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Offshore Wind Energy in India

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ABSTRACT
Offshore Wind Energy is a kind of renewable energy source, so it has attracted a lot of attention from industries, academics, societies and governments all over the world in recent times because pollution is a huge problem for everyone. In this paper, offshore wind energy will be compared with other renewable energy sources, and existing offshore wind energy projects around the world will be reviewed. We will also discuss various issues and challenges related to wind power generation. The report examines the recent initiatives of the Government of India, such as the announcement of the Offshore Wind Policy, the Marine Wind Targets for 2022, and the Expression of Interest (EOI) for the first 1 GW Offshore Wind projects in Gujarat. The report also addresses all the regulatory, operational, and implementation challenges that will affect the growth of this market in India..
Keywords: *Energy; wind energy; capital cost; turbines;*

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I. INTRODUCTION

Offshore wind turbines generate electricity from ocean winds (kinetic energy of the wind). They operate in the same way as onshore wind turbines, the only difference being that in offshore wind, the turbines can be installed either on a permanent base connected to the seabed (a stable installation) or on a floating base anchored to the seabed.(a floating installation), equivalent resulting in generating more energy. Wind turbines are classified by the axis of rotation of the central rotor shaft (either horizontal or vertical axis) and whether they are located onshore or offshore (Tong, 2010).For modern commercial wind turbines, the main rotor shaft is connected horizontally. The power generation capacity of this source depends mainly on the diameter of the wind rotor and the speed. Renewable energy has great potential and can theoretically provide a relatively clean and unlimited supply of mostly local energy. Recently, the supply of global renewable energy has been growing steadily. For example, annual growth for wind energy has been about 30 percent, down from a very small base of 6.29 percent of total renewable energy resources. World Energy Outlook (2006) fossil fuel mand and trade flows and greenhouse gas emissions will continue to follow their current volatile pathways in the absence of new government action until 2030. The policy scenario is that a package of policies and measures being considered by countries around the world will significantly reduce the rate of increase in demand and emissions. Importantly, the economic cost of these policies will far outweigh the economic benefits that come from using and producing energy more efficiently. The use of wind energy is growing rapidly around the world because it is not expensive and is also a source of renewable energy.

II. LITERATURE REVIEW

Offshore wind power refers to the production and impart of electric power by harvesting of wind energy at offshore locations such as lakes, oceans and sheltered coastal areas. According to the Global Status Report 2019 (REN21, 2019), wind power is the highest installed capacity among all the renewable energy sources, putting up significantly low carbon energy production. Over the years, the ratio of offshore wind energy to onshore wind energy is escalating in terms of installed capacity, with 1% before 2010 and 4% in 2018 (Global Wind Energy Council, 2019). Further understanding of the effects of ocean-based waves is needed to ensure that the improvement of this structure is also stable with the increasing trend of offshore wind turbine size. According to (Rockmann, Lagerveld & Stavenuiter, 2017), the cost of setting-up ocean-powered wind farms is 38%, the highest of all costs among the other renewable resources. Therefore, a more efficient offshore wind structure design will be required to apparently reduce this cost further. Keeping this in mind, this research will focus on wave effects, particularly wave forces, pressure, and run-ups on offshore substructures.

1. GLOBAL OVERVIEW

According to the Global Wind Energy Council (GWEC), at the end of 2018, the global offshore wind capacity was approximately 23.1 gigawatts. In 2018, about 4.5 gigawatts were added, an increase of 57% over 2016 installations. Of all the offshore wind installations, the UK leads the world with the highest

34%, followed by Germany and China at 28 % and 20 % respectively. Denmark (6%), the Netherlands (5%), and Belgium (5%) are the other major segments. Other markets where offshore wind projects are located are Vietnam, Finland, Japan, South Korea, the United States, Ireland, Taiwan, Spain, Norway, and France. In 2018, China led the market with a 40% share in new offshore wind installations, followed by the UK with 29% and Germany with 22%. Compared to 2017, new offshore wind installations in the two major European markets - the UK and Germany - saw a decline of about 23%, while China saw a significant year-over-year growth of 55%. Wind energy has no harmful effects on our environment. 2020 was the best year in history for the global wind industry with 93 gigawatts of new capacity installed - an annual increase of 53%, but the growth is not enough. The world needs to install three times as strong wind power over the next decade to stay on the zero path and avoid the worst effects of climate change. Due to technological innovations and economies of scale, electricity by the global wind market has almost quadrupled. Over the past decade it has established itself as a source of competitive and flexible power around the world. In 2020, record growth was achieved by the addition of installations in China and the United States - the world's two largest wind power markets - who together installed about 75 percent of new installations in 2020 and account for half of the world's total wind power. Although clean energy is the technology with extremely low power capacity per megawatt, this report shows that the current deployment of wind power will not be enough to achieve carbon neutrality by the middle of this century, and now policymakers must take immediate action to boost the generation of wind power at the required speed.

