFID, UK) to promote sustainable rural livelihoods in Andhra Pradesh.

The project is structured so as to expand the enterprise incubation services offered under the rural development programmes offered by DFID, Canara Bank and Syndicate Bank to include assistance to entrepreneurs in designing and developing renewable energy enterprises/projects that create opportunities for income generation activities and help to establish capital and service chain linkages involving local private sector entities, non-governmental organizations (NGOs), technology suppliers and financing institutions.

The project is catalysing market development for renewable energy systems linked to productive applications; providing enterprise incubation services, training inputs covering all aspects of the commercialization chain, and initial small investments of seed capital; facilitating community involvement; and interfacing with ongoing rural development activities at the local level. Thus, the project is paving the way for sustained rural energy services at the local level through the entrepreneurial approach.

One of the biggest challenges facing Indian development planners is provision of reliable energy for small-scale household or "cottage" industries, agriculture enterprises, and other firms and NGOs implementing productive use applications in the rural areas of the country. Until now, most of the rural energy needs have been met by biomass burning, of which the preferred fuel is firewood, while animal dung and crop residues are also widely used. Commercial fuels, such as kerosene and LPG, have not penetrated the rural areas due in most part to the low purchasing power of the majority of the rural population and poor rural infrastructure. Though electricity grid extension has covered nearly 87 per cent of the 570,000 villages, the number of households having access remains below 30 per cent. Even in geographical areas with extensive rural household electrification, erratic and poor-quality supply of electricity remains a critical problem.

Continued dependence on biomass fuels has resulted in serious environmental problems of resource degradation and pollution with local as well as global manifestations. Also, quality of life remains poor, particularly that of women who are the primary collectors, processors and users of biomass. The increase in demand for energy, stemming from both population and income growth, coupled with the limited impact so far of demand reduction and efficiency-enhancing interventions such as improved cookstoves and biogas, continues to intensify the challenge of rural energy.

Lack of an organized efficient supply of energy to the rural areas also has a hidden cost. Energy is a prime mover in economic development. Per capita energy consumption is directly correlated to the overall quality of life of the

person. Lack of energy is among the key retarding forces preventing economic development and consequently slowing down poverty alleviation and growth of the rural sector. The severity of the problem continues to rise and calls for a re-look, to learn from previous experiences and develop a fresh attempt to accelerate the process of providing reliable energy to India's rural areas.

Renewable energy technologies (RETs) have long been recognized for their potential as environment-friendly, versatile and sustainable energy alternatives for rural areas of India. However, despite efforts by the Ministry of Non-conventional Energy Sources (MNES) and the India Renewable Energy Development Agency (IREDA), RETs have not yet succeeded as a major alternative source of energy in rural India. The programmes of MNES and IREDA designed to support small-scale distributed systems have relied on heavily subsidized credit, technology training and consumer awareness activities to stimulate the market for end-user finance for renewable energy systems (solar and biogas) for domestic use and a tiered set of capital and interest rate subsidies for water pumping in the agriculture sector. While end-users in some rural areas now have access to solar-powered lanterns or lights and biogas systems for their home, and agricultural operations are taking advantage of remarkable capital subsidies for solar energy to use for water pumping, the control of the credit and resources by an agent in the centre with limited reach in rural areas, the use of heavy capital and interest rate subsidies, and the focus on domestic use rather than on matching renewable energy technology applications with income enhancement opportunities have tied the success of these programmes to government budgets and political cycles limiting both the breadth and depth of development/penetration of projects that harness renewable energy resources.

In order to fully understand the barriers to the development of renewable energy enterprises/projects in rural India and to design a programme that helps address these barriers, we must first briefly review a few of the key characteristics of investments in renewable energy projects.

