Indian Wind Power

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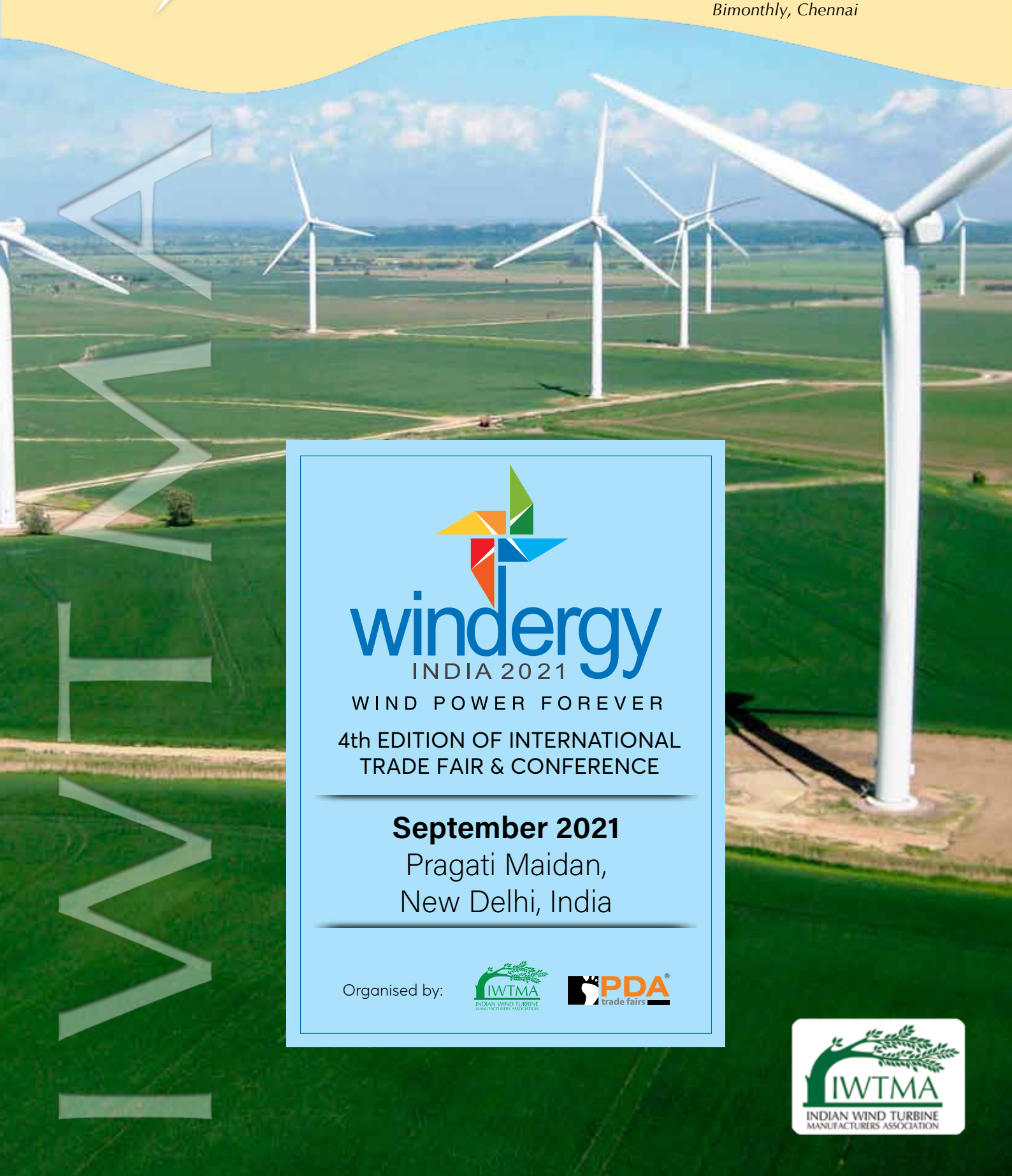

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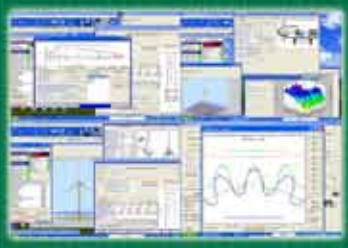
- Seminar / Workshops on Wind and Solar Energy



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IWTMA
INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

Indian Wind Power

A Bi-monthly Magazine of Indian Wind Turbine Manufacturers Association

Volume: 6 Issue: 5 December 2020 - January 2021

Contents

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IWTMA
INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

From the Desk of the Chairman – IWTMA

Dear Readers,

Greetings from IWTMA!

I take great pride that the largest democracy in the world, India, which is also one of the biggest manufacturers of pharmaceuticals, has not only rolled out Covid-19 vaccination for the country but also helped many countries in a path-breaking initiative by our Hon'ble Prime Minister and Government of India. Having said that, the pandemic is not yet over and we are witnessing an aggressive second wave, making it critical for us to be extremely cautious and to follow the protocol of wearing masks, social distancing and sanitization religiously.

As we close this financial year, unfortunately, there isn't much to celebrate as far as the capacity addition of wind energy and the business is concerned. While there was a setback due to the pandemic, the slowdown of the renewable energy industry had started from 2017 and it is absolutely vital and necessary to review the business environment in all aspects to achieve the targets set out by the Government of India. The overall ecosystem of renewables right from the Original Equipment Manufacturers who have brought in sophisticated technology, the component manufacturers who have given robust support in the supply chain and the MSME industry, is under tremendous stress today. It is particularly challenging when we have an installed manufacturing capacity of 10 GW of presumably one of the lowest cost WE equipment in the world, but are reduced to chasing a market of 1.5 GW per annum. This translates to just about 15% capacity utilization.

The unprecedented increase in cost of commodities such as steel, copper and aluminum has raised the cost of wind turbines by approximately ₹ 40 to 50 lakhs per MW which is ill-afforded in the current slowing market. The steep increase in the prices of petroleum products which will have a cascading effect on cost of all commodities and services will further affect capital goods industries like wind energy.

It is but reasonable that DISCOMs who are already financially strained are looking for the cheapest rate of electricity. The discovery of solar tariff at ₹ 1.99 has driven some earlier bided projects to cancellation. DISCOMs have expressed the expectation of renewable energy costs being at par or lower than the variable cost of fossil fuels. It seems unfortunate that concerns of climate change, global warming and rising air-pollution are still not driving the markets in India.

There are a number of opportunities for capacity addition other than the Centralized Procurement such as discovered tariff for retail investment, ISTS waiver for Open Access and Uniform Wheeling & Banking for Captive and Group Captive use. Government may think of reopening investment opportunities for profit making 'Navaratnas' and 'Mini Ratnas' to set up wind farms for their captive requirements which were highly successful in the past. This will be very similar to a scheme for procurement of power under CPSU scheme. Innovative steps are required in power demand creation to enhance per-capita consumption of power both in the domestic and commercial segments.

The industry is fully aware of energy being a concurrent subject. The industry specific three recommendations to further strengthen the sector are:

a) Mandating RPO for wind separately as done for solar and hydro
b) Performance Linked Incentive (PLI) for wind industry to bring in bigger megawatt size turbines to reduce Levelized Cost of Energy (LCOE)
c) Implement Wind-Solar Hybrid in the CPSU Scheme which is restricted to solar alone.

The industry is confident of adding 2.5 GW per annum over and above the bid procurement by opening up the market as per the suggestions given above. This will help to maintain the present level of localization with around 70 to 80% which is difficult to achieve with a 1.5 GW annual market as it has been for the last four years.

I have been an eternal optimist and my belief in the power of renewable energy is unflinching. I believe renewable energy is not just beneficial in itself; it is actually a catalyst for transformation across all sectors.

So, while this financial year closed on a very subdued note, I am confident that we will collectively work as an association with the government to resolve the obstacles and pave the path for renewed growth and enthusiasm in FY 21-22.

With regards,

Tulsi Tanti

Chairman

Governance of Indian Electricity Supply System – Observations on Financial Turnaround of DISCOMs

A. Velayutham
Former Member
Maharashtra Electricity
Regulatory Commission

1. Regulatory Aspects of Power Sector

1.1. The Electricity Supply System in India was governed by the Indian Electricity Act, 1910 prior to Independence. It created the legal framework for laying down of wires and other works relating to the supply of electricity. The Act envisaged the Electricity Industry growth is through Private Licensees.

1.2. Post-independence, the Electric (Supply) Act, 1948 mandated the creation of State Electricity Boards (SEBs). States, through SEBs have to extend supply to all. Development of Electricity System was through SEBs and through plan funds. The expansion and growth of the sector was through successive five year plans. Central Sector supplemented the effort of SEBs in Generation and Transmission from the mid-1970s. SEBs financial management was not to the desired level, tariff not related to cost of operation, free power or subsidised power with no commercial outlook. SEBs could not pay the fuel/ generation/transmission bills of Central Public Sector Undertakings (CPSUs).

1.3. In the reforms era, Government of India (GOI), inter alia, to ensure distancing the government from fixation of tariff and to attract private investment, initiated measures to the enactment of the Electricity Regulatory Commission Act, 1998. Later for harmonising and rationalising the provisions in the Indian Electricity Act, 1910, the Electric (Supply) Act, 1948 and the Electricity Regulatory Commission Act, 1998, a consolidated new Electricity Amendment Bill 2001 was submitted.

