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India's Potential in Wind Energy

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Abstract – Wind Energy in India finishes at the top in terms of installation capacity as well as energy generation. The total installation capacity of renewable energy in India which is 78 GW, wind energy contributes up to 38 GW as on March 2019. Considering the onshore wind installation capacity, it is estimated as 300 GW at 100 m hub height. In recent years, it has been observed that the onshore wind energy is adversely affected due to land acquiring issues. When we consider this important factor regarding land issues, offshore wind energy is the best option as India is having a large coastline of about 7600 km with shallow waters which is perfect to harness offshore wind energy. Considering this objective, the national offshore wind energy sector in India has been notified to provide a legal framework for development of offshore wind energy in India. Most of the people are unaware of the importance of wind energy in India as well as its future potential. This paper gives a detail information regarding the future potential of wind energy in India as well as its policy framework which will certainly help to educate people about its vitality and the future scope of wind energy in India.

Key Words: renewable energy, policy framework, onshore and offshore wind energy.

1. INTRODUCTION

Energy demand plays a crucial role in the economy of a country. The energy demand in India has been increasing rapidly to an average of 6.4% from 1990 to 2010, thanks to the significant economic growth experienced in this period. As a consequence of this drastic increase in energy demand, the conventional sources of energy are depleting at a rapid rate than expected. Energy generated through fossil fuels such as coal causes different environmental issues such as pollution which is leading to global warming as well as harmful diseases like skin cancer, lung cancer etc. Use of renewable energy will certainly result in less emissions to harmful greenhouse gases which are responsible for pollution and other health related problems. Also, the use of renewable energy will reduce the dependency on import of fossil fuels and help India to become independent in terms of energy.

Wind energy which comes under the category of renewable energy is one of the promising sources of energy which has its own advantages of being eco-friendly. "Wind energy" the term itself tells us the energy which is generated with the help of winds. Wind energy is non-polluting and inexhaustible form of energy. India being the first country to have ministry in the field of renewable energy has huge potential in wind energy. This fact is certainly clear from the rapid increase in cumulative global capacity, reaching 539 GW at the end of 2017 representing 10.7% of cumulative market growth.

Ministry of New and Renewable Energy in India ensures to provide all the necessary policy as well as support in order to develop India's potential in renewable sector. The MNRE has set up different work stations in each state to monitor the potential of wind energy as well as how it can be improved. This research paper depicts wind energy development in India as well as its policies and regulatory framework.

2. Objectives

- To study Wind energy potential of India
- To study onshore and offshore Wind energy with its advantages and disadvantages
- To compare installed capacity of wind energy with cumulative installed capacity
- To predict future potential of wind energy using forecast analysis
- To study India's offshore and onshore wind policy

3. India's Current wind energy status

When we consider the global rankings in wind energy production, India holds 4th position after China, United States of America and Germany. To monitor India's growth in wind energy, MNRE (Ministry of New and Renewable Energy) has setup NIWE (National Institute of Wind Energy). NIWE is a perfect organization which conducts different programs on assessing the wind data through its Research and development department. Total installed capacity of wind power in India is 34.4 GW. Out of the total electricity which is produced through renewable energy, 55% of it is produced by wind energy.

With the help of data which was obtained from MNRE, following graph was plotted which shows state wise distribution of installed wind power:

