A Review of Wind Energy Development

[1.]Viraj Kashikar
Assistant Professor
Department of Civil Engineering,
D.Y.Patil College of Engineering,
Akurdi

[2.]Pushpalal Patil
Department of Civil Engineering,
D. Y. Patil College of Engineering,
Akurdi

[3.]Rushikesh Lodhe
Department of Civil Engineering,
D. Y. Patil College of Engineering,
Akurdi

[4.]Bhushan Patil
Department of Civil Engineering,
D. Y. Patil College of Engineering,
Akurdi

[5.]Suraj Pimpalkar
Department of Civil Engineering,
D. Y. Patil College of Engineering,
Akurdi

***Abstract* - Energy is vital for the country's economic growth and improving the life standard of its citizen. India has spent lots of resources on increasing its energy capacity after independence. As a result, country's generation capacity has increased considerably. Everyone is aware of the danger caused by conventional energy generation on environment. Therefore India has been planning development of renewable energy generation through solar energy, hydro-electric energy and wind energy sources which are ecofriendly. Although energy generation through coal and natural gas is the dominant source of energy in the country, renewable energy has got special attention. Wind energy is the fastest growing renewable energy sector in India and is ranked 4th among the countries producing wind power. This paper has made an honest attempt to put a simple overview of wind energy development in the world and in India since late 20th century to present time. It also reviews the output of some research made across the world in various aspects of this sector. After reading this paper, one can have the idea of present day scenario of wind energy development programme.**

Keywords – Wind energy, WPD(wind power density), wind farm, MNRE

I. INTRODUCTION

The importance of electricity in modern world cannot be overemphasized. The quantum of electricity generated in a country has an important bearing on the industrial growth and also on the quality of life. Major electricity producing sources are coal and oil which have limited reserve for long term consumption. Apart from that these fuels produce atmospheric pollution due to emission of greenhouse gases and other pollutants. Efforts are being made globally to mitigate this problem and to concentrate more on producing energy through renewable sources. Wind energy is now generally considered as a commercially viable option to increase energy generation as well as reduce the atmospheric pollution and global warming. In last two decades the technology has developed well and the energy converting systems now operate with reliability in a cost effective manner.

II. WIND POWER GENERATION WORLD WIDE

The overall capacity of all wind turbines installed worldwide by the end of 2017 reached 539291 MW (Megawatt), according to preliminary statistics published by WWEA (World Wind Energy Association). 52552 MW were added in the year 2017, slightly more than in 2016 when 51402 MW went online. This is the third largest number ever
installed within one year, after the record years 2015 and 2014. However, the annual growth rate of only 10,8 % is the lowest growth ever since the industrial deployment of wind turbines started end of the 20th century.

All wind turbines installed by end of 2017 can cover more than 5% of the global electricity demand. For many countries, wind power has become a pillar in their strategies to phase out fossil and nuclear energy. In 2017, Denmark set a new world record with 43% of its power coming from wind. An increasing number of countries have reached a double-digit wind power share, including Germany, Ireland, Portugal, Spain, Sweden or Uruguay. The by far largest wind power market China installed an additional capacity of 19 GW(Gigawatt), slightly less than in 2016, and continues its undisputed position as the world's wind power leader, with a cumulated wind capacity of 188 GW. Together with an amazing deployment in solar power, the country is now well on its way of making renewable energy its main energy source.

Out of the leading markets, the US (6.8 GW added, reaching 89 GW in total), Germany (6.1 GW new, overall 56 GW), India (4.6 GW added, 32,9 GW total capacity) United Kingdom (3.3 GW new, 17.9 GW total), Brazil (2 GW new, 12.8 GW total) and France (1.7 GW new, 13.8 GW total) saw all very strong growth, very close to new record.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 12, December-2018

III. INDIAN WIND ENERGY PROGRAMME

The oil shock of the late 1970s had prompted energy planners all over the world to look for alternative sources of energy . The sudden increase in the price of oil had affected the balance of payment situation adversely. Hence, Indian government started to concentrate on renewable energy with the missionary work of becoming self-sufficient in energy. In 1981, Indian government had instituted the Commission for Additional Sources of Energy (CASE) with the purpose of formulation and implementation of policies for development of new and renewable energy and increasing R&D activities in the sector for technical progress. In 1982, a new department, Department of Non-Conventional Energy (DNES) was created in the then Ministry of Energy and given the responsibility of taking care of CASE. In 1992, this DNES was transformed into the separate ministry, Ministry of Non-Conventional Energy Sources (MNES) and became world's first ministry dedicated to renewable energy. This ministry has been re-named to Ministry of New and Renewable Energy (MNRE) in October 2006.

India is now fourth among the several countries that produce more electricity from wind power. In India, the Ministry of New and Renewable Energy (MNRE) and the Indian Renewable Energy Development Agency (IREDA) work in coordination with the state government's wind energy department. Each state has its own wind energy department as in Maharashtra (MEDA). IREDA deals with identification of wind potential sites, wind resource assessment, setting up government policy, financing/profitability, availability of equipment, service, perception of investors, constraints/barriers and suggestions, and so on. IREDA has set up Anemometry Masts (AM) all over India to measure wind power density (WPD). AMs have recorded the qualifying criteria of WPD in the country, being above 200 W/m^2 at a height of 50 meters and at an 80-meter height above ground level, and the number of stations along with the potential power capacity and achievement up to 2014.

