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## *Full Length Research Article*

# SOLAR WIND RENEWABLE ENERGY PROGRESS IN INDIA THROUGH POLICY UPDATES

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**ABSTRACT**

India is a developing economy facing major hurdles of providing energy access to all its citizens, large dependence on fuel imports for energy security, and fulfilling international protocols on climate change mitigation, although the economic and social development is the principal priority. The increase in energy demand due to growing population and industrialization along with depleting fossil fuel resources has stimulated the country's efforts in adopting power generation from renewable energy sources. India has been bestowed with enormous renewable energy potential, especially wind and solar energy, which if utilized properly, can fulfill the energy requirements of the country however these are not distributed uniformly across the country. This article presents the voyage of the Indian current power scenario along with renewable energy status. Moreover, an updated vision of wind solar renewable energy scenario, funding and prevailing policies along with regulatory provisions for renewable energy progress in India has been assessed.



## INTRODUCTION

India is situated in South Asia with the eleventh largest economy in the world and fourth in terms of purchasing power. The country is facing with the major challenges of providing energy access to all, heavy dependence on fuel imports for energy security, and complying with international protocols on climate change mitigation, although the economic and social development is the primary priority. The Indian Government is laying stress on renewable energy sources as these are a check on flexibility, efficiency, reliability, economics and emission. India was the first country in the world to establish a Ministry of non-conventional energy resources in 1981 as in Load and Generation Report, 2011-12 and 2012-13. Wind and solar renewable energy are ubiquitous, freely available, and environment friendly. The wind energy systems are not technically viable at all locations because of uneven wind speeds and being more unpredictable than solar energy. The combined utilization of these renewable energy sources is therefore becoming increasingly attractive and is being widely used as an alternative for other energy sources available (Nema *et al*., 2009). With these considerations the aim of this article is to describe Indian Current Power Scenario along with renewable energy status. An updated status of wind solar renewable energy scenario is visualized.

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Exploration of funding and prevailing policies along with regulatory provisions for Renewable Energy progress in India is another aspect which has been considered.

### Current power scenario of India

India's electricity generation is mainly from fossil fuels followed by coal, crude oil, and natural gas, which contribute to about 70, 40, 28, and 6%, respectively (Yep, 2011). the Central Electricity Authority (CEA), Government of India, has predicted the electricity production in India closer to 263.66GW as on March 2015, of which nearly 60% is still from coal followed by hydro (15.5%), renewable (13.1%), gas (8.7%), nuclear (2.2%) and diesel (0.5%) . 13.1% renewable energy is contributed maximum by wind (8.6%), small hydro power (1.5%), bagasse cogen (1.1%), solar (1.3%) and biomass (0.5%) (Figure 1). Renewable energy capacity of 34.35 GW which is 13% of installed capacity and approximately 7% of electricity produced as on March 2015 (Source: Ministry of New and Renewable Energy (MNRE), CEA Statistics; GEF National work shop in India MNRE).

### Renewable energy status in India

Renewable energy sources are in provide clean energy while reducing dependence on fossil fuels, leading to decrease in $CO_2$ emissions. Nations all over the globe are using renewable energy to supplement the energy needs and to reduce

environmental impact. Scientific progress, reduced cost, and governmental incentives have made wind and solar renewable energy sources to be need of the hour. Global renewable energy installed capacity of 673 GW as on December 2014, reported by Global wind energy council. Out of which 58% is contributed by Wind followed by solar PV (25%), bio power (16%) and concentrated solar power (1%). In which global wind energy is about 370GW and India ranks fifth with 22.6GW behind China (114.6GW), Unites states (65.9GW), Germany (39.2 GW) and Spain (23GW). Whereas global solar energy is 177GW and India ranks 6th with only 3.3GW behind Germany (38.2 GW), China (28.2 GW), Japan (23.3 GW), Italy (18.5 GW) and United States (18.2 GW) as depicted in Figure 2 [Source: IEA PVPS as on January 2014].

