Renewable Energy in India: Progress, Vision and Strategy

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India’s need to increase energy provision for its population and fast growing economy poses a formidable challenge which is perceived as both a great opportunity as well as a necessity for the country to increase the share of renewables in the overall energy mix. At the same time there is a need to provide energy access to rural areas and reduce import dependence on fossil fuels. India’s approach is to meet its energy needs in a responsible, sustainable and eco-friendly manner. A brief outline of progress made so far, plans for next decade, government policies and issues related to renewable energy financing, large-scale dissemination, research and development are given here. The paper outlines the basic strategy and approach being followed for the growth of the renewable energy sector and emphasizes the different important roles that can be played in the off-grid particularly in meeting the challenges of providing energy access to India’s rural areas and in reducing consumption of fossil fuels which is essential for future energy security of the country. It outlines the policies that have been followed to foster the growth of this sector and also indicates the targets and the future pathway.

Executive Summary

In the last six decades, in spite of installed electricity capacity in India having increased substantially demand has outstripped supply because of economic growth, urbanization and growing population leading to substantial energy and peak shortages which have consistently remained above 10 % level. Estimates suggest that in order to meet the deficits, diesel based captive generation of the order of around 20 % of the present grid connected electric installed capacity are in operation. In addition, electricity spread is an equally serious issue as more than 40% of the population has little or no commercial energy access for their living and livelihoods. Consequently, they have to depend on kerosene and for meeting their lighting and motive power needs.

India has been making continuous progress in conventional as well as renewable power generation. From the year 2002 onwards, renewable grid capacity has increased by almost 5 times, which is about 10.90% of the total grid installed capacity in the country, and contributing about 4.13% to the electricity generation mix. This compares favourably with that of the EU and far exceeds that of the US. In addition, India's per capita energy use continues to be far below that of industrialized countries, and per capita CO_{2eq} emissions are almost a third of the world average.

Renewable energy has been an important component of India's energy planning process. The Ministry has been facilitating the implementation of broad spectrum of renewable energy programmes through an elaborate implementation mechanism. Electricity Act 2003 was the first comprehensive framework that spurred development of renewable power in the country unfolding a developing regulatory structure composed of preferential tariffs, renewable purchase obligation and leading over to facilitating renewable energy certificates. The Government has also been supporting renewable energy development through an attractive mix of fiscal and financial incentives. These include capital/ interest subsidy, accelerated depreciation and nil/ concessional excise and customs duties and now Generation Based Incentives or feed in tariff.

Augmentation of tail-end power has been accorded high priority and an experiment is being planned with plants of 1-2 MW where power is fed to 11 kV grid. It is expected that this would

reduce the transmission losses by 5-7% and improve both voltage and frequency at the tail end. This concerns both solar photovoltaic and biomass plants through gasification route. This concept is already included in the Solar Mission and a programme is being formulated to set up 200 MW biomass gasifier projects of 2 MW capacities at the tail-end of the grid by 2022.

All the sectors of renewable energy are being developed. However, the wind power programme has been the fastest growing contributing to around 75% of the grid-connected renewable energy power installed capacity.

Among various renewable energy resources, India possesses a very large solar energy resource which is seen as having the highest potential for the future. The first, recently announced, the very ambitious Jawaharlal Nehru National Solar Mission with a target of 20,000 MW grid solar power, 2000 MW of off-grid capacity including 20 million solar lighting systems and 20 million sq.m. solar thermal collector area by 2022 is under implementation. The main objectives of the mission are to help reach grid parity by 2022 and help set up indigenous manufacturing capacity.

Off-grid applications are major Indian renewable energy priorities. Such applications not only replace fossil fuels but also make significant contribution to reduction in their consumption. As such the strength and potential of renewable energy lies in its ability to generate power in decentralized and distributed mode which has the advantages of production at consumption points and does away with land and environmental related concerns and problems. Accordingly, Ministry has put in place a policy framework for rapid up-scaling of off-grid programmes in an inclusive mode.

Rural electrification to meet unmet demand through renewable energy is a priority by itself. 150 villages have been covered in last 2 years through mini grid by rice-husk based gasification systems in Bihar. The Ministry has plans to cover about 10,000 villages from biomass-based systems and over 1000 villages from solar power up to 2022.

In order to provide cooking energy in rural areas, 4.27 million family size biogas plants are currently installed in India and by 2022 additional 2 million plants are planned. A pilot project has been launched to test the efficiency and marketability of improved community size cook-stoves. Ministry is also launching a new initiative for household cook stoves. Meanwhile, large solar cooking systems for institutions and solar dish cookers are also being encouraged.

The Ministry would like to step up renewable energy decentralized applications to save a billion litre of diesel/furnace oil/kerosene annually after 5 years. Telecom towers and industrial power generation are two focus areas to reduce consumption of diesel.

It is necessary to reduce electricity demand. Two areas are important and solar water heating is being promoted in residential, institutional and industrial sectors. Further, keeping in view rapid urbanization, huge growth in construction and high energy consumption of buildings, a National Rating System - GRIHA (Green Rating for Integrated Habitat Assessment) has been developed which is suitable for all types of buildings in different climatic zones of the country. The Government of India has already decided that all its new buildings would henceforth mandatorily conform to 3* or 4* GRIHA ratings. A mission approach is being attempted in this area of sustainable habitats.

The growth of renewable energy in India has largely been led by the private sector. Ernst and Young ranked India the fourth most attractive country for renewable energy investment in the world, only behind the United States, China, and Germany. As per an estimate, in 2009 the total financial investment in clean energy in India was at Rs 135 billion. Apart from this, Indian Renewable Energy Development Agency (IREDA) and other public sector agencies are also actively funding renewable energy projects.

Renewable energy is central to climate change mitigation efforts. Broad estimates indicate that mitigation from existing renewable energy portfolio is equivalent to around 4-5 % of total energy related emissions in the country. Although India is a favorable destination for Clean Development Mechanism (CDM) projects, with renewable energy projects having the major

share, but due to stringent project based approval process and high transaction costs, CDM potential is not being realized fully. Programmatic CDM requires immediate reform.

Research and technology development have been accorded high priority in the national renewable energy programme and mission mode research has been planned for developing solar, bio-energy and hydrogen technologies. Renewable Energy Incubation Scheme for encouraging entrepreneurs to set-up enterprise in renewable energy sector is under implementation. It is now planned to enlarge the scope and coverage.