First, investments in renewable energy projects are relatively information and capital-intensive. The greater information intensity arises primarily from the need for more upfront information regarding the energy resource compared to conventional power projects. Renewable energy resource assessments, in most cases, need to be site-specific and preferably with data for a significant period of time. Renewable energy technologies are also more capital-intensive than conventional hydrocarbon ones because of the large upfront investment cost in generation equipment (per kWh or BTU of output) needed to utilize a "free" or low-cost energy source. Due to the capital intensity, the financial viability of such investments and projects is often more dependent on longer-term financing structures available at the outset of the project.

Second, individual renewable energy investments are generally smaller than those made in conventional power generation projects due to constraints on local resource availability. Local resource availability is in turn limited by the low energy density of renewable energy resources. As extensive time and resources are necessary to catalogue the site-specific resource availability before financing can be considered, the technical and managerial know-how requirements and associated costs that occur prior to the project often represent a much larger percentage of project costs than in the case of conventional power projects.

Third, entrepreneurs developing small-scale renewable energy projects face the same *business* and *financial* risks associated with any enterprise. Business risk involves the variability in earnings resulting from the operations of the enterprise in a given business environment. Financial risk, on the other hand, involves the variability of earnings (and thus variability in returns to the equity investors) resulting primarily from the financial performance, capital structure and financial flexibility of the enterprise. Business and financial

risks are also affected by the enterprise team and its philosophies, strategies and policies. The viability of any enterprise depends on its ability to build a business based on solid concepts and competences in sound contexts that mitigate those risks.

Considering the aforementioned characteristics, the key barriers to development of small-scale renewable energy projects are fourfold. First, rural entrepreneurs do not usually have the knowledge and expertise necessary to write business plans for enterprises/projects that link renewable energy technologies with productive use applications, assess the rewards and risks of the project and estimate the costs to mitigate the associated risks. Specifically, entrepreneurs may have difficulty evaluating risks in one or more of the following areas: harnessing the natural resources, designing the technical approach for linking renewable energy technologies to productive use applications, securing fuel supply contracts or arrangements and permits to build and operate a project, designing the technology construct to source the renewable fuel and service the application in the most efficient manner, quantifying customers' ability to pay, pulling together a viable project team, contracting suppliers, and estimating revenues, capital costs and operating costs — all of which are necessary inputs before a project is presented to a financier for investment. In addition, the negotiations with financiers may be complex, involving concepts and approaches that are not familiar to the entrepreneur.

Second, the paperwork and soft costs associated with identifying and obtaining access to financing for small- and medium-scale projects is high relative to the financing needs. Without critical first-stage financing, most of the entrepreneurs interested in developing renewable energy projects will not be able to take the time away from normal business operations to implement renewable energy projects. Third, many of the renewable energy technologies are still relatively new to the market, so the commercial chains, networks, marketing and financial links, and other institutional structures that service traditional energy technologies are not in place to assist the entrepreneur even if she/he has the skills, know-how and capital. Fourth, given the "newness", there is a limited availability of investment capital to finance the high upfront costs associated with the initial stages of developing a renewable energy project.

The CREI project — jointly developed by UNDESA, Winrock International (WI) and Winrock International India (WII) — offers an innovative approach to overcoming the barriers to developing and mainstreaming a set of renewable energy enterprises/projects in rural India. The CREI team's approach is anchored to the proven concept of stimulating private investment in the development of renewable energy projects/enterprises by helping entrepreneurs develop projects/enterprises that link renewable energy technologies with productive use applications that generate positive cash flows. The team's upstream enterprise incubation, seed capital investment and financial facilitation services are designed to assist entrepreneurs in designing, structuring and developing such projects and complement the downstream investment interests of Syndicate Bank, Canara Bank, Infrastructure Development and Finance Corporation, and other financial institutions seeking a sound portfolio of well-prepared renewable energy projects/enterprises.

Specifically, under the CREI project the team has trained for-profit and not-for-profit entrepreneurs in the business and technical skills necessary to identify and evaluate opportunities to generate cash flow from renewable energy projects/enterprises by harnessing the energy for productive use applications as well as in organizing, preparing and presenting business plans to financial institutions, thus addressing the capacity barriers. The CREI team also provided initial seed capital investments to cover the costs of working through the business planning stage and facilitate entrepreneurs' access to and negotiations of financing by linking

them with existing credit facilities and other financial institutions as well as innovative financial mechanisms to address the issue of high front-end investment requirements and the need for patient debt and equity, thus addressing the financial barrier.

