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Commercializing solar photovoltaics: India



GENERAL INFORMATION

◆ **Implementing institution**

Indian Renewable Energy Development Agency Ltd. (IREDA)

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◆ **Details of institution**

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◆ **Implementation period**

Started in 1987; ongoing.

SUMMARY

In India, a combination of vast, untapped renewable energy resources and growing demands on the already stretched existing electricity supply system led to calls to integrate renewable energy into national energy planning and provision. This need to create a balanced mix between conventional and renewable energy meant that renewable energy technologies had to be taken beyond their research, development and demonstration stage so that they could be commercialized through appropriate financing mechanisms.

In 1987, the Ministry of Non-conventional Energy Sources (MNES) set up the Indian Renewable Energy Development Agency Limited (IREDA) to meet this need. In addition, MNES adopted several field-level programmes to demonstrate the use of photovoltaic (PV) technology and to research new technologies and local and national production capabilities. The most common systems used by these programmes are portable solar lanterns, fixed-type solar home systems, street lighting systems and small-capacity village-level power plants. To promote the schemes in individual Indian States, State field offices have been established and direct-marketing solar shops have been set up in several cities.

BACKGROUND AND JUSTIFICATION

The power generating capacity of India is 104,000 megawatts, and the demand for power is increasing by nine per cent a year. Even so, some 80,000 of the more than 800,000 villages in India do not yet have an electricity supply. Of these, 13,500 villages are remote or difficult to reach, and it is planned that many of these should be electrified with PV systems.

The estimated potential from solar energy is 20 megawatts per square metre. However, tapping this vast resource so that it can be used for commercial PV power generation calls for strong research and development (R&D) support, demonstration programmes and the creation of a manufacturing base that can serve the public.

PV systems have many advantages: they last longer than other systems, are more reliable and require less maintenance, are modular in structure, do not damage the environment, and are capable of providing power for a wide range of applications, including lighting, pumping water and telecommunications. However, the high initial cost of the equipment they require discourages their large-scale commercialization. The Government of India, therefore, has launched several schemes for the phased commercialization of PV technology, and in 1993/1994, it entrusted IREDA with the commercialization of solar PV technology in India.

The renewable energy programme is now the largest and most extensive of any developing country, and the increased use of renewable energy technologies has been facilitated by various government policy and support measures. The programme is administered by MNES, which is responsible for policy-making, planning, promotion and coordination of the different aspects of renewable energy.

Commercialization of renewable energy technologies for sustainable development requires an understanding and analysis of its potential and the development of innovative models to help it gain market penetration.

IREDA is now making rapid strides in the commercialization of solar, wind, hydro, biomass and ocean energy. Widely available, non-polluting and inexhaustible, solar energy in particular has many useful features that make it an attractive option. Solar PV technology allows sunlight to be converted into electricity without any moving parts and without causing pollution. Power plants can be set up in remote villages and hamlets in mountain, forest and desert regions, and solar PV technology can be used in the domestic, agricultural, commercial and power sectors. Initial high set-up costs of installing PV systems are being outweighed by subsidized power tariff rates and efficient transmission systems, making PV electricity generation an economical option in the longer term. Technological advances, greater public awareness, suitable policy measures and development of hybrid power systems can all help to make PV energy even more commercially viable.

DESCRIPTION

Before the large-scale commercialization project was launched in India, demonstration programmes to assess the performance of PV systems were implemented. There are four potential types of market for PV systems: government, government-driven, private leasing and direct sales on the open market. Under different demonstration programmes, PV systems were installed in government departments so that they could be tested. In the meantime, more and more applications for PV power were beginning to emerge and, as the technology advanced and systems became more reliable, private markets also began to open up, a move which required precautionary measures relating to standardization and quality control as well as suitable incentive structures.

In 1993/1994, IREDA launched its Solar PV Market Development Programme, which follows a commercialization strategy based on experience gained over previous years. Under this programme, IREDA has supported 149 projects that have received some 1.377 billion rupees in loans. Energy conserved by using power generated from PV sources is estimated to be 9.1 million units.