Ministry has initiated a series of activities for meeting ever increasing human resource requirement in renewable energy area. These include award of Renewable Energy Fellowships, incorporating renewable energy in the course curriculum; training programmes for renewable energy professionals.

Renewable energy is experiencing new enthusiasm and vibrancy all across, and the foundation of a new economy is being laid that is inclusive, sustainable and aspires for de-carbonization of energy in a definite time frame.

Renewable Energy in India: Progress, Vision and Strategy

1.0 Background

1.1 In the last six decades, India's energy use has increased 16 times and the installed electricity capacity by 84 times. In 2008, India's energy use was the fifth highest in the world. Nevertheless, India as a country suffers from significant energy poverty and pervasive electricity deficits. In recent years, India's energy consumption has been increasing at a relatively fast rate due to population growth and economic development, even though the base rate may be somewhat low. With an economy projected to grow at 8-9% per annum, rapid urbanization and improving standards of living for millions of Indian households, the demand is likely to grow significantly. As per the estimates made in the Integrated Energy Policy Report 2005, if the country is to progress on the path of this sustained GDP growth rate during the next 25 years, it would imply quadrupling of its energy needs over 2003-04 levels with a six-fold increase in the requirement of electricity and a quadrupling in the requirement of crude oil. The supply challenge is of such magnitude that there are reasonable apprehensions that severe shortages may occur.

1.2 Although in recent years availability of power has both increased and improved, demand has consistently outstripped supply and substantial energy and peak shortages of 10.1% and 12.7% respectively prevailed in 2009-10. Although peak deficit has declined from 16.6% in 2007-08, in most parts of the country, demand peaks are also 'shaved off' on account of lack of adequate supplies. There are also various estimates of 25000 to 35000 MW of power being produced by diesel generation to meet the deficits.

1.3 Electricity shortage is not the only problem. Its spread is an equally serious issue. More than 40% of the population has little or no commercial energy access for their living and livelihoods. Others with access often have to cope with poor and erratic availability. This not only deprives them of basic human need for quality of life but also constraints generation of

productive activities and incomes and employment in rural areas, which itself has become a critical factor in India's future development process. Further, the little supply that comes in such areas forces people to depend on use of kerosene for lighting and diesel for powering irrigation pumps and small enterprises. Both these are imposing further financial burdens on the economy because of high levels of subsidy and add to the problems of energy security.

2.0 Growth of Renewable Power

2.1 India has been making continuous progress in conventional as well as renewable power generation. The trajectory of growth of installed capacity since year 2002 (start of 10th Plan), 2007 (start of 11th Plan), and at present as on 30.9.2010, is given in Table 1 below:

Table 1: Source-wise Contribution to Installed Power Generation Capacity (in MW)

Time period	Thermal (%)	Hydro (>25MW) (%)	Nuclear (%)	Renewable Power (%)
1.4.2002	59% 74429	26% 26269	2% 2720	2% 1628
1.4.2007	65% 87015	26% 34654	3% 3900	6% 10258
31.9.2010	64% 106518	22.4% 37328	2.7% 4560	10.90% 18,155

It may be observed that renewable grid capacity has increased more than 5 times, from 2% to around 11% in only 8 years, and is contributing about 4.13% to the electricity generation mix. The high level of penetration of renewable power in India compares favourably with that of the EU and far exceeds that of the US.

2.2 In an attempt to bridge the gaps and to leapfrog to a higher growth rate, ambitious targets have been set for the conventional power sector (78700 MW for 11th Plan, around 83000 MW for 12th Plan and around 100000 MW for 13th plan period).

2.3 The growth so far is largely based on thermal but all other sources have also made important contributions. However, problems are beginning to occur in each sector of conventional power. Mining and import of coal are both facing problems, especially for the huge quantities required. Logistics and transport issues are also emerging. Moreover, at projected usage levels, questions are also raised about the period India's extractable coal reserves could last. Environmental and climate change threats are getting more severe and project clearances more difficult to get. In spite of many policy and infrastructural initiatives, it appears unlikely that quantities required to achieve projected conventional power capacity will be available. The question is what would be the quantum of shortfall. Already the Eleventh Plan target for conventional power stands reduced from 78,700 MW to 62,374 MW and even this is unlikely to be reached. The achievement in first 3 years is only 22,302 MW as against the original target of 47,220 MW. Large hydro projects are also facing problems – largely related to environmental issues and some to project execution in difficult areas along with attendant issues of building long transmission lines. Natural gas difficulties and its competitive usages also do not create optimism. Nuclear power capacity building continues to face its own problems, especially with the huge targets proposed.

2.4 In the above backdrop, therefore, it could reasonably be expected that there could be substantial and worrisome slippages in creating conventional power capacities over the next two decades and even in the long term. How then will the consequent energy requirements be met or shortages be dealt with? It is almost inevitable that this would lead to more consumption of diesel, furnace oil and kerosene. In a situation where we are currently importing more than 80% of the country's needs, and internal reserves unlikely to improve this percentage, serious problems of energy security would arise. Moreover, these may entail rising financial burdens of import and internal financial burdens of subsidies, which are already controversial. It is, therefore, imperative that substantive measures be taken to reduce their consumption for energy

purposes as also reducing consumption drastically in personalized urban and long-distance freight transport.

2.5 If energy shortages persist it is difficult to expect much improvement in energy access. India has an ambitious programme of rural electrification (RGGVY). However, even though this may provide grid connectivity to many uncovered areas (still leaving substantial numbers unconnected), actual supply of electricity through the grid would remain both constrained and unpredictable. Providing energy access and energy security for the poor would, therefore, continue to be a major issue and problem. Solutions to this simply have to be found which no longer appear possible from conventional sources.

3.0 Energy Consumption and CO_2 Emissions

3.1 We must keep another issue in the background. Despite the surging energy demand, India's per capita energy use in the year 2008 was 0.54 tons of oil equivalent(toe) which was far below that of industrialized countries, and even China (US-7.5 toe, Germany-4.08 toe, Japan-3.88 toe, China-1.6 toe). India's per capita $CO_{2\ eq}$ emissions were 1.5 tons in 2007, almost a third of the world average, and less than a quarter of total greenhouse gas emissions of the leading emitters of the world, China and the Unites States, in both annual and per capita terms. The emissions intensity of India's GDP declined by more than 30 percent during the period 1994-2007, due to the efforts and policies that the Government of India is proactively putting in place. The spread of energy access is not going to make much difference, but the massive rural-to-urban transition will. Notwithstanding addition of urban millions, India's per capita consumption, and consequently per capita emissions also, will continue to be much lower than others.

