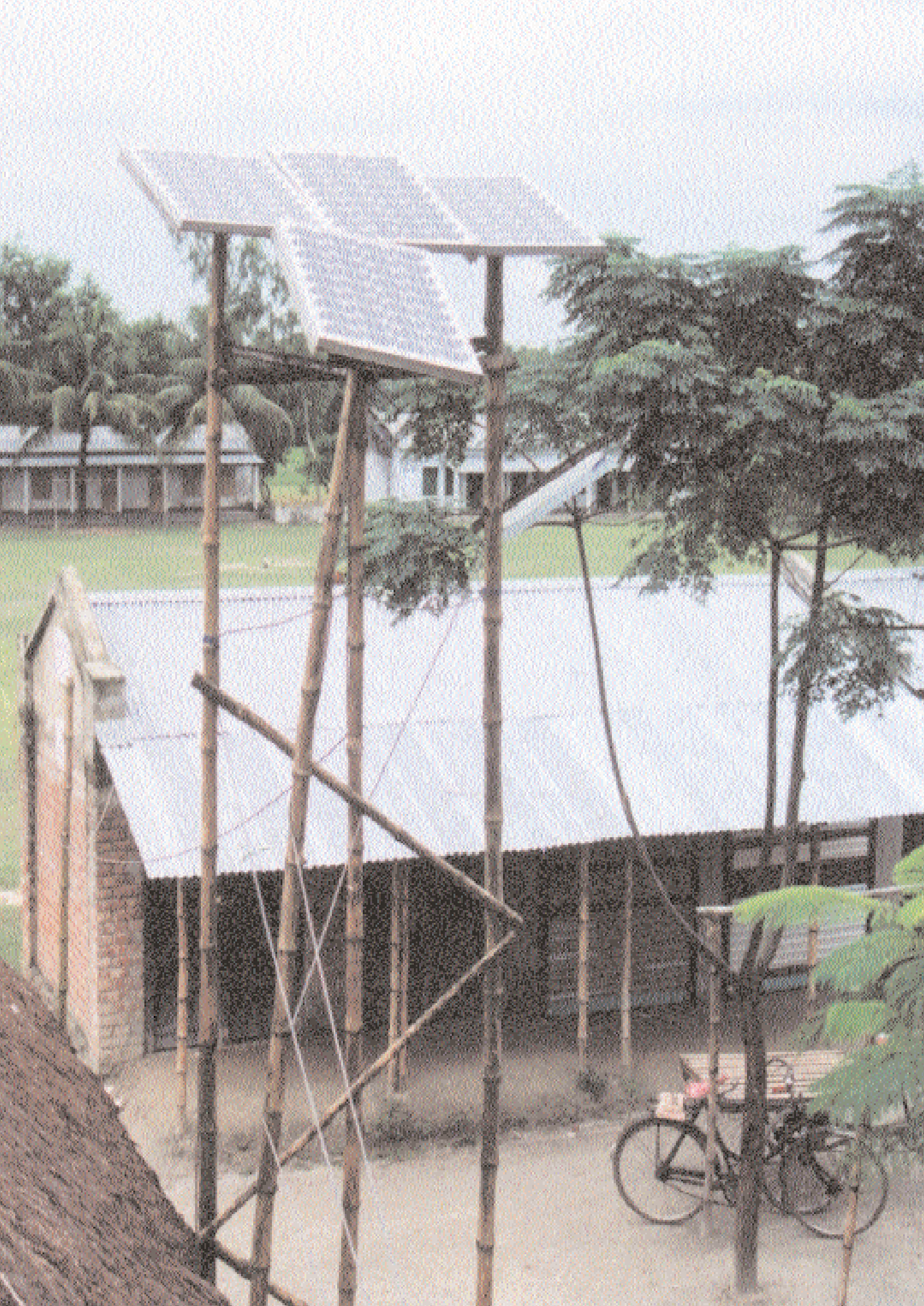

Renewable energy for Asia

Research and dissemination of selected technologies

In 1997, the Asian Institute of Technology (AIT) and the Swedish International Development Co-operation Agency (Sida) launched a regional research and dissemination programme to promote various renewable energy technologies in selected developing countries in Asia. The impacts of the programme are now becoming visible, as S. C. BHATTACHARYA and S. KUMAR report.