The project is being carried out in five districts in Andhra Pradesh (AP): Mehboobnagar, Kurnool, Nalgonda, Prakasam and Anantpur. This region, having nearly 5,680 villages with over 12.2 million people, falls in the semi-arid tropics of central India. This region is the subject of a US$ 40 million rural livelihoods project of the government of AP and DFID, and boasts of considerable institutional development by way of watershed development groups, women's self-help groups, and NGOs such as the rural development trusts of Canara Bank and Syndicate Bank.

Project objectives and components

The overall objectives of the project are threefold:

- First, to create an energy infrastructure in the rural areas of Andhra Pradesh that would directly address the alleviation of poverty through income generation and other means in an economically viable and environmentally sustainable fashion so as to improve the overall quality of life, especially among the poorer and marginalized sections of society;
- Secondly, to generate local entrepreneurial capacity for sustained commercial operation of rural energy service companies with primary emphasis on renewable energy and on creating opportunities for income generation activities in selected areas of rural Andhra Pradesh;
- Finally, to introduce climate-friendly solutions to meeting rural energy needs in a manner in keeping with India's national commitment to sustainable development.

The principal components of the project include:

- Entrepreneurial support to manufacturing and service providers;
- Entrepreneurial support to rural areas;
- Finance and credit support;
- Village electrification using renewable energy sources;
- Institutional capacity-building.

Entrepreneurial support to manufacturing and service providers

CREI has been instrumental in facilitating finance for three companies for their business expansion and promotion plans. With financial assistance from the project, two of these companies (whose core business is based on sale of solar PV products) were able to expand their dealership network in the rural areas by adding four new dealers. These two companies were also able to fund training programmes for their sales and marketing force geared towards the rural areas. One of them is developing small entrepreneurs as expert technicians for their products in rural areas by assembling a technician kit and supplying such kits to the qualified small entrepreneurs.

Further, three business plans for renewable energy manufacturing companies to strengthen their existing businesses are in the formulation stage. A brief description of these plans is given below:

- Andromeda Energy Technologies (AET): A leading manufacturer of solar products and related equipment with plans of expansion in rural areas of Andhra Pradesh. CREI is formulating business plans to support the

expansion of dealer networks, technicians and carriers and forwarding agents in rural AP. AET has already identified these small entrepreneurs and is at the advanced stage of finalizing the business logistics. AET's sales team will supplement the dealer network's sales and marketing efforts in rural areas. Among other things, the CREI project has plans to provide seed capital support for the dealers and support AET's training initiatives (technical as well as business-oriented) by leveraging services from rural training institutes in this area. Such training resource centres have been identified and discussions for training support have been initiated;

- Aditya Solar Shop ("Aditya"): a subsidiary business unit of the local chapter of MNES located in various districts of AP, giving direct access to rural markets in the SPV sector. "Aditya", situated in the Prakasam district in AP, has business plans and has identified 20-25 potential candidates as dealers. Assessment of the potential market for the SPV products covering 52 mandals in the Prakasam district has been done by "Aditya". CREI plans to lend support through seed capital for small enterprise incubation and necessary training in the areas of sales and marketing;
- SCA Green Technologies: a manufacturer dealing with SPV and wind-related products and equipment. The manufacturer is keen to make forays in the niche areas of solar dryers. CREI plans to promote this entrepreneur as a manufacturer of solar dryers in the project area. The manufacturer has demonstrated sufficient technical know-how and has the necessary production process in place. CREI also plans to lend support for the various aspects of design through a workshop involving an expert on the subject matter. The logistics of the support arrangement are being worked out.

The main approach of the project has been to identify local groups and organizations that could take up enterprise activities. The project region has a strong track record of promoting self-help groups, women's thrift organizations and non-governmental agencies. The project team focused on these groups to carry out enterprise development.