3.2 In 2008-2009 fossil fuels (coal, gas & diesel) provided around 80% of India's electricity. In 2008-09, coal provided 69% of electricity demand. In India, electricity generation contributed only around in general 42% of the carbon emissions, there is little chance of India reaching the emission levels of other countries, particularly, US and China in the foreseeable future.

4.0 Renewable Energy Drivers for India

4.1 It is clear from the above that India's need for secure, affordable, and environmentally sustainable energy has become one of the principal economic and development challenges for the country. It is also clear that while energy conservation and energy-efficiency have an important role to play in the national energy strategy, renewable energy will become a key part of the solutions and is likely to play an increasingly important role for augmentation of grid power, providing energy access, reducing consumption of fossil fuels and helping India pursue its low carbon developmental pathway.

5.0 Renewable Energy in India

5.1 Renewable energy has been an important component of India's energy planning process. The importance of renewable energy sources in the transition to a sustainable energy base was recognized in the early 1970s. At the Government level, political commitment to renewable energy manifested itself in the establishment of the first Department of Non-Conventional Energy Sources in 1982, which was then upgraded to a full-fledged Ministry of Non-Conventional Energy Sources (MNES) in 1992 subsequently renamed as Ministry of New and Renewable Energy (MNRE). This is the only such Ministry in the world. MNRE is the nodal Ministry of the Government of India at the Federal level for all matters relating to new and renewable energy. The Ministry has been facilitating the implementation of broad spectrum programmes including harnessing renewable power, renewable energy to rural areas for lighting, cooking and motive power, use of renewable energy in urban, industrial and commercial applications and development of alternate fuels and applications. In addition, it supports research, design and development of new and renewable energy technologies, products and services.

5.2 The extension programmes of the ministry are largely implemented through the State Renewable Energy Development Agencies. These agencies, in turn, mobilize participation of the State level machinery, local institutions, Non- Governmental Organizations (NGOs) and village level organizations for implementation of these programmes. However, increasingly the

channels are being opened out to move in market mode through other partners. MNRE has set up a Solar Energy Centre near Delhi with the state-of-art facilities for testing of solar thermal and solar photovoltaic materials, devices and systems. This will soon become an apex Centre of Excellence. It also does applied research and training. A Centre for Wind Energy Technology has been set up in Chennai for providing technical support to the Ministry in the implementation of its wind energy programmes. Research and Development programmes are sponsored in research institutions, national laboratories and in industries, both public and private sectors. For market development and financing of renewable energy projects, a separate financing institution called the Indian Renewable Energy Development Agency (IREDA) has been set up as a public sector undertaking. It is perhaps one of the only institution of its kind in the world which provides institutional finance exclusively in the field of renewables and energy efficiency.

5.3 Policy and Regulatory Framework for Grid Renewable Power

5.3.1 The development of grid interactive renewable power has essentially taken off with the Electricity Act 2003 –which mandates the State Electricity Regulatory Commissions (SERCs) to (i) 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 (ii) fix certain minimum percentages for purchase of renewable power in the area of each Distribution licensee and Section 61(h) mentions that these should be guiding factors while specifying the terms and conditions of determination of tariff. The National Electricity Policy 2005 has further provided for progressive increase in these levels and purchases by distribution companies through competitive bidding process. The Tariff Policy 2006 requires fixation by SERCs of a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs and procurement by distribution companies at preferential tariffs determined by the SERCs. As of date, most of the SERCs have specified percentages for purchase of electricity from renewable sources of energy (Annexure-I). Preferential tariff for grid interactive renewable power is being given in most potential States. Uniform guidelines by Central Electricity Regulatory Commission (CERC) for fixation of such preferential tariffs have been issued.

5.3.2 In January 2010, CERC issued a notification on 'Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation'. Renewable Energy Certificate seeks to address the mismatch between availability of renewable sources and the requirement of the obligated entities to meet their renewable purchase obligation. The National Load Dispatch Centre (NLDC) has been appointed as Central Agency for implementation of RECs. This Central Agency has prepared detailed procedures for registration, accreditation, issuance, and redemption of RECs. It is expected that REC market will be operationalised from 2011.

5.4 Financial and Fiscal Incentives

5.4.1 The Government has been promoting private investment in setting up of projects for power generation from renewable energy sources through an attractive mix of fiscal and financial incentives, in addition to the preferential tariffs being provided at the States level. These include capital/ interest subsidy, accelerated depreciation and nil/ concessional excise and customs duties. The level of capital subsidy being provided depends on the renewable resource and region, and varies from about 10% to 90% of project cost, the higher level being given for projects in North -Eastern Region/ Special category States. The existing level of incentives for different categories of renewable power projects are given at Ministry's website http://www.mnre.gov.in/**.** In addition, **G**eneration Based Incentives have also been introduced recently for Wind Power to attract private investment by Independent Power Producers not availing Accelerated Depreciation benefit and feed in tariff for solar power.

5.5 Impact of Policy Framework and Vision 2022

5.5.1 It is in the last decade after the enactment of Electricity Act and backed by framework of fiscal and financial incentives that renewable energy has got a great push. During the last several years the share of renewable power installed capacity has been constantly increasing. During the first three years of the 11th plan period, this has been 6,560 MW, while the conventional power capacity added has been 22,302 MW. It is also to be noted that 23% of all capacity today is large hydro which is renewable but not counted as such. Table 3 below gives an idea of the growth of

renewable energy capacity in the last decade. Major contribution has come from wind power which is about 70% of the total capacity.

Table 3: Plan-period-wise capacity addition in grid connected renewable energy based power

Resource	Potential (MW)	Capacity Addition (in MW)				
		Upto 9th Plan - Achievement	10th Plan - Achievement	11th Plan Targets	11th Plan Achievement Upto 30.9.2010	Cumulative achievements upto 30.9.2010
Wind power	48,500	1,667	5,427	9,000	4,714	12,809
Small Hydropower	15,000	1,438	538	1,400	759	2,823
Bio power*	23,700	390	795	1,780	1,079	2,505
Solar power	20-30MW/ sq.km	2	1	50	8	18
Total		**3,497**	**6,761**	**12,230**	**6,560**	**18,155**

**Including biomass power, bagasse cogeneration, urban and industrial waste to energy.*

5.5.2 This growth and the new additions in solar power make it entirely possible to achieve the Ministry's vision of 10% contribution to total electricity mix by 2022. This would, of course, require either total installed capacity of renewables to exceed the targets proposed or it could also result from an under achievement of proposed conventional power sources. This equation is quite dependant upon the total power capacities set up. However, the MNRE has even otherwise set for itself ambitious targets for capacity installations which are given in Table 4. Clearly, therefore, renewables have an important role to play in grid power generation in India.

