Government of India
Ministry of Non-Conventional Energy Sources

6

Wind Energy

Dr Manmohan Singh

Prime Minister of India

'Energy is an important input for economic development. Since exhaustible energy sources in the country are limited, there is an urgent need to focus attention on development of renewable energy sources and use of energy efficient technologies. The exploitation and development of various forms of energy and making energy available at affordable rates is one of our major thrust areas.'

Smt. Sonia Gandhi

Chairperson, National Advisory Council

'Today India is one of the few leading countries in the development and utilization of renewable energy. The country is blessed with various sources of non-conventional energy and I hope the efforts of Ministry of Non-Conventional Energy Sources will promote viable technologies that can reach the benefits of such sources to the poorest people in the far-flung regions of the country.'

Renewable Energy in India

Energy is a basic requirement for economic development. Every sector of Indian economy – agriculture, industry, transport, commercial, and domestic – needs inputs of energy. The economic development plans implemented since independence have necessarily required increasing amounts of energy. As a result, consumption of energy in all forms has been steadily rising all over the country.

This growing consumption of energy has also resulted in the country becoming increasingly dependent on fossil fuels such as coal and oil and gas. Rising prices of oil and gas and potential shortages in future lead to concerns about the security of energy supply needed to sustain our economic growth. Increased use of fossil fuels also causes environmental problems both locally and globally.

Against this background, the country urgently needs to develop a sustainable path of energy development. Promotion of energy conservation and increased use of renewable energy sources are the twin planks of a sustainable energy supply.

Fortunately, India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, the sun, wind, and small hydro power. (Large hydro power is also renewable in nature, but has been utilized all over the world for many decades, and is generally not included in the term 'new and renewable sources of energy'.) Municipal and industrial wastes can also be useful sources of energy, but are basically different forms of biomass.

Advantages of renewable energy are that it is

- perennial
- available locally and does not need elaborate arrangements for transport
- usually modular in nature, i.e. small-scale units and systems can be almost as economical as large-scale ones
- environment-friendly
- well suited for decentralized applications and use in remote areas.

The Ministry of Non-Conventional Energy Sources has been implementing comprehensive programmes for the development and utilization of various renewable energy sources in the country. As a result of efforts made during the past quarter century, a number of technologies and devices have been developed and have become commercially available. These include biogas plants, improved wood stoves, solar water heaters, solar cookers, solar lanterns, street lights, pumps, wind electric generators, water-pumping wind mills, biomass gasifiers, and small hydro-electric generators. Energy technologies for the future such as hydrogen, fuel cells, and bio-fuels are being actively developed.

India is implementing one of the world's largest programmes in renewable energy. The country ranks second in the world in biogas utilization and fifth in wind power and photovoltaic production. Renewable sources already contribute to about 5% of the total power generating capacity in the country. The major renewable energy sources and devices in use in India are listed in Table 1 along with their potential and present status in terms of the number of installations or total capacity.

Table 1

Renewable energy in India at a glance

Source/System	*Estimated potential*	*Cumulative installed capacity / number**
Wind power	45 000 MW	3595 MW
Biomass power	16 000 MW	302.53 MW
Bagasse cogeneration	3500 MW	447.00 MW
Small hydro (up to 25 MW)	15 000 MW	1705.63 MW
Waste to energy		
■ Municipal solid waste	1700 MW	17 MW
■ Industrial waste	1000 MW	29.50 MW
Family-size biogas plants	12 million	3.71 million
Improved chulhas	120 million	35.20 million
Solar street lighting systems	–	54 795
Home lighting systems	–	342 607
Solar lanterns	–	560 295
Solar photovoltaic power plants	–	1566 kWp
Solar water heating systems	140 million m^2 of collector area	1 million m^2 of collector area
Box-type solar cookers	–	575 000
Solar photovoltaic pumps	–	6818
Wind pumps	–	1087
Biomass gasifiers	–	66.35 MW

* as on 31 March 2005


राजीव गांधी
एवं विशेष डाक टिकट











National Electricity Policy 2005

The National Electricity Policy aims at achieving the following objectives.

1 Access to Electricity – available for all households in the next five years.
2 Availability of Power – demand to be fully met by 2012. Energy and peaking shortages to be overcome and spinning reserve to be available.
3 Supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates.
4 Per capita availability of electricity to be increased to over 1000 units by 2012.
5 Minimum lifeline consumption of 1 unit/household/day as a merit good by 2012.
6 Financial turnaround and commercial viability of electricity sector.
7 Protection of consumers' interests.