1.4. The Electricity Bill 2001 was introduced in the Lok Sabha on 30/08/2001. The bill was referred to the Standing Committee on Energy for detailed examination and report. The committee invited views of experts, individuals, consumer activists, state governments, SEBs, trade and officers unions, Ministry of Power (MOP), Central Electricity Authority, industry and commerce bodies etc. After taking into account all their views, the Committee submitted its report to the Parliament. The bill was well debated and passed by Lok Sabha & Rajya Sabha. After obtaining President's Accent, the Electricity Act 2003 (EA 2003) was notified on10th June 2003. The Electricity Act 2003 was considered as the Reform Act. The earlier Acts, the Indian Electricity Act, 1910, the Electric (Supply) Act, 1948 and the Electricity Regulatory Commission Act, 1998 were repealed. Some of the provisions of Electricity Act 2003 were amended vide Electricity (Amendment) Act, 2003 & Electricity (Amendment) Act, 2007.

1.5. Later Electricity (Amendment) Bill 2014 was introduced in the Lok Shaba on 19.12.2014; the bill was subsequently referred to the Standing Committee on Energy for examination and report. The committee has submitted its report on 7.5.2015. Based on Committee report and further consultation, the draft Electricity (Amendment) Act 2018 was prepared and the same was circulated by MOP vide letter dated 07.09.2018 for stakeholder consultation. However the Electricity Amendment Bill lapsed.

1.6. Again the draft Electricity (Amendment) bill 2000 is under discussion with Stake holders.

1.7. Financial viability of entire power sector depends on the financial viability of distribution sector. Keeping in view the importance of the issues, GOI/MOP had initiated measures to improve the performance of Distribution Sector since reform era. The same is further discussed.

2. Government of India/Ministry of Power Initiatives to Improve DISCOMs Finance since Reform Era

2.1 Montek Singh Ahluwalia Committee Report

- By the year 2000, due to deteriorating financial conditions, SEBs could not honour the power bills of Central Public Sector Undertakings (CPSUs). That affected CPSUs finance and its functioning. Government constituted an Expert Committee under the Chairmanship of Shri M.S. Ahluwalia (the then Deputy chairman Planning Commission) to address the issue.

- As per the Ahluwalia committee report, SEBs owed about Rs. 41,473 Crore to various CPSUs and the Indian Railways as on February 28, 2001. This amount consisted of Rs. 25,727 Crore of principal payment and Rs. 15,746 Crore by way of interest on delayed payments. Proposed one-time settlement of out standings of SEBs to CPSUs.
- The Empowered Group consisting of state Chief Ministers, Deputy Chairman Planning Commission, the Union Finance Minister and Power Minister, which deliberated on the Ahluwalia Committee Report, called for waiver of 60 per cent interest on delayed payments for the participating States. The remaining 40 per cent of the interest and the full principal amount was to be securitised through bonds issued by state governments.
- As a part of the settlement, the states/SEBs should accept the reforms such as setting up SERC, metering feeders and increasing revenue realizations. Memorandum of Understanding (MoU) by each of the State Governments would be entered with Ministry of Power for this.

The Cabinet Committee on Economic Affairs (CCEA), gave its approval to the scheme, proposed by MOP, one-time settlement scheme of the out standings/securitisation of past dues of SEBs to CPSUs, as per the recommendations of the Montek Singh Ahluwalia committee.

2.2 Shunglu Committee Report

- The Planning Commission had appointed a High Level Panel headed by Shri V. K. Shunglu, former Comptroller & Auditor General in July, 2010 to look into the financial problems of SEBs and to identify corrective steps.
- The Shunglu Committee presented its Report to the Deputy Chairman, Planning Commission on 15th December, 2011. The salient features of the Report, inter alia, includes:
  - The accumulated losses of Government DISCOMs for the preceding 5 years (2006-10) is Rs.1,79,000 crore before subsidy and Rs. 82,000 crore after subsidy.
  - These losses are primarily on account of poor managerial and operational practices of distribution companies compounded by irrational tariffs fixed by regulators. There is gap between the average cost of supply and the revenue realised

2.3 Accelerated Power Development Program (APDP) / Accelerated Power Development Reform Program (APDRP) / Restructured APDRP Schemes for Financial Turnaround of DISCOMs

2.3.1 Considering SEBs poor financial health, aiming financial turnaround in the sector, MOP, GOI launched Accelerated Power Development Program (APDP) in 2000-2001. Wherein additional central plan assistance was made available to States undertaking distribution reforms in a time bound manner by signing MOU with MOP, up-gradation of sub-transmission & distribution network (below 33 KV or 66 KV) including energy accounting & metering. 100% of metering to be completed in a planned manner.

2.3.2 In March 2002, APDP was renamed as Accelerated Power Development Reform Program (APDRP) with urban focus & introduction of reforms element. Incentive scheme was introduced for utilities achieving cash loss reduction. The AT&C losses during this program were reduced from 38.86% in 2001-02 to 29.24% in 2007-08.

2.3.3 MOP, GOI launched Restructured APDRP (R-APDRP) in July 2008 with revised terms and conditions as a Central Sector Scheme for XI Plan. Salient features - demonstrable performance in terms of sustained loss reduction, establishment of reliable and automated systems for sustained collection of accurate base line data for revenue & energy.

2.4 UDAY (Ujwal DISCOM Assurance Yojana) for Financial Turnaround

- Ministry of Power vide office memo dated 20/11/2015 notified UDAY (Ujwal DISCOM Assurance Yojana) Scheme for the financial turnaround of DISCOMs with an objective to improve the operational and financial performance of State owned DISCOMs.
- Features of the Scheme, inter alia, includes:
  - States will take over 75% of the DISCOM debt as on Sept 30, 2015 - 50% in FY 2015-16 and 25% in FY 2016-17.
  - States to issue non-SLR including SDL bonds, to take over debt and transfer the proceeds to DISCOMs in a mix of grant, loan, equity.

2.5 Budget 2021 (Extract from the copy of Budget Speech)

The viability of Distribution Companies is a serious concern. A revamped reforms-based result-linked power distribution sector scheme will be launched with an outlay of Rs.3,05,984 Crores over 5 years. The scheme will provide assistance to DISCOMS for Infrastructure creation including pre-paid smart metering and feeder separation, upgradation of systems, etc., tied to financial improvements.

3. DISCOM Performance - Analysis and Observation

3.1 CAPEX Schemes and Power Purchase Agreement (PPA)

- Capital Investment is required to be made by Licensees for various purposes like the creation of new infrastructure to meet load growth, to meet statutory requirements, to strengthen the existing system and increase its efficiency, replace old/obsolete assets, any such capital investment increases the capital base and consequently the reasonable

return thus affecting the tariff to consumers. It is therefore necessary to ensure that such capital investment schemes being proposed are necessary and justified, and do not impose an unnecessary burden on consumers by way of tariff. Once the capitalisation is achieved, the benefits actually accrued to the system should be captured and submitted to the Regulator in accordance with the guidelines specified.

- CAPEX (Capital Expenditure) have to be prepared with objective and scope. Regulator has to approve CAPEX scheme after prudential check.
- PPA should have all relevant clauses to safeguard the interest of Supplier and Purchaser. All approval of long-term/medium-term PPA, arrangement has to be obtained from Regulator. PPA provisions have to be honoured.
- Cost effective implementation of CAPEX may bring down tariff. Effective performance of Utility may earn for the organisation and incentives to employees.

3.2 Distribution Loss and Metering

- Electrical energy is a commodity. Purchaser is to pay for the commodity. Utility have to ensure the reliable quality supply to the ultimate consumer. If the energy bill is not paid by a consumer (including government offices), the connection has to be disconnected.
- In National Electricity Policy and National Tariff Policy, the term 'AT & C loss' is used in the place of 'Distribution loss'. 'AT & C loss' is the Aggregate Technical and Commercial loss, includes collection efficiency as a part of Commercial loss. If the non-receipt of raised bills is regularised under Distribution loss, this may result in higher tariff, burdening the honest (paying) consumer. As AT & C loss includes collection efficiency component, this shall not be permitted in a Regulator governed system. It is suggested that the term 'AT & C loss' may be replaced with 'Distribution Loss.'
- Commercial component, if any, excluding collection efficiency, may be addressed by State Electricity Regulatory Commissions (SERCs) during performance evaluation. SERCs need Distribution loss data at the time of computing ARR. Only technical loss has to be permitted as Distribution loss. Commercial loss, if any, has to be identified and be made nil in a time bound manner.
- To assess accurate distribution loss, 100 % metering of individual consumers including agriculture have to be completed, also Distribution feeder level & Distribution Transformer level metering have to be in place. It is further added that accurate distribution loss assessment would help evaluate energy efficiency, also evaluating correct subsidy component.
- 100% metering and Distribution loss with allowable technical loss, may help improve the finance of DISCOMSs and the reduction in consumer tariff.

3.3 Annual Revenue Requirement (ARR)/Tariff/ Subsidy

- In EA 2003, Tariff and Subsidy is addressed in sections 61 to 65. Government is to distance from the tariff fixation. Tariff fixation is prerogative of ERCs. Tariff is decided by ERCs based on the petition filed by DISCOM licensees and through public process in a transparent manner. ERCs compute ARR and the cost reflective tariff is determined based on ARR. Subsidy element is identified/addressed.
- Poor financial health is not attributable to gaps in EA 2003 provisions related to Tariff/subsidy. However it is attributable to lack of implementation of Act provisions. DISCOMs have to maintain account system in a transparent way as per guide lines of ERCs.
- Annual Revenue Requirement (ARR) evaluation identifies Average Cost of Supply based on net sales expected. Tariff is computed to recover total ARR. Subsidy is a policy decision by the Government and the government is to pay the subsidy as per Act provisions. Subsidy shall not be paid at the cost of DISCOMs.
- EA 2003 has listed the powers of ERCs under sections 94 & 94 and functions of SERCs in section 86. SERCs have to exercise the power to improve performance of Distribution Sector, as per EA 2003 provisions. Centre and State Governments have contributed to the performance of DISCOMs; reputed consumer activists have contributed to protect consumer interest.

