

## Wind Energy Utilization in India: A Review

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**Abstract:** The enormous population and economic development, made a massive demand for the electrical power in India. In the past decade, the majority of power generated was based essentially on fossil fuel. As India has infinite renewable energy resources there occurs a remarkable change, of shifting the power production from conventional power recourses methods to the non-conventional renewable energy recourses methods. Among the renewable energy recourses, wind energy plays a vital role in power generation. Even though wind energy has not been well utilised in India, It has made a significant progress in wind energy utilisation for power generation. Consequently, the prime objective of this study is to tackle some scenarios of investigation on wind energy utilisation for power production in India. The investigation includes major achievements, future aspects government initiatives and policy on wind energy utilisation. The investigation indicates that India is appreciably in advance in wind energy utilisation. Besides, the main problem that faces is the lack of obvious policies on wind energy utilisation and the government initiatives. However, Ministry of Non-Conventional Energy Sources (MNES) has been formed for the development of wind energy and other renewable resources. The immense development can only be seen in the future decades.

**Key words:** Renewable energy • Wind energy • Wind energy utilisation • Wind policy

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### INTRODUCTION

Energy crisis is the vital problem that the world faces in present decade. It is due to enormous growth of population and economy development. By analysing the past decade, the surplus energy crisis have been satisfied by burning coal, hydrocarbons-oil and natural gas leading to the carbon emissions that forms environmental crisis. The major environmental crisis such as global warming and irregular weather patterns affects the earth environment as well as raises the price of fossil fuel. As the prices of coal and oil, concerns the hidden cost about climate change and climate barriers. Therefore, in order to solve environmental crisis and energy crisis a new sort of energy resources was required. Hence, renewable energy resources into existence in the later part of the present decade [1]. The renewable energy resource uses the energy present in the environment to produce power and which in-turn reduces the impact of environmental crises. On the other hand, renewable energies in general (Wind, Solar, Hydro, Tidal, Geothermal, Biomass. etc) are commonly utilized to produce power. Among them, wind

energy and solar plant plays a vital role of producing power. Furthermore, they produce considerably lesser environmental impacts than the conventional energy resources. Furthermore, according to the survey from International Energy Agency, as India is obviously a developing country it consumes more than 28 percent by the year 2030 appropriately from the world's total energy production [2]. Hence, there must be an alternate energy resources installed in India.

India is consecrated with lots of alternate renewable energy resources such as solar, wind, Tidal, hydro and biomass. In India the utilization of wind energy is almost higher than other renewable energy resources as the wind flow in all season throughout the year. In wind energy utilization, India stands in the fifth place among the utilizer in the world. It stands after China, U.S.A, Germany and Spain in generation of wind power. The significance of renewable energy was predictable in the early 1970s. Later on, new wind turbine technologies are developing gradually and making a remarkable change than many other countries. Furthermore, they have capacity to generate 21.264 GW in present decade and over 15-16 GW

of new generation capacity is to be installed by 2020 [3-5]. Successively, it reduces carbon di-oxide emission of an average of 49 million tons by 2020. That in-turn reduces the irregular weather patterns in India. In addition to that, survey is made on government policy. The Indian government policy structure on wind energy utilization is particularly investor-friendly, has an attractive tariff plans and their rigid government provide a strong foundation for the growth of the wind energy sector. The MNRE has introduced “generation-based incentive” scheme. As per the scheme, investors will receive incentive of 50 paise per KW/hr of electricity generated by wind projects registered under the scheme. The incentive will, however, stop once the payout reaches Rs. 1 crore per MW of capacity. This incentive of Rs. 1 crore can be drawn in not fewer than four years and not more than 10 years. This decision to incentivize, have increased the foreign and domestic investors. Therefore, hopefully India have planned to raise its wind energy utilization in future decades by catalyze additional investments.