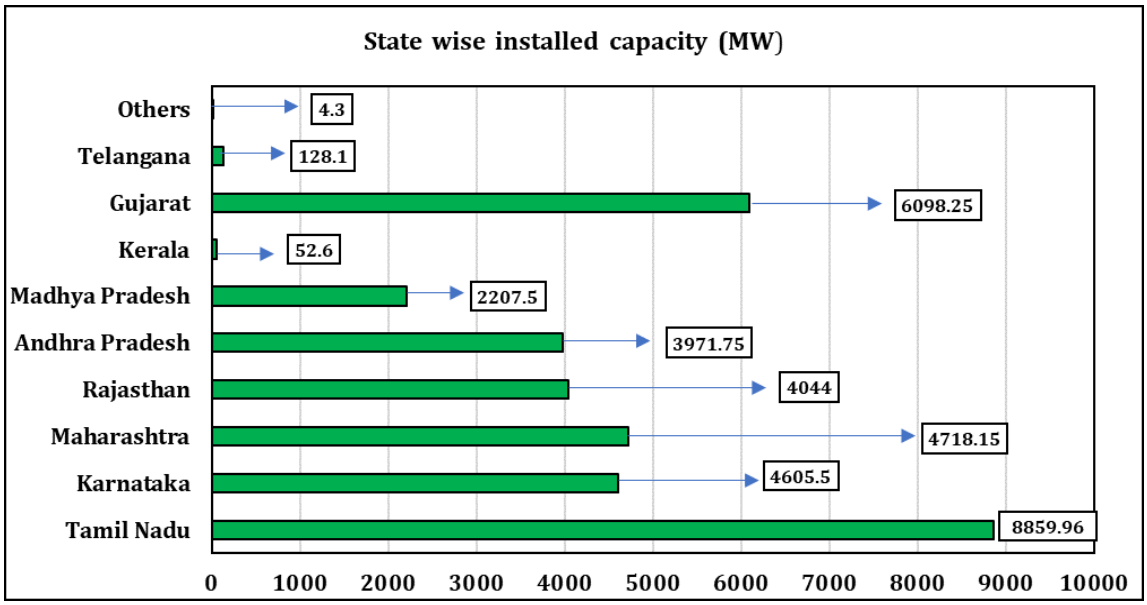

Fig No.1. State wise installed capacity of wind energy up to 2019 [7]

During 2016–17, MNRE had taken various policy initiatives in wind energy sector that include policies like introduction of bidding in wind deployment of wind energy utilization in the country to fulfil the country's electricity demand. To achieve the target electricity demand of the country the government has launched various programs to support the growth of renewable energy such as wind, solar etc. [10]

Based on data obtained for almost past 20 years from MNRE, year wise comparison was made between installed wind capacity and cumulative wind capacity, following table shows the data for wind capacity (installed and cumulative) in megawatts.

Table No.1. Year wise cumulative and installed wind energy capacity in India [7]

Year	Installed capacity (megawatt)	Cumulative (megawatt)
Up to 2002	1666.8	1666.8
2002-03	242	1908.8
2003-04	615.2	2524
2004-05	1111.7	3635.7
2005-06	1716.17	5351.9
2006-07	1742.05	7094
2007-08	1663.32	8757.3
2008-09	1484.9	10242.2
2009-10	1564.6	11806.8
2010-11	2349.2	14156
2011-12	3196.7	17352.7

2012-13	1698.7	19053.1
2013-14	2089.9	21132.5
2014-15	2297.9	23465.7
2015-16	3423.05	26777.39
2016-17	5502.37	32279.76
2017-18	1865.24	34145
2018-19	1480.97	35527.43

Based on the above table following graph was plotted which showed actual comparison between installed and cumulative wind energy capacity.