3.4 Analysis and Observation

- Since reform era, MOP/GOI have made number of initiatives to improve the financial health of DISCOMs. These include onetime settlement of dues, grant, bond issues, MOUs with Utility/Government for implementing reform measures through APDP/APRDP/R-APRDP and UDAY Schemes. EA 2003, the Reform Act have enough provisions to improve the finance of DISCOMs. Even with all these measures the DISCOMs debt level of about Rs.40000 Crores during the year 2001 have gone above Rs.7 lakh crore at present (year 2021).Budget 2021 have mentioned about the launching of schemes to improve the finance of DISCOMs as mentioned at para 2.5 above.
- Performance of individual DISCOMs is being computed by ERCs. Private distribution licensees are performing well. Some of the government DISCOMs and Electricity Departments have managed their distribution losses within permissible limits; also their financial performance is better. Their better performance is partly attributable to performance of Utility, absence of Government interference/political economy factors etc.
- As regards license conditions, it is same for private and government companies. If the governance is better, government distribution companies can do better. In

India, CPSUs have managed their operation and finance performance well.

- Privatisation/delicensing of DISCOM are being discussed as possible solutions to improve distribution sector. Private distribution licensee is recognised in EA 2003. Better performed government distribution companies/electricity departments may be allowed to continue. EA 2003 has provisions to deal with underperforming Distribution licensees. Action may be initiated accordingly.
- The Electricity Act 2003, National Tariff Policy and National Electricity Policy have provisions to improve the financial health. We should have the will to implement the same. CEOs of Government DISCOMs should be given functional freedom and be made accountable for the performance. Distancing the government from tariff fixation and giving functional freedom to DISCOMs may be ensured.

4. Final Observation

4.1 Distribution Loss & Metering

- It is suggested that the usage of term 'AT & C loss' may be replaced with 'Distribution loss'. Distribution loss may contain technical and commercial loss components. Ideally distribution loss should contain only technical loss component. Billing and collection efficiency shall not form part of commercial loss. It may increase tariff and burden the honest (paying) consumers. Commercial loss, excluding billing and collection efficiency, may be monitored and be made nil in a specified time period.
- 100% metering is essential to enforce accountability, loss reduction, energy erfficiency assessment, correct subsidy calculation etc.

4.2 Improving the Financial Health of DISCOMs

- Financial health of DISCOMs has to be addressed on top priority. Financial viability of entire power sector depends on financial viability of distribution sector.
- Cost effective implementation of CAPEX may bring down tariff. Effective performance of Energy Efficiency and Demand Side Management may improve the finance of DISCOMs. Utility may earn for the organisation and incentives to employees.
- DISCOM licensees may be of Private or Government owned. Privatisation may not be forced on the distribution sector. Better performed government distribution companies/ electricity departments may be allowed to continue. EA 2003 has provisions to deal with underperforming Distribution licensees. Action may be initiated accordingly.
- CEOs of Government DISCOMs should be given functional freedom and be made accountable for the performance. Distancing the government from tariff fixation and giving functional freedom to DISCOMs may be ensured.
- Political economy factors shall not be permitted to reduce the revenue of DISCOMs. Needy consumer may be given subsidy as a part of policy decision by the government and the government is to pay the subsidy as per Act provisions. Subsidy shall not be paid at the cost of DISCOMs. Cost of supply would be fully recovered by way of tariff in a Regulator governed System.
- ERCs may exercise their power to ensure DISCOM licensee discharge duties as per Act, Policy, Regulation and license conditions.

  Reliable quality power (50 Hz frequency) at the cost determined by Regulator may be ensured to the ultimate consumers.

India Fastest Renewable Energy Growing Market Globally: Orix

Mr. Hidetake Takahashi, Head of Energy Biz Orix has said that the long-term Indian renewable market is very promising and is one of the fastest growing around the world. The senior leadership team of Tokyo-based Orix is familiar with the vagaries of the Indian market, having being present locally since 2016 when it had acquired 49% of IL&FS's wind energy portfolio.

Source: *Economic Times, 23 March 2021*

Centre Enables Discoms to Relinquish Legacy PPAs

The Centre has issued directions to enable power distribution companies to exit power purchase contracts with old central utilities-run stations, freeing up nearly 20 Gw capacity that can enter into short and medium term tie-ups or sell on exchange. The choice has been given to the power distribution companies to continue or exit PPAs that have completed their 25-year term and allowing the generators to sell electricity in any mode. The old PPAs consist mostly of those between discoms and power plants of NTPC, NLC India, Damodar Valley Corp and state generation companies.

Source: *ET Bureau, March 25, 2021*

ReNew Power Commissions 300-MW Wind Farm in Gujarat

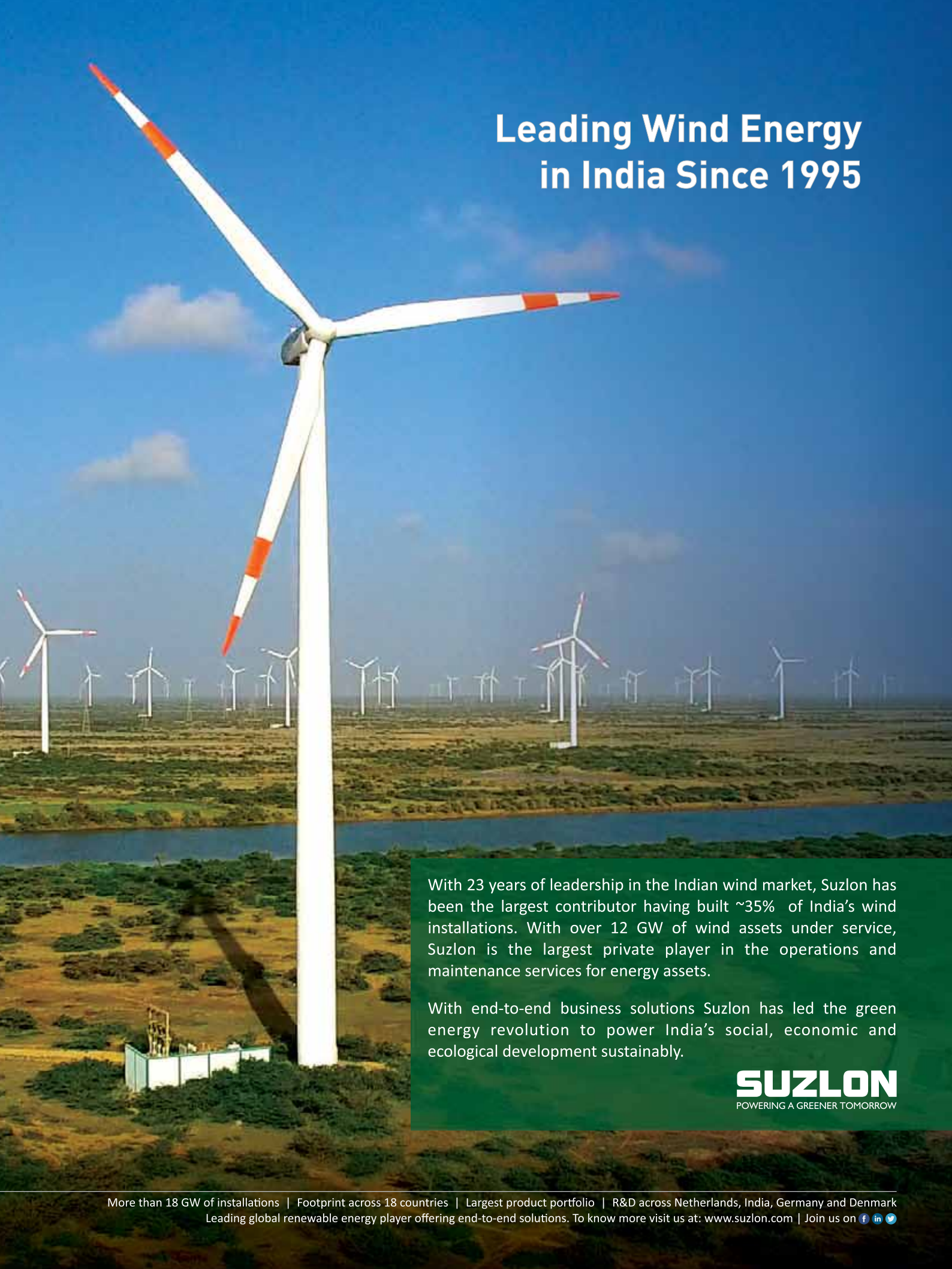
Renew Power has commissioned a 300MW wind power generation facility at Kutch, Gujarat. The project would provide clean power to Haryana and Orissa at a rate of Rs 2.44 per unit and would also provide direct employment to over 200 people.

Source: *ET Energy World, March 26, 2021*

100% Green Energy Option at 66 Paise Extra for a Unit in Mumbai

In a first, power users in the state have the option to go for 100% renewable energy supply by paying an extra 66 paise a unit for 'green power tariff' which was approved by MERC. MERC's order said all users (extra high voltage, high voltage and low voltage) will be eligible to opt for 100% renewable energy (RE). Such an option will also help increase awareness among consumers about use of renewable energy and support goal of integrating renewable energy. A power company official said that even low-tension residential users can opt for green energy at extra cost. The order will be applicable to Tata Power, Adani Electricity, BEST and MSEDCL supply area.

