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Review Article

ANALYSIS AND WIND POWER STATUS IN INDIA-ITS PROSPEROUS AND FUTURE OUTLOOK

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ABSTRACT
One of the renewable sources in abundance is wind energy, by harnessing it, the reduction of carbon emission can be done by reducing our dependence on non-renewable energy sources. This paper discusses about the current situations globally and in India on the installations and productions of wind energy. By identifying the potential regions for wind turbine, the improvement and new technologies can provide sufficient amount of electricity from wind source which can reduce scarcity which has been growing with population increase. A state wise wind power development and policies and future scopes of each state is discussed. For India's future wind energy will play a potential part as one of the biggest renewable sources is wind power.

Keywords: *Wind Power Status in India, Prosperous, Future Outlook*

INTRODUCTION
The energy consumption of the world has grown exponentially over the past few years. Energy shortage due to depletion in energy resource is a major cause worldwide. Around 28 percentage of world total energy is consumed by India and China by the year of 2030 according to International Energy Agencies. To reduce the scarcity of the electrical energy consumed, renewable energy such as solar, wind and hydro is considered.

Wind power is renewable energy which converts the wind power to electrical through a mechanical system (wind turbine). The abundance of wind in world can generate the power needed for the consumption of the of the world population.

One of India's fastest growing sectors is renewable wind energy. India's potential wind energy generation is estimated to be 100,000 MW. About of 25GW has been cumulatively generated throughout India until 31 Jan 2016 for the financial year of 2015-16 (Ministry of New and Renewable Energy, 2016). Strong southwest summer monsoon during the May to June and the weaker wind from northeast winter monsoon are wind conditions influenced in India. During summer the cool humid air moves towards the land and during the winter the dry air moves towards the ocean. March to August periods have uniformly strong winds throughout the whole Indian Peninsula. Tamil Nadu coastlines are only areas during November to march have higher wind conditions, other areas a proven to low wind speed conditions (Purohit and Michaelowa, 2007).

Global Wind Energy
India's current installed capacity is 25.1GW as of end 2015 which is 4th position in global scale. In the global scale China, US, Germany and Spain tops, cumulatively globally 432 GW has been generated in as of December 2015. In past 15 years' growth of 50 times has achieved in the installation of wind turbines and generation throughout the world. In 2009, a new trend was started when more than half of global installation has started coming from outside of traditional European and North American market. This change was primarily driven by China, which installed 16,000 MW in 2013 and has leadership status with 145,104 MW wind energy installed capacity now. Nevertheless, the global wind energy market witnessed a 22 % fall in annualgeneration up to ten years (Biswal and Shukla, 2014). This policy of providing incentive linked to generation will attract huge investment from domestic independent power producer and foreign investor as this has created a level playing field between domestic investor and foreign investor.

