



INFORMATION BULLETIN

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NON-CONVENTIONAL SOURCES OF ENERGY

Sources of energy can be classified into two broad categories—Conventional and Non-conventional. The Conventional sources of energy include fossil fuel i.e. coal, oil, natural gas, etc. The Non-conventional sources of energy are wind, sunlight, tide, etc. which are renewable. As such they are known as renewable sources of energy.

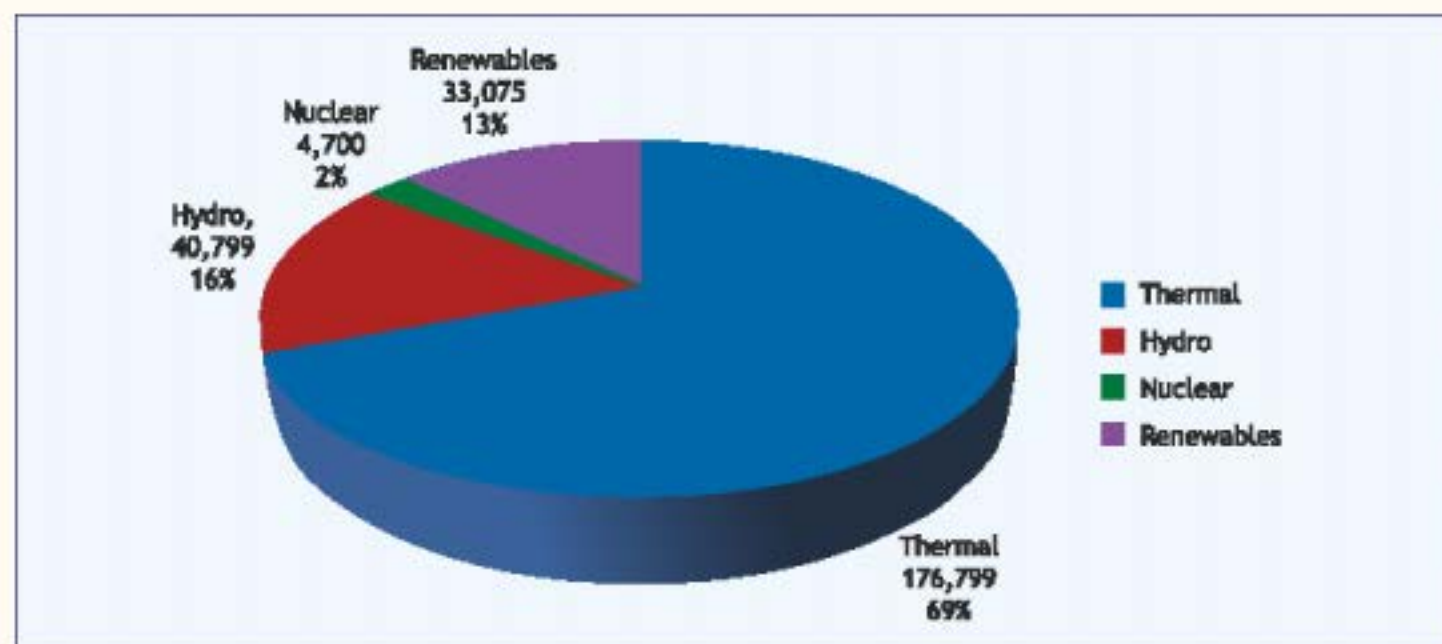
Renewable Energy is an emerging sector. This is an area where we are addressing issue of meeting our energy needs from perennial natural resources like solar, wind, hydro, biomass, etc. Renewable energy has great capacity to usher in universal energy access. Today, about 400 million people in India have no access to commercial electricity. In a decentralized or stand alone way, renewable energy is quite appropriate, scalable and viable solution for providing power to un-electrified or power deficient villages and hamlets. By providing energy access to the most disadvantaged and marginalized

communities, renewable energy could become the biggest driver of inclusive growth especially in rural areas.

India's Installed capacity of power generation: The present installed capacity of power generation in the country is 2,55,373 Mega Watts (MW). This includes 1,76,799 MW (69.23 per cent) from thermal, 40,799 MW (15.97 per cent) from hydro, 4,700 MW from nuclear (1.85 per cent) and 33,075 MW (12.95 per cent) from renewable energy sources. Major part of thermal power i.e. about 150 Giga Watts (GW) is generated from coal.