Source: *TNN, March 27, 2021*


Leading Wind Energy
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With 23 years of leadership in the Indian wind market, Suzlon has been the largest contributor having built ~35% of India's wind installations. With over 12 GW of wind assets under service, Suzlon is the largest private player in the operations and maintenance services for energy assets.
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Meso & Micro Scale Mapping Under National Wind Resource Assessment Programme of India (NWP)



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Deputy Director (Technical)

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Dr. Rajesh Katyal
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Wind Solar Resource Measurements/Offshore (WSOM) Division
National Institute of Wind Energy (NIWE), Chennai

India is blessed with abundant renewable energy (RE) resources like solar, wind, hydropower, biomass, etc., and has leaped in renewable energy capacity additions in the last few years as part of the country's commitment towards sustainability. With more than two decades of experience, the wind sector occupies an important place in our renewable energy portfolio. To substantiate this fact, during 2018, India was ranked as the fourth most attractive renewable energy market in the world and declared as one of the largest wind energy markets in the world. By December 2020, about 91 GW renewable energy based capacity has already been installed in the country which represents 15% of India's installed capacity. Out of total renewable energy capacity, wind energy represents a significant share i.e., about 43% of the renewable energy portfolio. Indian wind energy sector is more than two decades old and the Indian wind industry represents a successful 'Make in India' narrative with all wind turbines being made in India and over 80% of the components manufactured indigenously. The installed capacity in India has grown on an average of 20% over the last twenty years.

Besides, the Government of India had also pledged that the share of non-fossil fuel shall be increased, and by 2022 India's renewable energy capacity would be increased to much beyond 175 GW and later 450 GW by 2030. Hence, it can be inferred that the intentions and ambitious targets of the Government of India are highlighting the needed focus on the green power's contribution to India's sustainable development. India is not only committed to refine and strengthen the business and regulatory framework governing wind power in India but also to provide the necessary and reliable information on RE resources across the entire country. Hence, reliable information on the availability of renewable resources play a major role in achieving these targets and with this agenda, Ministry of New and Renewable Energy (MNRE), Government of India through National Institute of Wind Energy (NIWE), Chennai have been implementing National Wind Resource Assessment Programme (NWP) since 2001. Figure 1 illustrates the list of activities carried out under NWP.

Brief Background on Meso-scale Mapping

The successful development of wind energy requires a thorough understanding of the wind resource – in effect, an accurate climatology of the wind at a high spatial resolution. In the early years of the wind industry – 1970s and 1980s – such assessments were done mainly using field techniques, combined with a practical understanding of large scale wind patterns and the effect of topography on wind flow. While often very effective, these techniques suffered from a lack of transferability; expertise in one region did not always translate into expertise in another.

During 1980s and 1990s, a variety of computer modelling techniques emerged. Several involved equilibrium microscale wind flow models, the most prominent example being the Wind Atlas Statistical Package, or WAsP, developed by the RisØ National Laboratory of Denmark based on the theory of Jackson and Hunt (1975). This model creates a wind map and climatology of a region using data from a single reference mast. It and its cousins (MS-Micro, WindMap and others) are best suited to estimating the wind resource in areas of simple to moderate terrain slopes at distances of up to tens of kilometers from the reference mast (Bowen and Mortensen, 1996; Walmsley, Troen, Lalas and Mason, 1990).

In 1990s, the National Renewable Energy Laboratory (NREL) developed a "computer mapping system" that uses upper-air wind data from balloon soundings and various mathematical relationships between the wind and topography to estimate the wind resource over large regions at a grid scale of 1 km (Schwartz, 1999; Schwartz and Elliott, 2001). This method produced some of the first detailed wind resource maps of states in the United States (Vermont, North and South Dakota, and Illinois) as well as other countries (the Philippines and Mongolia, among others).

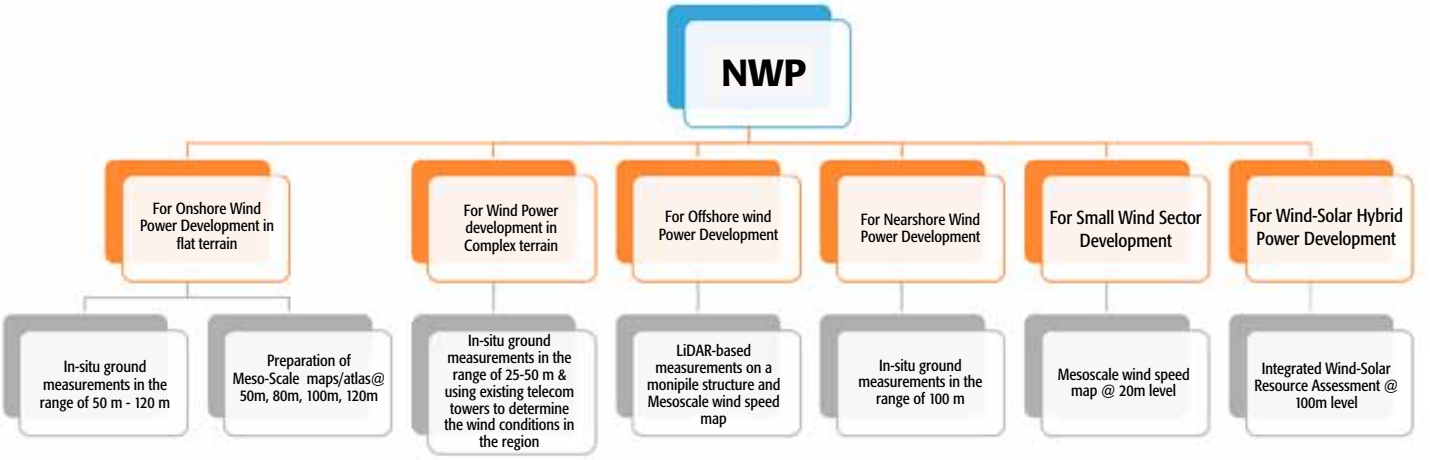

Figure 1: *Activities under NWP*

By late 1990s, mesoscale modelling techniques were beginning to emerge as a major focus of research. One of the first was the KAMM-WAsP method developed by RisØ. This method uses the KAMM mesoscale model to simulate a representative number of static "cases" sampled from a distribution of upper-air wind statistics (Frank, Rathmann, Mortensen and Landberg, 2001). The output of the model, at a typical grid scale of 2-5 km, is used to drive WAsP, which produces wind resource estimates at a much higher resolution.

Atmospheric Modelling

High-resolution numerical modelling of weather conditions provides sensitive information of good quality, which is crucial for the development of any wind project and are useful from the early stages of prospecting the wind farm design to long-term adjustments. In particular, the use of meso and micro-scale coupled wind resource products has gained widespread acceptance by the wind industry, offering reliable long-term reference data for wind condition characterization and the same has been utilized in this work. Under the study (for 100 & 120 m wind potential map), Meso to micro-scale coupling was solved within the modelling chain by seamless simulations of WRF down to 500m resolution. The core of the technical modelling approach used for this work was the atmospheric model Weather Research and Forecasting System (WRF) developed by NCAR/NCEP. The WRF-system is a community based, open-source model, where the latest advances in physics and numerics are incorporated in a modular way. The WRF model has been employed largely for research, climate analysis and operational weather forecasting.

The core of the technical modelling approach for these work is the atmospheric model Weather Research and Forecasting System (WRF) developed by NCAR/NCEP. The WRF-system is a community-based, open-source model, where the latest advances in physics and numerics are incorporated in a modular way. It represents a cutting-edge modelling technology as well as optimized dynamic and physical cores. It includes a nest domain, allowing zooming atmospheric circulation down to near wind-farm resolution.

The effort to develop WRF has been a collaborative partnership, principally involving the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (NOAA), the National Centers for Environmental Prediction (NCEP), the Forecast Systems Laboratory (FSL), the Air Force Weather Agency (AFWA), the Naval Research Laboratory, the University of Oklahoma, and the Federal Aviation Administration (FAA). WRF allows researchers to conduct simulations reflecting either real data or idealized configurations. WRF provides operational forecasting a model that is flexible and efficient computationally, while unlocking the advances in physics, numeric and data assimilation contributed by the research community.

WRF model has a long record on usage and it is employed operational in many weather services, cutting-edge research activities and different industry applications. WRF development has engaged a wide community of users, which meant large peer-review validations analysis, and upgrading of advances in the different components of the weather & climate modelling science.

WRF model is now the first generation of multi-scale chain modelling that can seamlessly go from regional to wind farm scales. Regarding, micro-scale backed, WRF incorporates innovation planetary boundary layer sub model (PBL) that can handle effectively turbulence and flow adjustments due to high-resolution orographic effects. Moreover, WRF is a unique solution to provide dynamic representation of wind flow at wind farm resolution including mechanical and thermal turbulence. WRF model includes a set of sub-models to treat dynamically and physically flow regime at very high resolution. These modules employ non-linear representations of different topography induced mechanisms.

Experience acquired from the studies of Vortex in more than 24,000 simulations completed with thousands of them checked against measurements has proven that the WRF model at a 500m resolution produces a realistic representation of flow circulation induced by high-resolution topography effects such as valleys, sea-land transition, hills, etc. By preserving the continuity of the WRF modelling chain, a more consistent site-specific

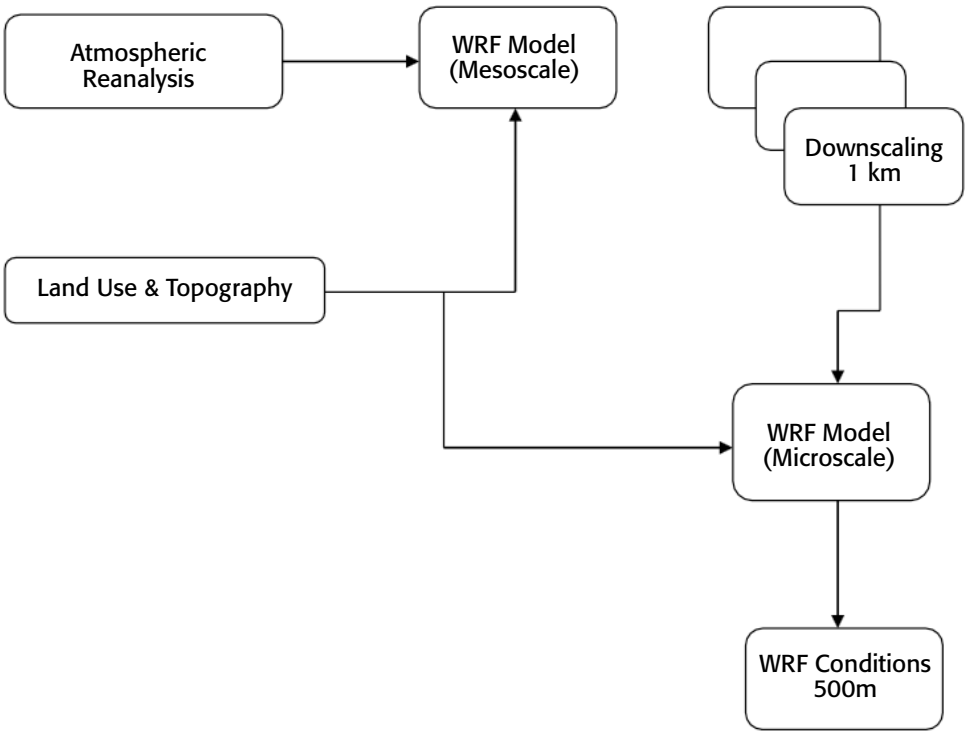

Figure 2: *Atmospheric Modelling Flow Chart*

assessment of wind energy parameters can be obtained, minimizing the impact of any artificial interpolation or adequation between different atmospheric scales.