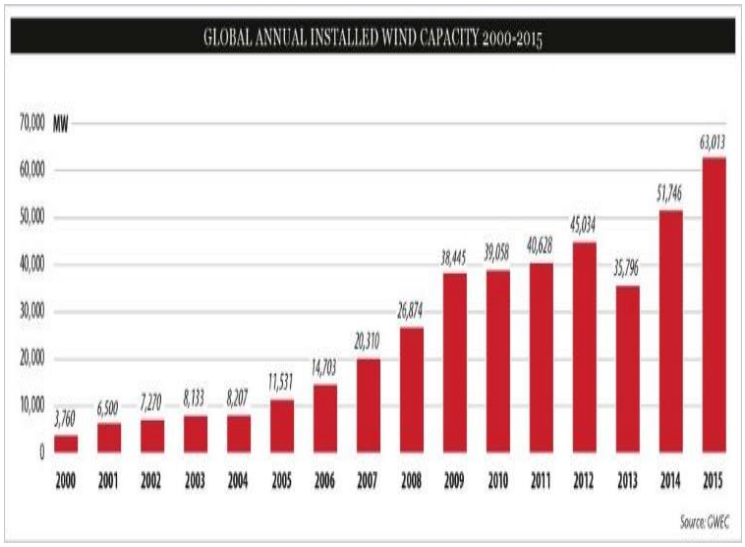
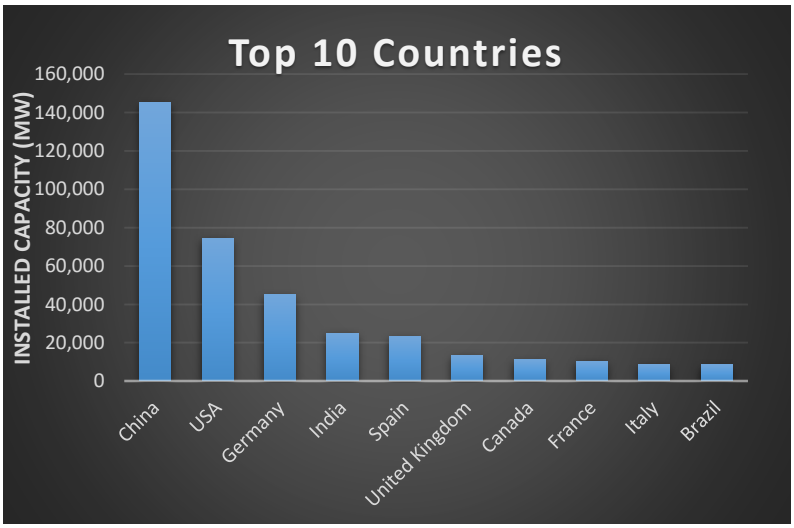


Figure 1: Global Annual Installed Wind Capacity from 2000 to 2015 (InWEA, 2007)

The contribution of china alone is 33.6% of the total world's wind energy. This has brought total global wind energy capacity to 432 GW. India with an installed capacity of 25.1 GW is in fourth place preceded by China (145 GW), U.S. (74.5 GW) and Germany (44.9 GW). In 2015 an addition of 63,013 MW has been installed globaly. Graph 1 presents the total installed capacity of top 10 countries as on end of 2015 (GWEC, 2016).



Graph 1: Top Ten Countries with Installed Capacity as of 2015

Wind Energy in India

India's electrical demands have constantly growing even though the modern energy service is only used by 60 percentage of population. The wind power estimated potential at 50 and 80-meter height cumulatively in India is 49GW and 102GW respectively according to calculations done by CWET. Other states estimated potential is shown in Table 1. It shows that Tamil Nadu, Gujarat and Karnataka have a high potential at 80 meters. The state wise sites identified for wind power development are highest in Tamil Nadu and Gujarat which have 47 and 40 sites respectively while with least sites eight and seven is Rajasthan and Madhya Pradesh respectively. Identified number of potential districts is highest in Tamil Nadu and Karnataka with each having 11 districts while Madhya Pradesh has the least number of districts

which are 5. Maharashtra with 128 has the highest number of wind monitoring stations established till now while Kerala has the least with 29 (Kasisomayajula, 2013), Tamil Nadu, Andhra Pradesh, Gujarat have 70, 78 and 69 stations respectively. Out of the established wind monitoring stations the highest number of stations operating are in Maharashtra has 20 followed by Andhra Pradesh which has 16. Rajasthan and Tamil Nadu have the least with 1 and 2 stations respectively. Installable wind potential is highest in Gujarat with 35071 MW followed by Tamil Nadu having 14152 MW while Kerala has the least with only 837 MW, rest of the potentials are showed in Table 1 with Maharashtra and Karnataka showing high potentials. Tamil Nadu presently has, the highest maximum installed capacity of 7394 MW while Kerala has the least 35.1 MW (InWEA, 2007). Out of high potential states, Tamil Nadu has already installed more than half of its estimated potential (Sangroya and Nayak, 2015).

Gujarat, Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu are having a large potential of wind energy. These states are having areas with good and consistent wind, suitable for commercial use of wind energy. India's wind energy capacity of 25,088 MW, mainly executed in Tamil Nadu (7394 MW), Maharashtra (4370 MW), Gujarat (3582 MW), Rajasthan (3053 MW) and Karnataka (2549 MW) as shown in Table 2. In total India has new installed capacity of 2,623 MW in the year 2015 (Gunjan *et al.*, 2015). The state governments of Tamil Nadu, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan, Haryana and West Bengal provide feed in tariff for purchasing wind energy.

