Offshore Wind Energy – India Status, Opportunity, Challenges, Barriers, Entry Model and Threats

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1. Status of Wind Energy in India

1.1 Overview of the Wind Energy Industry:

The development of wind power in India began in the 1990s, and has progressed steadily in the last few years. Currently, India has the fourth largest installed wind power capacity in the world. Wind power accounts for 6% of India's total installed power capacity, and it generates 1.6% of the country's power. In the recently released National Electricity Plan (2012) the Central Electricity Authority projected the need for 350-360 GW of total generation capacity by 2022. Despite major capacity additions over recent decades, power supply struggles to keep up with demand. Wind power accounts for about 70% of this installed capacity. Under the New Policies Scenario of the World Energy Outlook (2011), total power capacity in India would reach 779GW in 2035. To reach 779 GW in 2035, capacity must grow at a CAGR of 5.9%, or over 20GW per year from 2009 through 2035. The installed capacity from renewable energy sources is 42,849 MW as on 31.03.2016. Share of Renewable Energy Sources (RES) in the total installed capacity is about 13%. However, the share of renewables will substantially increase in coming years due to major thrust given by Government of India in promoting Renewable energy sources on account of these sources being clean and green. India is one of the best recipient of solar energy due to its location in the solar belt and has vast solar potential of 749 GW for power generation. Also, India has substantial wind potential of 103 GW due to its long coastline. In India, as on 31.03.2016, the total RES capacity was 42,849 MW out of total Installed Generation Capacity of 302,088 MW. This represents almost 14.2% of the total Installed Capacity. An Action Plan has been formulated by Government of India for achievement of a total capacity of 175,000 MW from Renewable Energy Sources by March, 2022. In addition to the progress made in wind turbine installed capacities, the progress of the overall wind energy ecosystem has been encouraging as well. Pointers to this are the increasing number of component manufacturers and the rapid utilization of India's land for wind energy. While the growth of wind power in India was largely driven by tax incentives until recently, it is expected that more IPPs (independent power producers) will be interested in investing in this segment with the recent announcement of generation-based incentives (GBI).

1.2 Wind Energy Capacity India

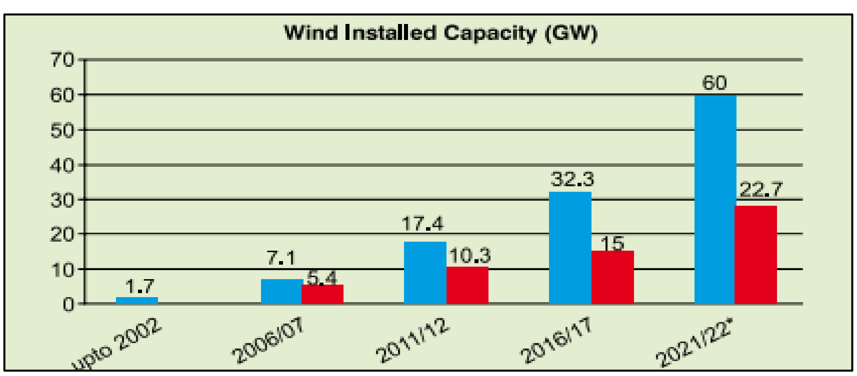

Fig. 1 Wind Installed Capacity in India

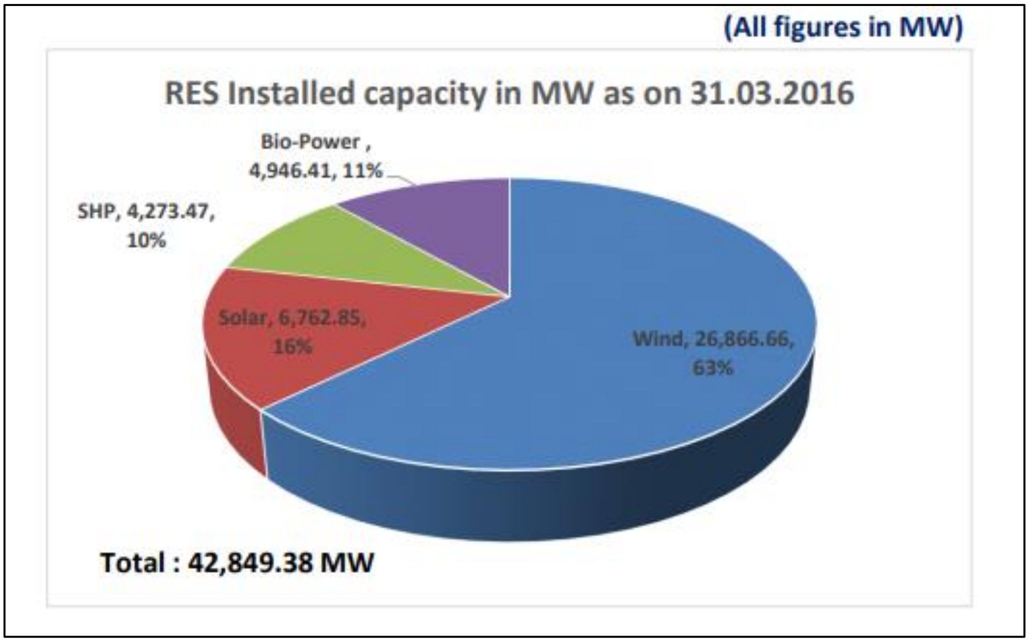

Fig. 2 The installed capacity of Renewable India

1.3 Renewable Energy Target India by 2022

Renewable Energy sector is now poised for a quantum jump as India has reset its Renewable Energy capacity addition target so as to have installed capacity of 175 GW by 2022, in view of the significant renewable energy potential in the country and commitment made by the investors/stakeholders. The targeted contribution of the major renewable energy sources to reach to the capacity of 175 GW by 2022.