India stands among the top five countries of the world in terms of renewable energy capacity. We have an installed base of over 33,075 MW. In terms of Electricity Generation, at present the renewable power installed capacity is generating around 65 billion units per year corresponding to about 6.5 per cent in the total electricity mix.

India Installed Generation Capacity in MW as on 31.10.2014



India has also done remarkably well in off-grid applications of renewable energy.

- > One of the largest decentralized off-grid renewable energy programmes in the world.
- > Over two million decentralized solar applications.
- > Over 4.75 million biogas plants.

- > Over 8.41 million sq. m of solar thermal applications installed in some of the farthest and remotest areas of the country.
- > Solar applications alone account for over 224 MW equivalent of power.

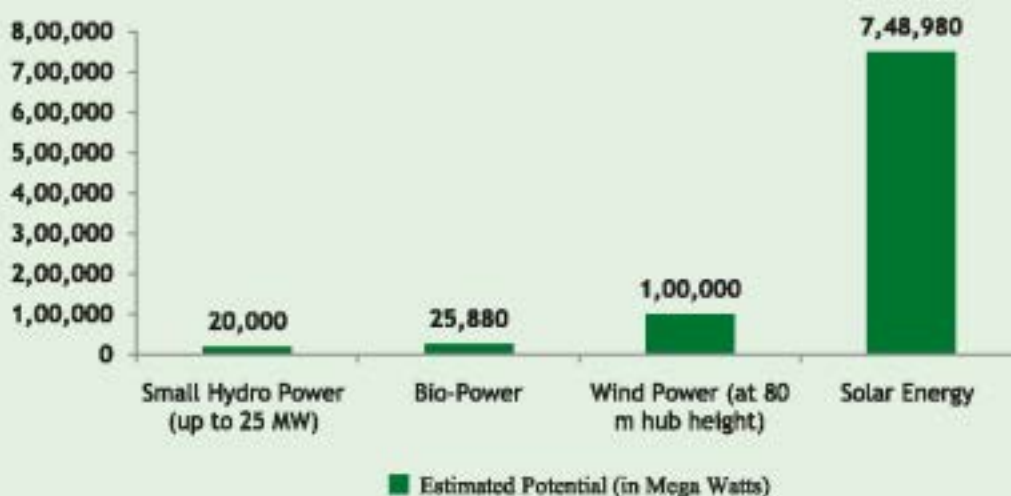
Potential of Renewable Energy

The total estimated potential of renewable energy is about 8,94,860 MW. The source-wise break up of renewable energy potential is as follows:

Renewable Energy Potential

Sl.No.	Resource	Estimated Potential (in Mega Watts)
1.	Wind Power (at 80 m hub height)	~ 100,000
2.	Solar Energy	>7,48,980
3.	Small Hydro Power (up to 25 MW)	20,000
4.	Bio-Power:	25,880
	Agro-Residues	17,000
	Cogeneration – Bagasse	5,000
	Waste to Energy:	
	– Municipal Solid Waste to Energy	2,600
	– Industrial Waste to Energy	1,280
	Total	>8,94,860 MW

Renewable Resources :Estimated Potential (in Mega Watts)