Economic growth, industrialization and the growing populations of the developing countries of Asia demand a huge growth in energy supplies in the region, while global environmental problems call for cuts in fossil fuel use. At present, some mature renewable energy technologies (RETs) present a viable option for meeting the growing energy demand, especially for providing energy services in remote and rural areas. Several Asian countries have already taken initiatives to promote renewables technologies, and some progress has been made. Mature technologies, such as wind generators, small hydro turbines, bagasse-based cogeneration and biomass gasifiers are supplying utility power in Asia. The pace of progress is expected to intensify in the future as the Clean Development Mechanism (CDM) begins to foster field projects for greenhouse gas emission mitigation. Consequently, the share of renewable energy in the total energy supply of these countries is poised to rise in the future.

However, before full commercialization of renewables can be achieved, many barriers need to be overcome. Apart from technological improvements, they also require appropriate financial mechanisms, enhancement of institutional/research capacity, and public awareness. Governments in Asia have a strong role to play in promoting renewable energy, by way of introducing and implementing appropriate policies.

The 'RETs in Asia' programme

Although Asia is endowed with abundant renewable energy resources, these have generally been under-utilized. After the energy crisis in 1973, efforts were initiated to promote renewable energy technologies in many Asian countries. However, the various teething problems inherent in developing almost any new technology set back the implementation of RE projects, often rendering them ineffective and leaving them incomplete. Problems included a lack of trained manpower, poor co-ordination among the various agencies involved (government agencies, R&D institutions, entrepreneurs, and users), lack of supportive government policies, and the costs of RETs, amongst other factors.

1

By the early 1990s, growing environmental problems associated with the use of fossil fuel gave rise to public

MAIN PHOTOGRAPH **PV micro-utility in an Asian village**
1 **PV training programme in progress**


2a

awareness of the need for alternative energy sources, and this created a new interest in renewables. With this in mind, the Asian Institute of Technology (AIT), with support from the Swedish International Development co-operation Agency (Sida), began the implementation of a regional programme in 1997. The goal of this programme, known as 'Renewable Energy Technologies in Asia: A Regional Research and Dissemination Programme' (or 'RETs in Asia') was to promote selected mature and nearly mature RETs (photovoltaics, solar drying, and biomass briquetting/briquette stoves) in six Asian countries, namely Bangladesh, Cambodia, Laos, Nepal, the Philippines and Vietnam.

Twelve institutions from these six countries participated in the first phase of the Programme (1997–1998). An additional institution joined in the second phase, from 1999–2001. A third and final phase has been approved recently, for the two-year period 2002–2003. This article presents the objectives and activities carried out under the regional programme since its inception.


2b

Objectives of the programme

The objectives of the 'RETs in Asia' programme are:

- to conduct technical research in adapting certain RETs to local conditions in the selected Asian countries where the science and technology infrastructure is weak
- to innovate and implement mechanisms for disseminating RETs in the selected countries
- to train entrepreneurs and technical personnel with a view to disseminating RETs
- to disseminate the results of the programme among policymakers.


2c

Activities and achievements

2 Demonstration of the three renewable technology types under the scheme
a PV-powered streetlighting
b Solar drier
c Biomass briquette stoves

Activities carried out in the participating countries and at AIT include development of solar driers, solar–biomass hybrid driers, PV power supply (micro-utility) systems, improved PV accessories and appliances, improved briquetting systems, briquette stoves and gasifiers. These were designed and adapted to local conditions and requirements. Demonstration systems were installed to create awareness on the technical and financial viability of renewable energy systems. Construction, operation and maintenance manuals of the developed devices were prepared, often in local languages, and disseminated to entrepreneurs and users. Technology transfer and training programmes were conducted to develop manpower and local expertise. The research capacity was also enhanced in the participating institutions through inter-institutional collaboration, tailored research/study programmes, training and fellowships. Seminars were conducted in each of the six countries, to disseminate the results of the activities and findings to policymakers and other institutions. The results of the adaptive research and demonstration activities carried out were presented in journals, magazines, conferences and seminars.