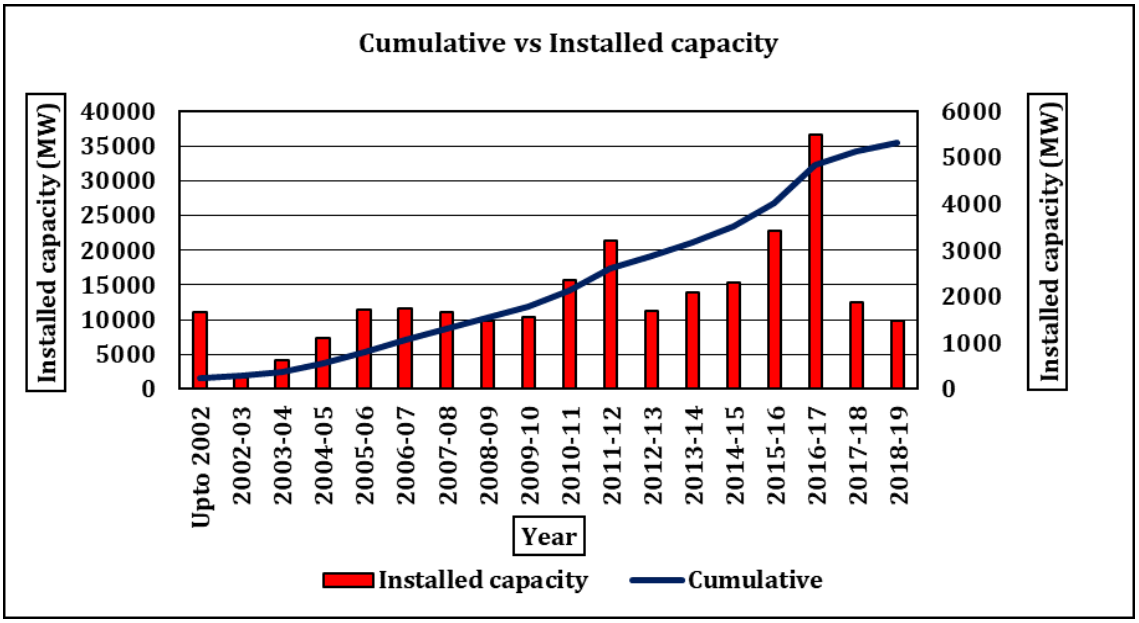

Fig No.2. Cumulative vs Installed wind capacity in India

4. Types of Wind Energy

According to the location of installation, wind turbines are classified into two categories namely: -

A. Offshore Wind Energy

Off Shore – Offshore wind turbines are situated on large water bodies where there is an almost constant source of wind energy supply. They are mostly installed over deep ocean farms or sea beds.

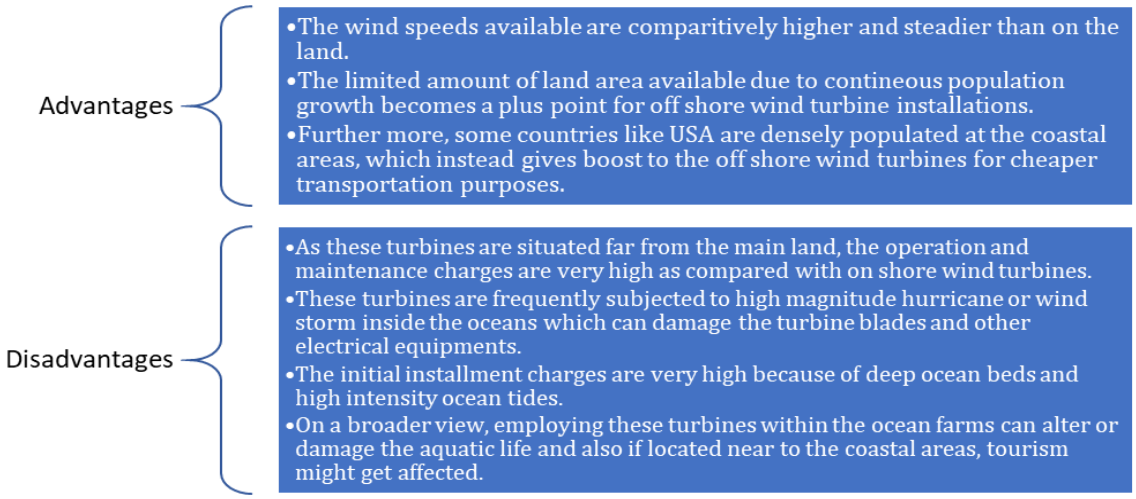

Fig No.3. Advantages and Disadvantages of Offshore Wind Energy

B. Onshore Wind Energy

Onshore – Onshore wind turbines are located on the landmass where the wind energy supply is adequate according to the respective requirements. They can be installed on mountains, along coastal areas or in the household backyards.