The Electricity Act 2003

The Electricity Act contains the following provisions pertaining to non-conventional energy sources.

Sections 3(1) and 3(2)

Under Sections 3(1) and 3(2), it has been stated that the Central Government shall, from time to time, prepare and publish the National Electricity Policy and Tariff Policy, in consultation with the state governments and authority for development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or material, hydro and renewable sources of energy.

Section 4

Section 4 states that the Central Government shall, after consultation with the state governments, prepare and notify a national policy, permitting stand-alone systems (including those based on renewable sources of energy and other non-conventional sources of energy) for rural areas.

Section 61

Section 61, 61(h) and 61(i) state that the appropriate commission shall, subject to the provision of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided by the following, namely, the promotion of cogeneration and generation of electricity from renewable sources of energy; and the National Electricity Policy and Tariff Policy.

Section 86(1)

Section 86(1) and 86(1)(e) state that the state commissions shall discharge the following functions, namely, promote cogeneration and generation of electricity from renewable sources of energy by providing, suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution license.

Wind Energy

Introduction

Wind energy has been utilized by mankind for sailing, grinding, and other mechanical applications for centuries. In the recent past, wind energy has emerged as a viable renewable energy option with increased application in water pumping, battery charging, and large power generation. It is environmentally benign and does not emit greenhouse gases (GHG).

Wind Power Generation

Generation of electricity has emerged as the most important application of wind energy world-wide. The concept is simple: flowing wind rotates the blades of a turbine, and causes electricity to be produced in generator unit. The blades and generator (housed in a unit called 'nacelle') are mounted at the top of a tower.

Technology

Wind turbines generally have three rotor blades, which rotate with wind flow and are coupled to a generator either directly or through a gear box. The rotor blades rotate around a horizontal hub connected to a generator, which is located inside the nacelle. The nacelle also houses other electrical components and the yaw mechanism, which turns the turbine so that it faces the wind. Sensors are used to monitor wind direction and the tower head is turned to line up with the wind. The power produced by the generator is controlled automatically as wind speeds vary. The rotor diameters vary from 30 metres (m) to about 90 m, whereas the towers on which the wind electric generators (WEGs) are mounted, range in height from 25 to 80 m.

The power generated by wind turbines is conditioned properly so as to feed the local grid. The unit capacities of WEGs presently range from 225 kilowatt (kW) to 2 megawatt (MW), and they can operate in wind speeds ranging between 2.5 m/s (metres per second) and 25 m/s.

Wind speed data of potential locations is compiled for a period of one to two years, to identify suitable sites for the installation of WEGs. Thereafter, WEGs are installed on the sites with appropriate distances between them to ensure minimum disturbance to one another. After the identification of sites, wind turbines generally take two to three months for installation. The equipment is tested and certified by agencies to ensure that it conforms to the laid-down standards, specifications, and performance parameters. The machines are maintained by the respective manufacturers after installation.