The WRF model provides wind speed, temperature & pressure among other variables at each of the 500m x 500m grid points and any height between ground level and the troposphere. This allows us to estimate the wind power density by making use of the wind speed and density on an hourly basis -a general gas law for air is used for deriving density values from pressure & temperature. Joint frequency distribution is obtained by binning the wind speed in 1m/s bins from 0 to 1, 1 to 2 and so on, and binning the wind direction in 30 degrees sectors north centered, that is from -15 to 15, 15 to 45 and so on. The joint frequency distribution can be presented in percentage or number of hours per year. Weibull Parameters are computed by using the WAsP assumption, which emphasizes the most energetic part of the histogram in the Weibull fitting.

Uncertainty of the results is estimated by running some different configurations of WRF model that is different turbulent schemes and slightly different initial conditions, which perturb the model and give an indication on how sensitive the studied region is to some changes in the model. The generated results by the different configurations are then post processed and mixed up in order to have an idea of how wide/uncertain the wind distribution.

Wind Resource Mapping under NWP

(A) 50 M and 80 M Wind Power Density Map

As a part of the outcome of the program, wind power density (WPD, in watts per square meters) maps have been prepared based on the measurements and mesoscale models. In 2005,

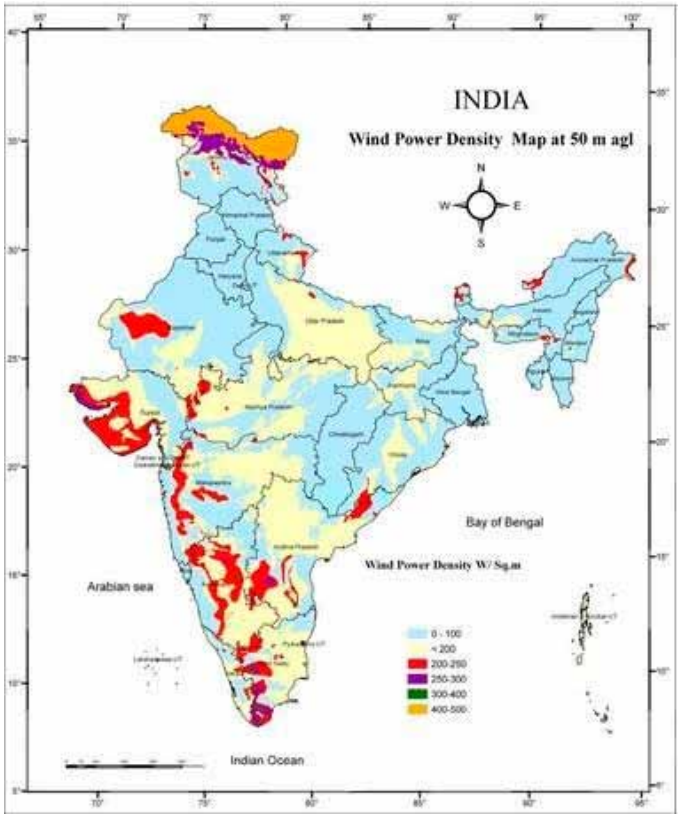

Figure 3: *Wind Power Density Map of India at 50m above ground level (a.g.l.)*

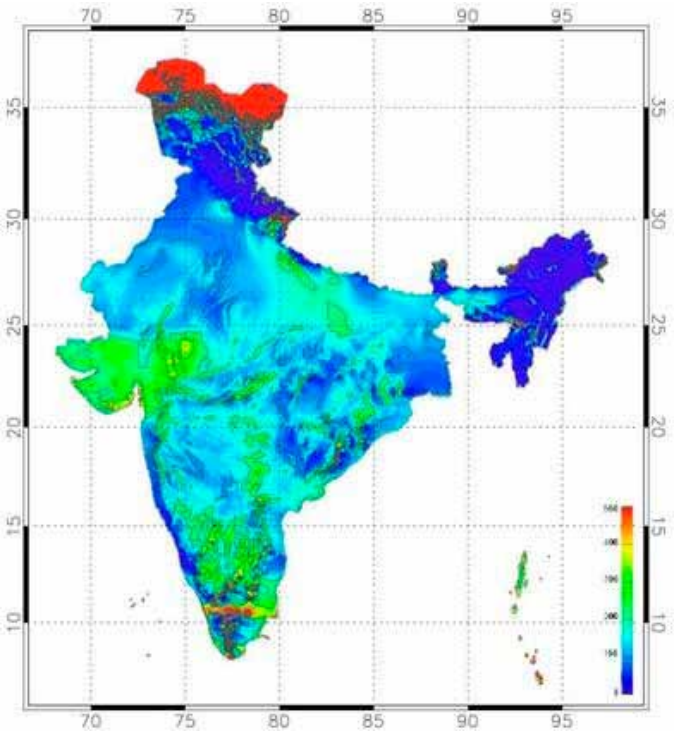

Figure 4: *Wind Power Density Map of India at 80m a.g.l.*

the wind power potential for 10 states at 50m has been estimated with relevant assumptions. From the discrete values of WPD at individual locations, the wind power potential over an extended area of land have been estimated. In the year 2010, the Indian wind atlas has been prepared and released by NIWE with a combined effort from RISO-DTU, Denmark using a much sophisticated mesoscale modelling technique called KAMM (Karlsruhe Atmospheric Mesoscale Model). NIWE (formerly C-WET) performed the potential estimation study at 50m and indicative study at 80m hub heights with 5km resolution in 2010 in collaboration with RISO-DTU National Laboratory for Sustainable Energy, Roskilde, Denmark by the name of 'Indian Wind Atlas'. As per the wind atlas, the wind power potential in the country at the 50m level was estimated as 49 GW. Similar exercise without any validation (higher elevation (>50m measured data were not available at that time) had been carried out for 80m level with the KAMM generated mesoscale map, and the results were calculated. The estimated installable potential at 80 m levels was found to be 103 GW. The wind power density maps at 50m and 80m level are given in Figure 3 and Figure 4 respectively.

(B) 100 M Wind Power Potential Map

With advancing hub heights, wind power potential study was revisited at 100m a.g.l. in 2015, and wind power potential at 100 m height was estimated as 302 GW. This was carried out at a higher spatial resolution of 500 m (as compared to 5km earlier), using the advanced meso-micro coupled numerical wind flow model and with the corroboration from about 1300 actual measurement sites spread all over India. Besides, the study was performed with actual land availability estimation using National Remote Sensing Centre (NRSC) 56m resolution

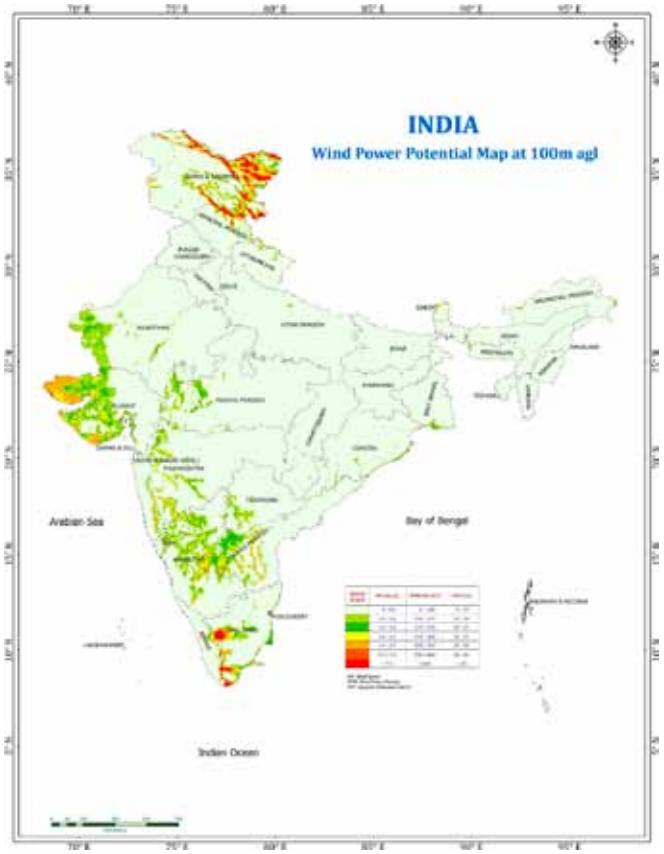

Figure 5: *Wind Power Potential Map of India at 100m a.g.l.*

Land Use Land Cover (LULC) Data and with consideration of 6MW per sq. km. The map was prepared in Capacity Utilization Factor (CUF) scale and CUF more than 20% were considered for potential estimation. Figure 5 shows the Wind Power Potential Map of India at 100m a.g.l.