**Worldwide Status of Wind Energy:** Wind energy is the only major source to fulfil the world’s total electricity demand. Wind is plenty in nature, widely spread and low production cost; it can be readily used without any process. According to the annual report by the Global Wind Energy Council in the end of December -2013, wind power utilizer have emerged over the past decade. The world’s annual wind energy utilization capacity quadrupled in 2010 to 2013 and the energy utilization capacity doubles all two years. Furthermore, the worldwide wind energy utilization has reached 336.327 GW at the end of mid-2014 [4]. This raise is a appreciably higher when compared to 2013 and 2012 and wind power production was around 4% of total worldwide electricity demand. The global wind energy utilization capacity has

risen by 5.5% within last six months and with 13.5 % on the yearly basis (from June-2014 compared with June-2013). From the comparative investigation, the annual utilization capacity rate in 2013 was at 12.8 % and has raised 0.7% by mid-2014. The five traditional wind energy utilization countries: China, USA, Germany, Spain and India in cooperation contribute’s a 72 % share of the total wind power production from Table 1. The china contributes a total wind capacity of 98 GW in mid-2014 and unquestionably it would have crossed 100 GW at present. The US market, after its effectual subside in 2013, has exposed its significant recovery, through a power of 835 MW, somewhat greater than Canada (723 MW) and Australia (699 MW). Consequently, Germany made a strong performance by adding 1.8 GW within the first half of 2014. This is comparatively lesser than its installation in past decade [6]. Furthermore, Spanish market has contributed only 0.1 MW in the first half of 2014. This could possibly slow-down the Spain market in the upcoming years. India reserved its position as second largest in Asia and fifth largest in the worldwide. India added 1.1 GW of new wind capacity till the mid-2014. Additionally, United Kingdom and the Brazil had made a brawny performance of adding 649 MW and 1.8 GW first half of 2014.

The top ten wind countries are show in table as per the utilization capacity installed still mid-2014. Based on the efficient usage and higher performance analysis, five countries China, USA, Germany, France and Canada has performed stronger than in 2013. Based on the inefficient usage and slightly lower performance analysis, five countries India, Denmark, Italy, Spain and UK saw a decreasing market. Portugal has dropped out and Denmark has entered the top list by installing 0.1 GW higher than the Portugal. The rest of the world produces 53.334 GW and the total wind capacity is about 336.327 GW by mid-2014.

Table 1: Top 10 cumulative installed capacity 2012–June 2014 (C-Wet)

Position	Country	Total Capacity till June-2014(GW)	Total Capacity end 2013 (GW)	Total Capacity end 2012 (GW)
1	China	98.588	91.413	75.324
2	USA	61.946	61.108	59.882
3	Germany	36.488	34.658	31.315
4	Spain	22.970	22.959	22.796
5	India	21.264	20.150	18.321
6	United Kingdom	11.180	10.531	8.445
7	France	8.592	8.254	7.499
8	Italy	8.586	8.551	8.144
9	Canada	8.526	7.698	6.201
10	Denmark	4.855	4.772	4.162
	Rest of the World	53.334	48.394	40.518
	Total	336.327	318.488	282.607

Table 2: Wind energy potential in India

State	Wind Potential in (MW)	Total capacity till June - 2014(GW)
Tamil Nadu	5,374	7.253
Gujarat	10,609	3.414
Maharashtra	5,439	2.976
Rajasthan	5,005	2.820
Karnataka	8,591	2.409
Andhra Pradesh	5,394	0.753
Madhya Pradesh	920	0.439
Kerala	790	0.055
Others	11,808	4.30
Total	49,130	21.264

**Wind Energy Potential in India:** In India, wind energy holds the major portion of 66.7% (of 31707.2 GW total renewable energy capacity) among renewable and continued as the largest supplier of clean energy. The Wind Potential in India was first estimated by Centre for Wind Energy Technology (C-WET) at 50m hub-height i.e. 49 GW but according to the new survey at 80m hub height, the potential grows as much as 102 GW. This stature was adopted by the government as the official estimate. However, Lawrence Berkley National Laboratory (LBNL) has stated the potential is over 300 to 400 GW from a survey taken from country-wide network of 774 wind monitoring and wind mapping stations in 27 Indian States [7]. The estimation shows that India's total wind potential is 49 MW, with Tamil Nadu, Gujarat, Karnataka and Maharashtra as the leading states up to mid-2014. This effort of estimation made possible to measure the national wind potential and identified the proper location for harnessing wind power for commercial utilize. By means, they have identified 219 suitable sites with high wind potential. Table 2 shows the installation capacity till June-14 along with wind energy potential in India.

