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A Comparison between India with UK to Study Challenges and Opportunities associated with Offshore Wind Energy

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***Abstract*---Offshore wind energy is a precise, reliable, and non-conventional source of power gained by profit from the wind energy generated on the high seaside or ocean. It relinquishes an elevation and more consistent pace than on the ground due to the inadequacy of limitations. In 2018 the vast potential of the offshore establishment had touched up to 23 GW. It is continuously developing with a pace of nearly thirteen percent, which is more substantial than the onshore rate is expanding. The total oceanic wind capability encompassing 79% is established in the north European region, and 20.9 percent were located in the Asia region. The motive of the study is to comprehensive analysis regarding the challenges and the opportunities of offshore wind energy. Further, the comparison is conducted among the two most potential offshore wind countries India and UK. Moreover, the paper also recommends some measures and future scope that assist India in taking advantage of the coastal area and enhancing its offshore wind resources by learning from the UK's well-established market.**

***Keywords*---offshore wind energy, challenges and opportunities of offshore wind energy, United Kingdom offshore wind energy, India offshore wind energy.**

I. INTRODUCTION

Offshore wind power production contributes to minimizing the interdependence on fossil fuels, overcoming greenhouse emissions, increasing energy security, and producing employment possibilities. Offshore wind energy is a precise, reliable and non-conventional source of power gained by taking profit of the wind energy generated on the high seaside or ocean where it relinquishes an elevation and more consistent pace than on the ground due to the inadequacy of limitations[1]. To obtain the most out of this resource, a megastructure is installed that is seated on the Seaford and furnished with the most developed and innovative technologies to produce or generate electricity from the available resources appropriately. Offshore wind energy has enormous potential because there are more substantial wind sources offshore than onshore because of the unavailability of any obstacle; the wind speed is very high, up to double as abundant as in the means of onshore wind [2].

During the preceding years, energy generation from offshore wind has appeared as one of the most encouraging ways to accomplish enhanced potential sustainability. Therefore, a significant dimension of the forthcoming schemes concerning wind power development is presumed to be offshore [3]. In 2018 the vast potential of the offshore establishment had touched up to 23 GW. It is continuously developing with a pace of nearly thirteen per cent, which is more substantial than the onshore rate is expanding. The total oceanic wind capability encompassing 79% is established in the north European region, and 20.9 percent were located in the Asia region [4]. Offshore wind power is nothing further than the unfolding of aquatic resources to maximize the potential for energy production. Some appropriate development blueprints illustrate that installation expenses of the offshore wind dynamism are around 1.5 to 2.5 times more costly than onshore wind expansion; constructing large scale offshore wind is complicated in developing countries. However, the offshore wind electricity potential base is more contemptible and comparatively more effortless to construct and maintain [5].

Several understandings proclaim offshore wind energy should be counted as a sustainable investment-

- The significant benefit of offshore wind energy is that the average wind velocity in the water body is usually higher and more steady than onshore; this allows the offshore wind turbine to operate more efficiently and smoothly over the seabed than the onshore with obstacles over the ground.
- Moreover, there is no hindrance over the water body.

The wind is more turbulent than on the onshore, which implies that the exhaustion influence on the turbine dynamo is more negligible. Therefore, the survival rate of the turbine is more remarkable.

- The other benefit is there are some purpose constraints. There is further unoccupied space, and offshore wind farms can be more adaptable and scalable, massive installations can be produced expeditiously and efficiently.

Prominent conditions need to be placed for offshore wind expansion to be thriving anyplace in the world-

- The administration must be willing and capable to generate potential and an economic ecosystem that promotes growth and development.
- A high-level technology framework parity is vital for the turbine working above the seabed.
- Operation and maintenance play a significant function to construct offshore wind plants responsible and economically achievable.
- Cost cuts were maximizing the commercial advantage is an essential priority.