Sl. No.	Renewable Energy Source	Targeted Installed Capacity by 2022
1.	Solar	100 GW
2.	Wind	60 GW
3.	Biomass	10 GW
4.	Small Hydro	5 GW
	Total :	**175 GW**

Table.1 Targeted contribution of the major renewable energy sources

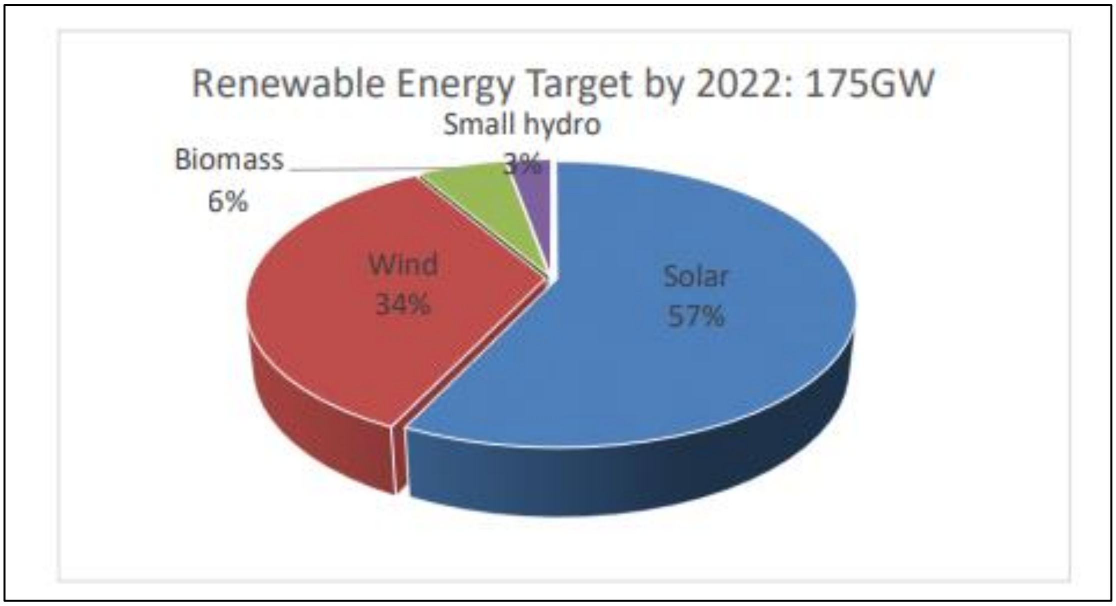

Fig. 3 Renewable Energy Target by 2022: 175GW

Year	Installed capacity of RES	Expected Generation in (BU)					Total Energy Requirement (BU)	% Contribution of RES to Total Energy Demand
		Solar	Wind	Biomass	SHP	Total		
2021-22	175 GW	162	112	38	15	327	1611	20.3
2026-27	275GW	243	188	64	21	516	2132	24.2

Table. 2 Estimated Electricity Generation from RES in years 2021-22 and 2026-27 in (Billion Unit)

2 Offshore wind energy developments in India

India has a long coastline of over 7500 kms. In April 2012, the Ministry for New and Renewable Energy constituted an Offshore Wind Energy Steering Committee under the chairmanship of the Secretary, MNRE, to drive offshore wind power development in India in a planned manner. The Government is looking to prepare a time-bound action plan for development of offshore wind energy, especially in the coastal states of Andhra Pradesh, Gujarat, Maharashtra, Odisha, Kerala, Karnataka, West Bengal and Tamil Nadu. A policy and guideline for offshore wind are likely to be announced in the near future by the Ministry of New and Renewable Energy (MNRE). The State of Tamil Nadu is likely to take a lead in harnessing its offshore wind resources and is in the process of installing a 100-metre mast for wind measurements in Dhanushkodi. According to C-WET, as per the preliminary assessment conducted by the Scottish Development International (SCI), Tamil Nadu has a potential of about 1 GW in the north of Rameshwaram and another 1 GW in the south of Kanyakumari. SCI, under the guidance of Centre for Wind Energy Technology conducted a detailed survey of the region to assess various parameters required for installing offshore wind farms. The technical feasibility study looked at offshore wind energy potential in favourable areas in the southern Peninsula and Kutch region in Gujarat. In a recent study conducted by WISE (World Institute of Sustainable Energy), the offshore wind potential of Tamil Nadu has been estimated as 127 GW at 80 m height.

2.3 Maritime Zones

There are two main maritime areas in which structures such as offshore wind farms can be built:

- Indian territorial waters, which generally extend up to 12 nautical miles (nm) from the baseline;
- Exclusive Economic Zone (EEZ), beyond the 12 nm limit and up to 200 nm, where under international law, India has right construct structures such as wind farm installations.
- Currently two sites are selected for installation of offshore wind power project, Gujrat and Tamilnadu

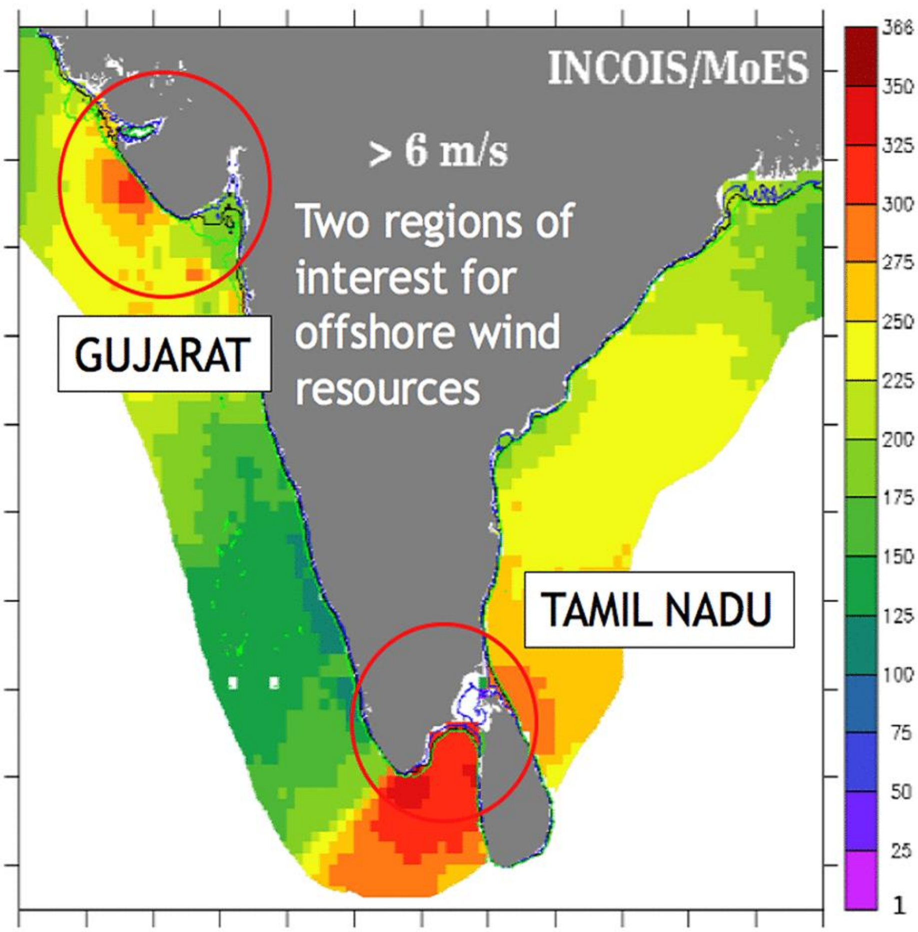

Fig:4 Indian offshore wind conditions showing the number of days per year the mean wind speed exceeds 6 m/s (Source: INCOIS)