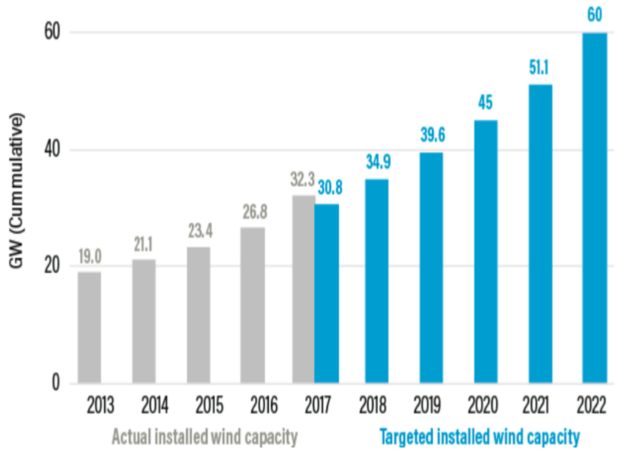

Fig-Year wise actual installed and targeted installed capacity (source – India's MNRE report 2017)

IV. WIND RESOURCE ASSESSMENT

Wind resource expressed in terms of annual average power per unit area which is known as wind power density (WPD). The primary requirement for successful implementation of wind power development programme rest on proper assessment of these natural resources. MNRE(Ministry of new and renewal energy) government of India is carrying out nationwide wind resource assessment programme under which wind mast with measuring instrument are installed at selected places and data are collected for 1 to 5 year period to assess wind resource for commercial exploitation. So far 598 wind monitoring stations are installed in India, out of which 225 stations have recorded wind data which meets qualifying benchmark of 200 W/m^2 WPD at 50m height.

Power available in the wind is defined by relation:

$P = 0.5dAV^3$

where P = wind power

d = air density

A = area intercepted

V = wind speed

& $P/A = 0.5dV^3$ = WPD (Wind Power Density)

Wind electric generator converts kinetic energy in wind to electric energy by using rotor gear box and generator and they are highly sophisticated machines based on aerodynamics principles and electronic control systems.

V. SITE DETAILS

For developing a wind farm project at a proposed site, proper study of site is required in a systematic manner. After this study with wind resource assessment, the other operations are proceeded. Therefore it is very much important to get the genuine site details. The following site study carried at Bardari village wind farm project in Ahemednagar district of Maharashtra serves a good example of it.

A. Location

The proposed site of wind farm is located around 17 km North East of Ahmednagar town on a hilly area near village Bardari under Taluka Nagar of Dist. Ahmednagar in Maharashtra state. The site can be approached from Ahmednagar through NH 22 by going towards Shegaon around 14 km in West direction and taking a diversion near village Lamanwadi towards North direction to village Bardari and going around 3 km. The latitude and longitude of the site are 19^{0}05'08" to 19^{0}05'49" North & 74^{0}49'42" to 74^{0}50'51" East for Hill respectively.

B. *Ambient conditions*

Ambient conditions available for Ahmednagar which is the nearest town for proposed sites are given below :

Maximum mean monthly temperature : 42.7^{0}C

Minimum mean monthly temperature : 7.8^{0}C

Average annual rainfall : 583 mm

Salinity : Non-Saline

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 12, December-2018

C. *Wind Resource*

The wind farm site is on a private agricultural land. The total area of the land is around 56 Ha spreading over four plots (Guts). Whole land comes under village Bardari. The site is having a hilly terrain. The altitude of the site is between 845 m to 890 m for hill above MSL. The site is having West-East orientation. The site is almost free from plantation. The nearest wind monitoring mast location to the proposed site is Khandke at an aerial distance of around 6 km from the site. This wind monitoring station is included in list of potential sites declared by MEDA and MNRE for establishment of wind power projects. Already there is large size wind power project near Khandke established by wind turbine manufacturer and developer Enercon, aggregating over 95 MW of installed capacity.

VI. LITERATURE REVIEW

The literature review pertaining to survey of wind power development in world and literature related to pure experimental aspects of wind turbine with various methods are presented below.

R. Thresher & M. Robinson[1] stated that power production from wind technology has evolved very rapidly over the past decade. Capital costs have plummeted, reliability has improved, and efficiency has dramatically increased, resulting in robust commercial market product that is competitive with conventional power generation. Complete wind generation plants are now being engineered to seamlessly interconnect with the grid infrastructure to provide utilities with a dependable energy supply, free of the risks of future fuel price escalation inherent in conventional generation. No single component improvement in cost or efficiency can achieve significant cost reductions or dramatically improved performance.

E. Wendell Hewson[2] made investigation into the amount of available power wind energy. There is vast energy available in the Earth's winds for man's use. Heat is conservatively estimated that wind power available for man is equivalent to output of thousand typical fossil fuelled or nuclear power plants of thousand MW capacities. By contrast, water power potential of Earth is only one tenth as large. Large wind generator have been built and used during the past 30 years.