Table 4: Projected Contribution of Grid –Interactive Renewable Power

(Capacity in MW)

Resource	Capacity at the end of 10th Plan	11th Plan Target	Total Targeted Capacity by end of 11th Plan(2012)	12th Plan Projection	Total Projected Capacity by end of 12th Plan (2017)	13th Plan Projection	Total Projected Capacity by end of 13th Plan(2022)
Wind power	**7094**	**9000**	**~16100**	**11200**	**27300**	**11200**	**38500**
Small hydro power	**1976**	**1400**	**~3400**	**1600**	**5000**	**1600**	**6600**
Biomass Power	**525**	**500**	**1025**	**500**	**1525**	**1000**	**2525**
Bagasse Cogen	**616**	**1200**	**1816**	**1400**	**3216**	**700**	**3916**
Waste to Energy	**44**	**80**	**124**	**200**	**324**	**500**	**824**
	1185	**1780**	**2965**	**2100**	**5065**	**2200**	**7265**
			~3000		**~5100**		**~7300**
Solar Power	**3**	**200**	**~200**	**3800**	**4000**	**16000**	**20000**
Total	**10258** *(27BU)*	**~12,500**	**22700** *(60 BU)*	**18700**	**41400** *(106 BU)*	**31000**	**72400** *(173 BU)*
Conventional Power Capacity Addition	**122071**	**78700**	**~200000** *(1314 BU)*	**83000**	**283000** *(1859 BU)*	**100000**	**383000** *(2516BU)*
Grand Total	**132329**	**91200**	**222700**	**101700**	**324300**	**130800**	**455100**
Share in -Installed Cap.	**7.7%**		**10.2%**		**12.8%**		**15.9%**
-Electricity mix	***3.5%***		***4.4%***		***5.4%***		***6.4%***

Assumptions:

1. *Existing Projections for Capacity addition/ Generation from conventional power during 11th and 12th plan as per 11th Plan proposals of MoP; Capacity addition during 13th plan broadly in line with IEPR projections, with pro-rata increase in Generation.*

2. *Estimated average annual electricity generation:*
   Solar: 1.50 MU/ MW for SPV; 2.00MU/MW for ST; Average: 1.75MU/MW- taking equal capacity through both routes.
   Wind: 2.00 MU/MW
   Bagasse Cogeneration: 4.00MU/MW
   SHP: 3.50 MU/MW
   Biomass Power and WTE: 6.00 MU/ MW

5.6 Renewable power plants at tail-end of grid

In the larger perspective of grid power this is a new area being experimented with in India. So far the emphasis has been on large plants whether they are wind, solar, hydro or biomass. Locations for wind and hydro are fixed. Solar Thermal also can currently be only of large

capacities. However, for biomass the difficulties of ensuring collection and transportation of fuel are leading towards smaller plants. For solar PV, while in the Solar Mission, the capacity so far has been restricted to 5 MW, a total of 100 MW capacity is being set up with smaller plants of 100 KW to 2 MW, which are connected to grid through 11 kV feeder. It is expected that small plants would reduce the transmission losses by 5-7% with respect to large capacity plants of 50-100 MW size and improve both voltage and frequency at the tail end. It would also help in further transmission of electricity of electricity downwards. The same approach is being planned for biomass based power plants of upto 2 MW capacity too as the logistics of fuel management would become much more manageable and more environment friendly. It is envisaged that hundreds of such plants will come up in the next few years thus improving the transmission infrastructure. Such a role can only be played by renewable sources.

5.7 The status of different programmes is briefly summarized here-in-under.

5.7.1 **Biomass Power and Bagasse Cogeneration Programme**

5.7.1.1 This programme aims at utilization of biomass like agro-waste in the form of straws, stalks, stems and fines; agro-industrial processing residues such as shells, husks, deoiled cakes, wood from dedicated energy plantations and bagasse from sugar mills for power generation using combustion technology. The current potential for power generation from surplus agro and agro industrial residues is estimated at 17000 MWe. With progressive higher steam parameters 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 5000 MW. Thus the total estimated biomass power potential is about 22,000 MW. A cumulative capacity of 2437 MW has so far been commissioned mainly in the states of Tamil Nadu, Uttar Pradesh, Karnataka, Andhra Pradesh, Maharashtra, Chhattisgarh, Punjab and Rajasthan, which includes 971 MW from biomass and 1466 MW from bagasse cogeneration in sugar mills.

5.7.2 Wind Power

5.7.2.1 The wind power programme of the Ministry is the fastest growing renewable energy programme and is almost entirely coming through private sector investments. India has a potential of around 48,500 MW. With a capacity addition of 12,800 MW, it contributes to around

75% of the grid-connected renewable energy power installed capacity. The major wind power capacity is in the states of Tamil Nadu, Gujarat, Maharashtra, Karnataka and Rajasthan. Wind electric generators of unit sizes between 225 kW and 2.10 MW have been deployed across the country. Wind Electric Generators of unit capacity upto 2.10 MW are being manufactured in the country. A Centre for Wind Energy Technology (C-WET), Chennai has been established in Tamil Nadu as an autonomous institution under the administrative control of the Ministry. The Centre serves as the technical focal point for wind power development and supports the growing wind power sector in the country through resource assessment and consultancy services. An ambitious target of 9,000 MW was set for 11th Plan, of which 5,715 MW has already been achieved upto September, 2010. This has been possible because of multi-dimensional approach of central and state governments. The main driving force for development of wind sector has been the provision of accelerated depreciation of 80%, an incentive also available to many other sectors. This provision has enabled large profit making companies, small investors and captive users to participate in the sector. However, independent power producers (IPPs) and foreign direct investment (FDI) were not able to avail the benefit of the accelerated depreciation provision. In order to increase the investor base, the Ministry has launched a scheme for Generation Based Incentives through which additional incentive of 50 paise per unit will be provided to the developers that do not avail accelerated depreciation benefit. The effort is to do 2000 MW or more annually.