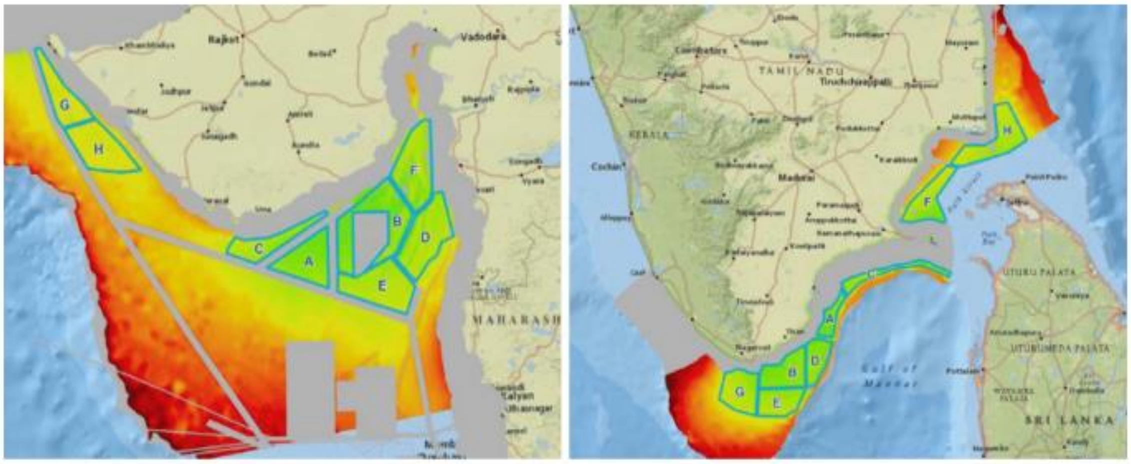

Fig.5 Offshore wind development zones in the waters of Gujarat (left) and Tamil Nadu (right) proposed by the FOWIND project. Green offers the most attractive conditions, whereas red is least favorable (Source: FOWIND)

4.An Emerging Supply Chain Opportunity

While countries like US, UK, Taiwan, Japan are yet to enter the offshore wind domain, plans for offshore wind in India seem certainly ambitious. With the announcement of the draft offshore wind policy by GoI several state government and private agencies are showing interest in this area.

India already has a mature wind turbine manufacturing and wind power industry and many major load centers such as Mumbai, Chennai etc. are near potential offshore zones. Offshore wind clearly presents an excellent opportunity for Indian wind industry to grow and leapfrog to advanced technologies. Moreover, for domestic manufacturing substructures present a major opportunity as it has low technical barriers to entry and requires less technical expertise. The skills, occupations, and qualifications required in the offshore wind sector are highly diverse. Generally, the availability of human capital is limited throughout the supply chain from R&D to O&M. According to the EWEA report 'Wind Energy-the Facts', engineers and experienced and qualified project managers are particularly scarce.

Key Regulatory Interventions to Promote Offshore Wind Manufacturing:

Currently study identifies challenges faced by RE manufacturing in India: (a) Taxes and Duties These issues and required interventions are as follows:

(a) Taxes and Duties

Issues	Short term Impact	Long term Impact	Applicable Technologies	Suggested Interventions by international companies to Govt. Of India	Relevant Agencies
High excise and custom duties on critical raw materials	Medium	High	Wind	• Reduce duties on crucial raw materials such as glass fiber, CRGO/CRNO steel, etc	Ministry of Finance/ Central Board of Excise and Customs
Service tax credit paid on imported sub-parts is not available, since the final product is exempted from excise duty	Low	Medium	All technologies	• Exemption of service tax on supporting services related to (i) installation; commissioning/repairs and maintenance of such exempted products and (ii) evacuation of power from a generation site to the state grid should be exempted from service tax. • Exemption of service tax on import of service (reverse charge mechanism)	

5. Major players in India

A few, like **Acciona, BP Alternatives, CLP Holding/Roaring 40s**, and Wind Energy Industry in India the **Theolia group** active in the global market, have already established bases in India and expect to play a major role in future developments. Indian wind power and energy utilities are increasingly showing interest in setting up wind power projects in India.

Component	Major Global players
Turbine	Siemens, Vestas and Senvion (earlier RE power) with about 95% market share
Foundations	Sif Group and Smulders from the Netherlands, Bladt from Denmark, Weserwind and Cuxhaven Steel from Germany

Vessels	A2SEA, BARD Engineering, MPI Vroon, Seajacks International, HOCHTIEF, DBB, and RWE Innogy
Electrical equipment	ABB, Alstom, Siemens, SEAS transmission, AEI Cables

Key Players in wind India

- Project Developer

Ramboll (www.ramboll-wind.com
GEC - Global Energy Concepts (www.globalenergyconcepts.com)
AWS Truewind (www.awstruewind.com)

- Pure component manufacturer

1.*Rotor / Blades*- LM Glasfiber (www.lmglasfiber.com) ; Sinoi (www.sinoi.de)
2. *Gear-box* –Moventas (www.moventas.com) ; Bosch (www.bosch.com)
3. *Controls*– Mita-teknik (www.mita-teknik.com) ; Ingeteam (www.ingeteam.com)
4. *Generators*– ABB (www.abb.com/windpower)
5.*Towers*– Siag (www.lausitzer-industriebau.de)

- Fully Integrated Service Providers:

Suzlon - INDIA (www.suzlon.com)
GE Energy – (www.gepower.com)
Vestas – (www.vestas.com)

6. Pre- entry Strategies –

1.Determine ***alignment*** with organizational goals & vision
2.Determine ***attractiveness*** of Offshore Wind-farm Business Segment
3. Determine the ***element*** of wind project to enter
4. Evaluate ***synergy*** between existing capabilities and required new capabilities
5. Calculate ***funds*** needed for entry
6.Propose a ***Risk Management*** Plan

7. Offshore Grid Delivery and Ownership Models

There are three main regulatory approaches that have been used to connect offshore wind farms to the onshore grid.