The PV manufacturing base in India has also been gradually strengthened so that the country can become self-sufficient in PV production. Between 1996 and 2002, annual production of PV modules and cells increased from 13 to

40 megawatts. For more than eight years, IREDA has been providing financial support to nearly 20 manufacturing units that produce different types of PV systems and components. Although most basic raw materials for solar PV cells still have to be imported, there is now less dependence on imports for other components. This has led to lower costs for final products and greater availability of products for end-users. Alongside the promotion of local manufacturers, care has been taken to develop new technologies so that India can be competitive in the world PV market.

By March 2002, solar PV systems capable of producing some 95.5 megawatts had been installed, 40 megawatts of which were exported. Table 1 gives a breakdown of this 95.5-megawatt total. Data include government and industrial markets, but direct sales are not included owing to the lack of reliable data.

Solar power is different from other renewable energy sources because, although it is widespread and readily accessible to end-users, the initial cost of the equipment required to begin generating electricity is far higher than that required by other renewable energy

sources. However, PV products and systems can be installed conveniently in remote areas, where they can provide an alternative or supplement to grid supplies wherever those supplies are unavailable or unreliable. High purchase and installation costs are offset by the environmental friendliness of PV systems, the high costs of fuels used in conventional electricity generation and the better performance of photovoltaics in terms of the efficiency of their transmission systems.

The main objectives of both the Solar PV Market Development Programme and the Solar PV Pumping Programme (for agriculture and related uses), therefore, have been the promotion of end-user participation in purchasing systems and the issue of loans to users.

To encourage the use of PV power, IREDA and MNES have formulated innovative financing mechanisms for the commercialization of PV technologies so that end-users can afford to purchase the necessary equipment. IREDA uses intermediaries to provide loans to consumers under four different financing models:

- the corporate model, which uses leasing and hire purchase mechanisms;

TABLE 1 | Photovoltaic power use in India (in megawatts), March 2002

PORTABLE LIGHTING	HOME LIGHTING	STREET LIGHTING	WATER PUMPS	POWER PLANTS	TELECOM	OTHERS	EXPORTS
4.4	7.0	3.2	5.9	3.0	16.0	16.0	40.0

- the cooperative model, which uses rental and leasing mechanisms;
- the NGO model, which uses leasing, hire purchase and rental mechanisms; and
- the dealer model, which uses direct sales to users.

These models allow users to procure systems from local suppliers at an affordable cost that is paid off in easy installments. For example, under the PV Pumping Programme, financing companies and the manufacturers or suppliers of systems can act as intermediaries between IREDA and users by providing leverage on the high initial costs of products so that they can be offered to consumers at reasonable prices.

Under the Solar PV Market Development Programme, World Bank lines of credit have been used to support 85 projects, generating a total of 2.1 megawatts of solar power. Table 2 gives a breakdown of the various systems that the programme has supplied.

Implementation of the programmes has also been designed to create and increase end-user awareness of solar power at the same time as the enhanced manufacturing capacity of the country makes more products available. However, it is difficult to raise public awareness of a new technology in such a vast country as India. The awareness-raising activities of IREDA have included the use of print and electronic media and the holding of seminars, business meetings and exhibitions to publicize its programmes. Over the past few years, meetings have been held in every Indian State (115 meetings in all). Videos have been produced, and a range of appropriate manuals and leaflets has been distributed to potential clients, market developers, consultants and business development associates.

The PV Pumping Programme is particularly important in India, which, as an agrarian country, gives priority to the needs of agriculture. MNES recognized the benefits of making farmers less dependent on the limited conventional

TABLE 2 | Systems procured under the Solar PV Market Development Programme

TYPE OF UNIT	NUMBER
Solar lanterns	39,000
Solar home lighting systems	3,602
Solar street lighting systems	1,016
Grid interactive solar power plants	344
Garden lighting systems	349
Solar water pumping systems	86
Stand-alone solar power plants	8
Others	33
Total	44,438

grid supply and launched the programme, which was implemented by IREDA, to popularize the use of PV pumping systems in agriculture and related areas.