5.7.3 Small Hydro Power

5.7.3.1 The Ministry has the mandate for developing micro/ mini/ small hydropower plants up to 25 MW station capacity. The estimated potential for power generation in India from such plants is about 15,000 MW from 5718 identified sites. So far over 760 small hydropower projects aggregating to 2,803 MW have been set up in various parts of the country and 285 projects of about 940 MW are in various stages of implementation. At present, a capacity addition of about 300 MW per year is being achieved, of which about 70% is coming through private sector. In order to accelerate the pace of small hydro development, both public and private sector participation for commercial projects and decentralized micro hydel for remote village

electrification are being encouraged. Focused attention is being given to States with maximum potential and improving policy environment to attract private sector investments.

5.7.4 Solar power

5.7.4.1 Among various renewable energy resources, India possesses a very large solar energy resource. Most parts of the country are blessed with good sunshine. There are about 300 clear sunny days in a year in most parts of country. The average solar radiation incident over India varies from 4 kWh/day – 7 kWh/day. The solar radiation received over the Indian land area is estimated to be about 5,000 trillion kWh / year. Therefore, it is natural for India to explore the possibilities of harnessing the abundant source of energy from the sun. Development of solar energy technologies, both solar thermal and photovoltaic, have been pursued since 60s. However, in the early period the development was focused more on low temperature solar thermal devices such as solar cookers and later water heaters. In the area of solar photovoltaics the initial focus was on development and utilization of devices and systems, primarily for off-grid and decentralized applications. As a result of initial research in the country an indigenous manufacturing base has been set up.

5.7.4.2 In June, 2008, a National Action Plan on Climate Change was announced, which included eight major national missions: one on solar energy being the centre piece. This mission envisages a major step up in the utilization of solar energy for power generation and other purposes.

5.7.4.3 Jawaharlal Nehru National Solar Mission (JNNSM) was launched by the Prime Minister in January 2010, with a target of 20,000 MW grid solar power (based on solar thermal power generating systems and solar photovoltaic (SPV) technologies), 2000 MW of Off-grid capacity including 20 million solar lighting systems and 20 million sq.m. solar thermal collector area by 2022. The Mission will be implemented in three phases. The first phase will be of three years (up to March, 2013), the second till March 2017 and the third phase will continue till March, 2022. The target for phase-I is to set up 1,100 MW grid connected solar plants including

100 MW of roof top and small solar plants and 200 MW capacity equivalent off-grid solar applications and 7 million sq. m. solar thermal collector area .

5.7.4.4 A new architecture has been designed for the 1000 MW projects. These will be implemented through NTPC Vidyut Vyapar Nigam (NVVN). NVVN will sell the solar power to the State utilities after bundling solar power with equivalent capacity thermal power. CERC has announced tariff for purchase of solar power by NVVN. The tariff for current year for PV is Rs.17.91 per unit and Rs. 15.31 per unit for solar thermal power. NVVN has issued request for selection of new grid power projects of 620 MW capacity. About 450 applications to set up 5,000 MW capacity have been received. These will now go through a process of bidding/ discount on CERC tariff. Therefore, tariff is expected to be lower than what CERC has announced. In any case, annual tariff reduction is proposed under the Mission.

5.7.4.5 In addition, project developers for 100 MW capacity of grid (below 33 KV) connected solar projects (of 100 kW to 2 MW capacities each) have also been selected. It is expected that 150-200 MW of solar power will be installed in the country by Dec 2011.

5.7.4.6 The main objectives of the mission are to help reach grid parity by 2022 and help set up indigenous manufacturing capacity.

5.8 Off-Grid Renewable Power Programmes

5.8.1 It needs to be underlined that for two major reasons Indian renewable energy priorities are different from that of the developed countries. Firstly, and most importantly, it provides energy access to large rural populations including those in inaccessible areas and meeting unmet demand in many other areas. Perhaps the remoter areas can get electricity only through renewable sources. Secondly there is another important, unrecognized ~~consequence~~ attribute of off-grid applications. In one way or the other, they replace fossil fuels and can make a significant contribution to reduction in their consumption which is so important from the point of view of energy security. For instance, rural lighting replaces kerosene, a biogas plant or solar cooking systems replace cooking gas, solar PV replaces diesel or furnace oil in various areas.

Renewable energy can also competitively meet the process heat as well as power requirements of large number of small and medium enterprises as well as in some other areas which use lot of diesel for power generation. Thus, Renewable Energy should not be seen only, or even primarily so, in the context of grid related power. Its great strength and potential also lies in its ability to generate power in decentralized and distributed mode which has the advantages of production at consumption points and does away with land and environmental related concerns and problems. This area generally remains largely unexplored or unexploited or even discussed.

5.8.2 Table 5 provides a summary of the achievements in off-grid/ distributed renewable power and decentralized renewable energy systems:

Table 5: Achievements in off-grid renewable power and decentralized energy systems

S. No	Resources/ Systems	Cumulative Achievements (up to 30.09.2010)
Off-Grid/Distributed Renewable Power (including Captive/CHP Plants)		
1.	Biomass Power / Cogen.(non-bagasse)	263.1 MW
2.	Biomass Gasifier	128.2 MWeq
3.	Waste-to- Energy	60.8 MWeq
4.	Solar PV Power Plants	2.9 MWp
5.	Aero-Generators/Hybrid Systems	1.1 MWp
	Total	456.0 MWeq
Decentralized Energy Systems		
1.	Family Type Biogas Plants	4.27 million
2.	SPV Home Lighting System	6,19,428 nos.
3.	Solar Lantern	8,13,380 nos.
4.	SPV Street Lighting System	1,21,227 nos.
5.	SPV Pumps	7,495 nos.
6.	Solar Water Heating - Collector Area	3.77 mln. sq.m.

While these achievements are evidently impressive, there is great potential and need for deployment of such off-grid/ distributed/ decentralized systems. The Ministry, therefore, is giving increased importance and attention to this area.

5.8.3 A new policy framework has been put into place for rapid up-scaling of off-grid programmes in an inclusive mode. The programmes are now being implemented through multiple channel partners including renewable energy service providing companies, financial institutions including microfinance institutions, financial integrator, system integrators, industry and programme administrators. In order to sustain satisfactory performance and generation of output in the envisaged energy forms a flexible funding approach has been adopted with bouquet of instruments including support in the form of capital subsidy, interest subsidy, viability gap funding etc. This apart, Ministry provides full financial support for undertaking pilot and demonstration projects through manufacturers and other organizations for demonstrating new and innovative applications of renewable energy systems.