A. Generator model

Under the generator model, the wind farm developer is responsible for the construction of the offshore grid connection and bears its entire cost. In such a model, developers have a high incentive to implement a cost-efficient connection because high cost or low availability directly affects their profits from the wind farm. The greater degree of control exercised by the developer ensures that the construction of the wind farm and the grid connection is coordinated, thereby avoiding the case of stranded assets. However, the generator model also significantly increases the project developers' costs and risks. This model has been used in Sweden for some projects.

B. TSO model

In the second approach, the transmission system operator (TSO) is responsible for extending the grid to reach the wind farm. This model is the dominant method for offshore grid connections in Europe and has been adopted by several countries, such as Denmark, France, Germany and the Netherlands. In Germany, for example, the responsibility for grid connection in North Sea projects is with Ten net TSO and for Baltic Sea projects with 50Hertz Transmission. The developer/operator undertakes the wind farm inner array cabling. The grid connection high voltage cables are laid, owned and operated by the respective TSO. The TSO model in Germany was altered in 2013. In the early years of offshore wind farm development, the government obliged the TSOs to provide a guaranteed grid connection by the time the wind farm reached technical operability. The technical and financial challenges faced by the TSOs caused grid delays exposing developers to financial risks and jeopardized investor confidence in the market. Since 2013, the upgrading of the offshore transmission infrastructure follows the Offshore Grid Development Plan (O-NEP) prepared by the German TSOs and submitted to the Federal Network Agency (BNetzA). This allows for coordinated development and the possibility of wind farms sharing offshore transmission assets. As a result of this change, the developer's right to a guaranteed grid connection has been replaced by an objective, transparent and non-discriminatory allocation procedure

C. Third-party model

The third-party model is the UK's current approach to offshore grid development. A tender is run to appoint a third party as the Offshore Transmission Owner (OFTO) to build, own and operate the connection asset between the wind farm and the onshore transmission network. This model, which launched in 2009, entitles OFTO licence holders to a 20-year revenue stream, subject to a satisfactory performance, indexed to the retail price index (RPI) in the UK. The OFTOs' revenue, which comes from the National Electricity Transmission System Operator (NETSO), is independent of wind farm performance, as the transmission asset owner is only required to ensure its availability, irrespective of actual power transmitted. As the UK was previously working under a generator model, the OFTO regime applies both to the transmission assets acquired from the wind farm developers as well as to the transmission assets newly built by OFTOs. The first license for an OFTO was granted in 2011 and by grid integration study – www.fowind.in

Regulatory Model	Advantages	Disadvantages
Generator Model	The offshore wind farm owner has an incentive to build reliable and cost efficient connections to maximize profit margins. In the EU under the Third Energy Package2 legislation a generation license holder cannot own a transmission	Places a large cost burden on the wind farm owner.

	license and hence cannot own transmission assets.	
	Experienced developers are well placed to manage the development risks and ensure that operational risks associated with the grid connection life time are also minimised.	The developer is required to subsequently sell the transmission assets to a transmission license holder once constructed.
	The grid connection operation and maintenance (O&M) can be integrated with the offshore wind farm O&M potentially reducing costs.	
	End of life decommissioning will be combined with the wind farm decommissioning potentially reducing costs.	
	No offshore interface with the TSO, all offshore assets are owned by the developer and there is no need to segregate wind farm and grid connection assets offshore (interface is onshore).	

Table: 3 Generator Model Advantages and Disadvantages

(The European Union's Third Energy Package is a legislative package for an internal gas and electricity market in the European Union. Its purpose is to further open-up the gas and electricity markets in the European Union. The package was proposed by the European Commission in September 2007, and adopted by the European Parliament and the Council of the European Union in July 2009. It entered force on 3 September 2009. Core elements of the third package include ownership unbundling, which stipulates the separation of companies' generation and sale operations from their transmission networks)

Regulatory Model	Advantages	Disadvantages
TSO Model	Potentially can reduce the cost burden on the Developer if the connection cost is paid for through use of system charges, rather than an upfront charge.	Potentially places a cost burden on the TSO if the connection cost is paid for through use of system charges 3 and financing risk where numerous connections are executed simultaneously by the same party
	The TSO can centrally plan the full network and may have the	TSO is a natural monopoly, the development of reliable and cost efficient connections is dependent

	opportunity to integrate the offshore wind farm grid connection within another strategic network development such as an interconnector or a strategic network reinforcement using an offshore route. Central planning will also be of benefit where there are multiple offshore wind farms in proximity to each other.	on the regulatory regime and regulatory oversight.
	In the EU, the TSO model ensures compliance with the Third Energy Package, hence no requirement for the sale of transmission assets after construction.	TSOs with limited offshore network may not be as well placed as the developer to manage risks and ensure that operational risks associated with the grid connection life time are minimised.
	TSO with substantial offshore grid plans can drive supply chain efficiency savings due to the scale of procurement.	Development, construction and operational risks reside with the TSO. TSO will require suitable regulatory incentives to minimise risks while maintaining cost efficiency.
		The grid connection stranding risk potentially resides with the TSO or the electricity customers.
		There will be an offshore interface with the TSO, which may require segregation of wind farm and TSO assets offshore.

Table.4 TSO Model Advantages and Disadvantages

(In Germany, the TSO, Tennet, had to sell shares in several offshore wind farm grid connection projects to raise the development funds required. Through this process Mitsubishi agreed to become co-financer of four of the transmission cable links.)

Regulatory Model	Advantages	Disadvantages
Third Party Model	Reduces the cost burden on the Developer and the TSO.	Adds complexity to the electricity regulatory regime and the governance arrangements, codes and standards required.
	Typically, a Third-Party Model would introduce competition and downward pressure on grid connection costs compared with the TSO model.	Increased risk of third party business failures impacting on the electricity industry.
	Adds a new market opportunity for businesses. There may be a requirement to reduce third party risks to incentivise investment.	Compared with the Generator model, this transfers certain risk costs from the wind farm developer/owner to the electricity consumer.
	Provides an opportunity for investors looking for longer term investments e.g. pension funds.	Requires the establishment of a competitive O&M service provision market.
	Brings new investment into the energy supply industry.	Adds additional party interfaces compared with the Generator Model and the TSO Model where responsibilities require to be decided e.g. which party is responsible for grid code compliance with the TSO, the generator party or the third party offshore transmission owner.
	Can introduce a party who is specialised in the financing, and ongoing operation and maintenance of offshore grid assets.	
	In the EU, ensures compliance with the Third Energy Package.	Introduces the need for a competitive tender process to award the OFTO license.