(C) 120 M Wind Potential Map

Wind turbine technology has evolved significantly over the last decade with an emphasis on greater energy capture and improved capacity utilization factor (CUF). Modern turbines have larger rotor diameter and higher hub heights. Hence, it became necessary to identify areas that have wind potential at higher heights. Considering this and using advancements of mapping techniques, wind potential assessment of the country at 120m hub height was undertaken by NIWE. The 120m high potential assessment is carried out in similar lines at a spatial resolution of 500m, using the advanced meso-micro coupled numerical wind flow model with the corroboration from 406 actual measurement sites spread across the country. The indicative wind potential at 120m a.g.l. is estimated by excluding unsuitable area/land features. The potential is further stated in terms of CUF and land categories for effective decision making by all stakeholders. The un-exploited potential areas are also covered for a better understanding of new potential locations in the country. The sensitivity analysis on the land use pattern and its suitability is also factored in, to understand the variation on the wind potential estimation. Based on the study, the installable

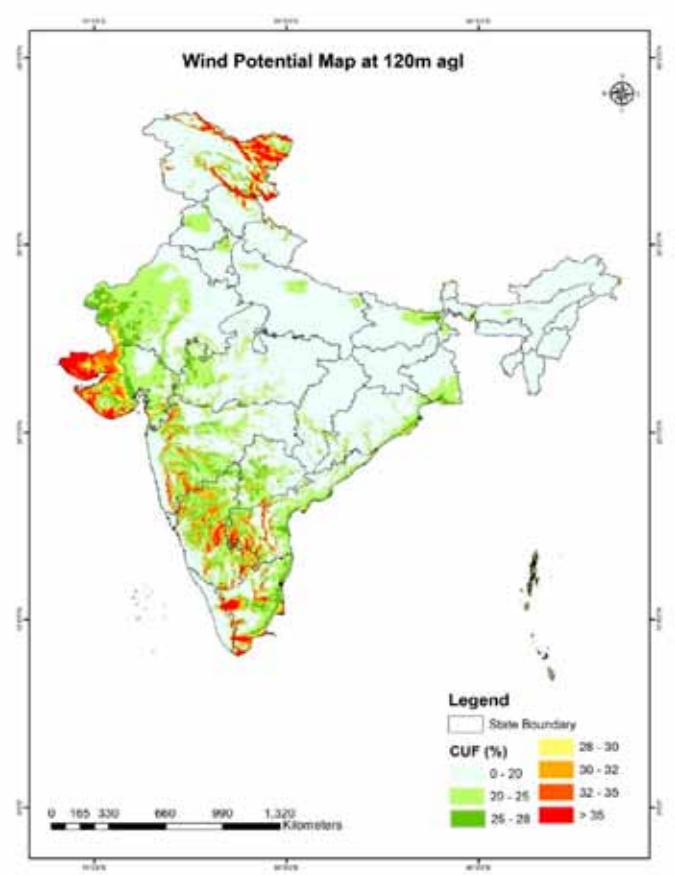

Figure 6: *Wind Power Potential Map of India at 120m a.g.l.*

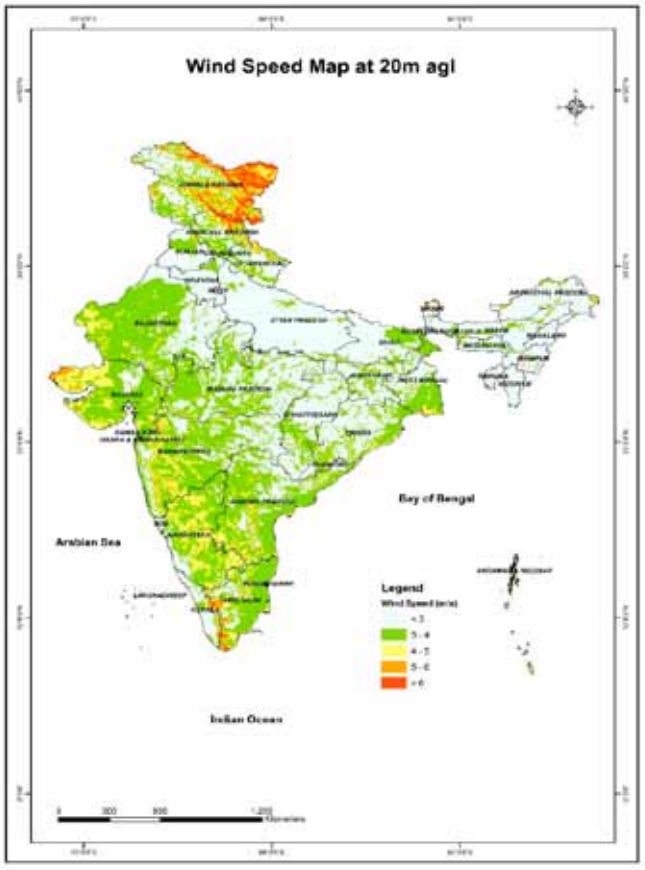

Figure 7: *Wind Speed Map at 20 m a.g.l.*

wind potential of India is estimated as 695 GW at 120m a.g.l. (above ground level) with 5D x 7D micro-siting configuration. Out of the total estimated 695 GW potential, 340 GW could be installed in the wasteland, 347 GW in cultivable land and 8 GW in the forest area. It is also noted that wind potential of 132 GW is possible in high potential areas with CUF greater than 32% and wind potential of about 57 GW is possible in the areas with CUF greater than 35%. Figure 6 shows the Wind Power Potential Map of India at 120m a.g.l. and Table 1 shows the main differences between Indian Wind Atlas 2010 and the Wind Potential Map at 100 m a.g.l.

Table 1: *Comparison between Indian Wind Atlas 2010, Indian Wind Potential Map 2015 & Indian Wind Potential Map 2019*

Parameter	Indian Wind Atlas (2010)	100m Potential Map (2015)	120m Potential Map (2019)
Flow Model	KAMM - WAsP	WRF	Dynamic meso-micro coupled WRF modelling technique
Model Resolution	5 km	0.5 km	0.5 km
Final Outcome	Wind Power Density (WPD) map	Capacity Utilization Factor (CUF) map	Capacity Utilization Factor (CUF) map
Height	50 m, 80 m	100 m	120 m
Land Availability Estimation	Assumption of 2% for Windy states and 0.5% for poor windy states	Actual Land availability estimation using NRSC Land Use Land Cover (LULC) Data – AWiFS 1:250K	Actual Land availability Estimation using NRSC Land Use Land Cover (LULC) data set with Level – II classification (AWiFS–56m resolution)
Validation	Up to 50 m	Up to 100 m	Up to 120 m
GIS layers	Static, digital (Pictorial View)	Dynamic, Online	Dynamic, Online

(D) Wind Speed Map at 20 M Level

To support the off-grid small wind/ hybrid sector, NIWE prepared a wind speed map at 20 m height using meso-micro coupled WRF (Weather Research Forecasting) modelling and at a very high resolution of 500 m covering the entire country including its islands. This map will facilitate the project developers in identifying suitable locations for the development of small wind power projects in the country. Figure 7 shows the wind speed map at 20 m a.g.l.

(E) Indicative Offshore Wind Power Potential Map at 120 M above Mean Sea Level

National Institute of Wind Energy (NIWE) was entrusted to carry out preliminary wind resource assessment and coordination of bathymetric/oceanographic studies for demarcation of the offshore wind energy blocks as per the National Offshore Wind Energy Policy notified by Ministry of New and Renewable Energy (MNRE) vide notification dated 6th October 2015. India is blessed with a long coastline of 7600 km and an Exclusive Economic Zone (EEZ) of nearly two million sq. km. The United Nations Convention on the Law of the Sea (UNCLOS) gives the exclusive rights over India's Economic Exclusive Zone (200 Nautical Miles from baseline) within which it can exercise sovereign rights in relation to activities such as fisheries, production of energy from water currents and wind. For any new offshore market, the cost drivers associated with different technologies vary significantly. The environmental constraints, seabed conditions and structure, wind resource, array layout grid connection, as well as the turbine technology for the site and the installation methods have to be correlated to understand the scale of opportunity and capital expenditure required to realize its development. Considering its potential various initiatives are being taken for the offshore wind development in the country through preliminary assessments, collaborative studies, etc.

One of such pre-feasibility studies for the offshore wind power development in Gujarat and Tamil Nadu was carried out under the Facilitating Offshore Wind energy in India (FOWIND) project, a consortium led by the Global Wind Energy Council (GWEC) during May 2015. As a part of this project, prefeasibility analysis of offshore zones in Gujarat and Tamil Nadu were carried out and eight potential zones were identified each off the coast of the States of Gujarat and Tamil Nadu.

Considering that an offshore wind resource map for the entire coastline of the country will be helpful, offshore map up to Exclusive Economic Zone (200 NM) has been prepared by NIWE using the satellite data. However, this needs to be re-checked by fresh long-term measurements to facilitate better and informed decisions.