5.8.4 The greatest potential area of off-grid relates to solar technologies. These include solar water heating systems, home lighting systems which include solar lanterns, solar cooking systems, solar pumps and small power generating systems. Under the Solar Mission, it has been proposed to cover 2000 MW equivalent by 2022 which includes all the above, except solar water heating systems for which there is a separate target of 20 million sq. meters. Within the off-grid component, there is a separate target of covering 20 million rural households with solar lights. This includes coverage under the Remote Village Electrification Programme where largely solar lighting is provided to villages where grid is unlikely to go and which is almost entirely funded by Central grants. In addition, in other areas where grid is available but power supply is of erratic nature solar lighting is financed through loans given through rural banks. These are very ambitious targets. However, the aspiration goals of the Ministry would raise the bar by another 2000 MW in the same period. Specifically targeting reduction in consumption of fossil fuels where solar power, even at current costs, could be somewhat competitive after getting some government support. This could be made possible by covering niche areas like solar-powering of telecom towers, large scale use by industrial establishments in the manufacturing sector where diesel generating sets have been installed for partly mitigating daytime use of diesel, increased coverage in areas like Ladakh where diesel is the prime source of energy generation, etc. This would require support of other institutions and industries. Naturally, the rising costs of oil and the lowering of cost of solar would play a catalytic role.

5.8.5 Solar cooking is an area which has been getting attention but perhaps requires more focus. India has been a pioneer in using two types of solar concentrating technologies for the purpose of steam generation for various applications. One is based on fixed receiver East-West automatically tracked parabolic concentrators (namely Scheffler dishes) and the other on fully tracked receiver and Fresnel reflectors (named Arun technology). Systems based on fixed receiver technology are under installation for last many years and about 70 systems covering over 20,000 sq. m of dish area have been installed so far. The second technology is under pilot scale demonstration. Systems based on both these technologies have mainly been installed for cooking, laundry and process heat applications. The World's largest system for cooking in community kitchen has been installed at Shirdi in Maharashtra to cook food for 20,000 people per day and is saving around 60,000 kg of LPG every year. Ministry would like to cover at least 1000 large solar cooking systems by 2022. All institutions including large institutions with hostels, hospitals/medical colleges, military/para-military establishments, industrial organizations, wherever large number of meals is cooked, are the targets. Essentially, these will reduce the consumption of cooking gas. Wherever such systems are set up, the hope is that the institutions would process the kitchen waste to produce biogas which would also be used in the kitchen for cooking purposes. Several such technologies/processes are available.

5.8.6 An important developing area is use of concentrating solar technologies for cooling/ refrigeration of which there is a great need. Since cooling demands are maximum during day time when solar energy is also available, particularly in the hot summer season, there is a vast potential. Recently, concentrating solar technologies have found applications for air conditioning also. A few such systems are operational in the country as pilot projects. Several research and development projects have also been initiated to reduce costs and increase efficiencies. This will be a future focus area as successful commercialization will bring huge power savings.

5.8.7 Another important area of off grid relates to rural cooking. Family size biogas plants and improved cook-stoves, both at the level of individual households or the community are the options available. About 4.27 million family size biogas plants are currently installed in India,

although the estimated potential is around 12 million. The present deployment is about 0.15 million plants annually. We are hoping to reach the coverage of additional 2 million plants by 2022. This is an important programme leading to reduction in drudgery among the rural women and girls engaged in collection of fuel wood and reduction in the rate of deforestation and getting many health benefits, apart from providing organic fertilizer. As far as cook-stove is concerned, the biggest problem relates to inefficient combustion of biomass and the inability of large number of people to spend money on processed fuels for improved cook-stoves because traditionally available biomass is used free of cost. A large number of community size cook-stoves currently use substantial amount of fire wood. A pilot project has been launched to test the efficiency and marketability of improved community size cook-stoves, so that the consumption of fire wood is reduced. This project covers governmental institutions like Anganwadi Centres, schools for mid-day meals and tribal hostels etc. apart from private dhabas (roadside eateries). Simultaneously a pilot project is being contemplated to test sustainable delivery models for household improved cook-stoves. The Ministry has also started the process of upgrading biomass cook-stove test centres as well as developing modified standards for various improved cook-stoves. The Ministry has announced that an international competition for developing new stoves would be conducted through the "X" Prize Foundation next year.

5.8.8 An extension of off-grid relates to rural electrification. Over 40% of the country's population is currently do not have energy access. This has become a major problem and inspite of large investments under the RGGVY for rural transmission, it has been found increasingly difficult to provide this access, especially in certain identified areas. Biomass based solutions are possible. They are relatively more viable commercially and can be implemented in market mode with some Government support. Already about 150 villages have been covered through mini grid by rise husk based gasification systems in Bihar. Pilot projects are under preparation for using pine needles in Himalayan pine forests. Lantana weed in the forests areas of Central India and possibilities of dedicated bamboo plantations are being examined. Pilot projects from solar to find suitable business models have also been carried out in several villages. These will, however, require substantial Government support or financial support which may come as grants through some fund or the other to meet the initial capital cost. In hilly areas water mills and micro-hydel

plants are being promoted. To meet unmet demand, the Ministry would like to cover about 10,000 villages from biomass-based systems and over 1000 villages from solar power up to 2022. These achievements could make a huge dent in the critical issues relating to energy access.

5.8.9 India generates over 600 million tons of biomass based on agricultural residues annually. This is the main source of energy for rural people in India and is characterized by low efficiency, drudgery associated with its collection and negative environmental effects. Biomass gasifier systems have the potential to provide captive electrical and thermal energy needs of industries to replace conventional fuels such as diesel, furnace oil and coal. More importantly, it is also capable of producing electricity for off-grid applications in rural areas as well as to feed into the tail end of the grid which is sustainable solution, in the context of serious shortage of electricity in rural areas. The Ministry has been promoting multifaceted Biomass Gasifier programmes with a view to utilize locally available surplus biomass resources in rural areas, where biomass such as rice husk, corn cab & stalks, arhar stalks, cotton stalks, small wood chips other agro-residues are available. Special thrust is being given for rice husk based power programmes especially for rice growing eastern part of the country comprising of eastern Uttar Pradesh, Bihar, Orissa and West Bengal, the region with the lowest per capita electricity consumption. These projects meet the unmet demand of electricity for lighting, water pumping and micro-enterprises in rural areas. The grid interactive projects (up to 2 MW) at the tail end of the grid at 11kV to reduce the transmission and distribution losses and stabilize grid voltages are now being piloted. So far about 112 MW equivalent biomass gasifier systems have been set up in industries for captive power and thermal applications. About 50 rice husk based gasifier systems are presently providing electricity for lighting and other electricity needs in almost 150 villages / hamlets in Bihar. It is planned to take up about 1000 villages / hamlets in next 1-2 years. A programme is being formulated to set up 200 MW biomass gasifier projects of 2 MW capacities at the tail-end of the grid by 2012.