*Equivalent i.e. Approximate



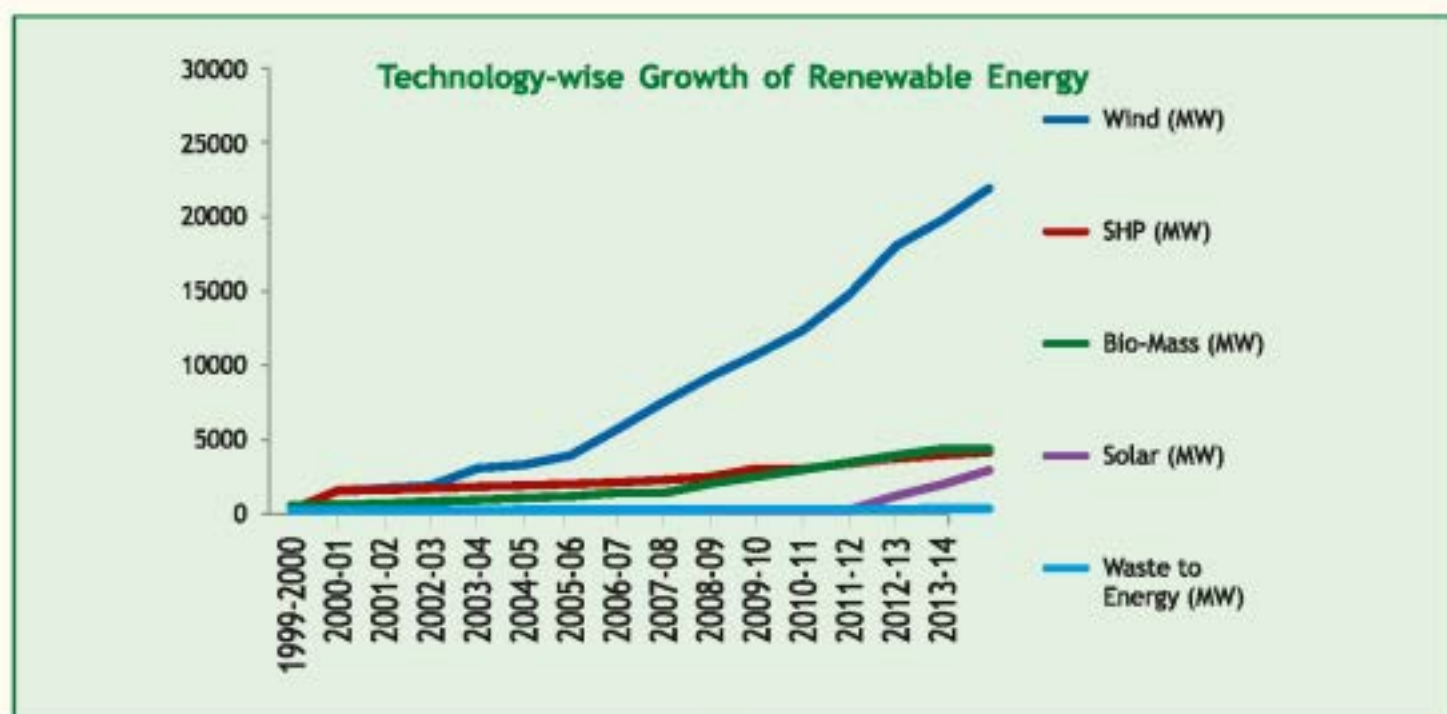
Renewable energy based decentralized and distributed applications have benefited millions of people in Indian villages by meeting their cooking, lighting and other energy needs in an environment friendly manner. The social and economic benefits include reduction in drudgery among rural women and girls engaged in the collection of fuel wood from long distances, employment generation at village level and ultimately improvement in the standard of living and creation of opportunity for economic activities at village level.

Growth in Renewable Energy Sector

The renewable energy landscape in India has witnessed a sea-change during last few years through tremendous changes in the policy with accelerated and ambitious plans to increase the contribution of solar energy. Renewable energy has been witnessing over 20 per cent growth in the last five years. From the total renewable power installed capacity of 14,400 at the beginning of the year 2009, it reached to a capacity of 33,075 MW now. Plan-wise growth in renewable energy is given below:

Plan-wise Renewable Power Growth

Resources	Beginning of 10th Plan 1.4.2002 (MW)	Beginning of 11th Plan 1.4.2007 (MW)	Achievements during 11th Plan (2007-2012) (MW)	Cumulative Achievements upto 31.3.2012 (MW)
Wind	1,628	7,092	10,260	17,352
Small Hydro	1,434	1,976	1,419	3,395
Bio power	389	1,184	2,041	3,225
Solar	2	3	939	941
Total	3,453	10,255	14,660	24,914



India's renewable energy sector is driven primarily by private sector investment and business opportunities that now exceed Rs. 20,000 Crore per year. Indian companies have begun to explore foreign stock exchanges as a source of funds. The vibrancy in the renewable energy industry could, to a large extent, be attributed to conducive policies and continuous facilitation by the Government. A large domestic manufacturing base has been established in the country for renewable energy systems and products. Companies investing in these technologies are eligible for fiscal incentives, tax holidays and depreciation allowance apart from the remunerative returns for the power fed into the grid.