Demonstration projects

CREI has been able to generate large-scale awareness of renewable energy products and their applications in the project area. Based on visits as well as demonstration of RET products available in the market, the communities were given a feel for the technologies available. The awareness creation programme also involved exposure visits by communities to locations where RETs are used, so that those models could be replicated in their habitations.

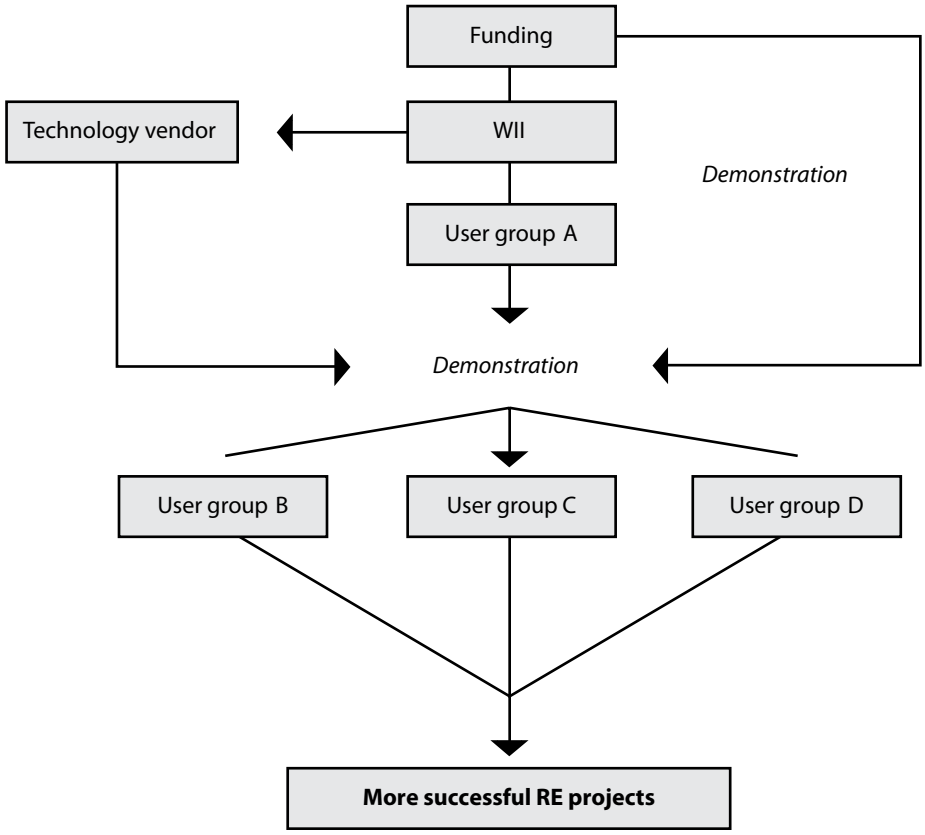
The flow diagram at the top of page 50 depicts how a successful demonstration project can spawn the development of many renewable energy projects.

CREI worked on the premise that setting up "demonstration" projects is key to earning the trust and confidence of all involved, especially of the people they are intended to help. While discussion forums and educational seminars on the applicability and use of technologies are necessary and helpful, it is the actual sight of such a system deployed and working that best convinces individuals to take the step themselves.

CREI is establishing similar demonstration projects for solar dryers and oil expellers.