So far, nearly 5,500 solar pumping systems have been installed throughout India for use in horticulture, animal husbandry, poultry farming, high-value crop production, orchards, silviculture, aquaculture, salt production, and drinking-water supplies. The systems that are supplied to farmers work entirely off solar energy without any need for diesel generators. They therefore prevent pollution and protect the environment. This has resulted in greater consumer confidence in solar energy and a boost to the solar power industry, which has been encouraged to develop its manufacturing base and infrastructure and to create a nationwide after-sales service network.

Special concessions have also been introduced to encourage entrepreneurs to set up PV projects in rural and remote areas. These include reducing the contributions from participating entrepreneurs, cutting interest rates, and waiving commitment fees and inspection charges.

Other measures have been pursued to improve the quality of products and build public awareness of the efficient performance of PV systems. IREDA, for example, has prepared performance specifications for PV products and systems that have been adopted by the corporate bodies and non-governmental organizations. In addition, PV modules and products have been tested at reputable laboratories

and test centres to check and verify quality parameters.

PARTNERSHIPS

As part of its efforts to build a PV supply infrastructure, IREDA has organized training programmes to create a national workforce to cope with after-sales service needs in rural areas. Nearly 900 engineers and technicians have taken part in the Solar PV Training Programme, which is one of the largest such programmes in the world and which calls on the assistance of internationally renowned experts such as Siemens.

Both the Solar PV Market Development Programme and the PV Pumping Programme have been supported by World Bank lines of credit.

REPLICABILITY

The IREDA experience shows how providing affordable financing mechanisms at the grass-roots level — thereby helping end-users to procure PV products — can play a major role in the commercialization process. However, there is no single financing model that can be universally applied under all PV market development programmes. Appropriate financing mechanisms must be adapted to local conditions and based on the economic situation of local consumers, the state of conventional power supplies, local need for and availability of renew-

able energy, costs of other sources of power, and the repayment capacity of end-users.

LESSONS LEARNED

IREDA encountered many barriers to the commercialization of solar PV technology in India. However, it has identified several essential requirements for the successful commercialization of renewable energy sources and technology. In general, there is a need for greater participation and active involvement from government, private-sector enterprises and financial institutions. To make the programme more sustainable and to increase consumer satisfaction with and confidence in PV power, it is essential to provide micro-financing and an effective product distribution and service network.

In terms of policy issues, appropriate policy support, fairly distributed fiscal and financial incentives, appropriate legislative mechanisms, and proper institutional and implementation mechanisms are needed.

With respect to product and technical issues, there is a need for reliable, packaged quality products; proper product and performance specifications; adequately trained service and maintenance personnel; and proper system integration.

Regarding financial issues, it is necessary to have motivated financial institutions, adequate awareness within financial institutions, consumer financing

routes and options, and financing through various sectors.

In terms of commercial issues, a good, reliable brand name, adequate warranty and guarantee mechanisms by manufacturers, publicity, demonstrations and a dealership network are necessary.

The following strategy and action plan are proposed for the promotion of commercial PV power:

- encourage the establishment of energy-servicing companies in different regions and areas of the country;
- motivate rural banks to act as intermediaries for micro-financing;
- involve cooperatives and non-governmental organizations in the promotion of solar PV technology in rural areas;
- increase the participation of corporate bodies and have them act as intermediaries in the leasing and hire purchase of PV systems for large numbers of consumers;
- carry out effective promotional activities — such as business meetings, seminars and advertising in the media — with financial intermediaries and business development associates;
- rationalize fiscal incentives so as to reduce the long-term costs of PV products; and
- offer attractive soft loans to consumers.

FUTURE PLANS

The IREDA Market Development Programme and commercialization process have great potential for future development and expansion. Commercialization is itself a continuous process that develops and grows as one challenge after another is overcome. New domestic and commercial markets need to be opened up and there is no one blueprint that works in all situations. Moreover, continuous upgrading of the technology is essential for cost-effectiveness: increasingly efficient, lower-cost systems are required.

Targets have been set for the large-scale utilization of PV technology by different sectors within the next five years. In addition, there are plans to electrify, using renewable energy sources, certain very remote villages that cannot be reached by the Government's planned extension of the national grid over the next 10 years. Solar PV power is likely to play a major role in this effort.