International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 11 | Nov -2016 www.irjet.net p-ISSN: 2395-0072

Feasibility of Offshore Wind Farm in India

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Abstract - *Wind energy is used for various purposes by people since thousands of years around worldwide. India is gifted by the long coast line about 7500 km. India's population is increasing day by day. Hence, the demand of electricity is also increasing, Maximum renewable energy sources should be used, to fulfill this increased demand. For this, off shore wind form is one of the potential option. Though off shore wind farms are costlier than the onshore wind farms, it has more benefits compared to the onshore wind farms in terms of environmental, economical and production of electricity. The offshore wind farms are therefore becoming popular around the globe. Accordingly, the Government of India is expected to launch the National Wind Energy Mission Board to activate the first project of offshore wind farm in near future. This paper is related to study of feasible places for the installation of off shore wind farms and its effects in India..*

Key Words: Wind form, offshore, Information Value Method, Raster data

1.INTRODUCTION

India is the country of population 1.252 billion in 2013 increasing annually at the rate of 1.2%. Of the 1.252 billion population of India, approximately 300 million people have no access to electricity[1]. Energy shortage up to 11.3% is anticipated for Southern and North Eastern regions of India according to a May 2015 report published by India's Central Electricity Authority[2]. There is need to generate new electricity to fulfill these demands. There is increase in share of renewable energy sources as new technologies are discovered. Wind energy is one of the most considered energy source which humans are using from thousands of years. Generation of electricity through wind farm is one of the key sources of energy in India. The onshore wind farms require more land . India has total 7600 km of coastline with three sides surrounded by the sea. Offshore wind farms nowadays, because of new technologies and its benefits are globally getting accepted. Over the open water surface the average wind speed is considerably higher which why there is enough wind available for wind turbines. As compared to onshore wind turbines, offshore wind turbines are less obstructive. Though the offshore wind farm works on the same basis as that of onshore wind farms, offshore wind farms are installed on the various types of platforms like gravity base structure, conventional steel jacket structure and floating platforms (mostly preferred). In this paper, the cost and feasibility of offshore structure in India are discussed.

2. Offshore structure- offshore wind farm

The distance of wind farm from the shore inside the sea is directly related with its effect on human societies. The onshore wind farms are already facing the NIMBY opposition. Though the floating platforms don't harm the sea bed, the wind turbines can directly or indirectly affect some sea water habitats. The sea birds can get harm due to wind turbines while flying over that area.
The sea species may get disturbed directly due to the wind turbines in the following sense

- Noise
- Vibration
- Physical Intrusion
- Visual Intrusion
- Interruption of known used routes

Disturbance due to maintenance access during operation
Potential barrier effects.
Seals can only get affected by pile driving operations, No general change in the behavior of seals at sea or on land could be linked to the construction or operation of the wind farm.[8]

1.1 *Case Study*

The Vindeby wind farm in Denmark is named as the world's first offshore wind farm, which is constructed in the year 1991. The Vindeby is located in the country Denmark and installed in the Great Belt Sea having GPS latitude 54.96 and GPS longitude 11.13. It has an alternative name as Ravens berg and is spread on area 3 km^2. The wind turbines are installed in two rows having 5 and 6 turbines in a row respectively

1.2 Track Records and Technical Details

Offshore construction was started in the year 1990 and completed in September 1991. The project cost was estimated 10 million Euro. This project is getting operated by DONG Energy. The whole project was developed by SEAS-NVE Elkraft. These are installed at a distance of 1.5 to 3 km from shore having water depth 2-6 m. The total installed capacity of 11 turbines is 4.95 MW. The technical details of the project are as follows

Nacelle	
Drive Train Type	High speed
Gearbox Ratio:	1:50
Gearbox Stages	3planetary stages, 1 helical stage

Generator Type:	Asynchronous
Generator Rated Power:	450 kW
Generator Number of Poles:	4 poles
Generator Rated Speed:	1500 rpm
Power Converter:	none
Power Frequency:	50 Hz
Turbine Voltage Level:	690 V
Transformer Voltage Level:	10 kV
Yaw Gears - Number:	2
Nacelle Weight:	27.6 t
Top Head Mass:	32.5 t
Structure Type:	Tubular
Structure Material:	Steel
Weight:	20 t
Turbine:	
Turbine Manufacturer	Bonus Energy - Now Siemens Wind Power
Turbine Model	Bonus 450 kW/37
Number of Turbines	11
Rated Power pr. Turbine:	0.45 MW
Estimated Watt pr. Rotor m2	419 watt
Operational:	
Cut-in Wind Speed:	5 m/s
Rated Wind Speed	15 m/s
Cut-out Wind Speed:	25 m/s
Rotor & Hub:	
Rotor Type:	3-bladed, horizontal axis
Rotor Position	Upwind
Rotor Diameter:	37 m
Rotor Area:	1075 m2