Business plans

CREI developed 20 business plans, with inputs from the rural groups, after technology options, costs and economic feasibilities were studied. These business plans were strengthened to make them robust and sustainable



by conducting thorough research and analysts on technical, economic, financial and business aspects. As part of the efforts to strengthen and sustain the business plans formulated, the following tasks were undertaken:

- Participatory Rural Appraisals (PRAs) of the villages under the business plans with an energy focus were initiated. Information critical for the success of business plans, such as the matrix ranking of economic activities of the communities, energy needs and availability assessment, applicability and awareness of RETs for productive uses, resources mapping, economic status of the groups etc., was gathered in this exercise.
- Market outlets for product outputs, users of the products, and dealers and vendors involved in this activity were established.
- Market data collection through surveys and interaction with local groups concerning raw materials such as non-edible oil seeds and agro- and biogas products was undertaken.
- Financial analysis and cash flow statements were prepared with experimental and market data for each economic activity.
- A feasibility report on livelihood improvement through energy plantation (mainly *Pongamia pinnata* and *Jatropha curcas*) was prepared. Among other things, this report focused on the technical and financial parameters of the plantation activity, economics, case studies and government initiatives.
- Solar drying of agro-products was identified and evaluated as a viable business activity by the rural groups. In the present market conditions, the solar dryer meant for small-scale drying of agro-products is too expensive and is not economically viable for the business plans formulated. Work was done with an entrepreneur to develop a suitable business plan.

- The CREI project, with support from the rural groups, is setting up marketing organizations along the lines of a cooperative system for the rural groups. This organization would serve as an apex body that would be responsible for all matters pertaining to production, business development and finances. It is broadly envisioned that one such organization would be set up for every 4 to 6 villages, with a handful of representatives from each village group being chosen to represent the rest. The profits and other proceeds would be paid to the individual group members as dividends.

Business plans based on solar lanterns

Traditionally, when villages need artificial light, they rent kerosene lanterns. But such lanterns have several disadvantages. They are smoky and unreliable, even dangerous. They are also expensive to rent, and one has to travel far to obtain them.

Chaithanya Mahila Sangam, a local women's self-help group with 35 members, wanted to find a solution to the perennial problem of how to earn a steady income without leaving the village. They were also concerned about the inconvenience and expense of kerosene lanterns. How could both problems be solved?

The CREI project mounted an awareness campaign about using solar-powered lanterns to earn money. Village representatives, including the *sangam* president, were invited to a demonstration. Solar power, they were told, is clean, available and best of all *free*. Renting them to customers at a price competitive with that of kerosene lanterns would be a sure way to provide the *sangam* with a steady income without having to walk long distances to work as labourers. Winrock selected an appropriate manufacturer, supported the *sangams* with rural meetings and organized training sessions. Marketing, mostly by word of mouth, the fastest method of communication in rural settings, was supplemented by displays at malls, local fairs and panchayat meetings.

The villagers decided to purchase five solar lanterns from a domestic manufacturer at a reduced corporate rate of Rs 2,500 ($60) each for a total of Rs 12,500 ($300). CREI provided the *sangam*'s 50 per cent share of the capital as a loan.

A three-day training session on best practices for both CREI staff and *sangam* members was organized. Also invited were some television and radio repairmen who were trained to repair switches and other movable parts. The *sangam* charges a rental fee of Rs 20 ($0.50) per day for members, Rs 30 ($0.70) for others. They make Rs 500-600 ($12-14) every month — about Rs 7, 000 ($160) a year. Importantly, the lanterns provided immediate income, which meant that the *sangam* was able to begin repaying its loan right away.

Groups in 16 villages are now in the business of renting out solar lanterns. Each has five lanterns. The groups are legal entities; each one is registered as a cooperative society. They have bank accounts, they deal with tax issues — in short, they have a sense of empowerment they never knew before.

Business plans based on energy plantations

Energy plantation activity presents several challenges, as it must motivate and convince the farmer community and wasteland owners of the benefits that accrue in the long run. A significant amount of groundwork has been done through orientation workshops and demonstrable plantation of pongamia and jatropha with inter-cropping of productive species and nurseries.

Jatropha, as well as pongamia, another oil-bearing seed tree, can be cultivated with ease in marginal lands. Both are resistant to drought, and both will grow on poor soils. Although the oil produced from both species

is in demand for a variety of uses, their main use is for biodiesel production, an important priority for many of India's state governments.