The United Kingdom and offshore wind

The United Kingdom has proven enormous success in offshore wind, which is responsive to perceive both the extensive possibility of offshore wind power for the UK and its considerable potential to provide to the UK marketplace. The United Kingdom is the world's most extensive offshore wind market; the total established volume was approximately 10.4 GW [6]. This capacity accounts for more than 20% of the UK current need yearly. The sequence of the sources and the power frequency put the UK in the pole situation to grasp the immense potential that wind of an as a generator of moderate carbon power emanation [7]. The Government of the United Kingdom incremented innovative technology and strategies for enhancing renewable electricity generation through providing renewable obligations are certificate trading schemes. Feed-in tariffs (FIT) schemes pay power users who spend in lowering carbon power production practices to produce and employ light.

India and offshore wind energy

India is one of the emerging countries all over the world for the growth and implementation of wind energy. The Indian wind energy sector is on the path to accomplishing the ambition of a 60 GW wind capacity mark onward of the 2022 deadline as it possesses previously established 34 GW potential plants [4,8]. There is considerable potential for offshore wind power with immense ability on the coast of Gujarat and Tamil Nadu. The Indian administration assists offshore wind resources in commencing environmental evaluation in the most desirable situation and promotes a strategic framework to supervise and approve the scheme and the regional supply chain. FOWIND (facilitating offshore wind in India) consortium diploid a LiDAR all the sites and marks in Gujarat and Tamilnadu, which are considered the two allocated stretches for the development of offshore wind energy. An additional 5 GW offshore capacity is proposed to be functionalized by the financial year 2021[9]. The option of about ten gigawatts of wind power potential is accomplished in 2020 with the motive to achieve the 60 GW onshore and offshore ability by the end of 2022.

Challenges of development of offshore wind energy in India

- The significant hurdles include seaside, cabling, source, characterization, foundation, turbine infrastructure, performance transportation, and infrastructure construction.
- There is no notable waste of current and seaside protection throughout the development and management stage.
- The offshore wind power plant deployment trials constitute a single-time expense for mobility and stationary of oceanic rifts.
- Further material is demanded for the formation of the offshore wind field and the interface channel.
- Lack of qualified employees with requisite professional expertise, knowledge, structure, and architectural understanding also creates complications.
- The investment in an actional measure such as elevator and lifting combines the sustaining of blade and nacelle.
- The offshore wind area meets professional uncertainties such as development, maintenance, subsistence technology, and commercial peril.

1.1 Background

Wind turbine installations exceeding the shoreline are called offshore energy system expansion of offshore blow current as stipulated in the preceding few ages due to notable wind sources possible over the seaside [10]. Offshore wind turbines ordinarily have more potential to generate energy compared to onshore. The most pre-eminent position site is established in tidal areas; therefore, it can bypass lengthy range energy transportation. Offshore turbines resolve the challenges like lack of plants less when assets and engaging ecological concerns correlated with onshore wind energy schemes have comprehensively prompted strong attention and financing aid in offshore dynamism outlines [11]. These technologies exhibit a remarkable resemblance to that of inland with only trivial alterations. The only substantial

variance is composing the foundation, which entails fluting or different rare foundations to consider for submersible column submergence [12]. Major offshore wind turbine foundation types usually can be of floating type structure. Offshore wind turbines are controlled to twist center fixed and decisive blows, all of which are frequently sharp; in consequence, architects must acquire the protection of wind turbines[13].

The offshore wind farm history has its own significance as the initial offshore wind field was founded in Sweden in the year 1990 as an archetype and developed as a marketable perspective to exercise following decade later as in 2001. Still, the analysis and investigations in the particular topic commenced in early 1980 [14]. After that, many researchers subsequently attempted to traverse the considerable attention under the careful research comprising offshore-related policies, contemporary situation and expected expansion and growth of offshore wind potential uncertainty associated with offshore energy, among others [15].