TABLE 1. Prototypes installed under the programme

Type		Number
Briquetting machines		11
Briquette stoves		75
Biomass pre-heaters		7
Improved screws		120
Biomass die-heating stoves		3
Smoke removing systems		2
Solar driers		7
Solar–biomass hybrid drier		1
Solar hybrid driers		12
Solar home systems		176
PV battery charging stations		3
PV micro-utility		9
PV power supply for	computer centre	1
	ambulance	1
	school	1
	village cultural centre	1
Streetlight, water pumping		1 each
Others[a]		18
Accessories (improved DC ballasts, charge controllers, converters, inverters, DC lamp circuits, white LED lamp components etc.)		A few thousand

[a] PV-operated sewing machine, hand drill, soldering iron, ceiling fan, colour TV adapter, PV lantern, DC lamp assembly etc.

During a three-year second phase (1999–2001) of the programme, a new partner institution (RONAST) was included. The second phase aimed to consolidate the

TABLE 2. Dissemination and training activities

No. of papers presented in international/regional journals, conferences and meetings		59
Manuals for training courses published (for users, technicians and entrepreneurs)		12
No. of regional seminars/courses/workshops conducted		38
No. of	technicians trained	988
	courses conducted	43

gains made during the first phase, multiply the benefits of adaptive research and dissemination carried out during the first phase, and further enhance the research capabilities of the partner institutions.

Researchers at the 'RETs in Asia' programme presented 15 papers at the World Renewable Energy Congress (WREC), held in Brighton, UK in July 2000. Three of these papers were selected best in their respective categories, and were awarded prizes.

Highlights of the 'RETs in Asia' programme

The highlights of adaptive research are presented on a technology-by-technology basis below.

Photovoltaics

- A database on PV systems and accessories available in the participating countries has been compiled in the form of technology factsheets (TFS).
- The adaptive research and capacity enhancement of PV technicians and entrepreneurs has led to the development of accessories locally.
- Local production of accessories facilitated the maintenance, repair and replacement of PV appliances and accessories by local technicians.
- PV micro-utility systems have been developed and demonstrated on a fee-for-service basis. This has enabled small shop owners to extend their working hours.
- Demonstration of solar home systems and battery charging stations has given the local participating institutions experience in the operation of such systems.

Solar drying

- Improved types/designs of driers were developed to cater for the requirements of various groups of end-users and products, ranging from fish to fruit drying.
- The technical and financial viability of solar and solar–biomass hybrid drying has improved by adapting drier designs suitably. Training and capacity enhancement on fabrication, operation and maintenance of driers has been provided for drier operators, technicians, entrepreneurs and users.
- An evaluation procedure has been developed for solar driers.

Briquetting

- Improved heated-die screw-press briquetting systems have been developed. This research has reduced the energy consumption in briquetting, enhanced the screw life and reduced smoke.
- A stand-alone briquetting system, which could run in locations with no access to the electricity grid, has been developed in Bangladesh.
- Transfer of the heated-die screw-press briquetting technology (design and fabrication of briquetting machines) has taken place, from Thailand and Bangladesh to Vietnam and Nepal.
- Many types of improved briquette stoves have been designed and developed, suitable for domestic, institutional and commercial use.
- Training on fabrication, operation and maintenance of briquetting machines has been provided for briquetting machine operators, technicians, and entrepreneurs.

The three case studies which follow briefly illustrate the impact of the 'RETs in Asia' programme in the participating countries.

Biomass briquetting in Bangladesh

Rice husk residue, converted into briquettes, is a good alternative to fuelwood for cooking. With certain specific improvements achieved in the briquetting technology, briquettes have become more cost-effective than fuelwood in some areas of Bangladesh, giving rise to the establishment of a briquetting industry in the country.