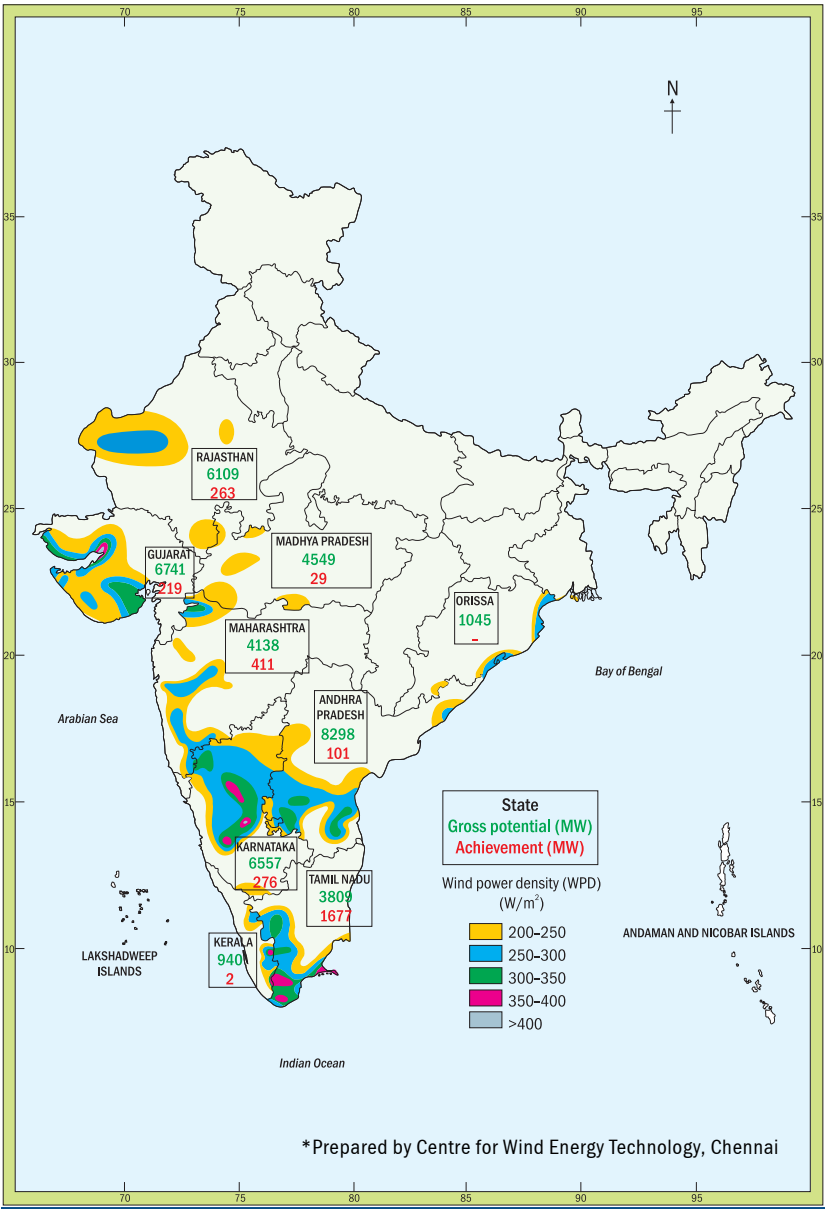
Wind Power Potential in India

India's wind power potential has been assessed at 45 000 MW. The current technical potential is estimated at about 13 000 MW, assuming 20% grid penetration, which would increase with the augmentation of grid capacity in potential states. The state-wise gross and technical potentials are given in Table 1.

Table 1

Wind power potential (gross and technical)

State	*Gross potential* (MW)	*Technical potential* (MW)
Andhra Pradesh	8275	2110
Gujarat	9675	1900
Karnataka	6620	1310
Kerala	875	610
Madhya Pradesh	5500	1050
Maharashtra	3650	3060
Orissa	1700	1085
Rajasthan	5400	1050
Tamil Nadu	3050	2150
West Bengal	450	450
Total	**45195**	**14775**



Wind power potential and achievements as on 31 December 2004

National Wind Power Programme

The Wind Power Programme in India was initiated towards the end of the Sixth Plan, in 1983–84. The programme aims at survey and assessment of wind resources, setting up demonstration projects, and provision of incentives to make wind electricity competitive. As a result, wind electricity has emerged as an option for grid-quality power generation. The costs in respect of wind monitoring stations are shared between the Ministry of Non-Conventional Energy Sources (MNES) and the state nodal agencies in the ratio of 80:20 (90:10 for north-eastern states). With 2980 MW of installed wind power capacity, India now ranks fifth in the world after Germany, USA, Spain, and Denmark. Most of the capacity addition has been achieved through commercial projects by private investors.

Wind Resource Assessment Programme

The Wind Resource Assessment Programme is being implemented by C-WET (Centre for Wind Energy Technology) in coordination with state nodal agencies. An annual mean wind power density greater than 200 W/m^2 (watts per square metre) at 50-metre height has been recorded at 211 wind monitoring stations, covering 13 states and union territories, namely Andaman and Nicobar Islands, Andhra Pradesh, Gujarat, Karnataka, Kerala, Lakshadweep, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttaranchal, and West Bengal. Handbooks titled *Wind Energy Resource Survey in India* have been published covering the wind data already generated.

