India's Performance in Renewable Energy

BHARAT VASANDANI, ENERGETICA INDIA

Energetica India peeks into details of numbers of installations and generation capacity in the renewable energy power in India. India is focusing on renewable energy and the results are there to be seen.

Renewable energy has been an important component of India's energy planning process since quite some time. India has been making tremendous progress where the renewable grid capacity as a percentage of total capacity has increased by almost four times. In April 2002, renewable energy based power generation installed capacity was 3497 MW which was 3% of the total installed capacity in the country. As on 31.01.2011, the renewable energy capacity in India reached 18,842 MW, which is about 11% of the total installed capacity of 1,72,283 MW. Major contribution has come from wind power which is about 70% of the total capacity. Please see figure no.1

According to the latest government numbers (as of 30.9.2011), renewable energy as a % of total energy generation in India has nearly touched 12%.

During the first three years of the 11th plan period and the current year upto 31.01.2011, renewable power capacity addition has been 8,584 MW, while the conventional power capacity addition has been 28,529 MW, which corresponds to over 23% of the total capacity addition. It is to be also noted that 23% of all capacity today is large hydro which is renewable but not counted as such. Please see figure no.2.

Off-grid renewable energy market is as much a focus as on-grid renewable energy. India is working to achieve off-grid penetration in places devoid of power transmission lines or in areas facing huge power cuts. Please refer to figure no.3.

Renewable Energy in India

Renewable Energy for Rural Applications

Under this, the support has come for programmes for the deployment of renewable energy systems band devices such as biogas plants, photovoltaic systems, biomass gasifiers, solar cookers and other solar thermal systems, etc. in rural areas of the country.

Biogas production is a clean low carbon technology for efficient management and conversion of organic wastes into clean renewable biogas and organic fertilizer source. National Biogas and Manure Management Programme (NBMMP) is being implemented in the country since 1981-82 for promotion of biogas plants based on cattle dung and other organic wastes. The NBMMP mainly caters to setting up of family type biogas plants for meeting the cooking energy needs in rural areas of the country along with making enriched bio-fertilizer availability to farmers.

In addition, India also has 'Biogas based Distributed/ Grid Power Generation Programme' (BGPG programme) from 2005-06 with a view to promote biogas based power generation, especially in the small capacity range (from 3 KW to 250 KW), based on the availability of large quantity of animal wastes and wastes from forestry,

Technology	Capacity Installed (MW)	% of Total	Technology	Capacity Installed (MW)	% of Total
Thermal	93838	54,47%	Thermal	100953	58,60%
Hydro	37367	21,69%	Hydro	38706	22,47%
Renewable	18842	10,94%	Renewable	20162	11,70%
Gas	17456	10,13%	Gas	17742,85	10,30%
Nuclear	4780	2,77%	Nuclear	4780	2,77%
	172283			**182343,85**	

Source: MNRE

Figures no,1 and 2: Renewable Energy as % of Total Installed Capacity in India (as of 31.1.2011 and 30.9.2011)

Resource	Estimated Potential	Upto 9th Plan	During 10th Plan	Targets for 11th Plan	During 11th Plan	Total Capacity
	MW				upto 31.1.2011	31.1.2011
Wind	48500	1667	5427	9000	6090	13184
Small Hydro	15000	1438	538	1400	977	2953
Bio Power	23700	390	795	1780	1488	2673
Solar Power	20-30 MW/ Sq.km	2	1	50	29	32
Total		**3497**	**6761**	**12230**	**8584**	**18842**

Bio Power includes biomass power, bagasse cogeneration, urban and industrial waste to energy.

Figure no.2: Plan-period-wise capacity addition in grid connected renewable energy based power generation installed capacity

rural based industries (agro/ food processing), kitchen wastes, etc.

Remote Village Electrification

The Remote Village Electrification Programme is being implemented to provide lighting / electricity using renewable energy, in those remote un-electrified villages and hamlets, which are not going to be covered for grid electrification.

Renewable Energy for Urban, Industrial and Commercial Applications

Solar energy and technologies for energy recovery from municipal, industrial and commercial wastes is also on focus in India to meet niche energy demands of urban, industrial and commercial sectors in the country. The programmes being looked at under this scheme include: i) Solar energy systems and devices including solar thermal and solar photovoltaic systems; ii) Energy recovery from urban, industrial and commercial wastes; and iii) Bioenergy and co-generation in industry.

Energy Efficient Solar/Green Building Programme

Buildings are major consumers of energy in their construction, operation and maintenance. Under Renewable Energy schemes, MNRE has not forgotten Energy Efficient Solar/Green Buildings Programme; promoting GRIHA rating system.

The Country has seen 117 projects with 4.98 million sq.meter built up area with 81 projects from Government Departments with 3.22 million sq. meter built up area have been registered for GRIHA certification. The target was 4 million sq.meter built up area during 11th Plan.

Solar City Programme

Under "Development of Solar Cities Programme" the proposal is to support 60 cities/towns for Development as "Solar/ Green Cities" during the 11th Plan period with the aim to promote the use of renewable energy in urban areas. At least one city in each State to a maximum of five cities in a State was to be supported.