Because both trees take a long time to reach maturity — jatropha takes about two years, pongamia four — part of the strategy is to sustain farmers' interest by promoting intercrops that command high demand in the market. Legume crops, because they increase soil fertility, are particularly favoured. The legume best suited to conditions in Chintula is horse gram. Horse gram grows well in marginal lands, yields 3 quintals/acre and sells for Rs 6 ($0.14) per kilogram. It is mostly used to make *rasam*, a soup. Another interim crop is henna. Henna is a perennial crop that commands a good price in the market. The project's thinking was that the promise of immediate income from horse gram and henna would give the farmers enough confidence to prepare the land for long-term gain from jatropha and pongamia. A typical farm only earned about Rs 2,000 ($47) in additional income from its horse gram crop, but the thing to consider is that previously unused land is now generating cash.

In total, 40 farmers are undertaking energy plantation farming with intercrops on 60 acres of former wasteland. The farmers contributed 50 per cent of the cost for land preparation, mostly through labour. They borrowed Rs 5,150 ($120) from CREI at 5 per cent interest over five years. The jatropha, which was planted 6 months ago, will not be ready for harvest for another 18 months.

Business plans based on biogas technology

A two-cubic-metre biogas plant is being replicated for production of gas for cooking purposes and domestic lighting purposes. The decision to implement a biogas energy solution for a particular household was arrived at after comprehensive evaluation of the geographic conditions, raw material availability, sustainability and maintenance.

Currently, the households depend on firewood for cooking needs. Availability and fetching of firewood are major issues that the community would like to do away with. The firewood option is also a major health and environmental hazard. This option is very expensive for the group to sustain and the group is looking at alternative sources of fuel for cooking. Each household spends 2-3 hours every day to collect this fuelwood. By eliminating the need to collect the firewood, daily work-hours may be increased from the present 6 hours to 8 or 9 hours. With the gas being supplied through this biogas initiative, the monthly expenditure on firewood and the time saved on fetching it translate into additional income for the group.

On the lines of the SPV lanterns demonstration project, a couple of biogas plants have been constructed for domestic uses of cooking and lighting to gain the acceptance of the community. The results are encouraging, prompting several households in the community to take up this activity. Ten such families who own cattle have come forward to take up this activity.

Business plans based on non-edible oil-expelling activity

One of the most important agricultural interventions that have come out of the CREI project is the cultivation of oilseed tree crops, especially jatropha and pongamia. Both of these oilseeds are poisonous and cannot be consumed by either humans or animals, but the oil is used for medicinal purposes and is also a highly effective organic pesticide. These oil-bearing seeds, along with traditionally popular neem and castor, can be used to make money for cash-poor village women. Since the seeds of each of these four plants mature at different times of the year, oilseeds of one species or another are available nearly year-round.

The difficulty with oilseed production is the cost of expelling the oil from the seed. Oil expellers are expensive — about Rs 1.5 lakh ($3,500) — and therefore out of reach of most villagers. However, Winrock's

CREI project, as part of its promotion of the commercialization of renewable energy, agreed to guarantee a loan of Rs 1 lakh ($2,300) to a women's *sangam* in Kothapally village, and the women contributed Rs 50,000 ($1,160) from their savings.

The *sangam* accrues its savings from the dues of members at Rs 20 ($0.50) per member per month, as well as from interest on loans to others. The women lend at 24 per cent interest, about Rs 2 ($0.05) per month, as opposed to outside moneylenders, who charge 60 per cent interest, about Rs 5 ($0.12) per month. New members are continually invited to join the *sangam*, and all castes are welcome.

The location was strategic. Kothapally is located close to the important town of Mall, where the residents of 25 villages spread throughout three districts (Mahbubnagar, Ranga Reddy and Nalgonda) do their shopping. The proximity of Kothapally to Mall means that the products of the oil expeller can be conveniently marketed. The Kranthi Mahila Sangam, which now has 100 members, was established in 2000. The president, Guddula Narsamma, says, "Traditionally, we collected wild oilseeds daily, selling them at Rs 1-1.5 ($0.02-0.03) a kilogram. After CREI came, we were able to sell directly to the *sangam* — there was no longer any need to leave the village at all."