Master plans

Master plans are available for 97 potential sites for wind power in Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh,

Maharashtra, Orissa, Rajasthan, Tamil Nadu, and West Bengal. The master plans provide information on the availability of wind, land, grid availability, and accessibility to the site, which enables project promoters and state nodal agencies to undertake proper planning and implementation of the projects. The master plans have been provided to the state nodal agencies and are made available to project promoters, developers, and consultants through C-WET at a nominal cost.

Cost of Wind Power Projects

The cost of wind power generation varies between Rs 4 and 5 crores per MW, depending upon state characteristics. The machines can be maintained at a cost of Rs 0.25 to 0.60/kWh. The projects are estimated to have a pay-back period of five to eight years.

Promotional Incentives

Wind power projects have been set up through private investment. The promotional incentives available are listed below.

- 80% accelerated depreciation in the first year.
- Concessional import duty of 5% on five specified wind turbine components and their parts.
- Favourable tariffs and policies in several states.

Manufacturing Base for Wind Turbine

Wind turbines are produced in the country by about a dozen manufacturers, mainly through joint ventures or under licensed production agreements. A few foreign companies have also set up their subsidiaries in India. A few Indian companies are manufacturing WEGs without any foreign collaboration. A list of manufacturers of wind turbine models possessing valid approvals, along with their foreign collaborators, is given in Table 2 (A and B). Indian-made wind turbines are also being exported to some countries.

Table 2A

Wind turbine manufacturers in India with models having valid type approvals

Wind turbine manufacturers	*Capacity*	*Model*	*Rotor Dia /* (RD)	*Hub height* (HH)
Bharat Heavy Electricals Ltd Ranipet	800 kW	Nordex N50 (N50s R46LM 23.3 IEC 1a)	RD: 50 m	HH: 46 m
Elecon Engineering Company Ltd, Gujarat	400 kW 600 kW	T400-34 T600-48	RD: 34 m RD: 48 m	HH: 34 m HH: 50/55/ 60 m
Enercon (India) Ltd Mumbai	230 kW 330 kW 600 kW	E-30 Enercon E-33 E-40 / 6.44 / E2	RD: 30 m RD: 33.4 m RD: 44 m	HH: 50.6 m HH: 49.04/ 49.92 m HH: 46/56.85/ 74.85 m
GE Wind Energy India GE Power Controls India Pvt. Ltd, Bangalore	1500 kW	GE Wind Energy 1.5s	RD: 70.5 m	HH: 64.7 m/ 85 m
Vestas RRB India Ltd Chennai	225 kW 500 kW	V27 V39-500 kW with 47 m rotor diameter	RD: 27 m RD: 47 m	HH: 31.5/50 m HH: 40/45/ 50 m
NEG Micon (India) Pvt. Ltd Chennai	750 kW 950 kW 1650 kW 1500 kW	NM 48 NM 54 NM 82 NM 72C	RD: 48.2 m RD: 54.5 m RD: 82 m RD: 72 m	HH: 45/50/55 m HH: 55/72.3 m HH: 70/78 m HH: 62/78/80 m
NEPC India Ltd Chennai	225 kW	NEPC-225 kW	RD: 29.8 m	HH: 45 m
Pioneer Asia Wind Turbines Chennai	850 kW 850 kW	Gamesa Eolica G52-850 kW Gamesa Eolica G58-850 kW	RD: 52 m RD: 58 m	HH: 44/55/65 m HH: 44/55/65 m
Suzlon Energy Ltd Pune	350 kW 300 kW 1000 kW 1250 kW 1250 kW 1250 kW	Suzlon N 3335/ 350 kW& Suzlon N 3330/ 300 kW Suzlon S64/ 1000 kW Suzlon S64/ 1250 kW Suzlon S66/ 1250 kW Suzlong S66/ 1250 kW	RD: 33.4 m RD: 64 m RD: 64 m RD: 66 m RD: 66 m	HH: 50 m HH: 65 m HH: 65 m HH: 65 m HH: 75 m

Table 2B

Wind turbine manufacturers and wind turbine models that are under type certification / testing at C-WET

