

Renewable Energy in India Programmes and Case Studies

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1. Introduction

Renewable energy sector growth in India during the last four years has been significant, even for electricity generation from renewable sources. The grid connected systems with installed capacities in the MW range indicate a growth of 96% for wind power, 26% in small hydro, 234% for biomass/co-generation power and 200% for solar photovoltaic power. Even for the decentralized systems, the growth for solar home lighting systems has been 300%, solar lanterns 99% and solar photovoltaic water pumps 196%. This is a phenomenal growth

in the renewable energy sector mainly for applications that were considered to be supplied only through major electricity utilities.

Renewable energy systems are also being looked upon as a major application for electrification of 20,000 remote and unelectrified villages and hamlets by 2007 and all households in such villages and hamlets by 2012.

Keywords : renewable energy programmes, solar, photovoltaic, wind, biomass

2. India's Programme Planning for Renewables

The need to increase the use of renewable energy sources for sustainable energy development was recognized in the country in the early 70s. A significant thrust has been given to the research, development and induction of renewable energy technologies in different sectors. To begin with, these endeavours were steered and overseen by the Commission for Additional Sources of Energy (CASE). The Department of Non-Conventional Energy Sources was created in the Ministry of Energy and entrusted with the charge of promoting non-conventional energy sources. In 1992, DNES was upgraded and it started functioning as a separate Ministry of Non-Conventional Energy Sources (MNES).

The Ministry takes care of the following specific items:

- Commission for Additional Sources of Energy (CASE);
- Solar energy including solar photovoltaic devices and their development, production and applications;
- Research and development of biogas and programmes relating to biogas units.

- Programme relating to improved wood stoves and research and development thereof;
- All matters relating to small/mini/micro hydel projects of and below 25 MW capacity;
- Research and development of other non-conventional/renewable sources of energy and programmes relating thereto;
- Integrated Rural Energy Programme (IREP);
- Soft funding for renewable energy systems through Indian Renewable Energy Development Agency;

The Commission for Additional Sources of Energy was established in 1981 and has the following responsibilities:-

- Formulating policies and programmes for the development of new and renewable sources of energy.
- Co-ordinating and intensifying research and development activities in new and renewable sources of energy.
- Ensuring implementation of Government's policies in regard to all matters concerning new and renewable sources of energy.

3. Functional Groups

The Ministry is broadly organized into six Functional Groups dealing with 'Rural Energy', 'Power from Renewables', 'Energy from Urban and Industrial Wastes', 'New Technologies' and 'Administration and Coordination'.

4. Policy Initiatives

MNES has set a goal of increasing the share of renewables to 10% of the additional planned capacity in the next 10 years, by 2012 – that is 10,000 MW. The Central Government can mainly act as a catalyst and facilitator, with implementation being carried out by the States or by the private sector. Action is, therefore, to be taken by the States to evolve streamlined procedures for various statutory clearances, for land allotment, for providing grid connectivity, and for creating the infrastructure for power evacuation. The Ministry has been able to persuade the State Electricity Boards to incorporate renewable energy based electricity into their systems. They have, though somewhat erratically, provided concessional tariffs, wheeling, banking, third party sale and

power evacuation facilities. 15 States have so far announced policies for grid connectivity of renewable energy projects. However, in order to accelerate progress and attract investments, policy support and creation of a conducive regulatory and legislative framework are critical.

The Ministry had prepared a Draft Renewable Energy Policy Statement. The Ministry is interacting with the regulatory commissions in various States to help in bringing about a rational pricing framework that takes into account a rational pricing framework that takes into account the environmental costs and other externalities of conventional energy, as well as the benefits of non-conventional energy options, with a view to providing a level playing field in the energy sector.

5. Potential of renewable energy use and achievements during (1999-2003)

Following Table reflects potential of renewable energy use in India and installed systems/capacities by the last quarter of 2003. It will be noticed that the growth of power generation systems, utilizing renewables has been very high.

S.No.	Programmes	Potential	Utilization		
			As on 12.10.99	As on 12.10.03	Growth during the last four years (%)
A. GRID CONNECTED SYSTEMS					
1	Wind Power (in MW)	45,000	1022	2002	96
2	Small Hydro Power (in MW)	15,000	1218	1530	26
3	Biomass/Cogeneration Power (in MW)	19,500	171	571	234
4	Urban and Industrial Waste Power (in MW)	2,500	2	26	1200
5	Solar Photovoltaic Power (in MW)	20	1	3	200
	TOTAL		2414	4132	71
B. DECENTRALIZED SYSTEMS					
6	Biogas Plants (Nos. in million)	12.0	2.88	3.55	24
7	Community/Institutional/Night-Soil based Biogas Plants (Nos)	120	2,673	3,902	46
8	Improved wood stoves (Nos in million)		25	35	40
9	Solar Home Lighting Systems (Nos)		64,000	2,60,000	300
10	Solar Street Lighting Systems (Nos)		32,920	43,470	32
11	Solar Lanterns (Nos in million)		2,22,000	4,42,000	99
12	SPV Pumps (Nos)		2,160	6,400	196
13	Solar Water Heating Systems (lakh sq meter collector area)	140	0.57	0.7	22

6. Major Achievements

India's major achievements renewable energy development can be summarized as follows:

- Over 4200 MW grid power from wind, small hydro, biomass and solar energy.