Another improvement is that unlike previously, when each woman worked alone, now they are all involved. They benefit individually by collecting the seeds, and as a group by selling them. They also benefit from the added value derived from the cake made from the oilseed residue, which is sold as insecticide.

The project's marketing efforts are geared towards four uses:

- To blend the oil with diesel for use as fuel;
- For domestic lighting purposes;
- For sale as raw material to biofuel production units;
- Sale of the cake as a manure.

Business plans based on solar drying

Agricultural produce tends to ripen at the same time, so that markets are often glutted with particular crops, a situation that leads to low prices and fierce competition. To avert such a situation and provide year-round income, the CREI project approached the Vasundara village with the idea of drying crops to preserve them. While open sun drying may be the most inexpensive and extensively used option for many of the products, it is unhygienic, unreliable and time-consuming.

After due consideration, the villagers agreed to use their savings to buy a solar dryer, and nothing would ever be the same. The first step was to identify the correct dryer. That took six months. Solar dryers are not an off-the-shelf item in India, and the CREI team, once it understood what the Vasundara women wanted, had to hire a local manufacturer to build it to specifications. The cost was Rs 40,000 ($930). The women borrowed half the money from the CREI project, which gave them a generous repayment time of seven years. However, the solar dryer was such an unqualified success that the Vasundara women expected to be able to pay back the full amount in only two years.

Every element in the enterprise was covered in extensive training sessions in the food-drying process, as well as associated matters such as hygiene. The women learned about food grade standards and quality control in drying and packing operations. Marketing was an important component in the training as well, and links

were made to supermarkets that stock dried food products. Special deals were struck with college hostels, where the women would provide dry foods for specific functions. And of course the products would be sold regularly in local markets.

The process began with a participatory approach, which led to the identification of local resources and skills. Once renewable energy technologies were adopted, business plans could be developed, leading to capacity-building.

In solar drying, different procedures must be followed for each commodity. The most important foods in Peddathundla are ginger, coriander, chillies, tomatoes and curry leaves. Although each commodity is different, the average time for drying food is 9-10 hours. Vasundara employs four of its members to manage the solar dryer at a daily wage of Rs 30 ($0.70). The women could make Rs 40 ($0.90) outside, but they much prefer this arrangement because they do not have to leave the village.

The women make more than Rs 3,000 ($70) per month — about Rs 40,000-50,000 ($930-$1,160) per year. Their revolving fund is continually replenished, and their lending business flourishes. Besides the Vasundara group, two other groups have invested in solar dryers, and more are sure to follow.

Capacity-building

The CREI project's focus has been on developing these rural groups as enterprises with a vision for long-term success. Towards this end, tailored training programmes were drawn up for business plans generated during the implementation stage. Most of these training programmes are now completed with support from the local NGOs, equipment vendors and other training institutes. The areas of training include accounting and book-keeping, business management, creating and improving technical and managerial capacities of the groups and leaders, and marketing and technical aspects related to operation and maintenance of RET systems.

Although the CREI project goal was to formulate and develop a few demonstrable and working business plans based on clean energy technologies, the ultimate goal is to use these pilot models and replicate them in other rural areas of Andhra Pradesh and India. In this regard, CREI has mobilized additional financial resources from the Swiss Agency for Development and Cooperation (SDC) to carry out capacity-building activities. The primary goal of this additional initiative is to create a pool of resources and skills that may be utilized effectively in developing and implementing livelihood projects based on renewable energy technologies.

The experiences and the lessons gained from the implementation of the CREI project will be shared with the target audience for further replication and expansion in other CREI districts. The business development process from CREI will be tailored into specific training modules for enterprise incubation activities.