5.9 Demand Side Management

5.9.1 Almost 40% of the total energy is utilized in the building sector. As urbanization is growing rapidly, this sector will create great demand for energy in the future. A green building designed through solar passive concepts and including active renewable energy systems can save substantial conventional energy apart from generating energy for meeting various requirements in different seasons. Keeping in view our climatic conditions, a National Rating System - GRIHA (Green Rating for Integrated Habitat Assessment) has been developed which is suitable for all types of buildings in different climatic zones of the country. It is expected that the Rating system will promote the design and construction of green buildings in the country. Moving beyond buildings, Ministry is making attempts to develop green campuses. The Government of India has already decided that all its new buildings would henceforth mandatorily conform to 3* or 4* GRIHA ratings. A new scheme on 'Development of Solar or Green Cities' has been launched to encourage and assist the Urban Local Bodies in assessing their present energy consumption status, set clear targets for upto 10% reduction in projected demand, and prepare action plans to generate energy through renewable energy sources and conserve energy utilized in delivering urban services. A mission approach is being attempted in this area of sustainable habitats.

5.9.2 It is estimated that installation of 1000 domestic solar water heaters, can result peak load sharing of 1 MW. Mandatory provisions, therefore, are being made to make solar water heating mandatory in buildings and sector where hot water demand is met by electricity or other sources. Large scale deployment of this mature renewable energy technology thus not only allow avoided utility cost but would also result substantial saving of electricity and fossil fuels.

5.10 Financing of Renewable Energy Projects

5.10.1 Renewable power generation capacity in India has been set up largely through private sector investments and has been possible due mainly to a conducive, strong and clear policy framework and investor friendly environment. New investment is the most potent indicator of growth of the sector. As per an estimate, in 2009 the total financial investment in clean energy in

India was at Rs 135 billion. Ernst and Young ranked India the fourth most attractive country for renewable energy investment in the world, only behind the United States, China, and Germany.

5.10.2 Indian Renewable Energy Development Agency (IREDA), established in 1987 as a Public Limited Government Company, under the administrative control of MNRE, is a specialized developmental financial institution with the objective to provide financial support to specific projects and schemes for generating electricity and/or energy through new and renewable sources and conserving energy through energy efficiency. It offers term loans to renewable energy projects at rates slightly more favorable than general commercial lending rates. As of March 31, 2010, IREDA financed 1,921 projects with a loan commitment amounts totaling over Rs 121.8 billion. Between 1987 and 2009, actual disbursements are at Rs 66.44 billion. This funding has supported the installation of 4.38 GW of power generation capacity. The loan commitments during 2009 were over Rs 18.24 billion and loan disbursements were over Rs 8.9 billion for 29 projects totaling 271 MW of power generation.

5.10.3 Other government agencies that actively fund renewable energy projects are the Power Finance Cooperation (PFC), the Rural Electrification Corporation (REC), and National Bank for Agricultural and Rural Development (NABARD). Corporate financiers of renewable energy projects in India are primarily concentrated on the large wind and hydropower projects, where captive power generation and the application of accelerated depreciation benefits play a significant role. Of late, the growing awareness and favorable government policies & regulatory mechanisms (both at central & state level) have led to gradual increase in confidence of domestic commercial banks providing loans to renewable energy projects. A number of microfinance institutions (MFIs) facilitate the purchase of renewable energy systems like solar cookers, solar lanterns, or small biogas plants in off-grid areas of the country. The Self Employed Women's Association (SEWA) is perhaps the most well-known example of an MFI in India.

5.11 Human Resource Development

5.11.1 An estimate indicates that implementation of the National Action Plan on Climate Change could create an additional 10.5 million direct jobs in wind, solar and biofuel energy

production. Further, global expansion of wind power could create 288,500 Indian jobs if Indian firms were able to penetrate 10% of the global market.

5.11.2 Ministry has initiated a series of activities for meeting ever increasing human resource requirement in renewable energy area. These include award of Renewable Energy Fellowships for post graduate, M.Tech, doctoral degree and at the post doctoral levels; institution of Renewable Energy Chair at academic institutions, incorporating renewable energy in the main course curriculum of various of engineering branches and mechanic trades; support to educational institutions for undertaking degree/diploma programmes in renewable energy; training programmes on different aspects of technology to renewable energy professionals working in State Nodal Agencies/Government/ Utilities, research & development institutions, NGOs, community based organizations, banking and financial institutions etc; organization of training-cum-study tours; and also developing of training modules for various category of professionals. The national renewable energy fellowship scheme has been augmented to provide fellowship to 400 students/researchers every year. To provide financial assistance to educational and research institutions to set-up infrastructural facilities such as laboratory, library and other teaching aids. In addition, Ministry has planned National Solar Energy Fellows Programme under which 10 eminent scientists will be awarded fellowship of Rs. 1 million per annum, in addition to contingent and research grant. This apart, Renewable Energy Chair is planned to be instituted at 15 premier institutions. As such Ministry has launched a comprehensive programme to address human resources needs of different level of professionals and stakeholders.

5.12 Renewable Energy and Climate Change

5.12.1 Renewable energy is central to climate change mitigation efforts. Broad estimates indicate that mitigation from existing renewable energy portfolio is equivalent to around 4-5 % of total energy related emissions in the country. Further, the vast market potential and well-developed industrial, financing and business infrastructure, has made India a favorable destination for Clean Development Mechanism (CDM) projects, with renewable energy projects having the major share. National renewable energy plans offer ample opportunity for CDM projects and technological innovations.