Table.5 Third Party Model Advantages and Disadvantages

According to these model No single model is a most perfect solution to developing and operating offshore transmission networks. However, this is an issue that must be clear in the policy laid down for offshore wind farm developments in India since it determines the cost and risks borne by the various stakeholders. For the first few projects, the OFTO (Illustrative Offshore Transmission Owner) model may not be the most appropriate because of the added complexities of running a separate auction. In addition to the generator and TSO model, policymakers in India could also adopt a hybrid of the two, where the developer constructs the offshore transmission network but it is subsequently handed over to the TSO.

8. Recommendations

Barrier	Mitigation	Key Stakeholders
No policy exists for delivery and ownership of offshore transmission systems	Select either generator built or TSO built model for ownership of the first offshore wind projects Initiate a Central Working Group to frame an enduring national offshore transmission policy	CEA, CTU, STUs MoP, MNRE, CEA
No framework exists for offshore transmission network planning.	Initiate a Working Group to evaluate the optimal transmission topology and system planning regime for Gujarat and Tamil Nadu.	CEA, CTU, STUs
There is limited experience in India for the planning, design and construction of offshore transmission systems.	International consultants may fill the gap in the short term. A longer term roadmap for development of local competencies should be devised.	CTU, STUs

Table:6 Offshore Grid Development Recommendations

9. Barriers to Offshore Development in India

(i) Resource Assessment	(ii) Permits and Clearances

• Rough weather and sea conditions as compared to onshore, therefore high risks in resource assessment • High costs of offshore met masts, also much higher costs incurred on seabed assessment and bathymetric studies and Environment Impact Assessment • Lack of reference data, especially over a long-term • Accounting for sea surface roughness and atmospheric stability • Wake effect or losses not accounted for offshore • Proper mapping of fishing and shipping channels and marine mammal movements needs to be done to determine development restrictions	• Naval, Coastguard and Air force clearances may be required stage-wise as India has high threat perceptions from its neighbours when compared to the European countries • Possibility of government interference in the case of any schedule or plan change because of technical reasons from environmental angle, although prior approval may have been taken • There will be restrictions on the nationality of personnel and vessels operating in view of defence, IB regulations & recent cases of marine offence by foreign ships • Fishing community has to be taken into confidence for development because of their livelihood and political influence
(iii) Supply Chain • Offshore wind uses large turbines under a different set of conditions from onshore, therefore, dependence on imports would be more initially • High modulus carbon fibre which is expected to be in short supply would be required for wind turbine blades • Subsea cables are in short supply world over, which may take at least 4 years to ease (EWEA estimate) • Copper for cables, transformers, generators etc. may be a supply constraint in the future • Large casting and forging for bearings, shafts and gearing systems are not manufactured in India. For this reliance will be on foreign manufacturers and suppliers • HVDC power stations to be installed will need heavy electrical equipment and foreign expertise	(iv) Finance, Infrastructure and Human Resources • High capital expenditure is the single biggest factor that deters investors from investing in offshore wind • Risks involved in offshore wind are much higher compared to onshore. Some risks may not even be factored into costs • High interest rates prevailing in India • Bottlenecks in clearances, environmental impact assessment etc. pose additional risks • Development of dedicated ports is required for an offshore industry. Initially ports can be used for mobilization, but later manufacturing ports will need to be developed • Grid availability at port and connection via subsea cables will be a challenge. Balancing mechanisms would be required to incorporate large amounts of wind energy into the grid

• Mostly, large turbines use direct drives and permanent magnet generators. China holds a monopoly • Corrosion-resistant materials for towers. • Planning needs to be accurate in order to avoid cost overruns, because of the weather-dependent schedule • Installation vessels for WTG, sub-sea cable and foundation structures will be a challenge in view of the fact that not all vessels suitable for offshore oil platform installation will be suitable for wind farm installation • No turbine installation vessels in India as of date • Lack of suppliers of foundations and vessels in India	• Space requirement for vessels and assembly on ports • Rail and road access to ports • Operations and maintenance would be much more difficult than for onshore; suitable facilities such as crew boats and helipads for helicopters will be needed in the port. • Technical expertise would be needed for all activities, ranging from resource assessment to planning, construction, installation and operation • Safety is a major issue for offshore wind. Hazardous conditions and rough weather make offshore wind operations a challenging task

10. Government of India Initiatives and Policy

A. Amendment in Tariff Policy

Renewable Purchase Obligation (RPO) was introduced through the Electricity Act, 2003, mandating the obligated entities to procure a minimum percentage of their total energy procurement from renewables. The state regulators declared the requisite RPO level, ranging from 3% to 12%, for the year 2016/17. The amended Tariff Policy notified in January 2016 provides for purchase of renewable energy by different states in more or less the same proportion. The policy further provides for prescribing long-term growth trajectory of RPO by Ministry of Power, Government of India, in consultation with MNRE.The MoP has issued RPO trajectory up to 2019 notifying uniform RPOs across the country. Since the wind power potential is concentrated in 7–8 windy states, to facilitate the inter-state transmission of (wind) power from one windy state to other states, the Tariff Policy provides for waiving of the interstate transmission charges and losses for inter-state sale of wind power.The Ministry of Power (MoP) on September 30, 2016, issued an order for waiver of ISTS charges and losses for wind and solar power subject to the following conditions: I. The waiver is applicable for wind power projects commissioned till March 31, 2019, and for 25 years from the date of commissioning of the projects. Further, the waiver is available for projects having power purchase agreements (PPAs) with discoms for compliance of RPO. II. For solar, the waiver was valid up to June 30, 2017, as per CERC regulations. III. The waiver is only applicable for solar and wind projects awarded through a competitive bidding process.

B. Forecasting and Scheduling

At this juncture, it is important to note that the infirm nature of wind power, attributed to both natural wind fluctuations as well as man-made designs of wind turbine, poses a challenge for grid security and stability. The issue, however, could be addressed through proper forecasting and scheduling of wind power. The CERC has already notified a mechanism for scheduling and forecasting in case of inter-state transmission of solar and wind power. The states of Gujarat, Tamil Nadu, Madhya Pradesh, and Odisha, have already notified draft regulations for intra-state transmission of wind and solar power and the states of Andhra Pradesh, Chhattisgarh, Jharkhand, Karnataka, and Rajasthan have already finalized these regulations. NIWE, Chennai, has undertaken the forecasting and scheduling exercise in Tamil Nadu which has resulted in better management of transmission system for evacuation of wind power in the state and during 2016/17, over 12 BU of wind power was evacuated compared to around 7 BU earlier. Similar initiatives have been carried out in Rajasthan and Gujarat as well. For proper forecasting and scheduling, it is necessary to put in place a metering and communication infrastructure at all pooling stations for real time generation of data.