1.3 Offshore wind farm in India

Europe is leading in the generation of electricity by using offshore wind farms. There are total 45 offshore wind farms, in 9 European countries, having average size of wind farms of 3.2 MW. [9]

As India has the large coastline of length about 7600 kms and most of the land is surrounded by the sea, the country can produce well amount of electric energy with the help of offshore wind farms. In India 22 GW of onshore wind capacity already installed, India's plans to expand offshore is worth learning from. The Indian Government will provide subsidy for surveys and studies, as well as obtaining clearances involved for the implementation of the project.

According to IS 4651(Part 1):1974 (.Part I) deals with site investigation and collection of data necessary for the planning, design and construction of marine structures. Existing local data on tides, storms, wave heights, littoral drifts, mud banks, etc, and records of previous investigations in the vicinity and information compiled. The behavidur of existing structures which may be of similar nature to the ones proposed, and the influence of the soil and water on the materials of construction are readily available.

According to IS 4651(Part 1):1974 (.Part I) information required is grouped under the following headings:

a) Survey
b) Meteorological data
c) Oceanographic data
d) Geological data
e) Soil investigation
f) Seismic data
g) Local resources

Winds -For preliminary studies, information may be obtained from the available meteorological department. Wind map are readily available Recording of velocity and direction of wind at the proposed site shall be obtained by installing continuous and self-recording anemometers. The data shall be collected for at least a period of one year and shall also be correlated with fhe data available at places nearest to the site.

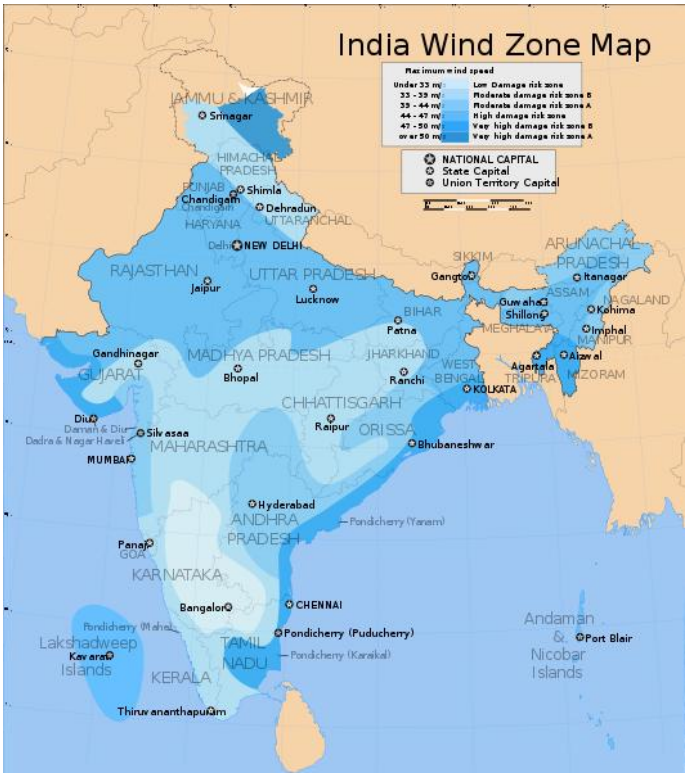

Fig-1:India wind zone map
(Sourse-https://commons.wikimedia.org)

1.4 Feasible area

Gujarat coast

The offshore wind measures higher speed as compared to onshore. The large part of Arabian Sea is within India's EEZ (Exclusive Economic Zone) region.

The Gujarat has the benefit of south-west wind comes all over state from Arabian sea. The state of Gujarat has gradual bed slope at coastal land, which is helpful to settle up the offshore wind turbines. The state of Gujarat has coastal length

over 1600 kms, which is one third of the coastal length of India.
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[5]

The average wind speed in Gujarat recorded by the NREL (National Renewable Energy Laboratory) is 8m/s. [4] This is sufficient speed to generate electricity by a wind turbine.

Available raster data are processed in Ilwis environment. This raster data processed by using information value method. Wind map, metrological map crossed by giving weightage shown in Fig. 2.