**Wind Energy Programme in India:** The wind energy programme in India begins at the end of 1984. At the beginning, energy programme was adopted based on business-oriented policy, which lead to the triumphant business development by implementing advanced technology. Later in 1990, National programme for wind energy development was formed. The National programme embraces wind potential estimation activities; research and technical development; making alertness and opening new wind energy sites; motivating utilities and industry to contribute; expanding the structural capacity of manufacturers, processing, setting and maintenance support for wind generator set-up; and wind policy support. The programme aims at catalyzing

commercialization of alternative renewable energy generation within the country.

The Wind Resources Assessment Programme is being enforced through the State Nodal Agencies, Field analysis Unit of Indian Institute of Tropical Meteorology (IITM-FRU) and Center for Wind Energy Technology (C-WET). Wind in India are manipulated with the robust south-west summer monsoon, that begins in the month of May-June, when cool, wet air moves towards the land and also the weaker north-east winter monsoon, that begins during the month of October, when cool, dry air moves towards the ocean. The wind flow is strong all over the Indian isthmus, except eastern costal isthmus during the month of March to August. Furthermore, wind flow is weak all over Indian isthmus except the Tamilnadu coastline during the month of November to March [8, 9]. Outstanding feature taken place in the Indian programme is wind power investors have shown their interest in planting commercial wind power plant all over the India. The wind power installed capacity is 21.164 GW as per the estimation in Indian atlas taken by (C-WET) still mid of 2014. The wind potential is calculated at 50 meter hub level of the wind turbine with respect to 2 % land allocated to wind plant. Moreover, at present the Indian market is installed with larger wind turbines at 80-100 meter hub level. Such development in hub level and technology made the wind potential higher value with the same land availability than that obtained with the 50 meter hub level with same land availability. The total commercial project installed till mid-2014 is estimated about 21264.06 MW [10-13].

Wind energy status in India: India's rapidly growing economy and population leads to relentlessly increasing electricity demand. The IEA predicts that by 2020, 327 GW of power generation capacity will be needed, which would simply an addition of 16 GW per year. This urgent need is reflected in the target the Indian government has set in its 11th Five Year Plan (2007–2012), which envisages an addition of 78.7 GW in this period, 50.5 GW of which is coal. Wind energy program was commenced in India by the end of the 6<sup>th</sup> five yearly plan during 1983-84 and in the last few years it has increased considerably. The main objective of the program was the commercialization of wind energy production, support research and development, provide help to wind projects and to create awareness among people. Under this program Ministry of Non Renewable Energy (MNRE) has done various modification regarding incentives, schemes and policies for wind energy. India is relatively new comer to the wind energy sector as compared to Denmark or USA.

Table 3: India's largest wind power facilities (10 MW and greater) (C-Wet)

Power plant	Owner	Location	Total capacity (MWe)	
			City	State
Vankusawade Wind Park	Suzlon Energy Ltd.	Satara Dist.	Maharashtra	259
Cape Comorim Aban	Lloyd Chiles Offshore Ltd.	Kanyakumari	Tamilnadu	33
Kayathar Subhash	Subhash Ltd.	Kayathar	Tamilnadu	30
Ramakalmedu	Subhash Ltd.	Ramakalmedu	Kerala	25
Muppandal Wind	Muppandal Wind Farm	Muppandal	Tamilnadu	22
Gujdimangalam	Gujdimangalam Wind Farm	Gujdimangalam	Tamilnadu	21
Puthlur	RCI Wescare (India) Ltd.	Puthlur	Andhra Pradesh	20
Lamda Danida	Danida India Ltd.	Lamda	Gujarat	15
Chennai Mohan	Mohan Breweries and Distilleries Ltd	Chennai	Tamilnadu	15
Jamgudrani MP	MP Windfarms Ltd.	Dewas	Madhya Pradesh	14
Jogmatti BSES	BSES Ltd.	Chitradurga Dist.	Karnataka	14
Perungudi Newam	Newam Power Company Ltd.	Perungudi	Tamilnadu	12
Kethanur Wind Farm	Kethanur Wind Farm	Kethanur	Tamilnadu	11
Hyderabad APSRTC	Andhra Pradesh State Rapid Transit Corp.	Hyderabad	Andhra Pradesh	10
Muppandal Madras	Madras Cements Ltd.	Muppandal	Tamilnadu	10
Poolavadi Chettinad	Chettinad Cement Corp. Ltd.	Poolavadi	Tamilnadu	10