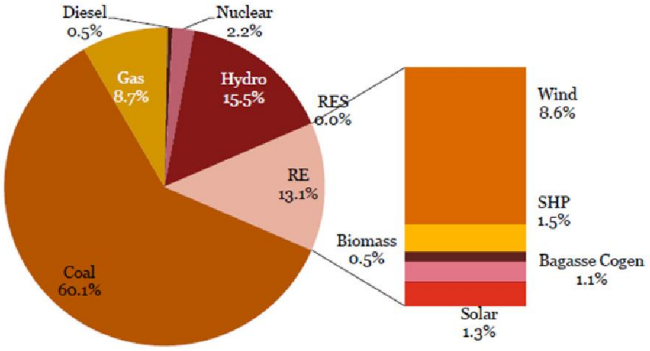


**Figure 1. Current Power scenario of India (MNRE, 2015)**

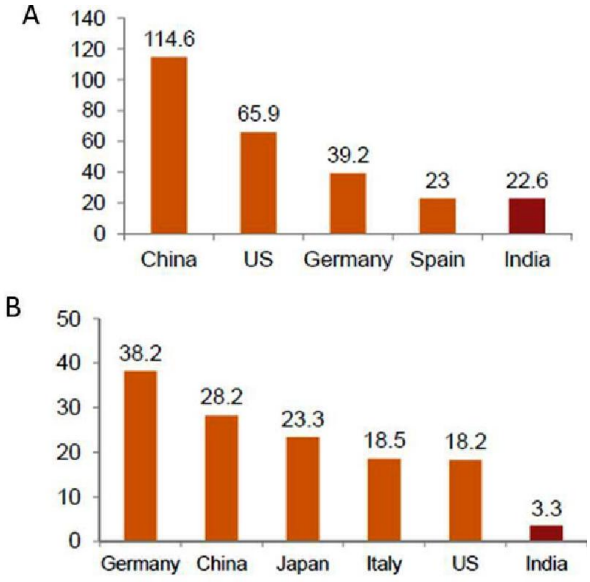


**Figure 2. India's position in harnessing Wind (A) and Solar (B) renewable energy (MNRE,2015).**

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electrical power, windmills for mechanical power, wind pumps for water pumping or drainage, or sails to propel ships. Wind energy has been the fastest growing renewable energy sector in the country.