Renewable energy in India is associated with enhancing energy security and providing environmental sustainability. It also provides lifeline energy solutions to inhabitants of thousands of remote villages and hamlets. Decentralized energy systems, solar home and community lighting systems, irrigation pumps, aero-generators, biogas plants, solar cookers, biomass gasifiers and improved cook stoves are being used in the most

remote and inaccessible areas. The widespread dissemination of such simple but extremely useful Renewable Energy products are supported by the government. Solar energy provides us with an ideal resource to provide clean power across the length and breadth of the country.

The gross installed capacity of grid interactive renewable power in the country stood at about 31.7 GW as on 31st March 2014 as shown below. Wind energy continues to dominate India's renewable energy industry, accounting for 67 per cent of installed capacity (21,136 MW), followed by biomass power (4,120 MW) small hydropower (3,804 MW), and solar power (2,647 MW). The launching of the Jawaharlal Nehru National Solar Mission Phase-II symbolizes both and indeed encapsulates the vision and ambition for the future. It is expected that the renewable energy share in total installed capacity of power generation will be about 17 per cent in the year 2017 and would be about 9 per cent in the total electricity mix against present of 6.5 per cent.

Cumulative Deployment of Various Renewable Energy Systems in the Country (as on 31.3.2014)

Sector	Achievements during the year 2013-14	Cumulative Achievements (as on 31.03.2014)
I. GRID-INTERACTIVE POWER (CAPACITIES IN MW)		
Wind Power	2083.30	21136.3
Small Hydro Power	171.40	3803.7
Biomass Power & Gasification	101.60	1365.2
Bagasse Cogeneration	310.92	2648.4
Waste to Power	10.50	106.6
Solar Power	962.10	2647.0
Total	3639.82	31707.2
II. OFF-GRID/CAPTIVE POWER (Capacities in MW_{EQ})*		
Waste to Energy	17.10	132.7
Biomass (non-bagasse) Cogeneration	60.70	531.8
Biomass Gasifiers	0.6000	17.5
- Rural	7.1	147.2
- Industrial		
Aero-Generators/Hybrid systems	0.1	2.3
SPV Systems®	49.6	174.4
Water mills/micro hydel	1.6 (416 nos)	13.21 (2643 nos)
Biogas based energy system	0.55	3.77
Total	137.35	1022.8
III. OTHER RENEWABLE ENERGY SYSTEMS		
Family Biogas Plants (numbers in lakh)	0.6	47.4
Solar Water Heating—Collector Areas (million m ²)	1.1	8.1

*MW Equivalent

®Solar Photovoltaic

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

India's renewable energy installed capacity has grown from 3.9 GW in 2002-03 to about 31.7 GW in March 2014. Wind energy has been the predominant contributor to this growth. It also accounts for 21.1 GW or 67 per cent of the installed capacity, followed by biomass power (4.0 GW), small hydro power (3.8 GW), and solar power (2.65 GW).

Wind Energy Programme: Wind energy has emerged as most successful renewable energy option in India and is the fastest growing renewable energy technology for generating grid connected power amongst various renewable energy sources. A total capacity of 21,132 MW has been established up to March 2014 in the country. India is the fifth largest wind power producer in the world, after China, USA, Germany, and Spain.

Biomass Power and Bagasse Co-generation Programme: Biomass Power and Bagasse Co-generation Programme aims at efficient utilization of biomass such as agro residue in the form of stalks, stems and straw; agro-industrial residues such as shells, husks, deoiled cakes and wood from dedicated energy plantations for power generation. The potential for power generation from agricultural and agro-industrial residues is estimated at about 17,000 MW. With progressive higher steam temperature and pressure and efficient project configuration in new sugar mills and modernization of existing ones, the potential of surplus power generation through bagasse cogeneration in sugar mills is estimated at 5,000 MW. Thus the total estimated biomass power potential is about 22,000 MW.