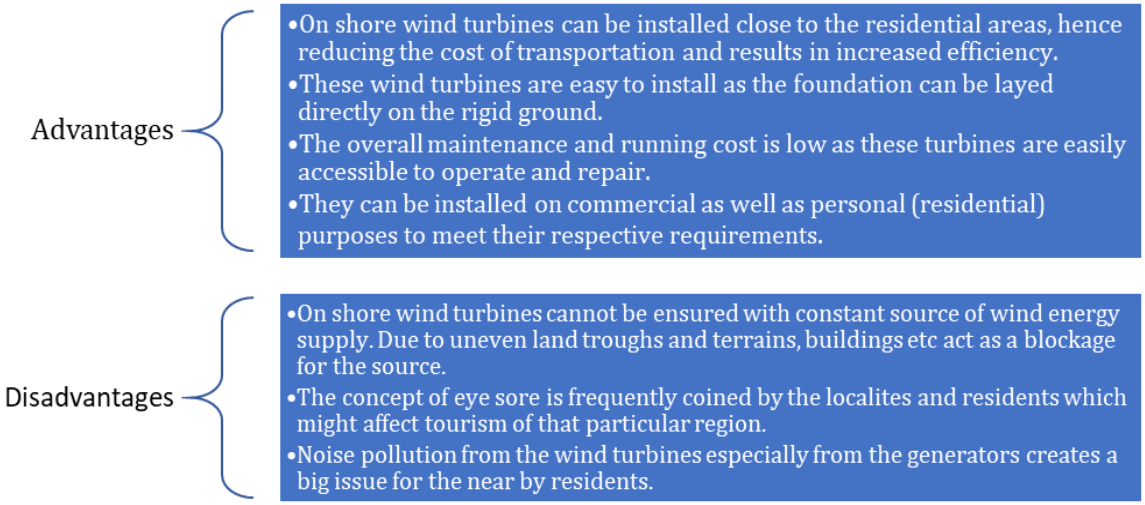

Fig No.4. Advantages and Disadvantages of Onshore Wind Energy

5. India's Wind Energy Policies

Indian government has always been encouraging for sustainable energy supply for which renewable energies are being specifically brought into attention in the Indian subcontinent. Considering wind energy and its installation, government has come up with two policies viz

A. Onshore Wind Energy policy
B. Offshore Wind Energy policy

These two policies hold different and distinct level of importance for the entire country. They are equipped with different visions, objectives and method of installation which will be discussed in detail as we proceed our study

5.1. Onshore Wind Energy Policy

Since 1995, India has been accelerating on development of wind energy sector for which the total installed capacity as of 2016 is about 28 GW. This has awarded India with 4th position globally in terms of wind power installed capacity. But because, wind energy having intermittent nature has imposed ample of problems for grid integration

Following are some of the site selection criteria for wind farm installation: -

a. Permission for Land: - The project developer should ensure that all the legal matters regarding land possession are finalized and secured from the future growth point of view.
b. Wind source availability: - Before commencing the project, the site in-charge has to make sure the availability of the wind energy source according the capacity being installed. Along with this, the quality of the data being assessed should be accurate to estimate the project viability, potential and design life of the wind turbines
c. Environment acceptability: - The site which is being selected, if it is imposing any kind of barrier for civil aviation department or falls under the vicinity of migratory birds, then the project developer has to carry necessary clearances and permits from the respective authorities to avoid any future discrepancies.

5.2. Offshore Wind Energy Policy

With the announcement of Government's National Action Plan on Climate Change (NAPCC), Government of India is constantly uplifting the proposed projects and research areas put forward by the states as well as private firms. Removing barriers and imparting newer and latest technology for the implementation of offshore wind energy stands strong among other ongoing conventional energy projects

Objectives: -

- To boost the investments for the offshore wind energy sectors.
- Exploring Off shore wind energy farms in the Exclusive Economic Zone (EEZ) considering private and public partnerships
- To meet the energy requirements and curb carbon emissions.
- To cultivate skilled manpower and ensure employability in the offshore wind energy sector
- To create coastal infrastructure and establish a full loaded supply chain management system for heavy construction, fabrication, operation and maintenance work activities

6. India's future potential in Wind energy: -

Wind energy is completely based on the potential of selected site, therefore throughout analysis is essential before selection of any site. The Government of India has set up around 800 wind monitoring stations all over the country through National Institute of Wind Energy (NIWE). It has also issued wind potential maps at 50m, 80m and 100m above ground level.