- 3600 remote villages/hamlets, including those in Sunderbans, Bastar, Ladakh and the North East electrified through solar energy.
- Deployment of 7.5 lakh solar photovoltaic systems for lighting, communication and related uses.

- 7 lakh sq. meter collector area solar water heating systems installed.
- Largest solar-steam cooking system for 15,000 persons/day set up at Tirupati Tirumala Devasthanam.
- 3.5 million biogas plants installed for cooking and lighting applications.
- 35 million improved wood stoves in rural homes.
- Integrated Rural Energy Programme Implemented in 860 blocks
- Demonstration of the use of ethanol, bio-diesel and hydrogen for vehicles and stationary applications.
- Zero emission vehicles including two, three and four wheelers and passenger buses being promoted under research and development and demonstration programmes.
- Fuel cell vehicle developed and demonstrated for the first time outside the USA, the European Union and Japan.
- Bangalore declared solar thermal city with Thane in Mumbai to follow soon.
- 30 MW capacity Solar Photovoltaic products exported to various developed and developing countries.
- Constitution of Hydrogen Energy Board for drawing up and implementing the National Hydrogen Energy Roadmap.
- 280 Energy Parks set-up in educational institutions for demonstration of renewable energy systems and devices
- Rs.25,000 million direct subsidy given so far to beneficiaries/users of renewable energy systems and devices, including subsidy for grid connected renewable power projects.
- Rs. 32,000 million loan provided so far by Indian Renewable Energy Development Agency Limited for 1600 renewable energy projects.

7. Major Future Goals

India has established following goals for renewable energy applications :

- Electrification of over 20,000 remote and unelectrified villages and hamlets through renewable energy by 2007; and all households in such villages and hamlets by 2012.
- Around 10 percent additional power generation capacity through renewables by 2012.
- Research and development in new technology areas, viz, Hydrogen, Fuel Cells, Hybrid Vehicles, Geothermal, Tidal etc.
- Benchmarking renewable energy systems and devices to international standards, specifications and prices.

8. Specialised R&D Institutes

To achieve above mentioned goals India has also established following R&D institutes under the Ministry of Non-Conventional Energy Sources :

- Sardar Swaran Singh National Institute for Renewable Energy set up as a premier Research and Development Center near Jalandhar in Punjab.

- Centre for Wind Energy Technology set up as a scientific and industrial research organization for wind resource assessment, equipment certification and R&D at Chennai in Tamil Nadu.
- Solar Energy Centre set up for development of solar energy systems and devices at Gurgaon in Haryana.

9. Innovative Systems, Successful Applications - Case Studies

Solar Applications

World's Largest Solar Steam Cooking System at Tirumala, Andhra Pradesh

The world's largest solar steam cooking system has been installed by the Tirumala Tirupathi Devasthanam (TTD) at Tirumala in Andhra Pradesh. The system has a capacity to prepare food for 15,000 people/day and employs automatic tracking solar dish concentrators, which convert water into high pressure steam. The steam thus generated is being used for cooking purposes in the kitchen of TTD. It has been hooked up with the existing boiler working on diesel so as to make the system reliable under all climatic conditions.

The system has been designed to generate over 4000 kgs of steam/day at 180 degree centigrade and 10 kg/sqcm which is sufficient to cook two meals for around 15,000 persons. It is modular in nature and consists of 106 automatic tracked parabolic concentrators arranged in series and parallel combination, each of 9.2 sq meter reflector area. Each unit of concentrators is connected to a central steam pipeline going to the kitchen. The system is made of indigenous components and the reflectors are of acrylic mirrors having reflectivity over 75%. Its installation was completed during September 2002 and was inaugurated on 11th October 2002. The system is expected to save around 1,18,000 litres of diesel per year, valued at Rs. 2.3 million.

The total cost of the system is about Rs. 110 million, which includes back up boiler, utensils and annual maintenance contract for five years. The system has been installed by M/s Gadhia Solar Energy Systems, Valsad under a demonstration scheme of MNES with 50% financial support. Balance of the cost has been borne by the TTD trust. A total of 6 such systems have been installed in the country.

This technology could be very useful at places where rice is the staple food and cooking is done on a very large scale.