Small Hydro Power Programme: The estimated potential for power generation in the country from small/mini hydel projects is around 20,000 MW from 6474 identified sites all over the country. The Government has been providing Central Financial Assistance to State Governments and private sector to set up small/mini hydro projects, water mills etc. The total installed capacity of small hydro projects (up to 25 MW), at the end of 11 Plan, was 3395 MW. This was achieved by adding a capacity of 1418.84 MW during 2007-2012. The cumulative physical achievement till 31.03.2014 is 3803.67 MW. The 12th Plan target for small/mini hydro is 1600 MW.

Jawaharlal Nehru National Solar Mission (JNNSM): Jawaharlal Nehru National Solar Mission was launched on 11 January 2010. The Mission targets include (i) deployment of 20,000 MW of grid connected solar power by 2022; (ii) 2,000 MW of off-grid solar applications including 20 million solar lights by 2022; (iii) 20 million sq. m. solar thermal collector area; (iv) to create favourable conditions for developing solar manufacturing capability in the country; and (v) support R&D and capacity building activities to achieve grid parity by 2022. The Mission is to be implemented in three phases.

Grid Connected Solar Power Projects: Against Grid connected Power Projects under Phase-I of JNNSM, 1154

MW capacity has been allocated. 11 projects of 50.5 MW capacity (48 MW PV + 2.5 MW ST) under migration scheme and 26 projects of 140 MW capacities under Batch-I are commissioned. 71 projects totalling 90.80 MW of Grid Connected Small Power Projects (RPSSGP Programme). Solar PV projects totalling 330 MW under Batch-II have been declared commissioned. One Solar Thermal Project of capacity 50 MW has been commissioned. In all, over 2,870 MW capacity of grid connected solar power projects under various schemes, have been commissioned so far in the country during Phase-I.

Grid-Interactive Rooftop and Small SPV Power Plants: There is a large potential available for generating solar power using unutilized space on rooftops and wastelands around buildings. Small quantities of power generated by each individual household, industrial building, commercial buildings or any other type of building can be used to partly fulfill the requirement of the building occupants and surplus, if any, can be fed into the grid.

If the existing roof space of buildings is utilized, the Grid Connected SPV Rooftop systems on buildings can also replace/supplement the existing DG gensets installed for minimum load requirement for operation during load shedding. These loads are generally varying between 5 KW to 100 KW. This is possible, if the distribution company (DISCOMS) for that area allows the power to be fed into the grid and has the necessary arrangements including availability of meters.

The cost of generating solar power at present is a little higher than the tariff charged from consumers by DISCOMS in most cases. With Central Financial Assistance (CFA) of about 30 per cent, it may be possible to generate power between Rs. 6-7 for the next 20 years. This electricity would be cheaper than the diesel genset based electricity and this could also be cheaper than the cost at which most DISCOMS would make power available to the same consumer.

The Government is promoting the grid connected Solar PV rooftop systems under the programme on "Off-grid and Decentralized Solar Applications", which has a provision to connect the small SPV Plants with grid to export excess power. The individual project upto 100 KWp* capacities are being promoted.

Under Off-Grid Solar Photovoltaic projects of capacity 220 MWp* have been commissioned under JNNSM. Approximate 30,000 sq.m. collector areas of various concentrating solar thermal systems comprising of more than 150 systems have been installed so far, including a solar thermal cooling system. In addition, a number of solar steam cooking systems have been installed at schools & college hostels and religious institutions across the country. Continued emphasis was laid on research and development in various areas of solar energy technologies and application. The focus was on indigenization of technology, product development and resource assessment.

*KWp—Kilo Watt peak.

*MWp—Mega Watt peak.

Renewable Energy for Urban, Industrial and Commercial Applications

The Government has been promoting the use of technologies for energy recovery from municipal, industrial and commercial wastes and solar energy, for meeting certain niche energy demands of urban, industrial and commercial sectors in the country. The programmes being implemented during the year include: (i) Energy Efficient Solar/Green Building Programme; (ii) Energy Recovery from Urban, Industrial and Agricultural Wastes; and (iii) Bioenergy and Cogeneration in Industry.