With the help of data obtained from National Institute of Wind Energy (NIWE) following bar graph was plotted which shows that maximum wind potential exits in seven Windy states as given below: -

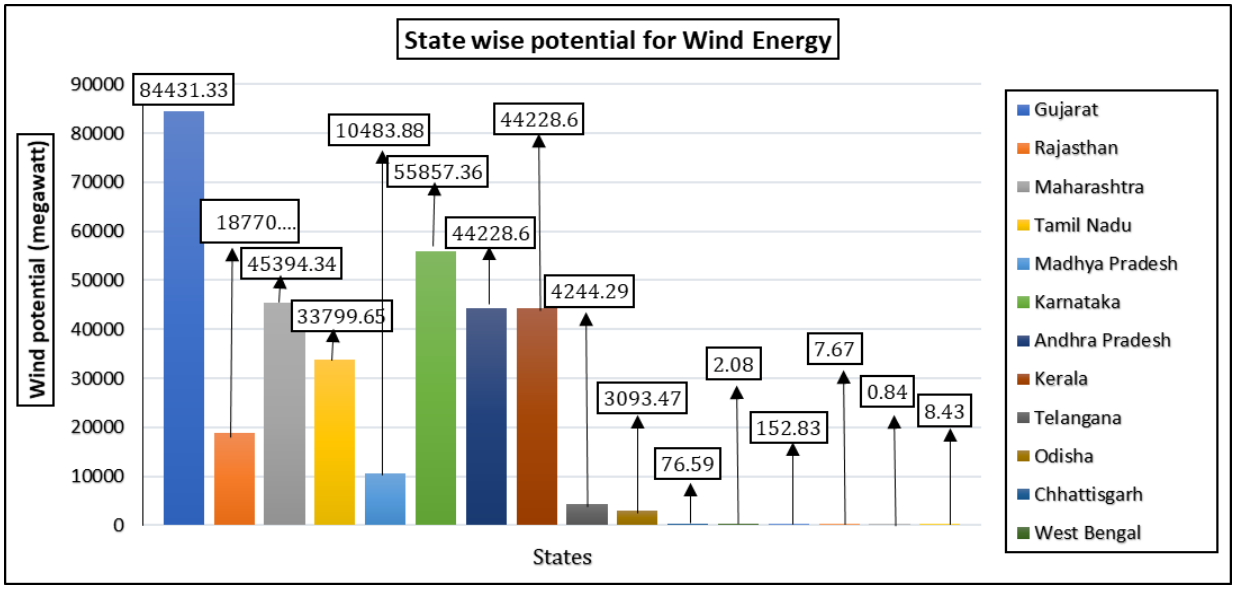

Fig No.5. State wise potential for wind energy [8]

6.1. Forecast Analysis for future potential of Wind Energy

Based on data obtained from MNRE up-to year 2019 following line graph was plotted [7]: -