1.2 Literature Review

Over the last decades, wind energy appeared as one of the most notable non-hydro renewable areas offering significantly to the global efforts on promoting low-carbon power schemes. Europe and East Asia have been at the lead of wind energy expansion together. They consider almost 70% of the total established capacity and the utmost of the world's most giant wind turbines positioned and composed. The paper [16] highlights the superior technology and advancement in wind energy. Also, it indicates technologically innovative and scientific improvement production internationalization difficulties before glancing at the strategies taken by Europe and the East Asian government. Another paper [8] features estimating the trials faced by India to handle offshore wind energy and its opportunity and opportunity from an Indian perspective. Paper ascertained several typical difficulties to offshore wind energy, and one of the most notable ones was high commercial expense in terms of the Indian perspective [17]. The research exposed that offshore wind power has a long-term profitability approach from an Indian perspective. The paper also advises actions to exclude the particular trails in this relative area [9]. The overall paper outlines the United Kingdom and its wind energy, engendering capacity, opportunity, and difficulties. The worldwide established potential of offshore wind has climbed swiftly. Capacity constituent data from the United Kingdom of wind farms was bestowed in the document [17], rendering penetration into the current production of the wind farm contrasted to the earlier onshore farms. Offshore wind turbines farm over time, and the business is utilizing the knowledge from preceding experience to deliver better enforcement at the further freshly established field. Reducing the electrical charge from a blow to a commercially feasible level is one of the most considerable hurdles in the manufacturing sector [18]. The business must overcome the difficulties linked with changing component authenticity and developing and adopting relevant satisfactory monitoring systems and maintenance artifacts to make it more sustainable and easily accessible for the world [19]. The paper analysis of central offshore wind energy difficulties and clear policy plan outline for functional maintenance design specifications to trigger offshore wind construction exercise for the medium to lengthy projects is reinforced in the investigation [20]. The study and extension remunerations are granted to support possible management investors, stakeholders, executives, and generators, and the wind field developers in their perception and drafting. The environmental values of European offshore wind fields are estimated to optimize scheduled monitoring of offshore wind plans in India [21].

1.3 Research Gap

The only gap identified is the lack of appropriate data concerning the comparison study as very few of the research only highlights the comprehensive comparison of the offshore resources in the UK and India.

1.4 Research Question

Q. Comparison between India with the UK in wind offshore opportunities and challenges?

1.5 Importance of the Study

Plenty of researchers are conducted in the offshore wind energy and related field, although few of them concentrate on studying the comparison of UK and Indian offshore opportunities and challenges. So the study has immense significance as it analyses the UK and Indian offshore wind energy effectively. Because of climate change and global warming, the essentiality of alternate energy has become the need of the hour. Exploring the potential of alternative resources of energy is enormously searching on the worldwide level. Countries generating extreme levels of carbon emission like India and the UK are more desperately researching for new opportunities for alternative energy. The research provides a keen comparison among the two most potential offshore wind countries India and UK. The study also provides a comprehensive analysis regarding the challenges and the opportunities of offshore wind generating capacities in these countries.

1.6 Research Objectives

- Comprehensive analysis regarding the challenges and the opportunities of offshore wind energy.

- Comparison among the two most potential offshore wind countries India and UK.

II. RESEARCH METHODOLOGY

To conduct the effective analysis based on the comparison of UK and Indian Offshore wind industry the paper implemented quantitative methodology.

2.1 Research Method & Design

The paper selected the qualitative method to analyse the relevant information based on the secondary approach based on existing literature research. It uses secondary data from scholarly literature and online resources for research purposes. The research is systematically evaluated by employing online journals and national and international resources to conduct a smooth analysis and reach a conclusion. For this purpose, the paper explored more than 65 papers and online resources in initial reading, and eventually, when writing the paper, it selected 22 research papers.

III. ANALYSIS OF DATA

Q. Comparison between India with the UK in wind offshore opportunities and challenges?

The comparison of UK and India highlighting diverse components can be illustrated in the below table.

Table 1: the comparative analysis of offshore wind energy. [4,6,8,9,21,22]

Factors	UK	India
Coastal region	12429	7516.6
Present Offshore Wind Capacity	7.2 GW	500MW
Target 2022 Short- term project)	--	5GW
Tentative capacity till 2030 (Long-term project)	40GW	30 GW
Offshore wind energy position	Developed phase as it holds the leading position.	Under Developing or initial phase.
Renewable energy generated	<10% of country's need	--
Location	More than 22 locations	2 location- Gujrat & Tamil Nadu
Seaward site location	Between 10-25 km	Between 23-40 km
Electricity production cost	£3m/ MW	12 rupees/ unit

IV. RESULTS & FINDINGS

In this section, the paper illustrates numerous obstacles faced by the government and administration for harnessing offshore wind technology with the intention to attain renewable and sustainable energy. Moreover, the appropriate measures need to be taken to effectively handle the challenges facing India and the UK to explore the offshore wind energy sector.