Energy Efficient Solar/Green Buildings Programme

Buildings are major consumers of energy in their construction, operation and maintenance. Globally, about 40 per cent of energy consumption is estimated to be in building sector. At present, India is experiencing heavy construction activities in all spheres, thereby the energy demand is increasing rapidly.

A green building minimizes the demand on fossil fuel based energy, maximizes the recycle, reuse, renewable energy and energy efficient devices & appliances. Consequently, energy conscious architecture has been promoted which includes the use of solar passive design concept, use of eco-friendly and less energy intensive building materials, integration of renewable energy and energy efficiency, water conservation, waste recycling etc.

The Government has been implementing a Scheme on "Energy Efficient Solar/Green Buildings" since, February, 2009 which aims to promote the widespread construction of energy efficient solar/green buildings in the country through a combination of financial and promotional incentives mainly for capacity building, awareness, seminars and workshops and other promotional activities etc. Under this scheme 97 Government buildings have been provided support for acquiring Green Rating for Integrated Habitat (GRIHA) rating.

Development of Solar Cities Programme

The "Development of Solar Cities" programme aims at minimum 10 per cent reduction in projected demand of conventional energy at the end of five years, which can be achieved through a combination of energy efficiency measures and enhancing supply from renewable energy sources. The Ministry of New and Renewable Energy (MNRE) assists Municipal Corporations and Urban Local Bodies in preparation of a master plan for increasing energy efficiency and renewable energy supply in the city, setting-up institutional arrangements for the implementation of the Master Plan and awareness generation and capacity building activities. The MNRE has a target to support 60 cities/towns for Development as "Solar/Green Cities". So far under the programme 46 cities have been sanctioned of which master plan of 39 cities have been finalized.

Akshaya Urja Shops

Akshaya Urja Shops are being established in each district to make renewable energy products and devices easily available to the people and to provide after sales

and repair services. The programme is in operation through State Nodal Agencies (SNAs). Financial support in terms of soft loans from designated banks and a maximum of Rs. 2.40 lakh as recurring grant/incentive for the first two years of operation from the MNRE is available for establishing such shops. Service charge is also provided to SNAs. A total of 340 shops in 31 States/UTs (including 113 Aditya Solar Shops sanctioned under the erstwhile scheme of the MNRE) have been established under the programme.

Energy from Urban, Industrial and Agricultural Wastes/Residues

Management and safe disposal of waste generated by rapidly increasing urbanization, industrialization and the developments taking place in the country is getting unprecedented importance for reducing adverse impact on our environment. Technologies are now available that help in generating substantial quantity of decentralized energy while treating wastes besides reducing their quantity for safe disposal. According to a recent estimate, there exists a potential for generation of about 4000 MW of power from urban and industrial wastes in the country.

The MNRE is promoting all the technology options available for setting up projects for recovery of energy from wastes. While incineration and bio-methanation are the most common technologies, pyrolysis and gasification are also emerging as feasible options. Thus, energy can be recovered in the form of biogas, heat and/or power. The major benefits of recovery of energy from wastes are to bring about reduction in the quantity of waste by 60 per cent to 90 per cent for safe disposal; reduction in demand for land as well as cost of transportation of wastes to far-away landfill sites; and reduction in environmental pollution, besides generation of useful decentralized energy.

The MNRE is implementing the programme aimed at a variety of materials, such as municipal solid wastes, vegetable market and slaughterhouse wastes, cattle dung, agricultural residues and industrial wastes. Financial assistance being provided for projects of various types are as follows:

- **Setting up five pilot projects on energy recovery from Municipal Solid Wastes:** Rs. 2 crore per MW, subject to ceiling of 20 per cent of project cost limited to Rs. 10.00 crore per project, whichever is less, is provided for five pilot projects.
- **Power generation/production of Bio-CNG from biogas generated at Sewage Treatment Plants:** 40 per cent of the project cost subject to a maximum of Rs 2.0 crore/MW for projects for generation of power/production of bio CNG from biogas being produced at Sewage Treatment Plants.
- **Power generation and production of Bio-CNG from other Urban Wastes and their mix with Agricultural/Agro-industrial Wastes/Residues:** 40 per cent of project cost subject to a limit of Rs. 2 crore per MW for projects based on biomethanation technology for power

generation and production of bio CNG from night soil and any other urban wastes. Financial assistance of 20 per cent of project cost subject to upper limit of Rs. 2.0 crore/MW is provided for projects based on biomethanation technology for power generation from a mix of cattle dung, vegetable market and slaughterhouse wastes along with agricultural wastes/residues.