5.12.2 An analysis of CDM pipeline highlights the fact that there is not enough participation from private households, small enterprises and rural areas. In order to address this gap, MNRE has developed a framework for undertaking renewable energy projects under programmatic approach. It is expected that with CDM Executive Board's recent guidelines to establish simplified modalities for demonstrating additionality for project activities up to 5 megawatts that employ renewable energy, better options and opportunities would now be available. However, even with the new additionality guidelines, the stringent project based approval process of the CDM projects and associated high transaction costs have been acting as barrier. As a result CDM projects have largely been in the area of grid power and decentralized and distributed renewable energy projects have not been able to get the benefit of CDM because the high transaction costs.

5.13 Research, Design and Development(RD&D)

5.13.1 The feasibility of a larger application of renewable energy, to that of the present assessments, would depend on how rapidly the costs decline and efficiencies increase. As a result, research and technology development have been accorded high priority in the national renewable energy programme and mission mode research has been planned for developing solar, bio-energy and hydrogen technologies.

5.13.2 The Ministry supports Research, Design, Development and Demonstration (RDD&D) to develop new and renewable energy technologies, processes, materials, components, sub-systems, products & services, standards and resource assessment so as to indigenously manufacture renewable energy products and systems. A comprehensive policy on Research, Design, Development and Demonstration (RDD&D) is in place to support R&D in new and renewable energy sector, under which financial support ranging from 50-90% of project cost is provided for collaborative Research, Design, Development and Demonstration projects in association with Industry. An ambitious plan for R&D in new and renewable energy sector had been set for the 11th Plan Period (2007-2012). A total of around 90 R&D projects with budget of around Rs.1400 million have been sanctioned during the first three years of the plan period. These

projects cover all renewable energy sectors: solar photovoltaic and solar thermal energy, bio energy including second generation bio-fuels, hydrogen energy and fuel cells, etc.

5.13.3 In order to make available quality product in the market, the Ministry has been focusing on developing specifications, certification, and standardization of renewable energy systems and products. Specifications have been developed for solar flat plate collectors, box-type solar cookers, solar PV panels and systems, biomass gasifiers, biogas plants and burners, wind electric generators etc. Further, standardization is perceived as a continuous activity and specification are updated on regular basis with concomitant improvement in the technology.

5.13.4 Ministry has been implementing Renewable Energy Incubation Scheme through Centre for Innovation, Incubation and Entrepreneurship (CIIE) of Indian Institute of Management, Ahmedabad. Under this initiative aspiring entrepreneurs wanting to set-up their enterprise in renewable energy sector are selected and supported through continuous hand holding including internship/grooming programme, evaluation of technologies being developed in various labs and patent search, and also by providing initial support for setting up enterprises. Initial results of the programme have been quite encouraging and it is now planned to enlarge the scope and coverage.

5.14 Conclusion

5.14.1 Historically, India has initiated systematic programmes for renewables including for research and development. However, the fast progress across the world which has melted the national boundaries in terms of technology adoption and implementation, the optimisms as well as demand created by economic growth in India and the increasing concerns regarding climate change have led to a situation where renewable energy is experiencing vibrancy all across, whether in industry, research institutions, a common villager, a developer, an investor, bankers and so on. Each one has some aspirations and expectations from this sector and may indeed have a great responsibility. It in a way is laying foundation of a new economy that is inclusive, sustainable and aspires for de-carbonization of energy in a definite time frame. However, there is

a long way to go. In order to create an enabling environment, new policy frameworks, technological innovations and human skills development programmes are under way.

5.14.2 While policy and budgetary support for renewable energy have progressively increased over the years, particularly for large scale grid connected power, there continue to exist many barriers that hinder up- scaling of renewable energy deployment. And perhaps more importantly, some critical gaps remain, particularly for decentralized distribution in the areas of access to capital, technology development & adaptation, innovation induction, and strategies to up-scale deployment. The National Clean Energy Fund, for the first time, has created an opportunity to think beyond the budget, and to create new instruments, strategies and pathways for renewable energy.

Annexure-I

Renewable Portfolio Obligation (RPO) specified by the State Electricity Regulatory Commissions

Sr. No.	State	Renewable Energy Source	FY10-11	FY11-12	FY12-13	FY13-14	FY14-15	FY15-16
1	**Gujarat**	wind	4.5%	5.0%	5.5%			
		Solar	0.25%	0.5%	1.0%			
		others	0.25%	0.5%	0.5%			
		Total	5%	6%	7%			
2	**Maharashtra**	Solar	0.25%	0.25%	0.25%	0.50%	0.50%	0.50%
		Non-solar	5.75%	6.75%	7.75%	8.5%	8.5%	8.5%
		Total	6%	7%	8%	9%	9%	9%
3	**Uttaranchal**	Solar	0.25%	0.5%	1.0%			
		Non-solar	3.75%	4.5%	5.0%			
		Total	4%	5%	6%			
4	**Manipur**	Solar	0.25%	0.25%	0.25%			
		Non solar	1.75%	2.75%	4.75%			
		Total	2%	3%	5%			
5	**Mizoram**	Solar	0.25%	0.25%	0.25%			
		Non solar	4.75%	5.75%	6.75%			
		Total	5%	6%	7%			
6	**Jammu & Kashmir**	Total	1%	3%	5%			
7	**Uttar Pradesh**	Solar	0.25%	0.5%	1%			
		Non solar	3.75%	4.5%	5.0%			
		Total	4%	5%	6%			
8	**Tripura**	Solar	0.1%	0.1%	0.1%			
		Total	1%	1%	2%			
9	**Jharkhand**	Solar	0.25%	0.5%	1%			
		Non solar	1.75%	2.5%	3.0%			
		Total	2%	3%	4%			
10	**Himachal Pradesh**	Solar	0%	0.1%	0.1%			
		Non solar	10%	11%	125			
		Total	10.10%	11.10	12.10%			

11	**Orissa**	Solar		0.10%	0.15%	0.20%	0.25%	0.30%
		Non-solar	1.0%	1.2%	1.4%	1.6%	1.8%	2%
		Co-gen	3.50%	3.70%	3.95%	4.20%	4.45%	4.70%
		Total	4.5%	5%	5.5%	6%	6.5%	7%
12	**Assam** Draft	Solar	0.05%	0.1%	0.15%	0.2%	0.25%	
		Total	1.4%	2.8%	4.25	5.6%	7%	
13	**Tamil Nadu**		14%					
14	**Delhi**		1%					
15	**Andhra Pradesh**		5%					
16	**Karnataka**		11%					
17	**West Bengal**		10%					
18	**Rajasthan**		9.5%	9.5%				
19	**Madhya Pradesh**		10%					
20	**Punjab**		4%					
21	**Haryana**		10%					