1.1. TARGET FOR OFFSHORE WIND

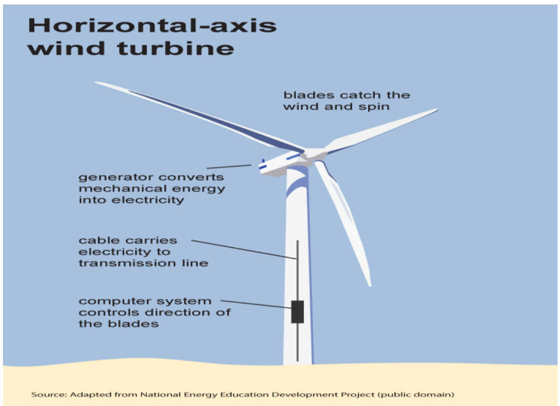
As per the statements made by the Ministry of New and Renewable Energy (MNRE) in June 2018, the short-term and deep rooted offshore wind energy targets were 5GW by 2022 and 30 gigawatts by 2030. These announcements point to a political direction towards the future of ocean-powered energy in India and will play an important role in safeguarding India's medium and long term energy. India has also allocated nearly 70 GW of potential area for offshore wind energy development. The MNRE recently invited Expressions of Interest (EoI) for the first 1 GW offshore wind project in India, which has received great response from both the Indian and the global markets.

2. TYPES OF OFFSHORE WIND TURBINES

There are two normal types of wind turbines.

2.1. **Horizontal-axis Wind Turbines**

This is the most common machine design used today. HAWTs are usually either two or three bladed and run at the speed of a sharp blade signal. It uses aerodynamic blades (ie air-files) attached to the rotor, which can be positioned either upwind or downwind. The axis of rotation of HAWTs is horizontal to the earth and parallel to the flow of air stream .Most of today's commercial wind turbines come under the HAWT category. HAWTs work primarily on lift principle. As the current of wind interacts with the rotor blade, there is a lift force which causes the rotor to rotate. Rotation speed varies with design features and rotor size. For a typical MW-sized turbine, this can be as low as 16 rpm. The number of rotor blades in the HAWT depends on the application for which it is used and the wind regimes in which they are required to operate. Single bladed rotor saves the blade material and makes them relatively inexpensive. Single blade designs are not very popular due to difficulties in balance and visual acceptance. Two bladed rotors also have these defects, but to some extent. Most of the modern wind turbines used to generate electricity have three-bladed rotors. For these routers, the loading style is relatively uniform and they are visually more acceptable. Wind turbines with more rotor blades (6, 8, 10, 12 or more) are available and are used for water pumping which requires high torque for initial control of the load imposed on the system by the water column. As the torque increases steadily (the ratio between the actual area of the blade and the swept area of the rotor), rotors with more blades (higher solidity) are preferred for such applications. However, highly solid rotors operate at low-tip-speed ratios and are therefore not recommended to be used by wind electric generators. Similarly, their efficiency will also decrease as aerodynamic losses increase with solidity. .Furthermore, depending on the wind current coming into a HAWT, there may be upwind or downwind type rotations and it is the rotor mounted in front of the unit or the turbines that stand their way backwards, which encounters the wind.The biggest advantage of upwind rotors is that they do not suffer from tower shadow effects.



2.1.1 **ADVANTAGES OF HAWTs**

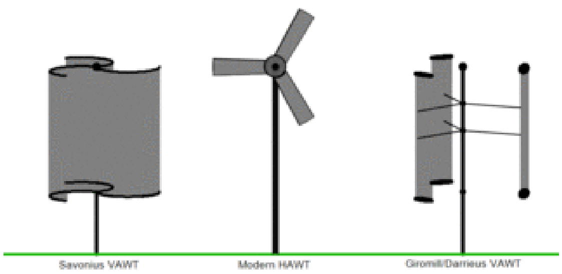
- Blades are to the sides of the turbine's centre of gravity, helping stability.
- Tall towers allow access to stronger wind in sites with wind shear. In some wind shear sites, every ten meters up, the wind speed can increase by 20% and power output by 34%.
- Tall towers allow placement on uneven land or in offshore locations.
- It can be sited in forests above the tree-line.
- Most are self-starting.
- Can be cheaper per unit of output because of higher production volume, larger sizes and, in general, higher capacity factors and efficiency.

2.1.2 DISADVANTAGES OF HAWTs

- HAWTs have difficulty operating in near ground, turbulent winds.
- The tall towers and long blades(Up To 180 feet(55m)long) are difficult to transport on the sea and on land. Transportation can now cost 20% of equipment costs.
- Supply of HAWTs is less than demand and between 2004 and 2006, turbine prices increased up to 60%. At the end of 2006, all major manufactures were booked up with orders through 2008.
- The FAA has raised concerns about tall HAWTs effect on radar near Air Force bases.
- Their height can create local opposition based on impacts to view sheds.