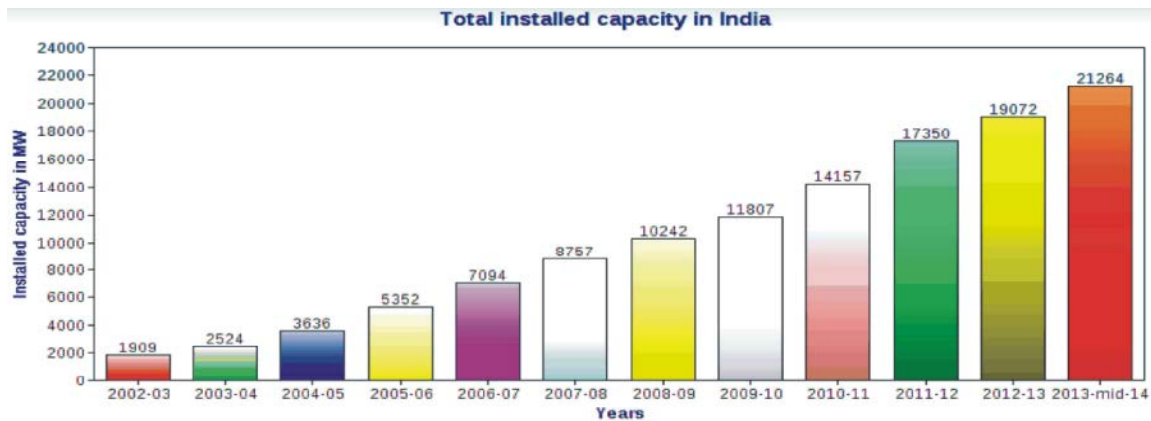


Fig. 1: Total installed capacity India till- June 2014

But Indian policy support for wind energy has led India and it ranked fifth with largest installed wind power capacity. The total installed power capacity was 21,264 MW till July, 2014. Now India is just behind USA, China, Germany and Spain [11]. Global installed wind power capacity shows India's better performance in wind energy sector shown in Table 3. The five main wind power countries are China, USA, Germany, Spain and India and they together represent a share of 73 percent of the global wind energy capacity.

As per MNRE, wind power accounts for the largest share of renewable power installed capacity i.e. 72 percent (2013), as compared to the other renewable sources. The total installed wind power capacity in India had reached 21.2 GW in July 2014 [7]. The total capacity added during financial year 2013- mid-2014 was around 2,192 MW.

India's cumulative installed capacity up to mid-2014 is shown in Figure 1. A rapid growth in wind power installation has been measured in southern and western states in India. A need for about 350- 360 GW of total energy generation capacity was reported by the Central Electricity Authority in its National Electricity Plan, by the year 2028. Only onshore wind potential has been utilised so far by India. In spite of the fact that India has long coast line over 7500 km, we have not yet tapped our offshore wind resource for energy generation. The Capacity Utilization Factor (CUF) of offshore wind turbines is much higher as compared to the onshore turbines because of the high offshore wind speed. Offshore Wind Steering Committee was established by MNRE in August 2012, which released a draft of the National Offshore Wind Energy Policy in May 2013 [14].