- **Power generation/production of bio CNG from Industrial wastes:** Financial assistance of Rs. 0.20 to 1.00 crore per MW depending upon the type of waste, technology deployed and the end use, subject to a ceiling of 20 per cent of the project cost.
- **Biomass Cogeneration (non-bagasse) in industry:** Capital subsidy on re-imburement basis is being provided after commissioning of the projects @ Rs. 20 lakh per MW for biomass co-generation (non-bagasse) projects.

Renewable Energy for Rural Applications

The MNRE has been supporting programmes for the deployment of renewable energy systems and devices such as biogas plants, photovoltaic systems, biomass gasifiers, solar cookers and solar thermal systems etc. for rural and semi-rural applications. It has also been implementing remote village electrification programme and village energy security test projects.

The Ministry has been supporting renewable energy programmes for rural areas of the country by deploying renewable energy systems such as family type biogas plants, solar water heating systems, solar cookers and other solar energy devices. In addition to family type biogas plants, the demonstration of integrated Technology package on Biogas-Fertilizer Plants (BGFP) for generation, purification/enrichment, bottling and piped distribution of biogas as technology demonstration under Research, Design, Development & Demonstration (RDD&D) policy was launched during the year 2009-10. The objectives of the integrated technology demonstration programme is to demonstrate the biogas fuel applications to meet stationary, motive power, electricity needs including cooking and heating requirements.

National Biogas and Manure Management Programme (NBMMP)

The objective of the National Biogas and Manure Management Programme (NBMMP) is to set up family type biogas plants for providing clean gaseous fuel mainly for cooking purposes and organic manure to rural households. These plants help to mitigate drudgery of rural women, reduce pressure on forests and accentuate social benefits besides improving sanitation in villages and reducing emission of black carbon and other Green House Gases.

The programme helps in supplementing the use of LPG and reduces pressure on forests and other conventional fuels like coal and kerosene. Based on the availability of cattle dung and other related studies

carried out in the past, including the 18 Livestock Census (2007) report released in December, 2010, there is an estimated potential of more than 12 million family size biogas plants, which can generate about 30 million cubic metres of biogas per day.

Research and Development

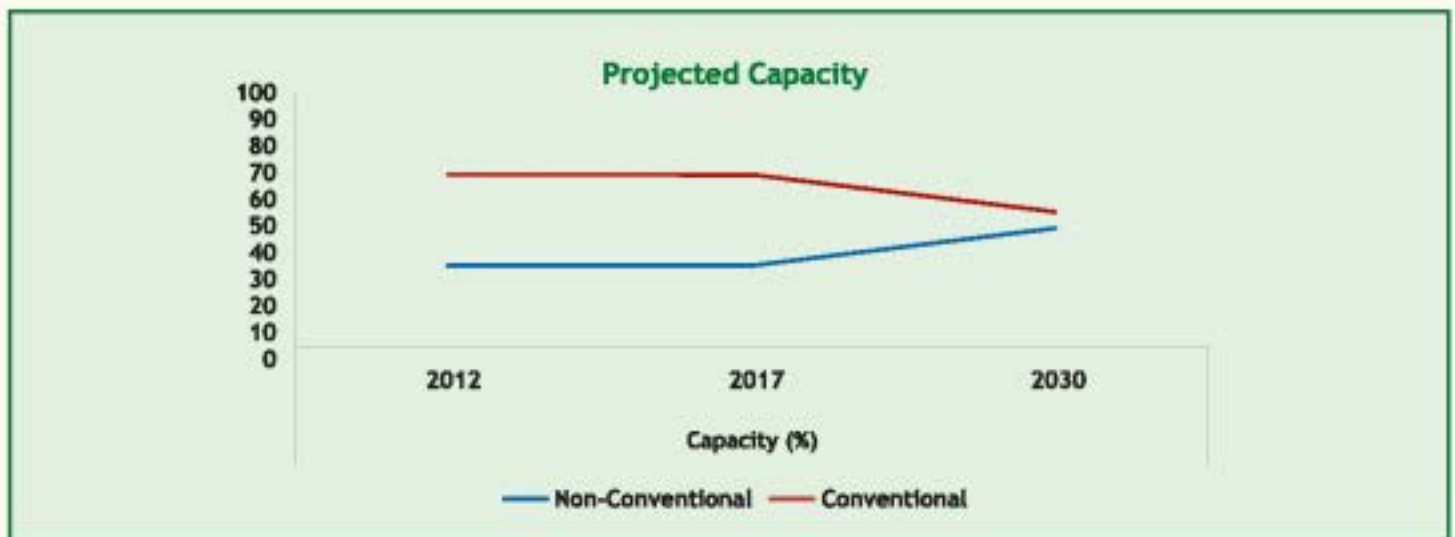
The Research and Development efforts of the MNRE are directed towards technology development and demonstration, leading to commercialization, apart from strengthening the capacity of R&D/Academic Institutions and Industry for taking up advanced research for technology development. The ultimate goal is to reduce the cost and improve efficiency in the near future. The prominent projects taken up include advanced research and demonstration of higher efficiency solar cells, solar thermal power generation, hydrogen energy storage and fuel cells development, development and deployment of improved biomass cook stoves, etc. Research & development activities have been taken up with national laboratories, universities, scientific & educational institutions & industry for improvements in the renewable energy systems and products. For the 12th Plan Period, a provision of Rs.945 crore has been made for RD&D in new and renewable energy. The focus is on improved efficiency, cost reduction and technology transfer and demonstration for their commercialization.