2.2 VERTICAL AXIS WIND TURBINES

A vertical axis wind turbine (VAWT) has blades mounted on top of the main shaft structure instead of the front part like an aircraft rotor. Used less often than their horizontal counterparts, VAWTs are more in practice in residential areas. The two most common designs include a turbine that resembles two parts of a 55-gallon drum, each mounted on a rotating element (Savonius rotor), and a smaller model that is somewhat of an egg batter (Darrieus model). Savonius models are more commonly used and allow air to flow through a hub to replace the generator. The turbine rotates when the wind blows through the blades. The unit has two or three blades and can be lower and closer to the ground than the horizontal system. A Giromill also resembles an egg beater in design but has two-three straight blades on the vertical axis. Helical blades which are similar in structure to DNA form another design. In general, vertical axis wind turbines come with their advantages and disadvantages over alternative configurations.



2.2.1 ADVANTAGES OF VAWTs

- They can generate electricity in any wind direction.
- A strong support tower is not needed because the generator, gearbox and other components are placed on the ground.
- Lower production cost than horizontal axis wind turbines.
- Since there is no need to point the turbine in the direction of the wind to be effective, there is no need for yaw drive and pitch mechanism.
- Easier installation than other wind turbines.
- Easy to move from one place to another Low maintenance cost.
- They can be installed in urban areas with less danger to humans and birds because the blades move at a relatively low speed.
- They are especially suitable for areas with extreme weather conditions, such as in the mountains where they can provide electricity to mountain huts.

2.2.2 DISADVANTAGES OF VAWTs

- Since only one blade of a wind turbine operates at a time, the efficiency is very low.
- They need initial pressure to start, the process uses some of its own electricity.
- They are much less efficient when compared to horizontal axis wind turbines. This is because they have an extra drag when their blades rotate.
- They have a relatively high vibration because the air flows near the ground creates turbulent flow.
- Wearing vibration bearings increases the cost of maintenance.
- They cause noise pollution.
- The guy wires that hold the machine need to be installed.

III. CHALLENGES OF OFFSHORE WIND

The potential for offshore wind energy is enormous, but not without the technical and implementation level challenges that make ocean-powered wind energy difficult and expensive to use. Below are some of the challenges associated with these projects.

3.1.HIGH CAPITAL COST

The foundation and installation cost of offshore wind projects is much higher than that of onshore wind projects. Also, in India, the cost will be higher due to possible lack of installation and ancillary vessels, lack of local infrastructure and trained manpower. Lack of historical technical data Historical data, including resource map and bathymetric data (information on sea depth at various positions), is essential for identification of suitable wind turbine locations, designing wind turbine foundations, and estimation of energy production. .However, this data is not available which may cause ambiguity and delay in project design. In addition to ship lanes, military territory, dredging regions, oil exploration and fishing zones, submarine communication cables, the unavailability of a lot of relevant information is also an obstacle, while high capital costs at high prices lead to higher tariffs, compared to the current onshore wind rates. Offshore wind tariffs in India are expected to be in the range of INR 7-9 per unit, compared to the current rate of INR 2.8-2.9 per unit for onshore wind.

3.2 ANGRY BIRDS

Birds are a difficult problem for sea air, colliding with turbines and disrupting nesting grounds, causing project developers to clash with environmentalists who are usually natural allies of renewable energy. Birds have also become a problem for planned coastal wind projects in Germany and the United States, but the wind industry tries to be kinder to the birds and find various solutions to this problem without harming them.

3.3 MERITS

- ❖ High wind speeds: Winds are stronger, permanent and less turbulent than land, especially on marine reservoirs (due to the absence of barriers and less roughness of the surface) resulting in faster wind speeds
- ❖ No use of land: Due to the growing population, land scarcity has led to the construction of wind farms along the coast. This change will release the land for other useful purposes
- ❖ High energy production: Coastal wind turbines can be much larger than the balance of their shores, resulting in more energy.
- ❖ Coastal areas benefit the most due to lower transmission costs and disadvantages, smoother transportation of large capacity turbines and less noise pollution and visual interference

IV. ACTIVE OFFSHORE WIND ENERGY PROJECTS

Project name	Owner
Gujarat-TATA Power	TATA power
ONGC pilot project	Oil and Natural gas corporation(ONGC) LTD;
ONGC-Commercial Project	Oil and Natural gas corporation(ONGC) LTD;
Gujarat-Green shore energy	Green shore energy Pvt Ltd
Tamil Nadu-Bharat light & Power	Bharat Light and Power Pvt Ltd;
Tamilnadu-Suzlon	Suzlon Energy Limited
Tamil Nadu-Greenshore energy	Greenshore energy Pvt Ltd;
ONGC-Vertical Axis Pilot Project	Oil and Natural gas corporation(ONGC) LTD;
First 1000MW Commercial offshore wind farm in India	Ministry of New and Renewable Energy(MNRE)
Fowind-Facilitate Offshore Wind in India-Tamilnadu	

V. CONCLUSION

We should encourage maximum use of offshore wind power plants as high speed can generate maximum electricity and it is also used without any land. Offshore wind energy offers a wide range of capabilities, but there are many technical and operational challenges in using it on a large scale. In particular, for countries like India, where the deployment of ocean-powered air has not yet ended, it is important to understand all these regulatory and technical challenges

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