Table 1: Estimated Potential of Wind Power Generation throughout India at 50m and 80m

No.	States / UTs	Estimated Potential (MW)	
		50 m	**80 m ***
1	Andaman & Nicobar	2	365
2	Andhra Pradesh	5394	14497
3	Arunachal Pradesh	201	236
4	Assam	53	112
5	Bihar	-	144
6	Chhattisgarh	23	314
7	Diu & Daman	-	4
8	Gujarat	10609	35071
9	Haryana	-	93
10	Himachal Pradesh	20	64
11	Jharkhand	-	91
12	Jammu & Kashmir	5311	5685
13	Karnataka	8591	13593
14	Kerala	790	837
15	Lakshadweep	16	16
16	Madhya Pradesh	920	2931
17	Maharashtra	5439	5961
18	Manipur	7	56
19	Meghalaya	44	82
20	Nagaland	3	16
21	Orissa	910	1384
22	Pondicherry	-	120
23	Rajasthan	5005	5050
24	Sikkim	98	98
25	Tamil Nadu	5374	14152
26	Uttarakhand	161	534
27	Uttar Pradesh	137	1260
28	West Bengal	22	22
Total		49130	102788

Feed in Tariff provides the minimum price at which wind energy based power must be sold to electricity distribution companies. This tariff is higher in comparison to the other conventional energy sources.

Future Scope

The main future scopes for the wind turbine are Repowering and installation of Offshore Wind turbines. These scopes increase the generation capability for the regions existing already and in regions to be explored mainly offshore which have high potential of energy generation.

Repowering

A productive opportunity is opened in wind power through repowering the wind turbine. The Repowering is replacing underperforming or old wind turbine which has a low generation capacity with most modern turbines which can capture the wind energy to its maximum. This optimisation can offer better returns and more power than the old wind turbines. Class I and II are the locations of the smaller capacity wind turbines which provide low capacity, these type of turbines where installed during 1990s. Most of the turbines have severed its life span and this can be repowered (Datta, 2015). Therefore, this First generation turbines which had small capacity is replaced with potential for repowering in India. The amount of power being tapped and untapped in presented in Figure 3. It can be seen from the Figure 3 that Andhra Pradesh and Gujarat still have high potential of wind energy to be tapped.

Table 2: Installed Capacity of the Top States in India up until 2015 March

States	Mar-09	Mar-10	Mar-11	Mar-12	Mar-13	Mar-14	Mar-15
Tamil Nadu	4304.5	4907	5904.4	6987.6	7162.18	7275.68	7394
Karnataka	1327.4	1473	1730	1933.5	2135.15	2323.85	2549
Maharashtra	1938.9	2078	2310.8	2733.3	3021.85	4064.95	4370
Rajasthan	738.4	1088	1524.8	2070.7	2684.65	2783.45	3053
Andhra Pradesh	122.5	236	200.2	245.5	447.65	783.35	913
Madhya Pradesh	212.8	229	275.5	376.4	386	423.4	568
Kerala	27	28	32.8	35.1	35.1	35.1	35
Gujarat	1566.5	1864	2175.5	2966.3	3174.58	3447.28	3582
Other's	1.1	4	0	3.2	4.3	4.3	2.4

Advanced higher capacity wind turbines to increase capacity that's been installed and to increase the electricity output. This replacement also decreases the infrastructure requirement is known as the Repowering if Wind Turbine.

Several studies done in India shows that 25% of the turbines are rated below 500 kW as these turbines where installed in mid-eighties. The turbines in mid-eighties where having the capacity range from 55 to 400kW, within heights of 30 to 40m tall turbines. The new turbines have greater capacities from 1.5 MW to 3 or greater megawatts, within heights of 80m t0 120m. Thus, the areas with low capacity installed require repowering for the maximum power generation for the existing sites. A fraction of those machines which were installed till 1997 will amount to 686 MWs with 2663 turbines. After 1997 the additional numbers of WTGs

Offshore wind generation is very effective method of generation of wind energy compared to on land production. Offshore wind turbines are constructed near water

Small Wind Farm

Wind turbines vary in size are collected together, Wind farms in US generated 74.5 GW in electricity. This generated power is transmitted to the central transformer via cables that are buried in the road

network then from there it flows to the regional grid power. In India there approximately 100 million small farmers holding varies size of lands. According to the wind resources availability there is possibility of placing wind turbines in the small farms for small industries those who consumes less than 10kW of power. If small wind turbines are promoted in India, millions of people can use the wind energy for their own use. This can avoid the scarcity of power shortage. As we just began to tap into the wind resource of the potential wind energy of the world of 3600TW which is 200 times more than worldwide consumption.