4.1 Challenges came in front of India and the UK for the offshore wind industry

There are several social, technical, political, environmental, and economic challenges addressed by the progression of the offshore wind energy industry. Challenges correlated with operation and maintenance are of remarkable attention to be the preponderance of developers. Some of the hurdles can be classified as-

- *Cost of offshore wind*

Offshore wind farms are not progressing as speedily and conveniently as conceived, notwithstanding notable technological improvements in the last few years. Numerous difficulties are facing the manufacturing industry for producing renewable sources of power that pave for sustainable development. In contrast to the onshore sector, offshore farms offer a more imposing uncertainty to recover the funds spent due to more distinguished and more

particular launching and maintenance and supervision costs.

The prime cause for more reluctant than predicted extension is that offshore wind is nevertheless more costly than traditional plants. With the intensification and advancement in turbine technology, the enlarged number of offshore assets being disposed of, and the operators' expertise. The expected expense of offshore wind energy manufactures alternates based on the situation, location, and design scale. However, offshore wind energy plants endure significantly pricier than those associated with onshore.

It is deserving of perceiving that the expense of maintenance is considerably lower than the cost of sustenance. Operational cost links costs connected with high-level asset supervision embracing remote practice monitoring and administrative monitoring power-related purchasing and management.

The cost of offshore wind power in the United Kingdom has progressed since its grounding stage. However, currently, the charge for electricity production is just half in the last five years as it is around £3m/ MW. There is a concern for the expense of power generated from the offshore wind energy plant, which was nearly 12 rupees per unit instead of the cost of 2.4 rupees per kilowatt for onshore wind energy.

- *Maintenance Optimization*

Maintenance and service are among the most regarding sections and stimulating from an offshore wind energy generation perspective. Presently restorative care is executed for subsisting onshore and offshore wind farms. This method was favourably employed over onshore with insignificant intervention from environmental circumstances, but it is essentially ineffective for offshore wind farms.

They were challenging to reach location, and the tremendous expense of the techno scientifically special and access equipment necessitated means that offshore operation and maintenance values have been assessed as three to five times greater than those of onshore.

This cost discrepancy has conceivably enhanced even more for the subsequent production wind farm development, which will be proper offshore in more high-priced average wind speed with more challenging sea conditions. Although condition-based sustaining precautionary practice can significantly depreciate the offshore operations and maintenance cost by lowering the number of manoeuvres visits and restorative maintenance performance requirements. This kind of preservation methodology in the range is repairing or replacing ingredients based on their salubrious being, including the particular machine's history. Advanced and reliable monitoring and interpretation methodology are prerequisites to adequately monitoring the turbines or wind farms.

- *Reliability*

Wind turbine authenticity performs a notable role in the financial success of wind farm projects. The reliability directly influences the scheme return stream to enhance handling and maintenance charges and lessen the availability and accessibility to produce energy due to turbine downtime. Executives and entrepreneurs are customarily highly uncertain about disclosing data concerning reliability because the turbine manufacturing sector is hugely competing for the marketplace, and incompetent data concerning a production technology has compact commercial pertinence. There is a restraint for the very lessened accessibility of data regarding product reliability. The product's reliability incorporates the learning practices comprising data gathering regarding different wind turbine populations, type and size, location, life, electricity-generating capability, and so on.

- *Condition Monitoring*

The need to victoriously recognize and execute before catastrophic breakdown occurs to reinforce wind turbine availability and overcome the potential electricity expense has emerged in the development of many condition monitoring practices. This methodology suitably worked in online effective remote monitoring and managed their elements effectively. It also serves in managing the corrosion uncertainty for turbine basements.

- *Technical Challenges*

Offshore wind energy plants are enclosed with tremendous technical hurdles such as production, installation, development and maintenance technology, and commercial ventures, including resource availability guarantee and business risk. Turbine installation and maintenance of vessels, engaging and controlling cable, construction negligence, edge breakdown, and functional accidents concerning elevations are technological difficulties.