Next Five Year Projections

Renewable energy has a central place in India's National Action Plan on Climate Change with 'National Solar Mission' as one of the key mission. Further, with well-developed industrial, financing and business infrastructure, India is perceived as an excellent investment opportunity in renewable power. The target during the 12th Plan is deployment of 15,000 MW for Wind Power, 2,100 MW for Small Hydro Power, 500 MW for Biomass Power, 1,400 for Bagasse Cogeneration, and 10,000 MW for Solar Power (Photovoltaics and Thermal). At the end of 12th Plan period, the contribution of renewables is targeted at 55,000 MW in the total power generation capacity of 318,000 MW and over 9 per cent in the electricity mix.

Installed Capacities in MW

Source	Installed capacity in March, 2012	Capacity addition Target for 2012-17	Target installed capacity in 2017
Wind power	17,352	15,000	32,500
Small Hydro	3,395	2,100	5,500
Biomass Power	1,150	500	1,700
Bagasse Cogeneration	1,985	1,500	3,500
Waste to Power	90	700	800
Solar Power	941	10,000	10,900
Total	24,914	29,800	54,900



Renewable energy sector in India has already emerged as a significant player in the grid connected power generation and is now an essential player for energy access. Renewable energy finds a special mention in this Government's manifesto and aiming to expand and strengthen this sector. Renewable energy is the

solution to meet the Nation's energy needs. The Ministry of New and Renewable Energy is working in close coordination with Ministry of Power and Rural Electrification Corporation in addressing issues for meeting energy requirements in innovative manner.

Ministry of New and Renewable Energy: The Ministry of New and Renewable Energy (MNRE) in the Government of India is the nodal Ministry to deal with all policy matters relating to Renewable Energy and present State's view at the National level. It is aiming towards addressing issues for accelerated exploitation of renewable energy potential in the country. Like Ministry of New and Renewable Energy in the Central Government, each State has a separate department to deal with this subject and address policy and implementation issues. MNRE works in close coordination with these departments of the States and have regular interaction with them.

Institutions under the Ministry: The following institutions are functioning under the Ministry of New and Renewable Energy:

- (i) National Institute of Solar Energy (NISE), Gwalpahari, District Gurgaon, Haryana.
- (ii) Centre for Wind Energy Technology (C-WET), Chennai, Tamil Nadu.
- (iii) The Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE), Jalandhar, Punjab.
- (iv) The Indian Renewable Energy Development Agency Ltd. (IREDA), New Delhi.
- (v) Solar Energy Corporation of India (SECI), New Delhi.