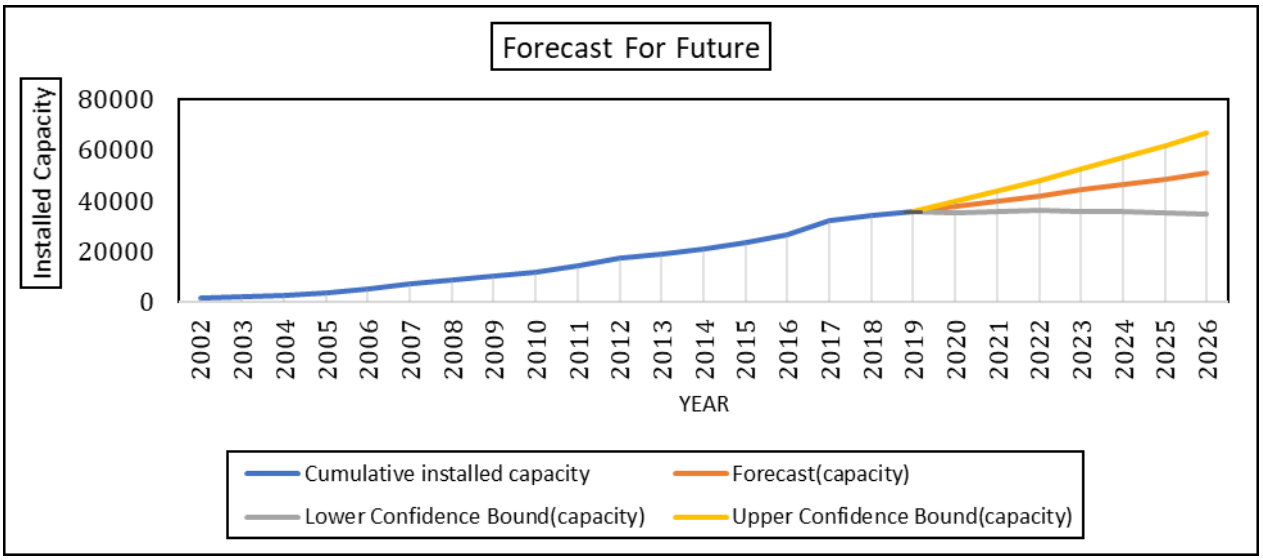

Fig No.6. Forecast analysis for wind Energy in India

The line graph above provides the data for installed and forecasted capacity (in MW) of wind energy in India. Starting from 2002 where the installed capacity was just 1666.8 MW has experienced a positive slope and reached 35527.43 MW in 2019. As we can see that after 2019 the line graph has been dissected into 3 parts viz. Upper bound confidence, Lower bound confidence and the forecast. The nature of forecast line shows similar growth rate as of installed capacity line and if continued to do so then India will be having around 42110 MW by 2022 and 50000 MW by 2026. Additionally, if wind energy started to gain more attention, then these figures might reach high up to 70000 MW by 2026, which could be great contributor to energy sector of India.

Based on above line graph following table was obtained which shows future potential of wind energy in India for next 5 years i.e., up to 2026

Table No.2. Forecast capacity in megawatt for next 5 years

Year	Cumulative installed capacity (MW)	Forecast (capacity in MW)	Lower Confidence Bound (capacity in MW)	Upper Confidence Bound (capacity in MW)
2002	1666.8	-	-	-
2003	1908.8	-	-	-
2004	2524	-	-	-
2005	3635.7	-	-	-
2006	5351.9	-	-	-
2007	7094	-	-	-
2008	8757.3	-	-	-
2009	10242.2	-	-	-
2010	11806.8	-	-	-
2011	14156	-	-	-
2012	17352.7	-	-	-
2013	19053.1	-	-	-
2014	21132.5	-	-	-
2015	23465.7	-	-	-

2016	26777.39	-	-	-
2017	32279.76	-	-	-
2018	34145	-	-	-
2019	35527.43	35527.43	35527.43	35527.43
2020	-	37723.11184	35461.76	39984.46
2021	-	39915.54209	35844.48	43986.60
2022	-	42107.97234	36029.60	48186.34
2023	-	44300.4026	36007.06	52593.74
2024	-	46492.83285	35786.82	57198.85
2025	-	48685.2631	35380.71	61989.82
2026	-	50877.69335	34799.65	66955.73

7. Conclusion

Wind Energy in India definitely has positive effects on economy as well as from the environmental point of view. India has the ability to emerge as the leading in terms of installed wind capacity as the nature has provided abundant resources of wind energy. Indian government is taking utmost efforts to meet the energy demands of the country through different renewable energy programmes. India has indeed vast potential in Wind energy for which an additional attention is required for better growth.

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