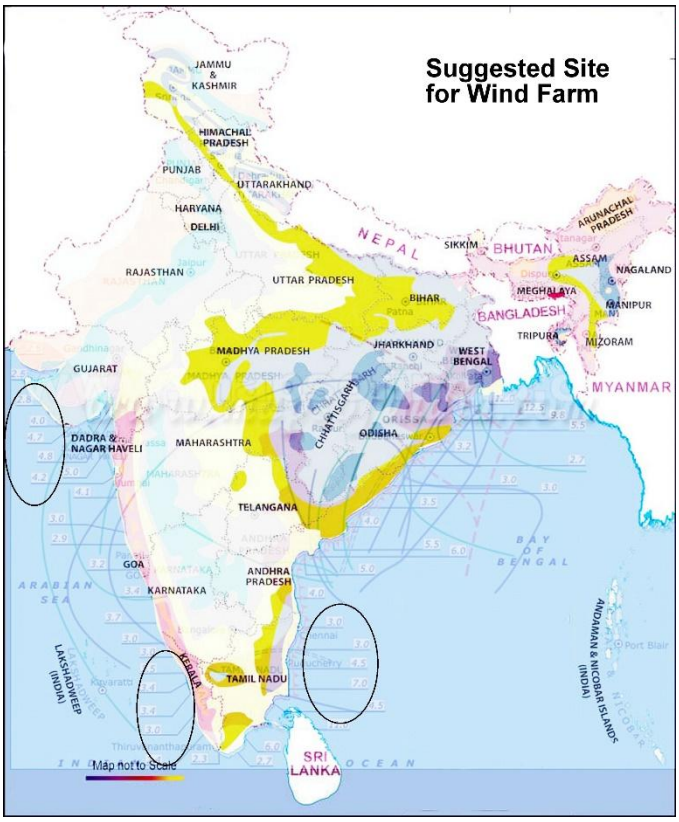

Fig-1: Probable Sites for Wind-Farm

2. Tamil Nadu coast

Tamil nadu is another state which is considered for the first offshore wind farm project in India along with the state of Gujarat. The construction of offshore wind farms in shallow water is easy, but as such places are getting fewer it is essensial to constuct them in depper sea. The EEZ (exclusive economic zone) area along the coastal line is large, this is why it will be beneficial to constuct the offshore wind farms in this region.

According to the available annual wind data, the wind speed is sufficient to devlope the electricity by using wind farms. As the wind farms in this region can be constructed in deep sea, the gravity type foundations are preferable

3. Kerala coast

The state is wedged between the Lakshadweep Sea and the Western Ghats. Lying between northern latitudes 8°18' and 12°48' and eastern longitudes 74°52' and 77°22', Kerala experiences the humid equatorial tropic climate also the state has a coast of 590 km with annual average: 4.30 (m/s)

2.ENVIRONMENTAL ASPECTS

The distance of wind farm from the shore inside the sea is directly related with its effect on human societies. The onshore wind farms are already facing the NIMBY opposition. Though the floating platforms don't harm the sea bed, the wind turbines can directly or indirectly affect some sea water habitats. The sea birds can get harm due to wind turbines while flying over that area.

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3. CONCLUSION

Wind farms are one of the most considerable renewable energy sources since last few decades. When there is comparison between the offshore wind farms and on shore wind farms, the offshore wind farms has more advantages. Hence, offshore wind farms should be adopted as feasible renewable energy source which will fulfill the electricity consumption of the increasing population.

Having the benefits of sea shore, there is immense potential for the development of offshore wind farms in India. Offshore wind farm are available in the state of Gujarat and Tamilnadu, as there is sufficient wind speed and other necessary natural resources. The EEZ (exclusive economic zone) along this coastline are feasible for the installation of offshore wind farm in India. Arabic sea coastal lines are feasible for the installation of offshore wind farms in India.

By considering these things, the MNRE (Ministry of New and Renewable Energy) has initiated the setup of first offshore wind farm in the state of Gujarat and Tamilnadu. The Government is expected to launch the National Wind Energy Mission Board to activate the project soon.

As highlighted in this paper, India should adopt the option of offshore wind farm, as it is feasible in India.

4.0 ACKNOWLEDGEMENT

This research was supported supported by Sanjay Ghodawat group of Institute, Atigre We are thankful to Mr. Sohel Gavandi

and Mr.Prajyot Patil who provided expertise that greatly help in the research.

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