The heated-die screw-press briquetting technology commonly used there required certain improvements, such as longer screw life and a reduction in the energy consumption of, and smoke produced during, the briquetting process, to enhance the economy of this process. Adaptive research carried out under the 'RETs in Asia' programme at the Bangladesh Institute of Technology (BIT) and at the AIT led to the identification of suitable hard-facing techniques, to increase the hardness of the screw, optimization of the screw profile and die temperature, development of a biomass pre-heater to heat the raw material before feeding to the machine, and development of a grid-independent briquetting machine. The briquetting screw is driven by a diesel engine, and a kerosene stove is used to heat the die.

The improved hard-facing technique resulted in 22 hours of continuous run by the briquetting screw, against 6 hours using conventional hard-facing electrodes. The production cost was reduced from Taka 2.03 (US$0.04) to Taka 1.78 ($0.03) per kg of briquette, while the cost of electrical energy consumption to run the briquetting system decreased from Taka 68.80 ($1.18) to Taka 48.80 ($0.81) per hour. Further reduction in the production cost was also demonstrated by using locally available materials (base metal, welding electrode) for fabricating the screws.

Improved briquetting systems incorporating the above technological improvements were demonstrated and disseminated among local entrepreneurs in Bangladesh. Improved briquetting machines were also manufactured

3 Biomass briquetting process
4 Hybrid cabinet drier with gasifier stove for pineapple
5 Dissemination material developed under the 'RETs in Asia' programme

and installed for commercial briquette production. Efficient briquette stoves were developed and disseminated among domestic users. The manufacture of briquetting machines and production and sale of briquettes and briquette stoves has already established a briquetting industry in the Khulna region of Bangladesh.

This has an impact at many levels, with the generation of rural employment and income, elimination of problems associated with the disposal of large quantities of rice husk residues, efficient utilization of energy resources, and a reduced use of fuelwood and subsequent conservation of forests.

PV micro-utility in Bangladesh

The economic fortunes of a large number of shop owners in rural Bangladesh are heading for a modest upturn as photovoltaic (PV) micro-utilities, a new and cost-effective system for rural electrification, are introduced in a growing number of bazaars in different parts of the country.

The Manikgonj Bazaar in the Dinajpur district of Bangladesh (about 400 km north of Dhaka) consists of about 30 small shops in close proximity to each other, including restaurants, grocery shops, doctors' clinics, barbers and tailors, amongst other shops. The bazaar usually begins in the evening and is open for about four or five hours after sunset. As this bazaar is not connected to the national electrical grid, the shops depend on kerosene lamps; some shopkeepers use locally made automotive batteries to power DC lamps and to watch TV. These batteries are usually charged by diesel-operated generators from the nearest town, which is about 10 km away.

A novel rural electrification concept was introduced by the Centre for Mass Education in Science (CMES) under the 'RETs in Asia' programme. A PV micro-utility system used as a source of lighting enables bazaars to maintain longer opening hours and increase their sales. The system has also eliminated their dependency on kerosene lamps.

The system is designed to supply uninterrupted power for about five hours every night to the twenty-four clients connected to its local grid. The system design is modular, and therefore any number of new clients could be readily added to the grid by increasing the number of PV modules and batteries accordingly. At the Manikgonj Bazaar, two separate systems have been installed to keep the cables short, each having seven 50 Wp solar panels, a battery bank and a charge controller. Each client is provided with one fluorescent lamp (7 W, DC), while a trained technician manages the micro-utility installation, conducts routine maintenance, performs necessary troubleshooting and collects the daily tariff. After a few weeks of installation and routine operation, the management of the system was transferred by CMES to the Bazaar Management Committee, consisting of members elected from the shopkeepers.

For a one-time connection fee of Taka 200 (US$3.45), the PV micro-utility supplies and installs one 7 W, DC fluorescent lamp, and charges a daily tariff of Taka 5 ($0.09) per lamp, or a monthly rate of Taka 150 for a five-hour supply of electricity every night. This represents a 42% drop in costs, compared with the monthly expense of Taka 260 for fuel and mantle replacement in the case of kerosene lamps. Micro-utility systems have thus proved to be the most affordable means of solar electrification.