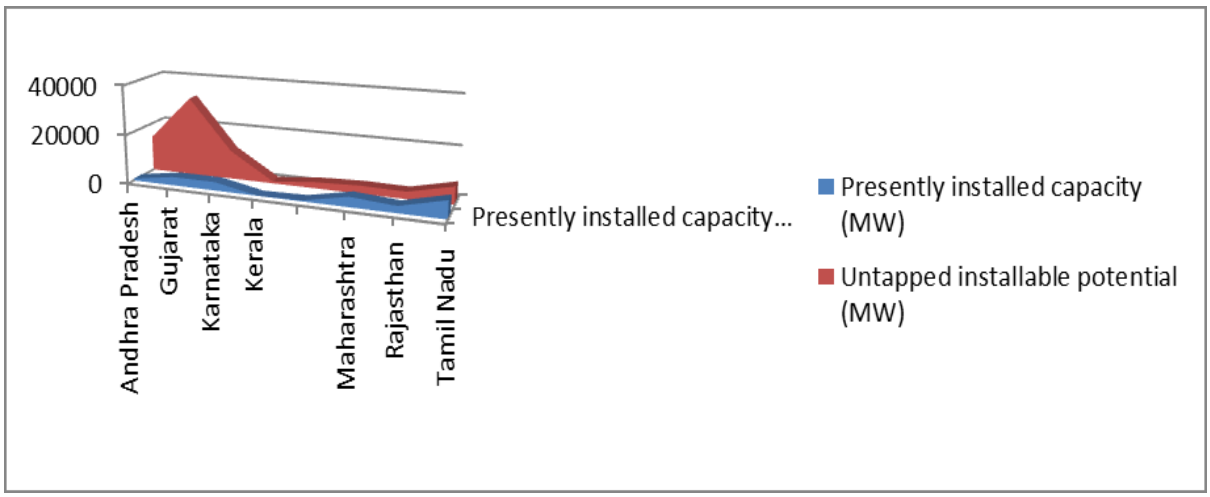


Figure 2: The Amount of Energy Installed Vs Energy not Installed

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Potential Wind Turbine Locations

Other possibilities of wind power generation are the use of wind from highways and in between railway tracks. The wind emitted from the high speed transportations can be captured and used for small purposes such as, highways during night time can provide light in hard to reach places for transmission lines.

Prospect Installation

India plans to install, through advancement in technology and research India is expected to install 60 GW by the year 2022, the year based plan is shown in Figure 5 (Kapoor, 2015). Global wind energy council estimated that by 2030 wind energy can supply up to 24% of India's power needs, while bringing additional investment of $10637.12 million investment every year.

Buy Back Policies

Most of the states have their own policies which favours wind energy development of that state. Table 3 compares between the different policies showing how state wise they vary.