Wind turbine manufacturers	*Capacity*	*Model/Rotor Dia (RD)* (m)/ *Hub height (HH)* (m)
Chiranjeevi Wind Energy Ltd 26, Kamaraj Road, Mahalingapuram Pollachi – 642 002 *Tel*. 04259-224438 / 225482 *Fax* 04259-224437	250 kW	C 2920 RD: 29.2 m HH: 31.5 / 41.5 m
Enercon (India) Ltd Kolsite House, Plot No. 31 Shah Industrial Estate, Veera Desai Road Andheri (West), Mumbai – 400 053 *Tel*. 022-5692 4848 *Fax* 022-2637 0085	800 kW	E-48 RD: 48 m HH: 56.85 / 74.85 m
NEPC India Ltd 36, Wallajah Road Chennai – 600 002 *Tel*. 044-2855 5118 / 2852 4541 *Fax* 044-2852 4709	600 / 750 kW 225 kW	NEPC-NORWIN-ASR-46/ 47-600/750 kW RD: 46 / 47 m HH: 45 / 60 / 65 m NEPC-225 kW RD: 29.8 m HH: 50 m
Pioneer Wincon Private Ltd 16 - SP, Developed Plot Industrial Estate, Guindy Chennai – 600 032 *Tel*. 044-2232 9145 / 2232 6240 *Fax* 044-2234 6626	250 kW	W 250/29 RD: 29 m HH: 30 m
TTG Industries Ltd 36, College Road, Chennai – 600 006 *Tel*. 044-2827 3204 / 2827 2590 *Fax* 044-2826 2416	250 kW	TTG 250 T RD: 28.5 m HH: 41.2 m
Vestas RRB India Ltd No. 17, Vembuliamman Koil Street K K Nagar (West), Chennai ´– 600 078 *Tel*. 044-2364 1111 *Fax* 044-2364 2222	600 kW	Pawan Shakthi-600 kW RD: 47 m HH: 65 m

Guidelines for Wind Power Projects

Comprehensive guidelines for wind power projects have been issued by the MNES from time to time. These guidelines relate to preparation of detailed project reports (DPRs), micro-siting, selection of wind turbine equipment, operation and maintenance, performance evaluation, etc. Users of these guidelines include the state electricity boards (SEBs), state nodal agencies, manufacturers, developers, and investors. The certification requirement for wind turbines was re-introduced with a time-bound provision for self-certification. C-WET issues a list of manufacturers of certified wind turbine machines on a quarterly basis.

Success Stories

A few examples of successful wind farms are briefly described below.

Muppandal–Perungudi (Tamil Nadu)

With an aggregate wind power capacity of 450 MW, the Muppandal–Perungudi region near Kanyakumari in Tamil Nadu has the distinction of having one of the largest clusters of wind turbines. About Rs 2500 crores has been invested in wind power in this region.

Kavdya Donger, Supa (Maharashtra)

A wind farm project has been developed at Kavdya Donger at Supa, off the Pune–Ahmednagar highway, about 100 km from Pune. This wind farm has 57 machines of 1-MW capacity each. Annual capacity utilization of up to 22% has been reported from this site. The farm is connected through V-sat to project developers as well as promoters for online performance monitoring.

Satara district (Maharashtra)

A conducive policy for private investment in wind power projects has resulted in significant wind power development in Maharashtra, particularly in the Satara district. Wind power capacity of about 340 MW has been established at Vankusawade, Thosegarh, and Chalkewadi in Satara district, with an investment of about Rs 1500 crores.

Wind Energy for Water Pumping and Off-grid Power Generation

Water-pumping windmills, aerogenerators (small wind electric generators), and wind–solar hybrid systems have been found to be useful for meeting water-pumping and small-power requirements in a decentralized mode in rural and remote windy areas of the country. The MNES is implementing a programme on 'Small Wind Energy and Hybrid Systems' to promote utilization of water-pumping wind mills, aerogenerators, and wind–solar hybrid systems for water pumping and power generation.

Water-pumping windmill

A water-pumping windmill pumps water from wells, ponds, and bore wells for drinking, minor irrigation, salt farming, fish farming, etc. Available windmills are of two types, namely direct drive and gear type. The most commonly used windmill has a horizontal axis rotor of 3–5.5 m diameter, with 12–24 blades mounted on the top of a 10–20 m high mild steel tower. The rotor is coupled with a reciprocating pump of 50–150 mm diameter through a connecting rod.

Such windmills start lifting water when wind speed approaches 8–10 kilometres (km) per hour. Normally, a windmill is capable of pumping water in the range of 1000 to 8000 litres per hour, depending on the wind speed, the depth of water table, and the type of windmill. Windmills are capable of pumping water from depths of 60 m. Water-pumping windmills have an advantage in that no fuel is required for their operation, and thus they can be installed in remote windy areas where other conventional means of water pumping are not feasible.