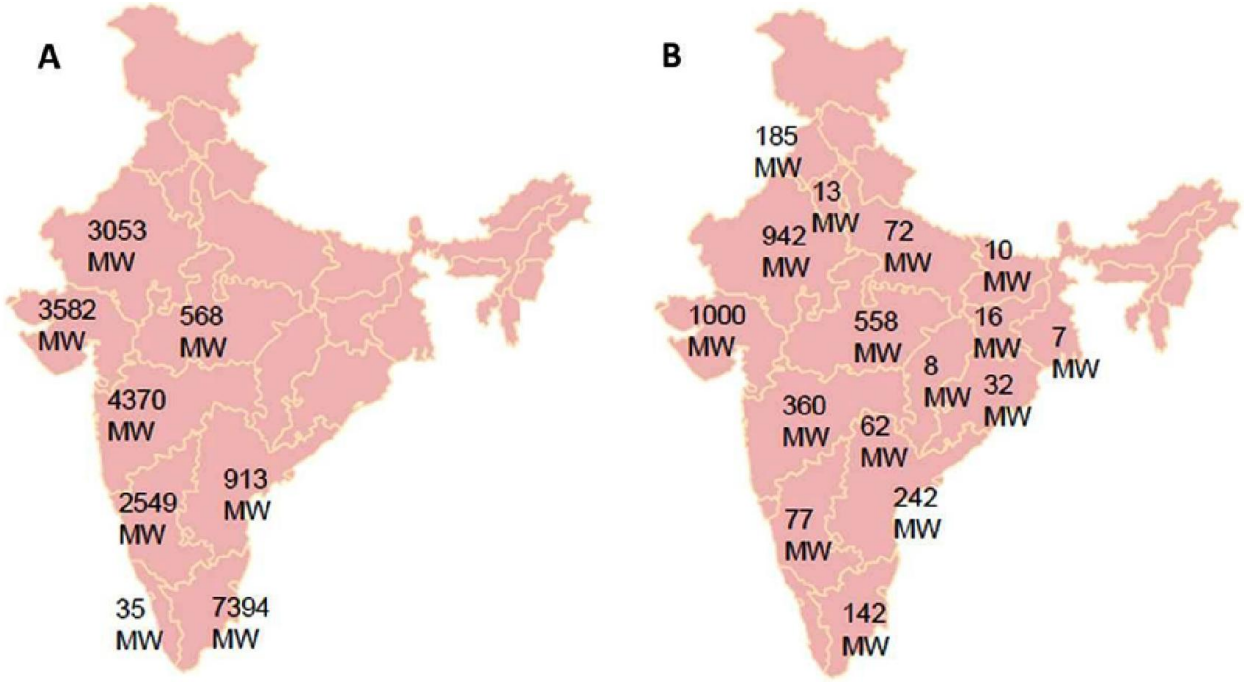


**Figure 3. Wind (A) and solar (B) energy across Indian states (MNRE, 2015)**

## Wind renewable energy progress in India

Wind energy is the kinetic energy associated with movement of large masses of air. This motion results from uneven heating of the atmosphere by the sun, creating temperature, density and pressure difference.

India is blessed with good sunshine hours along with 7,517 km of coastline and its territorial waters extend up to 12 nautical miles into the sea. Moreover, she is the 3rd largest annual wind power market in the world and delivers great business opportunities for both domestic and foreign investors. The ministry of Non-conventional energy sources of the Government of India implemented the wind energy program in

1983–84. The development of wind power in began in the 1990s and has significantly increased in the last few years. Current Status of wind energy across Indian states is depicted in the Figure 3(A).

Current Installed capacity of Wind energy is 22.6GW in 2015 (MNRE, 2015). According to CWET, the Wind power potential in India at 50 m hub- height is estimated to be 49.13 GW and at 80m hub Height is estimated to be 102.8 GW (Source: Ministry of New and Renewable Energy (MNRE), CEA Statistics; GEF National work shop in India MNRE, 13th May, 2015). Wind resource assessment is an endless process for identification of potential areas for wind farming. There are around 220 sites all over country having wind energy density of 200W/$m^2$ and above at 50 m height. Wind electric generators of unit sizes between 225 kW and 1.65 MW have been deployed across the country as indicated by Wind power in India, Wiki along with India Wind energy Outlook (2011 and 2012). India is a dominant market for the wind industry representing annual growth in 2.1GWof new installations.

The global wind markets propagated by an average 28% per year in terms of total installed capacity during the last decade. According to IEA project India will require 327 GW power generation capacity by 2020. Wind power would then be about 81 TWh every year by 2020 and a stretch of 174 TWh by 2030 and save 48 million tons of $CO_2$ in 2020 and reach to 105 million tons in 2030. The wind power investment would drop to about 910 million dollars by 2030 in India. Moreover, investment in wind power would also drop from the current level of € 3.7 billion per year to only € 2.4 billion by 2020 in India as stated in Indian Renewable Energy Status Report, 2010. Investigation and progress activities are being undertaken through research institutions, national laboratories, universities and industry for the development of cost effective technologies and systems to improve the quality of power generation from wind. Research and Development activities are coordinated through the Centre for Wind Energy Technology (C-WET). The future of wind energy in India is extremely bright and there is no doubt that in the renewable energy sector, wind power would play a predominant role in adding to the national grid clean and non-polluting energy to a sustainable lifestyle (Bakshi, 2002).

**Solar energy/ solar renewable energy progress in India**

Sunlight can be converted directly into electricity using photovoltaic (PV). The photovoltaic generation is a technique of converting solar radiation or photon energy into direct current electricity using a semiconductor material that exhibits photovoltaic effect. The International Energy Agency has numerated photovoltaic applications into four categories, namely, off-grid domestic, off-grid nondomestic, grid connected distributed, and grid connected centralized (Nema *et al*., 2011). The dominance of photovoltaic (PV) among renewable energy technologies is owed mostly to its noiselessness, non-toxic emission, and relatively simple operation and maintenance (Moosavian *et al.,* 2013). These are important and relatively inexpensive sources of electrical energy where grid power is inconvenient, unreasonably expensive to connect, or simply unavailable. India is densely populated and has high solar insolation which provides an ideal habitat for generating electricity from solar energy. India has huge solar potential as it lies between the Tropic of Cancer and the Equator with average annual temperature ranging from 25 °C to 27.5ºC. Moreover, received solar energy equivalent is more than 5000 trillion kWh per year, which is far more than its total annual consumption as indicated in Solar Power in India, Wikipedia. The energy density is low and the availability is not continuous in spite of that it has now become possible to harness this abundantly available energy very reliably for many purposes by converting it to usable heat or through direct generation of electricity.