C. Green Energy Corridors

The maximum wind power potential is concentrated in 7–8 wind resource-rich states wherefrom wind power is evacuated from the resource rich to the off-taker states. This requires strengthening of transmission in intra-state as well as interstate transmission infrastructure. The Green Energy Corridors Project, instrumental in identification of transmission requirement for renewable power capacity addition during the Twelfth Five Year Plan period, is currently under implementation. Intra-state transmission infrastructure projects of total cost over `10,000 crore, in eight states, have already been approved and the central government is providing 40% of the project cost as grant from National Clean Energy Fund and another 40% of the project cost is available as soft loan through the German Bank KfW.

D. Repowering Policy

Most of the wind turbines installed up to the year 2000 are of capacity below 500 kW and are at present located at sites replete with high wind energy potential. It is estimated that over 3,000 MW capacity installations are produced by wind turbines of 500 kW capacity or below. In order to optimally utilize the wind energy resources, repowering is imperative. The main features of the repowering policy are enumerated as follows: ¾ As part of the policy, wind turbine generators of capacity 1 MW and below will be eligible for repowering. ¾ IREDA will provide an additional interest rate rebate of 0.25% for repowering projects. ¾ Benefits available to the new wind projects, that is, accelerated depreciation or GBI as per applicable conditions will also be available. ¾ In case augmentation of transmission system from pooling station onwards is required, the same would be carried out by the respective state transmission utility. ¾ Additional generation could either be purchased by discoms at feed-in-tariff applicable in the state at the time of commissioning of the repowering project or allowed for third party sale.

E. Draft Wind–Solar Hybrid Policy

Research has revealed the complementary nature of solar and wind power and how hybridization of the two technologies will aid in minimizing the variability, apart from optimally utilizing the infrastructure, including land and transmission system. Accordingly, with the objective of providing a framework for promotion of large grid connected wind-solar PV system for optimal and efficient utilization of transmission infrastructure and land, reducing the variability in renewable power generation, and achieving better grid stability, MNRE issued the draft Wind–Solar Hybrid Policy. The goal of the policy, currently pending approval, is to achieve wind– solar hybrid capacity of 10 GW by 2022 and to encourage new technologies, methods, and way-outs involving combined operation of wind and solar PV plants. The states of Andhra Pradesh and Gujarat also issued draft hybrid policies.

F. Wind Bidding Scheme

Out of 302 GW wind power potential in the country, over 297 GW is concentrated in the eight windy states in the country. To enable discoms of non-windy states to fulfill their non-solar RPO obligation through purchase of wind power at a tariff determined by transparent bidding process, a scheme for setting up of 1,000 MW Inter-State Transmission System (ISTS) connected Wind Power Projects was sanctioned by MNRE on June 14, 2016. PTC India Ltd was selected as trading company to sign PPAs with successful bidders and back-to-back power sale agreements (PSAs) with state utilities/bulk consumers under the Scheme. Solar Energy Corporation of India (SECI), the implementing agency of the Scheme, issued tender document on October 28, 2016, and e-reverse auction was conducted on February 23, 2017. The first wind bid was concluded at record low wind tariff of Rs3.46 per kWh of wind energy. The SECI issued letter of allocation (LoA) to the selected five bidders on April 5, 2017, and the projects under the Scheme are likely to be commissioned by September 2018. The wind tariff in India touched the lowest level of Rs. 2.64 per kWh in the second wind auction (1,000 MW) conducted by SECI on October 4, 2017. Wind bidding guidelines under Section 63 of Electricity Act, 2003, are likely to be issued by the Ministry of Power, which will enable the states to bid for wind power projects.

G. Draft National Offshore Wind Energy Policy (available on www.mnre.gov.in)

Objectives:

- To Promote Deployment of Offshore Wind Farms up to 12 nautical miles from coast.
- To Promote Investment in the Energy Infrastructure.
- To Promote Spatial Planning and Management of Maritime Renewable Energy Resources in the Exclusive Economic Zone.
- To Achieve Energy Security and to reduce Carbon Emissions.
- To Encourage Indigenization of the Offshore Wind Energy Technology.

• To Promote R&D in the Offshore Wind Energy Sector.

• To Develop Skilled Manpower and Employment in the industry.

Draft Policy:

Geographical Coverage

• Up to 12 Nautical miles from the baseline – where the sea is relatively shallow (territorial waters)

• R&D activities up to 200 Nautical miles (Exclusive Economic Zone of the country)

Salient Features of Policy

• Preliminary Resource Assessment and demarcation of blocks.

• EIA study of proposed wind farms regarding aquatic life, fishing etc., studies relating to navigation, undersea mining and related exploration/exploitation activities and other users of the sea.

• Oceanographic studies - to determine construction costs for special

foundations, special ships for both operation and maintenance requirements.

• Sea Bed Lease Arrangement.

• Single Window Procedure for Statutory Approvals (NOWA).

• Grid Connectivity and Evacuation of Power

• Technology

• Fiscal and Monetary Incentives

• Security & Confidentiality of data collected during studies and surveys.

10. Opportunity for Taiwanese companies

1.Environmental Awareness

Now a day's environmental awareness has been increased among the population of India. They have started saving energy and trying to reduce pollution. This factor is favorable for the wind power energy as it anoption to thermal power, which is also responsible for polluting the environment. So wind energy is having benefit of no pollution as it produces pollution free wind energy.

2.Government Initiatives

As government has also understood the importance of natural resources, the govt. is in favor for wind energy which uses wind and provide pollution free energy. Govt. of India is supporting firms those provide untraditionalenergy. As a part of this industry Taiwanese companies can gain advantage of govt. initiatives. Govt. is also providing tax exemption on their earnings and also providing subsidies for encouraging investment in backward areas of society to generate employment.

3.Untapped Offshore Market

The rapid technological advancement in offshore wind energy and the decline in cost of installing and running offshore wind farms could power the next wave of adding renewable energy capacity in India. Gone are the times when onshore wind energy made all the news. Now, its counterpart, offshore, is not only making waves, it is also being hailed as one of the most efficient ways to power a nation.

Offshore wind power is becoming increasingly cost-effective with installations close to 14.5 GW at the end of 2016, according to the Global Wind Energy Council (*GWEC*). India has the world's fourth largest onshore wind market with a total installed capacity of over 32.6 GW. "Since the country does have an acute need for large-scale, clean and indigenous energy generation to fuel its rapidly growing economy, offshore wind power could play a very important role here due to the large wind resources available near centers of high-energy demand," GWEC said.