- *Environmental challenge*

Offshore wind energy is one of the alternative energy resources that have immense potential for sustainable energy security. However, harm to the marine environment and birds has constantly been a questionable matter. The strengthening environmental attention corresponded with offshore wind improvement is noise level, the possibilities of a collision, impact on eco-friendly space at the extreme

depths of the sea and culminating layer of the ocean body habitat, conversion of the food web, and contamination from growing basil transactions for relief of containment from seafloor sediment. Noise and fluctuation generated by turbines have an unfavourable impression on marine ecosystems.

4.2 Bright Opportunities: offshore wind energy

India stands fifth in the onshore wind energy globally, and it is convinced to develop in the offshore energy sector at its own velocity. Because the offshore industry is hitherto to begin in India, it can effectively learn lessons from a well-experienced country like Britain and other countries to practice operational measures for establishing and prospering offshore wind energy plants. The paper proposes some guidelines and recommendations which assist India to move ahead without affecting adverse fiscal stipulations and possible inaccuracies in the forecast. The recommendations are

- MNRE and other members must operate collectively to ensure that the procedures for offshore wind energy in India are stably prolonged and smooth in a convenient manner to promote more beneficiation for renewable energy resources. Because steady and reliable strategies promote investor belief without ambiguity and heighten the investment, whether private or FDI, in a particular sector.
- Create well-built controls measures and processes for transportation and grid integration, indicating that it is essential to create an anticipated transmission and grid integration administrative mechanism with the transparent allocation of accountability and liability to interconnect offshore wind energy facilities.
- Simplify certification process, rules, protocol, and permission criteria by the management, operators verifying actualities, and the governmental maritime offices can optimize method and model. It is suggested to use the knowledge obtained by advanced countries like the UK for a balanced strategy in the offshore industry.
- Formulate a combined procedure for onshore and offshore networks. Strengthening onshore is very much required to present production offshore; this will contribute to other parts of the offshore network through the onshore network for bulk power transfer.
- Drafting for utilizing advanced technology for reliability, cost-effectiveness, and attain high efficiency. A noticeable detail is using modern technology appropriately, like High voltage direct current transmission technology for high productivity and counters high transmission loss for extended intervals. Fostering an intelligent device employed for regulating power movement in the interface is also prescribed as a better opportunity for generating offshore electricity.
- Provide a cost-benefit evaluation of innovative development and management framework, using forward-looking and innovative measures, a more reliable wind turbine initiative series, forward transfer system, more active vessel, enhanced redundancy in the wind farm configuration, and so on. These promote the advancement of offshore wind farms. The benefit can be associated with much-developed countries like the UK, which will allow us to focus on the essential determinants.
- Cost-effective mechanisms such as utilizing advanced technology, attracting FDI, among others. India is the most exciting place for offshore wind ventures and essential incentives. There are several mechanisms and approaches to overcome the offshore wind energy expense and attain cost competitiveness that will expand investment in the field of the offshore wind industry.
- Optimized processes subdue shorter installation time and better access to offshore locations.
- Efficient bundling of grid connections of offshore wind farms reduces the costs of the plant.
- Unique design for offshore installation operation and maintenance of the wind turbine can also reduce the cost.

V. CONCLUSION

Some suggestions for the Indian offshore production to thrive in the prospective investment in infrastructure, convenience meeting adequate stakeholder, supervision and enduring policy approach can facilitate development in the offshore industry in India. Moreover, the National and regional authorities can execute a crucial role to be proactive and facilitate their enforcement by promoting more renewable resources generation capacity. Appropriately harnessing the advanced technology for manufacturing, transportation, operation and maintenance, and other variant divisions of offshore wind energy plants. Minimization of uncertainty and risk provide significant reduction potential such enabling step fill to assist take a virtuous initiator spiral of expense mitigation potential along with additional growth of the also developed energy market. India has immense potential and can appropriately learn a lesson from developed countries like the UK and assure that the offshore wind industry continues on its successful path.

VI. FUTURE SCOPE

- Promoting long-term strategy structure in support of the offshore wind
- By strengthening grid system to assist in a cost-effective

practice
- Modelling of wind and flow influence on offshore wind abilities
- Reducing the expense of establishment and practice
- Optimizing the establishment procedure and sustaining of offshore wind.

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