For instance even assuming 10% conversion efficiency of PV modules, it will still be thousand times greater than the likely electricity demand in India by the year 2015 (Khare and Gupta, 2012). Government encouragement and ample solar resources have also helped to increase solar adoption. The Jawaharlal Nehru National Solar Mission (JNNSM), a major initiative of the government of India, has set itself a goal of creating an enabling policy framework for deploying 20 GW of solar power by 2022. The target of the solar system installation is illustrated in Table 4. India's objectives and intentions are commendable. The final output of the recently released policy guidelines reflects both the overarching objectives of developing clean solar power, addressing power shortages and stakeholder concessions. This is the preliminary perspective on the recently released guidelines for new grid connected solar power projects in India (Solar Power in India, Wikipedia; http://WWW.energetica-india.com). Current status of solar energy across Indian states is 3744MW (March 2015) in figure 3(B) with current installed capacity of 3.744GW, and solar potential stands at 748GW.

**Solar scale up plans for 100 GW vision**

India will be among the top players in renewable energy as its target is: 200 GMW renewable capacity by 2021-22 which is bifurcated as 100 GW Solar Capacity, 60 GMW Wind Capacity and rest 40 GW by other means. Moreover, Solar Scale-up Plans for 100 GW Vision are by two categories as: Category 1 grid connected Rooftop Projects contributing 40 GMW and Category 2 Large scale Projects contributing 60 GW of energy ( Inside Solar park 20 GW, Outside Solar Park 40 GW) (http://india.gov.in/topics/power-energy/renewable-energy). 20GW through Solar park as already sanctioned in17 Parks (12 states with capacity 12,759 MW approved and request received for 5 more parks).

**40GW through grid connected roof**

Status under grid connected roof is 358MW projects sanctioned and 41MW installed moreover, potential for 124GW exists. Indian government targets 40,000 MW by 2022 of which 10GW during 2015-16 to 2017-18. Current support for financial assistance of 155 of the bench mark (reduced from 30% earlier). 360 MW of Solar rooftops projects sanctioned by MNRE and 49.677 MW commissioned.

**More updates in solar rooftops are**

14 states have rooftop provisions in their solar policy and 20 States /Uts have notified regulations; rooftop included IPDS

and guidelines issued; guidelines issued to include rooftop under housing loan and 9 banks have issued instructions; Central Electricity Authority (CEA) has notified technical standards for connectivity and metering.

**Advantages of solar rooftops**

Savings in transmission and distribution losses; Low gestation time; No requirement of additional land; Improvement of tail-end grid voltages and reduction in system congestion with higher self-consumption of solar electricity; Local employment generation; Reduction of power bill by supplying surplus electricity to local electricity supplier; Battery elimination makes easy installation and reduced cost of system.

**Regulations of solar rooftops**

13 states have come out with solar Policy supporting grid connected rooftop systems; Andhra Pradesh , Chhattisgarh, Gujarat, Haryana, Karnataka, Kerala, Manipur, Punjab Rajasthan uttar Pradesh Tamil Nadu Uttarakhanad and west Bengal; SERCS of 20 States/Uts have notified regulations for net metering / feed-in-tariff mechanism; Andhra Pradesh, Chhattisgarh, Delhi, Gujarat, Haryana, Karnataka, Kerala, Odisha, Rajasthan, Uttar Pradesh Tamil Nadu Uttarakhanad and west Bengal, Andaman and Nicobar, Chandigarh, Dadra and Nagar Haveli, Daman and Diu, Lakshadweep, Pondicherry, Goa ; Remaining states being pursed to come out with their policies /regulations.