It is great opportunity for Taiwanese company in Indian offshore market as not many competitors in market also government also support is available

4.Steady Growth in Demand

The government has already invited expression of interest for 1GW offshore wind tender in India, and has elicited interest from leading wind players in India and abroad, sources said. Leading clean energy players including Sembcorp Green Infra, ReNew Power, Mytrah Energy and France's Engie, among others have been shortlisted by the government for the technical stage of the tender.

India has the world's 4th largest onshore wind market with a total installed capacity of close to 33 GW. However, India has an acute need for large-scale, clean and indigenous energy generation to fuel its rapidly growing economy. Offshore wind power could play a very important role in India due to the large wind resources available near centers of high-energy demand.

5.Vast coastlines of India and low cost

In India we have a vast coastal line which is very supportive to establish wind mills at lower cost. So this can be a favorable factor for this industry as well as will give an ample opportunity to Taiwanese companies to extract more from this natural presence.

Cost component	Project lifetime costs, %	Pilot project opportunity		Mature project opportunity	
		Local	International	Local	International
O&M minor service	20	medium	medium	high	low
O&M other	12	low	high	medium	medium
other including development	12	low	high	medium	medium
drivetrain	8	low	high	medium	medium
foundations	8	high	medium	high	low
blades	7	medium	high	high	medium
substations	7	high	medium	high	low
O&M major service	7	low	high	medium	high
foundation installation	5	low	high	high	low
tower	4	high	low	high	low
turbine other	4	medium	medium	high	low
subsea cable installation	4	low	high	medium	high
subsea cables	3	low	high	medium	high

Table 7: Offshore wind farm costs and supply chain opportunities in the pilot projects

11. Threats to Taiwanese companies:

1.Intense Competition

The govt. of India has approved FDI limits up to 74%. This can be favorable factor for the whole industry, but for Taiwanese companies it is a threat. Thought is a market leader; its technology efficiency is not up to the mark as compared to global giants like VASTAS. So entry of global players will affect Taiwanese companies a lot.

2.Foreign Exchange Risk

As Taiwanese companies is having a global presence in field of the offshore wind, there is default risk of exchange rate fluctuations. As the exchange rates are fluctuating highly since last couple of years, it has become riskier for Taiwanese companies to do business in India.

3.Technology Risk

Earlier technology was not become obsolete so fast, but currentlytechnological development is v ery fast and new technology is beenintroducing in to the market very fast. So the company has to implement the new developed technology to compete in the market where it is having more corporate customers who generally know the product very well before using it.

12. Key Challenges for Offshore Wind in India

- Given the (relatively) nearshore profile of the offshore wind zones identified there are no significant technical barriers to the design and construction of their associated offshore grid connections. Smaller, pilot projects close to shore may connect via direct MVAC connections in the first instance, but it is likely that HVAC will become the preferred connection technology choice as the industry matures.

- Whilst offshore transmission systems are similar to onshore systems in their general principles there are certain key differences in their relative costs and specific implications of their characteristic design; e.g. presence of large quantities of submarine cable.

- The offshore electrical industry is relatively mature worldwide and therefore there is competence and capability in design of offshore power systems available, and it is recommended to tap into this experience to build capability in offshore power systems within key stakeholders in the Indian industry in anticipation of delivery of the first projects.

- The preferred grid topology should be carefully considered, and this will be closely influenced by the chosen offshore transmission delivery and ownership model. Early projects are likely to connect in an incremental, radial fashion however this may not be the long-term optimum model. However, a higher level of coordination between the planning of multiple offshore grid connections and the onshore transmission system requires that a more centralized offshore grid planning function be defined.

- Whilst an illustrative 500MW offshore grid connection is presented, it should be noted that variation of any parameters (size, location, connection point etc) is likely to influence the system design and this should not be taken as a default ‘blueprint’ for the design of offshore wind grid connections in India. There is likely to be scope to further optimize the interface between the onshore and offshore power systems.

• The policy on the delivery and ownership of the offshore transmission network needs to be a high priority since it determines the cost and risk structure for the project developers and the TSOs.

13. Various stakeholder overview in Indian power sector

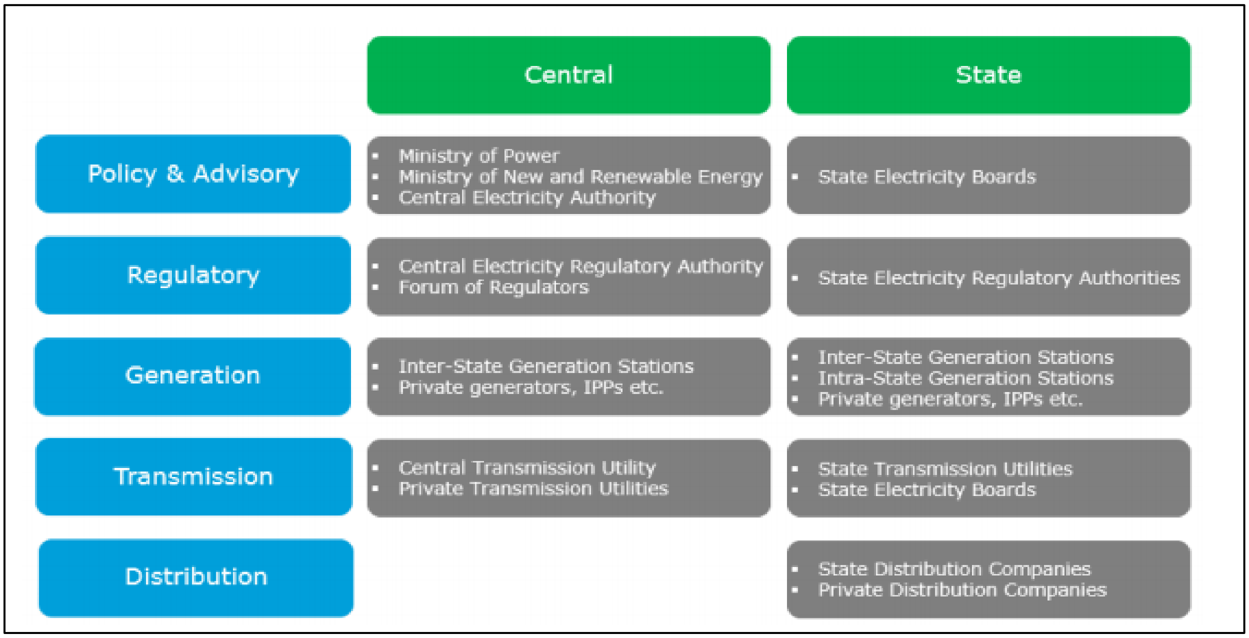

Fig. 6 Stakeholder overview in Indian power sector

Central Government stakeholder

stakeholder	Role
Ministry of New & Renewable Energy	MNRE is the nodal ministry for the development of offshore wind power in India. It drives the development of renewable energy sector in India. MNRE issues guidelines/directives and provides necessary guidance to NIWE. MNRE will be responsible for drafting the auction/market mechanism guidelines for the sector.
Ministry of Environment, Forest and Climate Change (MoEF)	MoEF is the nodal agency for the India’s environmental and forestry policies and program The role of MoEF would be to provide clearances and provide the guidance for the rules of environ- mental impact assessment for offshore wind projects and promulgate the necessary coastal zone regulations.