However, water-pumping windmills have limitations too. They can be operated satisfactorily only in medium wind regimes (12–18 km per hour). Further, special care is needed at the time of site selection as the sites should be free from obstacles such as buildings and trees in the surrounding areas. The cost of the system being high, many individual users do not find them affordable.

Cost

The cost of a water-pumping windmill varies from Rs 45 000 to Rs 150 000, depending on the type. In addition, Rs 10 000–Rs 20 000 is required for the foundation, storage tank, and the installation of the windmill. As the system involves moving parts, it requires frequent maintenance. The repair and maintenance cost of a windmill is about Rs 2000 per year.

The MNES provides a subsidy of up to 50% of the ex-works cost of water-pumping windmills, subject to ceilings of Rs 20 000, Rs 30 000, and Rs 45 000 in the case of direct drive, gear type, and AV-55 Auroville models, respectively. For non-electrified islands, subsidy of up to 90% of the ex-works cost is provided for the above types of windmills, subject to ceilings of Rs 30 000, Rs 45 000, and Rs 80 000, respectively.

Aerogenerator

An aerogenerator is a small wind electric generator having a capacity of up to 30 kW. Aerogenerators are installed either in stand-alone

mode or along with solar photovoltaic (SPV) systems to form a wind–solar hybrid system for decentralized power generation. An aerogenerator is suitable for power generation in unelectrified areas having adequate wind speeds. It consists of a rotor of 1–10 m diameter having 2–3 blades, permanent magnet generator, control devices, yaw mechanism, tower, storage battery, etc. The aerogenerator rotor starts moving at a wind speed of 9–12 km per hour. However, it produces optimum power at the rated wind speed of 40–45 km per hour. The limitation of not being able to provide power as and when it is required is overcome by storing it in a battery bank.

Aerogenerators cost about Rs 2.00–2.50 lakhs per kW. In addition, the cost of installation including civil works is estimated at Rs 5000 per kW. The repair and maintenance cost is about Rs 2000 per kW per annum.

Wind–solar hybrid systems

When an aerogenerator and an SPV system are interfaced, the power generation from these is mutually supplemented, and the resultant hybrid system offers a reliable and cost-effective electric supply in a decentralized mode. The wind–solar hybrid system mainly consists of one or two aerogenerators along with SPV panels of suitable capacity, connected with charge controller, inverter, battery bank, etc. to supply AC power. The major advantage of the system is that it meets the basic power requirements of non-electrified remote areas, where grid power has not yet reached. The power generated from both wind and solar components is stored in a battery bank for use whenever required.

The cost of the system varies from Rs 2.50 lakhs to Rs 3.50 lakhs per kW depending on the ratio of wind and solar components. The approximate cost of installation, including civil works, is about Rs 10 000 per kW. Repair and maintenance cost is about Rs 3000 per kW per annum.

Subsidy of up to 50% of ex-works cost of the system is provided, subject to a maximum of Rs 1.25 lakhs per kW to individuals, industries, and R&D and academic institutions. The MNES provides

a subsidy for community use and direct use by central/state government departments and defence and para-military forces of up to 75% of the ex-works cost of the system subject to a maximum of Rs 2 lakhs per kW. For non-electrified islands, subsidy of up to 90% of ex-works cost subject to a maximum of Rs 2.4 lakhs per kW is available.

System Availability and Repair/Servicing Facility

Water-pumping windmills, aerogenerators, and wind–solar hybrid systems are installed through state nodal agencies using central subsidy. A manufacturing base has been developed, and a non-exclusive list of manufacturers is given in Annexe 1. The state nodal agencies are responsible for providing repair/service facilities through the respective manufacturers.

Potential and Achievement

Water-pumping windmills require only medium wind regimes. Considering the availability of required wind speeds and the level of the prevailing water table, potential exists for installing water-pumping windmills in almost all states, except in hilly and rocky regions. Aerogenerators and wind–solar hybrid systems require high wind speeds and good solar radiation. Potential exists for their installation in Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttaranchal, Uttar Pradesh, West Bengal, and the windy regions of Jammu and Kashmir and all north-eastern states. So far, about 1000 water-pumping windmills and 380-kW aggregate capacity of aerogenerators/wind–solar hybrid systems have been installed in the country.