**Funding for renewable power in India**

Financial support for renewable energy in India depends on following: Feed in Tariffs are introduced by almost all states for renewable energy technologies; State Re Policies of states have formulated renewable energy policies and have added significant capacities; High demand supply energy gap: Power shortage prevails and energy gap is expected to increase; Accelerated depreciation (AD)-Key instrument for success of wind and it also exists for solar and biomass projects; Renewable purchase obligation (RPO)- RPOs mandated by the EA 2003 and national tariff Policy, REC mechanism launched to fulfill RPOs; Exemptions and other incentives- Excise and custom duty exemptions for most of the equipment, Machinery etc. 10 year tax holiday (Source: GEF National workshop in India, MNRE, Source: Ministry of New and Renewable Energy (MNRE), CEA Statistics; GEF National work shop in India MNRE on 13th April 2015).

**Prevailing policies and regulatory provisions for renewable energy progress in India (Source: GEF national workshop in India, MNRE)**

The increase in the country's energy demand along with population, the depleting fossil fuel reserves, and the growing concerns over environmental degradation have conveyed in new prototypes in Indian perspective. The government commenced norms for checking usage of energy, incentives for energy conservation, and deployment of renewable energy sources as it is with about 10% (CEA) power deficit, huge aggregate technical and commercial (AT&C) losses, and unrealistic tariff structure. Moreover, public policies were emphasized by government to increase the renewable power generation capacity. The energy policies announced by the government, the three major policies are five-year plans, the Integrated Energy Policy in 2008, and the National Action Plan on Climate Change (NAPCC) in 2008. The energy policies announced by the Indian government are as follow:

**Electricity Act (EA), 2003**

In 2003, the Electricity Act came into existence, originating from three of the earlier acts that regulated the electricity sector, *viz.*, the Indian Electricity Act (1910), the Electricity (Supply) Act (1948), and the Electricity Regulatory Commissions Act (1998). The act focuses toward rural electrification, generation, transmission and distribution, consumer protection, tariff principles, establishment of the CEA, trading development, measures against electricity theft, restructuring of state electricity boards (SEBs), etc. Section 3 provides policy provision for, the Central Government to prepare National Electricity Policy and Plan for development of power system based on optimal utilization of resources including renewable sources of energy. Section 4 provides policy provision for the Central Government that after consultation with the State Government can prepare and notify a national policy permitting stand-alone system (including those based on Renewable Energy sources) for rural areas.
Section 61 provides regulatory provisions that the appropriate commission that is CERC – Central Electricity Regulatory Commission and SERC – State Electricity Regulatory Commission, under this Act can specify the terms and conditions for determination of tariff and can be guided by promotion of generation of electricity from Renewable Energy. Section 86 (1) (e) provides to promote generation of electricity from Renewable Energy by providing suitable measures for connectivity to grid, sale of electricity to any person and specifying the quota obligation for consumption of Renewable Energy that is Renewable Purchase Specification (RPS) or Renewable Purchase Obligation (RPO).

**National Electricity Policy (NEF), 2005**

National Electricity Policy was notified by Central Government in February 2005 as per provisions of Section 3 of EA 2003. It was introduced to overcome the energy and peaking shortages, to supply reliable quality power at reasonable rates, to increase the per capita availability of electricity by 1000 units, and also to make the electricity sector commercially viable to take care of consumers' interests. Under this Policy Section 5.2.20 promotes private participation in Renewable Energy. Section 5.12.1 marks capital cost reduction in Renewable Energy through competition. Section 5.12.2 states that State Electricity Regulatory Commissions should specify appropriate tariffs to promote and specify targets for Renewable Energy.

**National Tariff Policy (NTP) 2006**

In 2006, the Tariff Policy was announced for fixing a minimum percentage for purchasing energy considering the availability of resources and its impact on retail tariffs, regarding procurement of electricity by distribution

companies, etc. Enabling provisions under this policy was to power procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission. In the long term, competitive bidding within specific renewable technologies such renewable technologies to compete with other sources in terms of full costs in the long term, Central Electricity Regulatory Commission to lay down guidelines for pricing of non-firm power (this is the power generated from RE sources for which the hourly variation cannot be accurately predicted due to nature's phenomenon), in case where competitive bidding is not followed.