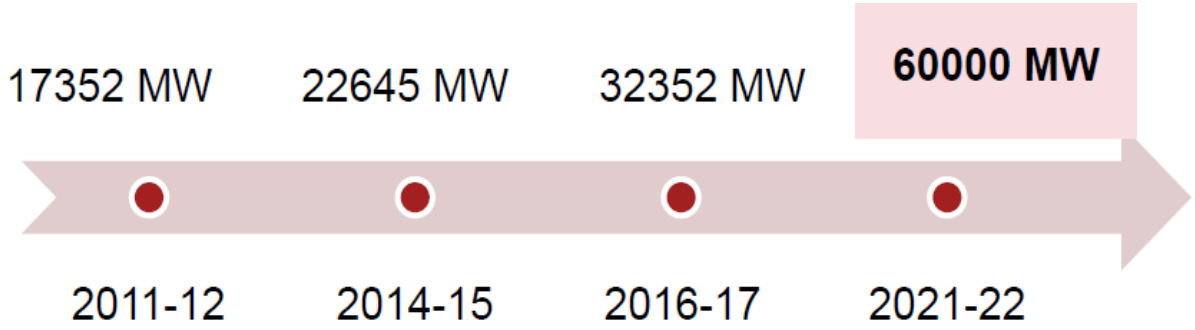

Figure 3: Installation Project up-to 2022

Table 3: Different State Government Policies in India

State	Wheeling	Banking	Buy-Back	Third Part Sales	Capital Subsidy	Other Incentives
Andhara Pradesh	5 % of energy wheeled	Not allowed	Rs. 3.50//KWh w.e.f. 09.09.2008 (frozen for 10 years)	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs	Industrial Status	Reactive Power: 10 p/KVARh upto 10% & 25 p/ KVARh above 10%.
Tamil Nadu	5% of Energy	5% (12 months financia	Rs. 3.39/ / KWh (No Escalation)	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs	Nil	Reactive Power: 25 p /KVARh upto 10% & 50 p / KVARh above 10%.
Karnataka	5% of Energy	Allowed @ 2% of energ	Rs. 3.40/ / KWh without any escalation for 10 years of commercial o/ation	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs	No Electricity Duty or 5 Years	Reactive Power: 40 p / KVARh
Kerala	To be decided by SERC	To be decided by SERC	Rs. 3.14/ KWh for 20 years	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs		
West Bengal	7.5% of energy fed of grid		Rs. 4/ KWh	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs		Reactive Power: 20 p /KVARh
Gujarat	4% of energy	Settlement to be done month to month & surplus energy at end of month & surplus energy at end of month shall be deemed as sold to Utility as / Tariff Rate.	Rs. 3.50/KWh for 20 years	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs	Electricity duty exempted	Reactive power < 10% energy wxempted, then 10 p/ KVARh. Reactive Power > 10% of energy expoeted, then 20 p/ KVARh
Madhya Pradesh	2% of Energy	Allowed, but proposal f	Year wise rates (Rs./kWh) from 1st to 20th year 1styr- 4.03 2nd yr - 3.86 3rd yr- 3. 69 4th yr- 3.52 5th yr - To 20th yr - 3.36	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs	No Electricity Duty for 5 years	Reactive Power: 27p/KVARh
Maharashtra	2% of Energy + 5% as T&D Loss	12 Months	Rs. 3.50/KWh (first year of commissioning) (Escalation of 15 p / year for 13 years)	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs	Power evacuation arrangement, Approach Road, Electricity Duty, Loan to Cooperative Societies	Reactive Power: 25 p/KVARh
Rajasthan	50% of normal charge as applicable for 33 KV, in addition to the transmission charges of 3.6% 8 surcharge	Six Months (Apr. to Sept. 8 Oct. to March. Utilization of banking energy not /mitted in Dec. to Feb.)	Rs. 4.2S/ KWh for Jaisalmer, Barmer 8 Jodhpur. Rs. 4.50/KWh for all other districts	Allowed under Electricity Act 2003 subject to regulation framed by respective SERs	Exemption from Electricity Duty @50% for 7 years	Reactive Power 5.75 p/KVArh with escalation of 0.25 p/year

Recommendation to Indian Government

Government has been support for renewable energy as central government policies have allowed many companies to set up Wind farms in India. Even though government supports companies, most companies find it difficult to thrive due to issues in grid and policies that are been held in by states. The recommendation most of the wind energy companies suggest is some favourable policies that gives both the company and government to expand.

Therefore, more installation of wind turbines in potential area can be connected to increase electric generation throughout India.

CONCLUSION

Unlimited potential is there in India, by utilising this through repowering and new ways the demand for the non-renewable can be reduced. The future development of the wind turbines depends on the government policies and the cost of setting up the wind turbines in the regions. Research and development centre has to be set up for further enhancement of the wind power extraction. India is on the

increasing wind production compared globally, this has to be maintained to achieve the targeted energy potential.

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