K. Suresh Babu[3] studied material selection technique for typical wind turbine blades using Multiple Attribute Decision Making (MADM) approach & analysis of blades. The efficiency of wind turbine depends upon material of blade, shape of the blade and angle of blade. So, the material of turbine blade plays vital role in wind turbine.

Linda Guittet[4] explored the possibility in extracting energy from the sea. Even if vertical axis turbine isn't concept commonly used for the extraction of wind energy, this concept needs to be examined in the case of extraction in water. One important point is that exploitation conditions and the structural forces applied to the turbine are different in water and in air.

In order to compensate some of the fluctuations introduced in the network by the large wind power penetration, one of the smart grid features, the electrical vehicles (EV), can be used. Zhe Chen's[5] research work shows that in power systems with a high wind power penetration, many hours with surplus of electrical power production might be expected. This energy could be consumed locally through demand side management of local consumers, especially the electrical vehicles, since the EV batteries could also discharge to the grid on request when the grid is in lack of power.

The work commissioned by the Carbon Trust Society[6] in UK as part of research described a methodology for estimating the mean wind speed at turbine hub height for a number of different environments (urban, suburban and rural). This methodology used to generate grids of wind speed data for the UK and demonstrated how these data can be combined with turbine power curves and population data to obtain an estimate of the total small-scale wind energy resource.

The article published by Erika Rinne[7] shows that the assumptions regarding turbine technology and land use policy are highly significant for the potential estimate. Modern turbines with lower specific ratings and greater hub heights improve the wind power potential considerably, even though it was assumed that the larger rotors decrease the installation density and increase the turbine investment costs. New technology also decreases the impact of strict land use policies. Uncertainty in estimating the cost of wind power technology limits the accuracy of assessing economic wind power potential.

The study was conducted by Deepak Sangroya[8] for analysing strategies of Indian government in development of wind energy industry in the country which concluded that investors have been positively participating in Indian wind energy programme, resulting to growth of installed capacity in the country over the years. However, high cost of generating energy from wind is a cause of concern. Total Cost of installing an onshore wind power system in India is 1300 to 1450 USD /KW. It is important for Indian government to introduce revolutionary changes in its wind energy programme to compete with China at international forum and to become global leader in wind energy. These changes can include starting offshore wind energy installation, repowering of old turbines with new higher capacity wind turbines, increasing R&D budget in wind energy technology and enhancing regulatory and tariff regime to bring wind energy into national power system.

VII. CONCLUSION

Electricity is the basic need modern human life. Generally there is always a gap between power demand and actual generation. The gap tends to increase day by day with industrial growth and modernisation unless adequate measures are taken in advance. During last few years wind electricity has emerged as most promising among various renewable energy sources for large scale power generation on commercial basis. Most important requirement of establishment of wind power project at any site is the availability of good wind resource to make the project financially viable. As per MNRE guidelines, a site is considered suitable for the wind power project it the WPD at the site is 200 W/sq.m or more at 50 m above ground level.

ACKNOWLEDGMENT

We would like to express our thanks to our guide Mr. Viraj Kashikar for his technical guidance, valuable suggestions and constant inspiration throughout the project work. We are thankful to Dr Ashok More, Head of Civil Engineering Department for her immense support and advice in our endeavour. We would like to express our greatest appreciation to the Principal Dr Vijay Wadhai who has been continuous source of encouragement and cooperation throughout. We take this opportunity to express sincere thanks to Mr. Viraj Kashikar for helping us in completing this project.

REFERENCES

1. "Wind energy technology: current status and R&D future" by R. Thrasher and M. Robinson (National Renewable energy laboratory) - March 2008
2. "Generation of the power from the wind" by E. Wendell Hewson (American Meteorological Society) - July 1975
3. "The material selection for typical wind turbine blades using a MADM approach& analysis of blades" by K. Suresh Babu (SRKR Engineering College, Bhimavaram) – June 2006
4. Linda Guittet, Mile Kuslulja, and T.Maitre, "Setting up of an experiment to test vertical axis water turbines" - 2004
5. "Research Developments on Power System Integration of Wind Power" by Zhe Chen, J.Hansen & A.Hansen - 2014
6. A report by the Met Office to accompany the Carbon Trust report, "Small-scale Wind Energy – Policy insights and practical guidance" – 2010
7. Article published in Nature Energy Volume 3, page – 494-500 "Effects of turbine technology and land use on wind power resource potential" by Erkka Rinne, Hannele Holttinen, Juha Kiviluoma & Simo Rissanen - 14 May 2018
8. "Development of Wind Energy Resource in India" published in International General of Wind Energy Research by Deepak Sangroya and‡ Dr. Jogendra Kumar Nayak Depatment of Management Studies, Indian Institute of Technology Roorkee, Uttarakhand – 2015
9. http://mnre.gov.in/file-manager/UserFiles/national-level-consultation-on-national- wind-energy-mission-09012014.htm
10. http://gwec.net/publications/global-wind-energy-outlook/