Ministry of Finance (MoF)	MoF would allocate the finance for offshore wind power development in budgets and brings amendment in case of tax exemption\ and other financial incentives.
Ministry of Civil Aviation (Director General of Civil Aviation)	Ministry of Civil Aviation is nodal ministry for civil aviation. It will issue clearances related to air traffic route and air safety.
Ministry of Petroleum and Natural	MoPNG provide clearances for utilization of seabed outside the oil and gas exploration zone and pipeline route. The experience of Ministry of implementation of projects in offshore exploration can be utilized for offshore wind power development
Ministry of Shipping (MoS)	MoS provide clearances to operate outside the international and national sea route, utilisation of national port, and permission for utilisation of vessels and ships for the offshore wind power projects.
Ministry of Defence (MoD)	Relevant Naval command would need to clear all movement and exploratory activities in strategic areas offshore prior to their commencement. MoD would need to provide clearance for any construction work happening on Indian seabed. Here NIWE could provide blanket permits for activity packages for project development as the nodal agency.
Ministry of Home Affairs (MoHA)	MoHA would provide security clearances, permission to utilization of seabed, for offshore wind farms
Ministry of Communication & Information Technologies (Department of Telecommunication)	DoT would provide the NoCs for utilization of seabed outside the seabed telecommunication cable route
Ministry of Earth Science	Ministry of earth science will deal with science and technology for exploration and exploitation of ocean resources and play a nodal role in Western and Southern Ocean research.
Central Electricity Regulatory Commission (CERC)	CERC would issue guidelines and policies related to offshore wind such as, but not limited to, tendering mechanism, power procurement, tariff determination, transmission, open access, power market etc.

Central Electricity Authority (CEA)	CEA would specify the technical standard for electrical lines and grid connectivity, safety stand- ard for construction, operation and maintenance of electrical lines.
National Institute of Wind Energy	NIWE as specified in offshore wind power policy is responsible for standardization and certifi- cation of wind turbines, research and development, Wind resource development and will be the nodal agency for the development of offshore wind.
Power Grid Corporation (PGCIL)	PGCIL would determine the availability of transmission facilities and would plan and coordinate all functions related to interstate transmission systems and will manage the offshore sub- stations

State Government

stakeholder	Role
State Government	State Govt. would provide clearance for working in coastal economic zone
State Electricity Regulatory Commission (SERC)	SERC would determine tariff, approve tendering documents, validate power purchase agree- ment, regulate electricity purchase, decide renewable purchases obligation, facilitate intrastate transmission and wheeling, specify grid code at the state level
State Maritime Board	SMB would provide permission for utilization and development of minor port, and related infra- structure for offshore wind development
State Transmission Utility (STU)	STU would provide permission to utilize the onshore state transmission line, provide infrastruc- ture support for onshore grid connectivity, operation and maintenance of grid
Department of Environment & Forest	DoEF would provide clearances related to environmental impact for activities on the coastal areas
State Fisheries Department (SFD)	Fisheries department issue clearances on no impact on fisheries zone due to offshore wind project after impact assessment process
Power Distribution Company (DISCOM)	Distribution utilities would sign the power purchase agreement, provide infrastructure for local distribution

District, Taluk and Village Level for Planning Stages Including Civil Society

stakeholder	Role
District Collector office (DC)	DC office will issue land use permits and conduct public hearing for environmental impact as- sessment
Gram Panchayat (Local Self-governing Body)	Gram Panchayat will provide clearances for the use of land in the coastal areas. Also it can be involved to create awareness and engage in discussions with villagers through gram sabhas.
Civil Society	Civil society representatives would participate in public hearings and express their concerns on impact of offshore wind on employment, environment and health on local population. Civil societies may include NGOs, environment and nature protection groups, local industrial bodies, local tourism committees, trade unions, etc.

R&D Community

stakeholder	Role
National Institute of Wind Energy	NIWE as specified in offshore wind power policy is responsible for standardization and certifi- cation of wind turbines, research and development, Wind resource development and will be the nodal agency for the development of offshore wind. NIWE could also lead the R&D Community in promoting cutting edge research to lower the COE from offshore wind farms in India through indigenisation of various aspects of the development cycle.
INCOIS	INCOIS is an autonomous body under Ministry of Earth Science. It would provide information ensuring appropriate marine zone planning – accounting for potential fishing zones, marine meteorological advisory and weather forecasts etc.
National Institute of Ocean Technology (NIOT)	NIOT is an autonomous body under Ministry of Earth Science (MoES). A key focus of NIOT is to develop reliable indigenous technology to solve the various engineering problems associated with resources in the Indian Exclusive Economic Zone (EEZ). NIOT has been associated with FOWIND as an advisor to the NIWE for LiDAR platform design and installation in Gujarat since 2016.

National Institute of Oceanography (NIO)	NIO is one of the constituent laboratories of the Council of Scientific & Industrial Research (CSIR). It conducts research and studies on observing and understanding the special oceano- graphic features of the North Indian Ocean. These studies include oceanographic data collection, environmental impact assessment and modelling to predict environmental impact. The institute also provides consultancy on a number of issues including marine environmental protection and coastal zone regulations. They could be tasked with undertaking widespread geotechnical and geophysical surveys for the Indian seabed in relevant areas of interest in the Indian EEZ.

14. Conclusions

India has made a committed start on its journey towards an offshore wind industry that has the potential to generate significant amounts of carbon-free, affordable and secure power. Important steps are being taken to fill in the existing, broad policy framework, and planning for the first projects is underway. India's initial projects will be critical: technological and commercial success coupled with public support will add momentum and confidence to the offshore wind programme. It will also see the cost of electricity from offshore wind reducing as technology improves, the local supply chain drives down capital and operational costs, and growing investor confidence pushes down the cost of finance.

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