Energy Recovery from Urban and Industrial Wastes

Increasing urbanization, industrialization and the developments taking place in the country also lead to generation of larger quantities of wastes necessitating increased efforts for their management and safe disposal for reducing adverse impact on the environment. With the availability of technologies it is possible to use waste for decentralized energy generation. According to estimates, there exists a potential for generation of over 3600 MW of power from urban and industrial wastes in the country.

Resources	Cumulative Achievements
Off-Grid / Distributed Renewable Power (including captive/cogeneration plants)	**MW as of 31.1.2011**
Biomass Power / Cogen (non-bagasse)	274 MW
Biomass Gasifier	128 MW equivalent
Waste to Energy	68 MW equivalent
Solar PV Power Plants	4 MWp
Aero-Generators / Hybrid Systems	1MW
Total	461 MW equivalent
Decentralized Energy Systems	
Family Type Biogas Plants	43.26 lakhs
SPV Home Lightning System	6,69,805 nos
Solar Latern	8,17,549 nos
SPV Street Lighting System	1,22,697 nos
SPV Pumps	7,495 nos
Solar Water Heating- Collector Area	3.97 million sq.m
Source: MNRE	

Figure no.3: Deployment of Off-Grid / Decentralized Renewable Energy Systems

Programme on Biomass Co-generation (Non-Bagasse) in Industry

Several industries require electrical as well as thermal energy for their operations, which can either be met through different energy sources or through co-generation using only one fuel. The power and steam generated from such co-generation plants can be used for meeting the captive requirements and the surplus power produced can be exported to the grid. Such projects are being set up in a number of industry sectors namely paper and pulp, solvent extraction, rice mills, pharmaceutical industries, etc.

Power from Renewable Grid-Interactive and Off-Grid Renewable Power

Wind:

Wind energy has today emerged as the most promising renewable energy technology for generating grid connected power amongst various renewable energy sources. India is now the fifth largest wind power producer in the world, after USA, Germany, China and Spain. Please refer to figure no.4

Biomass:

Biomass power programme is implemented with the main objective of promoting technologies for optimum use of country's biomass resources for grid power generation. The benefits from biomass include its renewable nature, wide availability, being carbon neutral and the potential to provide large productive employment in rural areas. The constraints are competitive uses of biomass leading to possible non-availability or rise in costs.

States	Potential	Capacity installed during 2010-2011	Cumulative capacity
	in MW	(upto Jan 2011)	upto Jan 2011
Andhra Pradesh	8968	44,8	180,9
Gujarat	10645	172,18	2035,81
Karnataka	11531	121,3	1594,1
Kerala	1171	0	27,75
Madhya Pradesh	1019	7,8	237,2
Maharashtra	4584	125,05	2202,8
Rajasthan	4858	292,7	1381
Tamil Nadu	5530	613	5519,72
Others	255	0	4,3
Total	**48561**	**1376,83**	**13183,58**

Figure no.4: Status of Wind Power in India in 2010-2011

Bagasse Cogeneration Programme:
One of the success stories of power generation in modern India is that of bagasse based cogeneration in sugar mills. The optimum cogeneration capacity installed in the Indian sugar mills is one of the highest among all the major sugar producing countries of the world. Most of the sugar mills have been using alternative biomass materials at the design stage itself such as rice husk, cane trash, cotton stalk wood, etc to generate electricity during off season. These advanced optimum bagasse cogeneration projects benefit not only the sugar mills but also the sugarcane farmers as the value addition to their cane is enhanced and thus they can realize more for it.

Small Hydro Power:
Hydro power projects up to 25 MW capacity are classified as small hydro. The estimated potential for power generation in the country from such plants is over 15,000 MW. The Small Hydro Power (SHP) programme is now essentially private investment driven. 23 States have announced their policies to invite private sector to set up SHP projects. India is looking at least 5000 MW of capacity is added from small hydro projects in next 10 years or so.

Solar:
The government came out with the Jawa-

	New NVVN		Migration		IREDA		Total	
States	**No.**	**MW**	**No.**	**MW**	**No.**	**MW**	**No.**	**MW**
Solar PV Projects								
Andhra Pradesh	4	20			11	10,5	15	30,5
Chhattisgarh					2	4	2	4
Gujarat							0	0
Haryana					10	9,8	10	9,8
Jharkhand					8	16	8	16
Karnataka	2	10					2	10
Madhya Pradesh					3	5,25	3	5,25
Maharashtra	1	5	3	11	3	5	7	21
Orissa	1	5			8	8	9	13
Pondicherry					1	1	1	1
Punjab			2	7	7	8,5	9	15,5
Rajasthan	21	105	8	36	12	12	41	153
Tamil Nadu	1	5			7	7	8	12
Uttarkhand					3	5	3	5
Uttar Pradesh					5	8	5	8
Total	**30**	**150**	**13**	**54**	**80**	**100,05**	**123**	**304,05**
Solar Thermal								
Andhra Pradesh	1	50					1	50
Gujarat	1	20					1	20
Rajasthan	5	400	3	30			8	430
Total	**7**	**470**	**3**	**30**			**10**	**500**
Source: MNRE								