Success Stories

Water-pumping windmills

Three water-pumping windmills of AV-55 type installed in and around Auroville have become the exclusive source of drinking water for the

community, which is fully dependent on the water lifted by these windmills. The maximum number of water-pumping windmills have been installed in Gujarat, for irrigation and drinking water purposes.

Aerogenerators

The West Bengal Renewable Energy Development Agency (WBREDA) has installed six aerogenerators of 3-kW capacity each in the existing SPV power plants at Sagar and Mousani islands. A number of aerogenerators have been installed by the Maharashtra Energy Development Agency (MEDA), and are working satisfactorily. An aerogenerator of 3.2-kW capacity, installed at the Manashakti Research Centre, Lonawala, is supplying electricity to illuminate 22 streetlights on the road connecting the centre's hostel to the highway. The aerogenerator is visible from the Mumbai–Pune highway.

Wind–solar hybrid systems

Wind–solar hybrid systems have been installed for a variety of applications. Some of them have been installed on islands and in coastal areas. One notable project is a 5-kW capacity wind–solar hybrid system installed on Vagator beach in Goa, which has become a destination point for tourists. The system illuminates 60 CFLs (compact fluorescent lamps) of 18 watts rating each. These CFLs are the only source of illumination on the beach. A 15-kW wind–solar hybrid system has recently been installed at the famous pilgrimage site of Bhimashanker Deosthan, in Pune district, Maharashtra. This system provides electricity to meet the needs of the entire temple complex. It has become a point of attraction for a large number of devotees visiting the temple complex. A large number of wind–solar hybrid systems have been installed in Maharashtra by MEDA, including a unit that provides power to the local area network of computers and other needs in their own office complex in Pune.

Rajiv Gandhi Akshay Urja Diwas

On 20 August 2004 – the 60th Birth Anniversary of our Late Prime Minister Mr Rajiv Gandhi – the Ministry organized the Rajiv Gandhi Akshay Urja Diwas. Initiated by the Hon'ble Minister of State (Non-Conventional Energy Sources), Mr V Muttemwar, the occasion saw the release of a commemorative stamp by the Hon'ble Prime Minister, Dr Manmohan Singh, at a function attended by Smt. Sonia Gandhi, Chairperson, United Progressive Alliance (UPA), Members of the Union Cabinet, Members of Parliament, Chief Ministers, Foreign Dignitaries, Administrators, Scientists, and students among others.

The day was also appropriate to advocate renewable energy, since Mr Rajiv Gandhi was a keen enthusiast of scientific advances that would enable India to leap into the 21st century. Thus, a human chain of nearly 12 000 school children was formed in the National Capital to promote a renewable future. In the rest of the country too, functions such as rallies and human chains were organized. In addition, competitions such as essay writing, painting, quizzes, and debates were held, all of which covered different aspects of renewable energy – from biogas to biomass to solar, hydro, and wind power. The essence of these public activities was to generate mass awareness and disseminate information about the advances made in renewable energy technologies, and with the ultimate objective of achieving '***Akshay urja se desh vikas – Gaon gaon bijlee, ghar ghar prakash***'. The success of the Rajiv Gandhi Akshay Urja Diwas has encouraged the Ministry to make it an annual affair, to be celebrated on 20 August every year.

Whom to Contact

Individuals and organizations interested in wind power systems may approach the concerned state nodal agencies in their states, or the manufacturers of such systems. A non-exclusive list of manufacturers of water-pumping windmills, aerogenerators, and wind–solar hybrid systems, who are eligible to supply and install the systems under the programme of the MNES, is given in Annexe 1.