PV micro-utility systems are growing in popularity in Bangladesh. Since CMES installed the system in the Manikgonj Bazaar, two more systems, one in the Alok Dihi Bazaar with 21 connections and another in the Chinibashdanga Bazaar with 18 connections, have been installed in the same district.

Solar–biomass hybrid drying in the Philippines

A solar–biomass hybrid fruit drier has been developed for rural co-operatives in the Philippines, for

use in the processing of mangoes and pineapples. This was based on the demonstration and testing of a prototype by the University of the Philippines.

Dried fruit is a promising business in the Philippines. It is consumed in considerable quantities within the country, while small quantities are also exported. Dried fruit is sold in grocery shops and department stores, while institutional buyers such as restaurants, resorts and schools are also major consumers.

The farmers of the MSS multi-purpose co-operative in the village of San Lorenzo, Camarines Norte province, earn their living by cultivating pineapples. Fresh and processed/dried pineapples are their produce, for the local market. The pineapple variety cultivated by these small farmers is Formosa, which yields fruits of a size between 0.45 kg and 0.95 kg. Fruits about the size of a fist are all too common in this variety, and these have little market value. These fruits are therefore discarded and left to rot in the field.

The University of the Philippines Los Banos (UPLB), through the 'RETs in Asia' programme, developed a solar–biomass hybrid drier for drying the sliced pineapples in a controlled environment, and demonstrated this to the co-operative members. The solar–biomass drier includes a biomass gasifier stove, which uses locally available coconut shells as fuel. It operates using solar energy during the daytime, and biomass fuel later in the evening, enabling uninterrupted drying of the product. Continuous drying enhances the product quality, and also increases the production rate, which is especially crucial during high season, when a large quantity of fresh fruits are to be processed within a short period of time. The drier can dry 50 kg of sliced pineapple fruit per batch from a moisture content of 92% (wet basis by weight) down to 20% in about 18 hours.

The experience with the drier has already drawn the attention of similar co-operatives operating in the Bayombong (Nueva Viscaya) region. Many local co-operatives and food processing companies have expressed their interest to develop similar driers for mangoes, pineapples, tamarind, kamias and tomatoes.

The investment cost of the hybrid drier can be typically paid back within two years. The drier has mainly demonstrated its economic viability in two ways:

- by offering an opportunity to process and store surplus fresh fruits during high season, thereby reducing the loss of fresh fruits
- by enabling continuous drying, thereby enhancing the quality of the dried fruits, and generating income.

An indirect benefit is the generation of additional employment in areas such as the pre-processing of fresh fruits and vegetables (cutting, peeling and slicing) and packaging of dried fruits/vegetables.

Training and dissemination

As part of the capacity building activities, several training programmes were conducted for technicians, operators, entrepreneurs and other users in the participating countries. Technology transfer and exchange visits were arranged between the institutions, to learn from each other's experiences. Researchers from the collaborating institutions also participated in academic and research activities at AIT.

The results of the programme activities were disseminated to policy personnel, entrepreneurs, researchers and academics, technicians, users and the public through specially targeted activities.

Seminars were organized in each participating country to present the results of the programme to policy personnel, senior government officials, and funding organizations. Reports summarizing the activities and achievements of the programme in each country have been prepared, and are available at the project website (www.retsasia.ait.ac.th). Workshops and courses were conducted for entrepreneurs and technicians, specific to each technology on their design, construction, operation and maintenance. The research results obtained were presented at international and regional conferences, and published in journals. Details are available on the website as mentioned above. General articles were also published in local magazines.


5

To promote the technologies amongst the general public, advertisements, brochures, leaflets, posters and calendars were prepared. Demonstrations of the technologies were arranged in exhibitions and seminars. Dissemination was also carried out through interviews given by project researchers on television and radio and in magazines.

Conclusion

The 'RETs in Asia' programme has provided mutually beneficial partnership opportunities between the participating institutions and AIT, contributing significantly to the promotion and dissemination of renewable energy technologies in the Asian region. The regional networking approach of the programme is found to provide a unique opportunity for the participating institutions to learn from each other.

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