**National action Plan for Climate Change, 2008**

The NAPCC was pronounced in 2008 (Kapoor *et al*., 2014; Sharma *et al*., 2012) in sight of the climatic changes and environmental issues in the country to achieve sustainable development, which gives way to economic objectives and environmental obligations. Moreover, this policy reflects the commitment of the government to the world, toward India's per-capita carbon emission, regarding the protection and improvement of vulnerable parts of the society through sustainable development. The NAPCC includes eight missions of which the major two energy related missions are the Jawaharlal Nehru National Solar Mission (JNNSM) and the National Mission for Enhanced Energy Efficiency (NMEEE) (Khare *et al*., 2013). With a vision to have a considerable increase in power generation from solar energy, the government of India launched the JNNSM (Jawaharlal Nehru National Solar Mission, Ministry of New and Renewable Energy (MNRE), Annual report 2013–2014) on 11 January 2010 with a target to install 22,000 MWof solar power through grid-connected and off-grid power plants by the year 2022. The objectives of the NMEEE to be implemented by the BEE include demand management with a target to save at least 10 GW of energy by the end of 2012 as per the 11th five-year plan. A dynamic minimum renewable purchase standard (DMRPS) may be set with escalation each year till a pre-defined level is reached. NAPCC has set the target of 5% RE purchase for FY 2009-10, with increase of 1% in target each year for the next 10 years.

**Renewable Energy Certificate (REC) Mechanism, 2010**

A mechanism of renewable energy certificate will enable and recognize the interstate Renewable Energy transactions. It also seeks to address the mismatch between availability of Renewable Eenergy sources and the requirement of the obligated entities to meet their Renewable Purchase Obligations across states.

**CERC regulations, 2012**

Central Electricity Regulatory Commission (CERC) Regulations was applicable from 1 April 2012 for a period of 5 years for terms and conditions for Tariff Determination from Renewable Energy Sources. It is applicable in all cases where tariff, for a generating station or unit is based on renewable sources of energy, is to be determined by CERC and these regulations shall apply subject to the fulfillment of eligibility criteria specified in regulation 4 of the CERC Regulations (http://ireda.gov.in). Revision in Regulations for next control period to be undertaken at least six months prior to end of the first control period and in case regulations for next control period are not notified until commencement of next control period, the tariff norms shall continue to remain applicable until notification of the revised Regulations subject to adjustments as revised Regulations. The CERC Regulations also specify the tariff design, financial principles and technology specific parameters for each renewable energy technology. It also acts as guidelines for tariff determination at state level and is not mandatory for state commissions to adopt. However, deviating from the CERC Tariff Regulations would require a "distinctive reason" for any commission to do so.

**Conclusion**

India is a giant country and home to surplus cultures, ideas, religions and a diligent economic sphere. India is on track to increasing its economic pace to become a superpower in the near future. The massive growth in the economy is putting a severe stress on the energy sector. Even with vast resources of certain conventional fuels, such as coal the country is deemed inefficient and not at the level necessary to provide services to the growing economy of the country, which is showing in various reliability reports about India. Indian policymakers have finally accepted the growing need of reforms should shift from conventional approach to a modern smart grid approach is progressing taking inspiration from the advanced western countries. The strategy consists of an approach to achieve various goals by tapping into more readily available resources, rather than putting a pressure on the mining industry of the country. Various Missions have been introduced such as the JNNSM and the National Mission for Wind Energy, that is helping shed the conventional ideas and to embrace a modern approach totally targeting non-conventional sources of energy.

A smart grid approach will upgrade the electrical infrastructure of the country to a modern, well connected, efficient and reliable system that provides a platform for the economic and overall development of the country. Even though India still in the early stages with regards to the smart grid, it will have to increase the number of smart grid deployments and take lessons from each initiative so as to achieve a centralized national smart grid. Technology transfer, security protocols and investor regulations are core areas on which the policy makers must focus to make the smart grid deployment a reality for India. India being endowed with year round solar radiation and wind flow, must exploit this source to the fullest extent as it is abundant and will remain as long as Earth is in existence irrespective of the cost involved today. There is a need for further R&D improvements in solar PV and wind technologies that can reduce the cost of renewable system. According India may reach "Grid Parity" in solar energy in 2017 and in wind energy in 2022. For further development it is necessary to focus on a specific technological system which requires better policy measurement and requires more effort of the government in that way.

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