This offshore wind map is prepared using QuikSCAT (Quick Scatterometer) monthly average surface wind data. The spatial resolution of the QSCAT data is 0.25deg Latitude x 0.25deg Longitude and the data period used for the analysis is from Nov 1999 to Oct 2009 (10 years). The NASA QuikSCAT

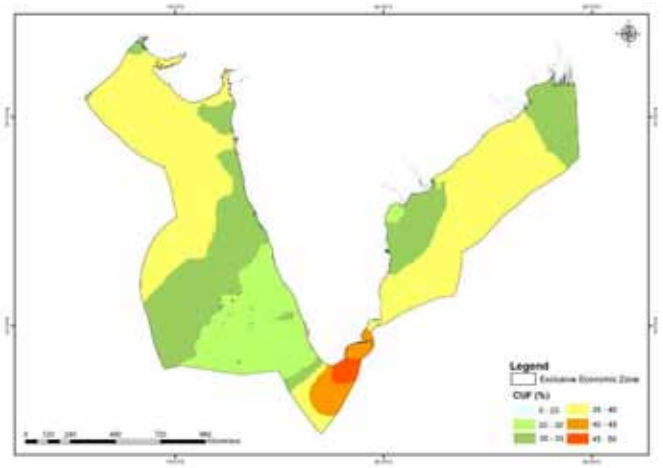

Figure 8: *Offshore Wind Power Potential Map up to EEZ at 120m amsl*

(Quick Scatterometer) is an earth observation satellite carrying the SeaWinds scatterometer. Its primary mission is to measure the surface wind speed and direction over the ice-free global oceans. Scatterometers such as QuikSCAT emit pulses of low-power microwave radiation and measure the power reflected back to its receiving antenna from the wind-roughened sea surface. The surface winds are measured from the roughness of the sea surface based on measurements of radar backscatter cross section.

The data obtained from QuikSCAT satellite is at 10m (surface wind data) and the same has been extrapolated to 120m using power law index value of 0.11. The capacity Utilization Factor (CUF) has been estimated using the 120m extrapolated wind speed value with Weibull factor 'k' as 2. The map is prepared for the entire Exclusive Economic Zone (EEZ) of India –up to 200NM by interpolating the point values.

Conclusion

Wind maps derived from mesoscale modelling are valuable for assessing the mean wind speed climate over a wide area, and also for generating wind data at specific sites. The ability to obtain reliable wind data at sites where there are no actual wind data and use it to drive the higher resolution industry standard model, could result in significant savings of both time and money for wind energy developers. Although, it cannot substitute for on-site measurements, Mesoscale modelling can provide useful information for the identification and preliminary evaluation of wind project sites. In order to support and facilitate all the stakeholders of the Indian wind sector, NIWE has been tasked by MNRE, Government of India to prepare and publicize the wind, solar & hybrid power potential maps on regular basis depending on the technology development and need of the hour. Accordingly, NIWE will be preparing and publishing the 150 m wind power potential and wind-solar hybrid potential maps on war footing basis for the benefit of various stakeholders and policy makers.

Energy Utility Partnership Program (EUPP) of USAE and USAID

Like any other markets where goods are freely traded, the energy market needs an institution to supervise it and rules to ensure the transparency of the exchanges and prevent market manipulation. Independent monitoring is required to ensure that market participants cannot exercise market power, collude or engage in any other behaviour that could give them a greater market share, or higher profits. As an increasing number of countries move to deregulate their electricity markets, they will need to establish independent monitoring system for these markets. India is actively considering the establishment of such a unit within the Central Electricity Regulatory Commission.

The Energy Utility Partnership Program (EUPP) is a cooperative initiative between the United States Energy Association and the United States Agency for International Development under the Bureau for Development, Democracy and Innovation (DDI). EUPP works around the world to promote energy security, clean energy access, and capacity building to achieve self-reliance. The EUPP team strengthens the capacity of utility executives and employees in USAID-assisted countries to: Effectively manage and operate power systems, Run financially viable businesses, Increase energy access; Design off-grid power sources, and Integrate sustainable energy resources into their power grids.

By bringing countries together and encouraging knowledge sharing of global best practices, EUPP enables emerging markets with access to U.S. public and private sector expertise and technical assistance. This transfer of information enables country partners to improve management efficiency, achieve economic pricing, increase revenue collection, privatize utility functions, enhance employee productivity, and operate within a regulatory environment. These partnership activities are conducted through executive exchanges, training sessions, technical assistance using industry experts, in-country workshops and conferences.

Source: USEA, 6 February 2021

Solar Installed Capacity Surpasses Wind

The share of solar power in India's installed power capacity mix reached 10.3%, while the share of installed wind capacity is 10.25%. The installed capacities of solar and wind power stood at 38.8 GW and 38.6 GW, respectively, as of December 2020. Wind in India has had over a decade plus in head start over solar. By the time solar installations in India began in 2010, wind had already surpassed 10 GWs. However, solar in recent years has seen explosive growth driven by falling costs.

Source: *Mercom India, 4 February 2021*

PGCIL Bags Two Power Transmission Projects in Rajasthan

State-run Power Grid Corporation of India Ltd (PGCIL) has won two electricity transmission projects in Rajasthan under tariff-based competitive bidding. The firm bagged a "transmission system strengthening scheme for evacuation of power from solar energy zones in Rajasthan (8.1GW) under phase II Part A" on build, own operate and maintain basis comprising of establishment of a new 400/220kV Substation, 400kV D/C Transmission lines and associated Substation extension works. It also won a "transmission system strengthening scheme for evacuation of power from solar energy zones in Rajasthan (8.1GW) under phase II Part B" on build, own operate and maintain basis which comprises of establishment of 765kV D/C Transmission line and associated substation extension works.

Source: PTI, 31 January 2021

$43 billion deal for 'world's biggest' offshore wind farm in South Korea

A $43 billion deal was signed on 5th February 2021 to build what the South Korean government said will be the world's biggest offshore wind power complex, as it seeks to achieve carbon neutrality by 2050. South Korea has few energy resources of its own and relies on imported coal -- a cheap but dirty fuel -- for around 40% of its electricity. The agreement was signed to build the complex off Sinan in the country's southwest, which he said would be seven times bigger than the world's current largest offshore wind farm. With a maximum capacity of 8.2 gigawatts, the government is banking on it being the equivalent of six nuclear power stations.

Source: Economic Times, Feb 05, 2021

Investors Storm into Alternative Energy Funds Ahead of Biden Presidency

Investors are rushing to invest in alternative energy funds this year on hopes of more green reforms, with President-elect Joe Biden set to take office next week. According to Lipper data, alternative energy funds that primarily invest in solar, wind, and water firms around the world saw an inflow of $4 billion in the week ended January 13. They have lured a whopping $5.2 billion in just the first two weeks of 2021, after seeing inflows of $17.1 billion in 2020, the data showed. On the other hand, traditional energy funds which invest in companies that deal with fossil fuels, have seen an outflow of $113 million in the last week, their sixth consecutive outflow. Biden has pledged to tie the U.S. economic recovery to tackling climate change in a significant policy shift from Trump's easing of regulations on fossil fuel. He has also vowed to rejoin the international Paris climate accord that Trump exited.

Source: Reuters, January 16, 2021

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Ramón López Mendizabal
Energy Director, ESTEYCO,
Barcelona, Spain
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Our telescopic concrete tower on-shore prototype is just about to be finished in China. This realization is expected to become, once completed at the end of 1Q 2021, the highest self-supported wind tower ever built in the world.

Telescopic technology, patented by ESTEYCO, was initially tested in 2015 with an on-shore prototype without turbine at its top that was erected near Madrid. Some years later in 2018 the first off-shore fully operational prototype was installed in Gran Canaria Island, becoming the first off-shore wind turbine installed in Southern Europe. Its main advantage was to avoid the need of heavy, scarce and expensive lifting means like heavy cranes or vessels - as they are not required neither for the tower nor turbine installations.

The solution is right now being implemented in Henan province, Continental China, achieving a hub height of 170m and supporting a 3.6MW - 155m rotor diameter turbine. It combines three concrete levels - heights ranging from 40 to 50m - with conventional tubular steel sections at its top. Concrete levels are cast-in-place at the ground level by means of a climbing formwork. These levels are arranged one inside the other, concentrically, prior to the beginning of the auto-lifting phase.

The solution, from that moment on, will be using heavy-lift strand jacks always placed at 40-50m height, reusing them to lift one tower section after the other. Such recoverable jacks lifting each level will be supported by the one below, which also helps for guiding the lifting section as it rises, in a self-installing procedure in which the tower itself is the only supported structure required.

The whole construction process includes 3 stages:

- On-site construction of concrete sections.
- Upper steel level, nacelle and rotor assembly.

Figure 1
Tower Ready for the Beginning of the Lifting Works

- Self-erection system (2 lifting operations).

Both the concrete construction and the installation of the steel level have already been finalized, being the tower ready for the beginning of the self-lifting process, scheduled to be carried out during March, 2021.

Some pictures from the work accomplished so far can be seen next:

Figure 2
Pre-assembly of Reinforcement Cages on the Ground

Figure 3
Lifting and Arrangement at its Final Position of the Pre-assembled Reinforcement Cage

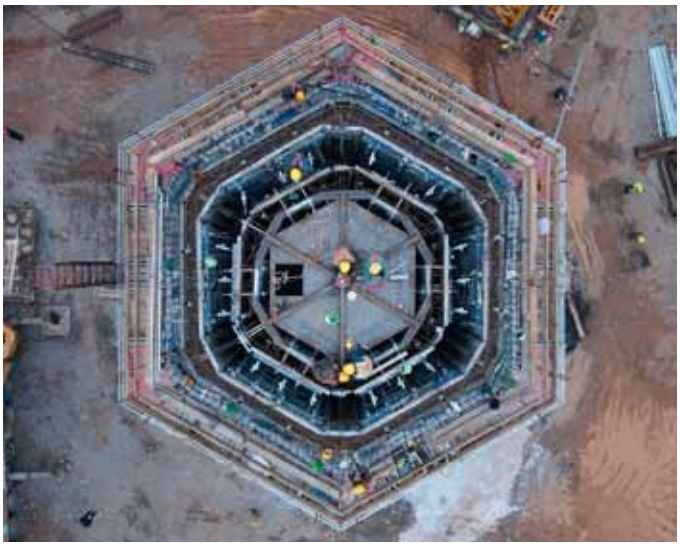


Figure 4
Concrete Levels One Inside Another

Figure 5
General View of the Concrete

Figure 6
Nacelle assembly

Figure 7
Rotor assembly

After the erection of the tower and all the planned tests to be performed, it is expected that our self-lifting technology will be recognized as one of the more solid and cost-effective alternatives to provide extra high HHs within the wind sector at a reasonable cost and timeline, as 1 tower/week rates are realistically expected to be attained in future serial productions.