For further information, please contact

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Pallikaranai, Chennai – 601 302 — *E-mail* cwet@md4.vsnl.net.in

ANNEXE 1

Manufacturers of water-pumping windmills, aerogenerators, and wind–solar hybrid systems

(a) Water-pumping windmills (wind pumps)

Manufacturer	*Type of windmill*
Aureka, Tamil Nadu *E-mail* aureka@auroville.org.in *Tel*. 0413 262 2278, 262 2134 / 651 *Fax* 0413 262 2274	AV 55 Auroville
Auto Spares Industries, Pondicherry *E-mail* ajmindia@eth.net *Tel*. 0413 233 4554, 233 8791 *Fax* 0413 233 3447	Geared type
Kamal Engineering Works, Nalanda, Bihar	Modified 12 PU 500
Marut Energy Equipment Pvt. Ltd, Maharashtra *E-mail* marketing@solarecindia.com *Tel*. 0253 238 0436, 238 0061 *Fax* 0253 238 0061, 238 4061	Geared type
Nalanda Engineering Works, Nalanda, Bihar	Modified 12 PU 500
Om Engineering Works, District Kutch, Gujarat	Geared type
Prototype Development Training Centre Rajkot, Gujarat	Geared type
Rural Engineering School, Gujarat *Tel*. 02847 22104 *Fax* 02847 22104	Geared type
Sarvodaya Engineering Works, Bihar *Tel*. 06112 222506	Modified 12 PU 500
Scientific Instrument Co. Ltd, Ghaziabad *E-mail* sicogzb@del3.vsnl.net.in *Tel*. 0120 273 2644 273 2954 Fax 0120 273 6235	Geared type
Vikas Engineering Works, Nalanda, Bihar	Modified 12 PU 500
Wind Fab, Tamil Nadu *Tel*. 0422 257 2079	Geared type

(b) Aerogenerators and wind–solar hybrid systems

Manufacturer	*System*
Auto Spares Industries, Pondicherry *E-mail* ajmindia@eth.net *Tel*. 0413 233 4554 / 233 8791	Aerogenerators and Wind–Solar Hybrid Systems
Auroville Energy Products, Auroshilpam, Auroville *Tel*. 0413 262 2582	Aerogenerator and Wind-Solar Hybrid Systems
Bharat Heavy Electricals Ltd, Hyderabad *E-mail* ccx@bhelrnd.co.in *Tel*. 040 238 82230 / 237 73476	Aerogenerators and Wind–Solar Hybrid Systems
Exide Industries Ltd, Kolkata *Tel*. 033 247 8320 *Fax* 033 247 9819	Aerogenerator and Wind-Solar Hybrid Systems
Jindesh International, New Delhi *E-mail* khannas@giasdla.vsnl.net.in *Tel*. 011 2467 1651 / 2467 2565	Aerogenerator 72 W
Lotus Solar Solutions Ptv. Ltd, Gurgaon, Haryana *E-mail* lotussolar@hotmail.com *Tel*. 95124 5045157 *Fax* 95124 5045158	Aerogenerator and Wind-Solar Hybrid Systems
Machinocraft, Pune *E-mail* achino@pn2.vsnl.net.in *Tel*. 020 437 1457 / 437 3923	Aerogenerators and Wind-Solar Hybrid Systems
Marut Energy Equipments Pvt. Ltd, Nasik *E-mail* marketing@solarecindia.com *Tel*. 0253 238 0436 / 238 0061	Aerogenerators 72 W-10 kW
Rajasthan Electronics & Instruments Ltd, Jaipur *E-mail* reiljp@reiljp.com *Tel*. 0141 220 3038 / 220 3562	Aerogenerators and Wind–Solar Hybrid Systems
Square Engineering Pvt. Ltd, Pune *Tel*. 020 2431 8185	Aerogenerators and Wind–Solar Hybrid Systems
Tata BP Solar India Ltd, Bangalore *Tel*. 080 852 0082 / 3852 0973 / 3852 0974	Aerogenerators and Wind–Solar Hybrid Systems
Unitron Energy Systems Pvt. Ltd, Pune *E-mail* unitron@pn3.vsnl.net.in *Tel*. 020 2668 7006 / 2668 4399	Aerogenerators and Wind–Solar Hybrid Systems
Vistar Electronics Pvt. Ltd, Pune *E-mail* Vistar.electronics@gems.vsnl.net.in *Tel*. 020 543 9267 / 543 1207	Aerogenerators and Wind–Solar Hybrid Systems

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'The promotion of renewable energy sources in the country requires widespread publicity and greater awareness of the potential of these energy sources and the products available. The Ministry of Non-Conventional Energy Sources is expanding several of its programmes so that these sources can contribute to sustainable development of the nation. The Ministry will work towards reducing the costs of renewable energy products and making them easily available to the people. The motto of the Ministry is "Akshay urja se desh vikas" and the ultimate goal is "Gaon gaon bijli, ghar ghar prakash".'

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