Roof-Top SPV Systems Catch- Up

A rooftop grid-interactive SPV power system can meet the partial load during peak demand of a building and supply grid-quality power to the utility when power is not required on holidays. A typical grid-interactive system comprises SPV modules, which supply electrical power to the load through a high-quality inverter. The inverter converts the direct current (DC) generated by SPV to grid-quality alternating current (AC). When the SPV system produces more power than is needed in the load area, the excess power can be sold to the utility.

During 2001-02 five projects with an aggregate capacity of 275 kWp were commissioned. This brings the total rooftop systems installed up to February 2002 to nine. In addition two rooftop systems are under installation. Among the projects commissioned during the year are those at the Vidyut Saudha Building in Hyderabad and at the Bikalp Shakti Bhawan in Kolkata.

The West Bengal Renewable Energy Development Agency (WBREDA) has set up the Kolkata project, which has a capacity of 25 kWp. WBREDA has entered into an Energy Adjustment Agreement with the West Bengal State Electricity Board, under which the WBREDA would pay net energy charges. A bi-directional import-export energy meter keeps a record of the net energy consumption by the WBREDA and the electricity charges are based on net energy consumption at Bikalp Shakti Bhawan.

Biomass Applications

Co-generation - Bagasse based Cogeneration System

A 17 MW co-generation power project set up by M/s Kakatiya Cement Sugar & Industries Ltd., in 2002 at Peruvancha village, Kallur Mandal, Khammam District, Andhra Pradesh. The project is the first of its kind for a sugar mill. A high pressure boiler of 87 ata./515 deg C has been installed, which ensures high energy efficiency & better utilization of bagasse resulting in more steam and hence more electricity.

The project envisages generation of power to meet captive sugar plant requirements, cement plant requirements and export of about 10.85 MW of surplus power during season and 14.70 MW during off-season, to the State grid. The project uses bagasse generated from the crushing operations of the sugar mill during season, and stored bagasse, cane trash and coal during off-season.

The project was completed in a record period of 18 months. It achieved a PLF of around 90% in the very first year. The cost of the co-generation project was Rs. 501.7 million. The technology used was indigenous, except for the turbo-generator, which was imported.

The project has generated direct employment opportunities to about 100 persons and has also contributed to economic development of the area.

Agro-Waste and Industrial Waste Utilizing Gasifier

The 8 MW Biomass based Power Project with export of 7.20 MW of surplus power after meeting 0.80 MW for in-house auxiliary consumption has been set up at Patancheru in Medak District of Andhra Pradesh. The project utilizes a variety of agricultural wastes and industrial wastes for generation of power, such as sugar cane trash, coffee shells, toor dal stalks, corn cobs, ground nut shells, poultry manure, jowar husk, waste crops, juliflora, eucalyptus, cotton talks, saw dust, wood husk, rice husk and bagasse.

The project was commissioned in February 2002. A PLF of 90% has been achieved in the first full year of commercial operation. The technology used is totally indigenous.

The company has tied up with M/s AP Forest Development Corporation Limited for developing fast growing clone eucalyptus plantations in about 500 acres of barren land for fuel supply to the plant. The Plant has generated direct employment to over 110 persons, and has also contributed to the economic development of the region.

10. Alternative Fuels Programme makes Headway

Already a 50 kW phosphoric acid fuel cell (PAFC) power plant has been tested for distributed power generation and a fuel cell vehicle based on an indigenously developed proton exchange membrane fuel cell (PEMFC) system is being operated for demonstration, education and performance evaluation in Chennai.

Hydrogen fueled power-generating sets, two-wheelers and catalytic burners for industrial and residential uses have been developed and demonstrated. Hydrogen powered vehicles and fuel cell vehicles are truly zero-emission vehicles.

Prototypes of nickel metal hydride (NiMH) batteries have been developed with indigenously available alloys and tried on electric bikes. The MNES has been implementing a demonstration programme on battery operated electric vehicles through the State Nodal Agencies and Departments.

MNES has also sanctioned a pilot project for demonstration and field performance evaluation of 300 battery-operated three-wheelers. Some companies including BHEL and Scooters India Ltd are developing and deploying battery operated passenger vehicles.

Manufacture of hybrid electric vehicle has also been taken up. These are based on a combination of the engine of a conventional vehicle with electric motor powered by traction batteries and/or fuel cells.

Efforts to tap the geothermal and ocean energy potential are continuing. The geothermal fields in Tattapani in Chattigarh are being developed for power generation and the country's first tidal power plant of 3 MW capacity is being planned in the Sundarbans area of West Bengal.

11. Conclusions

India has launched a massive programme of renewable energy utilization. Recent successes through market approach ensure larger applications on a sustainable basis. The level of use will however, depend on availability of fossil fuels and their price. Recent resolve of SAARC at its meeting at Islamabad on January 4, 2004 reflects political support for renewable in South Asia Indian technical inputs can be crucial in such development.