Figure no.5: Grid Connected Solar Projects under JNNSM

	Solar Photovoltaic Systems			Power Plants	
States	**Lanterns**	**Home Lights**	**Street Lights**	**Stand Alone**	**Grid Connected**
		Nos.		**kWp**	**kWp**
Andhra Pradesh	0	1	0	25,64	0
Arunachal Pradesh	0	2000	0	0	0
Gujarat	0	0	0	235,5	5000
Haryana	1470	8479	980	0	0
Maharashtra	0	0	0	0	1000
Mizoram	2519	2350	0	0	0
Punjab	0	0	400	0	1000
Rajasthan	0	24449	90	964,2	4800
Sikkim	2730	335	0	0	0
Tamil Nadu	0	0	0	0	5000
Delhi	54	0	0	0	2088
Total	**6773**	**37614**	**1470**	**1225,34**	**18888**
Data as of 31.1.2011 Source: MNRE					

Figure no.6: Installation of SPV Systems during 2010-2011

harlal Nehru National Solar Mission (JNNSM) to establish India as a global leader in solar energy, by creating policy conditions for its rapid diffusion across the country quickly and achieve a scale, large enough to drive down costs to levels required to achieve grid parity by 2022. The Mission targets include (i) deployment of (a) 20,000 MW of grid connected solar power by 2022, (b) 2,000 MW of off-grid solar applications including 20 million solar lights by 2022, (c) 20 million sq. m. solar thermal collector area, (ii) creation of favourable conditions for developing solar manufacturing capability in the country; and (iii) supporting R&D and capacity building activities to achieve grid parity by 2022.

The Mission would be implemented in three phases. Government has also approved a target to set up 1,100 MW grid connected solar plants, including 100 MW capacity plants as rooftop and other small solar power plants for the first phase of the Mission till March 2013. In addition, a target of 200 MW capacity equivalent off-grid solar applications and 7 million m^2 solar thermal collector area has also been approved. Please refer to figure 5 and 6.

Off-Grid Renewable

Distributed/decentralized renewable power projects using wind energy, biomass energy, hydro power and hybrid systems are being established and emphasised in India to meet the energy requirements of isolated communities and areas which are not likely to be electrified in the near future.

Small Wind Energy and Hybrid Systems:

Small wind energy systems (SWES), namely water pumping windmills, aero generators and wind-solar hybrid systems are being used for harnessing wind and solar energy in un-electrified areas or areas having intermittent electric supply. MNRE is implementing a programme on "Small Wind Energy & Hybrid Systems" for promotion of the systems.

Biomass Gasifier Programme:

Biomass Gasifier based power plants are being promoted to produce electricity using locally available biomass resources in rural areas where surplus biomass such as small wood chips, rice husk, arhar stalks, cotton stalks and other agro-residues are available to meet the unmet demand of electricity for villages for lighting, water pumping and microenterprises. In addition, the industry is also seeing promotion of small biomass gasifier and combustion based power plants connected at the tail end of grid for captive power and thermal applications in rice mills and other industries.

A summary of renewable energy installations and achievements in India can be done from figure no7.

Renewable Energy Programme	Target for 2011-2012	Achievement during 2011-2012	Cumulative Achievement upto 31.8.2011
Grid-Interactive Power	**MW**	**MW**	**MW**
Wind Power	2400,00	833,00	14989,00
Small Hydro	350,00	111,30	3153,93
Biomass Power	460,00	86,50	1083,60
Bagasse Cogeneration		111,50	1779,03
Waste to Power:	25,00		
1. Urban		1,20	20,20
2. Industrial			53,46
Solar Power (SPV)	200,00	8,50	46,16
Total	**3435,00**	**1152,00**	**21125,38**
Off-Grid / Captive Power	**MW equivalent**	**MW equivalent**	**MW equivalent**
Waste to Power:			
1. Urban			3,50
2. Industrial	15,00	10,18	72,30
Biomass Power (non-bagasse) cogeneration	80,00	31,99	327,95
Biomass Gasifiers:			
1. Rural	3,00	1,20	15,55
2. Industrial	10,00	4,50	125,88
Aero-Generators/Hybrid Systems	0,50	0,12	1,24
SPV Systems (>1 kW)	20,00	3,50	72,50
Water mills/micro hydel	400 nos	143 nos	1818 nos
Total	**128,50**	**51,49**	**618,92**
Remote Village Electrification			
No. of remote village/hamlets provided with RE systems	500	742	8846
Other Renewable Energy Systems			
Family Biogas Plants (No.in lakhs)	1,5	0,12	44,16
Solar Water Heating- collector's area (million sq m)	0,6	0,2	4,67
Source: MNRE			

Figure no.7: Renewable Energy Implementation in India as of 31.8.2011