The following are the expected outputs from this capacity-building initiative, which will complement the CREI project:

- A pool of trained personnel who could impart knowledge and skills necessary for potential small entrepreneurs establishing businesses using renewable energy;
- NGOs, self-help groups and other user groups with adequate awareness and other skills required to implement renewable energy projects for sustainable livelihoods (about 6-8 in all, covering five districts of AP) as business proposals;
- Successful pilots under CREI replicated in other districts of AP through sharing of successes and experiences (especially from Winrock International India);

- Training modules for implementation of renewable energy projects;
- Sensitization of financial institutions and creation of a suitable atmosphere for lending to renewable energy projects.

Finance and credit support

CREI has established links with local banks and other financial support agencies with the RETs for livelihoods agenda to fund the initiatives. At the proposal stage, CREI envisaged linkages with Syndicate Rural Development Trust (SRDT) and Canara Bank Trust for entrepreneur incubation, and to consider them for managing the fund of $154,000 allocated under the project towards seed money assistance to prospective entrepreneurs/user groups. But after consultations with both banks, it was concluded that SRDT and Canara Bank Trust could not be engaged to take up the seed funding activity originally envisaged under CREI. As an alternative, the CREI team began working with Basix, a microcredit organization based in Hyderabad and working in all the project areas of CREI, using it as the financial intermediary to administer the funds. A framework on the seed capital mechanism and its modus operandi was developed.

The business initiatives involving the SPV lanterns have started earning income, facilitating loan repayments, as lanterns' lease/hire has become an attractive and popular option. The repayments are diverted into a separate loan account with a leading commercial bank. CREI plans to utilize the repayment history and the viability of these business models to attract commercial banks and microcredit institutions for mainstream lending for renewable energy projects.

With a view to building upon and enhancing the ongoing initiatives on the promotion of the commercialization of RETs under CREI, the project team has developed the innovative concept of establishing a risk guarantee fund. The purpose of this fund would be to provide an impetus to commercial lending for RET enterprises/projects through partial coverage of business and financial risks that could potentially be borne by entrepreneurs and lending institutions involved in such enterprises/projects. Anchored to the proven concept of linking enterprise assistance services with long-term credit and financial facilitation, the introduction of a risk guarantee fund, positioned as a financial product, will complement the activities so far undertaken under CREI by incubating investment interests of lending institutions.

Establishment of resource centre

In August 2005, CREI formally established a resource centre in Hyderabad to act as a repository of information related to renewable energy businesses, and to provide advisory services. The centre is hosted by the Andhra Pradesh Industrial and Technology Consulting Organization (APITCO) in partnership with the Rural Economic and Educational Development Society (REEDS). Winrock International India (WII) would provide relevant technical assistance to the resource centre. The CREI project would fund 70 per cent of the resource centre implementation cost and the balance would come as a cost-share from APITCO/REEDS. A detailed marketing plan was being developed by REEDS and APITCO for the long-term sustenance of the resource centre. In addition, a coordination group, which would function as an action team, would be set up to coordinate and implement all the resource centre activities. This working group is composed of project team members from WII, APITCO and REEDS.

A tripartite memorandum of understanding outlines the roles and responsibilities of WII, APITCO and REEDS in the resource centre implementation. The memorandum of understanding also includes specific

project deliverables, schedule of activities, budget, marketing plan for sustainability of the resource centre and the setup of a coordination group for the operation of the resource centre.

The resource centre would function as information centre/help desk and perform the functions of collecting, analysing and disseminating information and capacity-building on:

- Appropriate technologies and information on manufacturers, suppliers etc.
- Relevant rules and regulations;
- Relevant financial and technical assistance agencies;
- Training modules;
- Outreach and communication;
- Project/business facilitation.

Outreach

Based on the achievements of the project so far, the project team prepared two outreach documents: a brochure explaining the goals and principles of CREI, and a publication containing six case studies of the CREI businesses. The case studies effectively illustrate CREI's success in providing value addition and income generation through RET interventions. The case studies also highlight the specific technology intervention and cost economics for future replications. A dissemination plan identifying a strategy and target audience will be put in place for outreach/communication on the CREI project model.

05-67024—March 2007—500