Steady market growth for wind in India: India is emerging as a major wind turbine-manufacturing hub today due to favourable policy framework, low manpower cost, raw material availability and vast market potential. Currently 18 existing manufacturers have a consolidated annual production capacity of over 10,000 MW. Some of the international companies with subsidiaries in India are sourcing over 80% of their components from Indian component manufacturers. Besides manufactures like Enercon, RRB, Suzlon and Leitmer Shiram, Win Wind has also set up a blade manufacturing facility in India [12,13]. The Indian manufacturers have ramped up their production capacity over a period of time. Besides meeting the domestic demand, some manufacturers have also started exporting turbines. The wind turbine manufactured in India has been exported to countries like Thailand, Turkey, Estonia, Netherlands, the UK and srilanka. According to estimates by WISE the annual wind turbine manufacturing capacity is likely to cross 22,000 MW by the end of 2014 if all manufacturers go ahead with their plans.

**Indian Wind Energy Policy:** In 1993, when the MNES issued guidelines for purchase of power from renewable energy sources by state utilities, it marked the beginning of initial policy support for renewable energy based power generation in India [15]. The most important development after this was the enactment of the Electricity act, 2003 with specific provision for promotion of renewable energy. However, the EA 2003 changed the legal and regulatory framework for the renewable energy sector in India. The significant provision of this Act are Section 61(h) which give power to state electricity regulatory commission for fixing prudential tariff for renewable energy projects so as to promote investment while Section 86(1) enables state commissions to create market for RE and co-generation projects by prescribing a minimum percentage of electricity to be procured from non conventional energy sources [16-18].

Regulatory and policy incentives for wind power: India, as part of its obligations to the United Nations climate convention (UNFCCC), released a National Action Plan on Climate Change (NAPCC) in June 2008 [18] that laid out the government's vision for a sustainable and clean energy future. The NAPCC stipulates that a dynamic minimum renewable purchase target of 5% (of total grid purchase) may be prescribed in 2011-2013 and this should increase by 1% each year for a period of 10 years [19]. That would mean that by 2020, India should be

procuring 15% of its power from renewable energy sources. Current policy and regulatory incentives for wind power development are listed as follows.

Generation based incentive: Initially implemented in June 2008 and then re-launched in December 2009 by the union government for grid connected wind power projects. A GBI of INR 0.50 per kWh (~1 US cent), with a cap of approximately \$29,000 per MW per year, totalling \$116,000 per MW over 10 years of a project's life was offered under this scheme [20]. The GBI scheme includes captive wind power projects, but excludes third party sale. The scheme is applicable for the projects commissioned on/after 27.12.2013. Eligibility criterion is that projects should not avail accelerated depreciation and should sell the electricity to grid at a tariff fixed by SERC/state govt. The scheme is modified and likely to be announced by MNRE.

## CONCLUSION

India's growing energy demand requires efficient energy management. In the coming years energy mix of the country is going to change. There is no doubt that renewable sources of energy would play critical role in ensuring energy security of the country. There is enormous potential to generate energy from renewable sources like solar and wind. The government of India has been very actively involved in promoting renewable energy. It has been observed that the size of wind turbine has increased and the cost of production has decreased. The future challenge is to bring down the cost further and make it more competitive. The wind turbine cost contributes 68–84% total cost. Hence, it is important to design, develop and market newer, technologically superior and more cost efficient wind turbines to reduce unit cost of wind power. It is high time for the government to develop a comprehensive renewable energy policy and design support schemes to send across positive signals to the wind power producers. These producers should be encouraged to invest in wind energy. No doubt, India has marked its presence all over the world in generation of wind energy. It has huge potential for producing wind energy too, but there are still some lacunas. Indian government has laid the foundation for a broad-based renewable energy program and designed it specially to meet the growing energy needs and to fulfil energy shortage. Despite all its efforts, India is unsettled by China and has now slipped to the fifth rank in its contribution to global wind energy production.

Analysis shows that the main factor behind China's lead is presence of a countywide renewable energy law. It may be concluded that India will have to improve in order to compete with China and become the leader in wind energy generation.

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