Wind Power Installations in India from April 2020 to February 2021

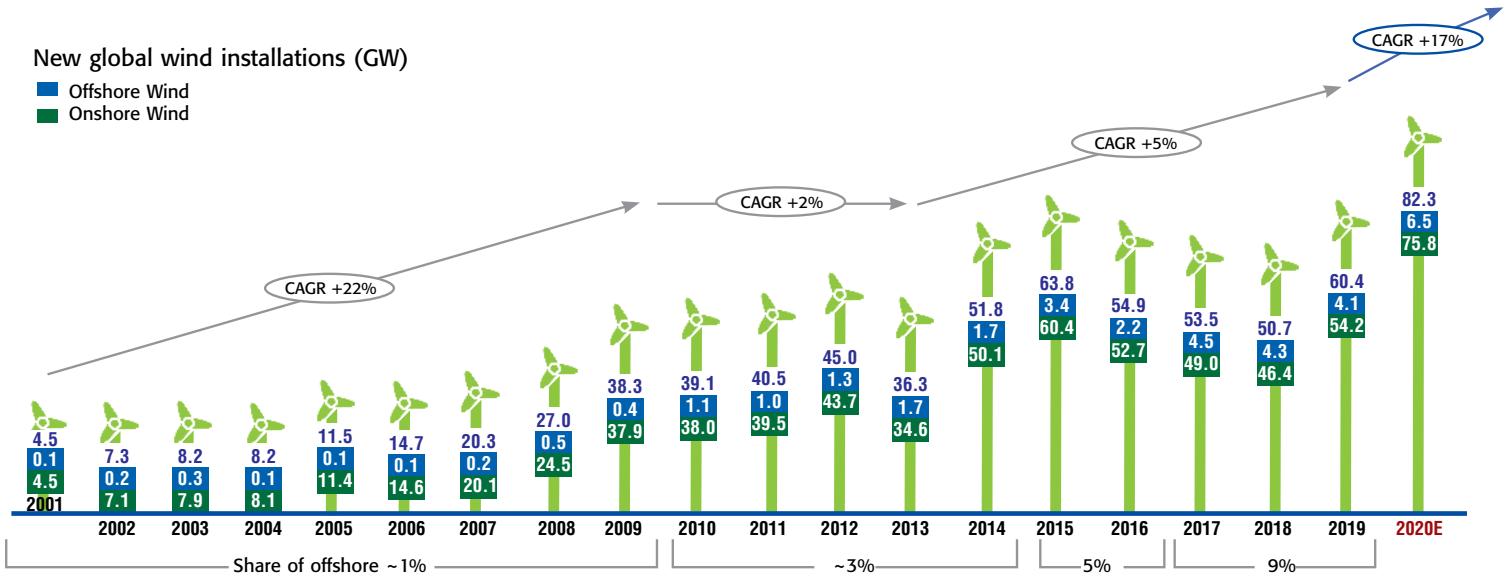
S.No.	State	Total installation during FY 19-20	Total Operational in FY 19-20	April,20	May'20	June'20	July'20	August'20	Sept'20	Oct'20	Nov'20	Dec'20	Jan'21	Feb'21	Total installations during FY 20-21	Total Operational in FY 20-21
1	Andhra Pradesh	2.00	4092.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.20	0.00	4.20	4096.70
2	Gujarat	1468.45	7541.51	2.11	6.30	73.19	98.40	50.60	72.60	80.80	116.50	150.50	52.00	61.90	764.90	8306.41
3	Karnataka	95.70	4790.60	0.00	4.20	0.00	0.00	0.00	0.00	0.00	36.00	38.00	3.30	40.50	122	4912.60
4	Kerala	10.00	62.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.90
5	Madhya Pradesh	0.00	2519.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2519.90
6	Maharashtra	206.20	5000.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5000.38
7	Rajasthan	0.00	4299.65	0.00	0.00	0.00	0.00	0.00	0.00	27.10	0.00	0.00	0.00	0.00	27.10	4326.75
8	Tamil Nadu	335.44	9304.33	0.00	0.00	13.00	0.00	8.00	52.00	31.00	18.00	2.10	0.00	3.10	127.20	9431.53
9	Telangana	0.00	128.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.10
10	Other	0.00	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.30
	Total	2117.79	37744.16	2.11	10.50	86.19	98.40	58.60	124.60	138.90	170.50	190.60	59.50	105.50	1045.40	38789.56

GWEC
GLOBAL WIND ENERGY COUNCIL

2020 - A Record Year for Wind Energy

A Gust of Growth in China makes 2020 a Record Year for Wind Energy

Despite COVID-19 Impacts, Wind Installations are Rising Globally



Courtesy: Global Wind Energy Council (GWEC)

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Repowering of Wind Farms in India

Dr. Sanjiv Kawishwar
Director CORE (Center of Renewable Energy), India

Introduction

Most of the early wind turbines in India having capacity below 500kW are installed at the sites with the best wind resource potential for a higher hub height. Additionally, many turbines in the megawatt class are nearing the end of design life, raising the question of repowering. Repowering speaks of replacing old low capacity wind turbines with more powerful and modern units with the purpose of raising electricity generation levels at the refurbished wind sites. The process involves replacing old machines with fewer, larger and taller modern units which are quiter, more reliable and can produce more electricity. Most of the wind-turbines installed up to the year 2000 are of capacity below 500 kW and are at sites having high wind energy potential. It is estimated that over 3500 MW capacity installations are from wind turbines of around 500 kW or below. Most of these old turbines are installed in the states such as Tamil Nadu, Gujarat, Madhya Pradesh and Maharashtra. Repowering of these turbines is required to optimally utilise the wind energy resources.

Repowering Policy

The National Repowering Policy was released on 5th August 2016 by Ministry of New and Renewable Energy (MNRE), Government of India aimed at promoting the optimum utilization of wind resources in the country. Turbines at 1MW or below are eligible for repowering, and may be revised upwards by MNRE based on experience.

Generation due to added capacity is incentivized by allowing its sale to DISCOM at the F-i-T applicable (at the time of commissioning of the repowering project) or via third-party sale. However, DISCOMs are allowed to procure the power corresponding to the average of the last three years' production at the existing PPA terms.

The Policy helps keep project development costs low by not penalizing the generator for not honouring the PPA during the execution of the repowering project. Additionally, the State Transmission Utility (STU) is required to support the project by carrying out required augmentation to the transmission system from the pooling station onwards.

Financing support is given by mandating the Indian Renewable Energy Development Agency (IREDA) to provide an additional 0.25% rebate on its financing.

The Policy mandates State support in a number of aspects. The State is required to support the larger footprint necessary for repowering through procurement. Additionally, the 7Dx5D rule for micro siting has been relaxed for repowering.

State Nodal Agencies (SNAs) are to be appointed for detailed implementation support. MNRE may agree to bear costs of augmentation, conditional on further negotiation.

Risks

The structural integrity of the turbine as a system, in addition to individual components is an important consideration to risk of structural failures. In particular, a reliability risk arises when components are upgraded/modified/renewed during repowering. A reduction in component reliability negatively affects project availability and O&M costs.

DNVGL-SE-0263 provides a framework for the analytical and probabilistic techniques used for assessment of loads and estimation of lifetime of in-service turbines. This framework may be used to plan inspections and tests aimed at identifying risks to structural integrity. Structural Reliability is covered by technical standard ISO 2394:2015.

Lifecycle

Repowering Certification may be obtained according to DNVGL-SE-0190 standard on Project Certification. A Statement of Compliance (SoC) for Repowering is obtainable as part of a project-specific certification process. The aim of the assessment is to minimize lifecycle cost. Both positive and negative impacts on reliability may be quantified for the specific project.

To assist in decision-making for repowering, detailed audit requirements for continued operation may be implemented, for

which GL standard on Continued Operation (GL-IV-1-12, Edition 2009) provides guidance. Regular technical audits of turbines may be instituted as a management process to assist in planning for asset management.

Condition Monitoring may also be used for assessment purposes by providing detailed data useful for component fatigue assessment and inspections. DNVGL-SE-0439 (Certification of Condition Monitoring) specifies required process and delivers an SoC.

Making use of existing components such as drivetrains may require detailed inspections earlier than new equipment. This necessitates planning for the operating life after repowering.

Repowering Decision

Due diligence of the available set up is necessary to arrive at a decision on repowering. All technological, regulatory, legal, commercial, local and financial aspects must be covered for due diligence.

Specific environmental risks may arise as a result of repowering. Noise and shadow flicker impacts in nearby areas may change. Increased total turbine height increases shadow flicker, while a similar relationship exists between rotor length and noise. In order to obtain permits in time, project developers should engage with regulatory agencies at an early stage.

Access to location may be difficult on account of larger rotor length. Other site issues include Right-of-Way (RoW), complex terrain, and infrastructure upgradation. Regulatory compliance for clearances and approvals may affect scope of repowering. Disposal of old turbines requires careful consideration.

Resource assessment and risk evaluation are inputs for evaluation of project economics. Site-specific design, O&M/ other costs, financing, and applicable policies help obtain LCOE/ acceptable IRR as the target output. Appropriate process should be followed for decommissioning and project execution.

Resource Assessment

Resource assessment should consider quality of site data and extrapolation to higher hub height. Data can be analyzed for locations/regions of interest, including data for solar hybridization. Identification of wind class is required to assess basic site suitability of the WTG.

Design risks arise if a non-standard turbine configuration is chosen during repowering. Such risks should be addressed using full aero-elastic simulations after consideration of site-specific inflow characteristics.

As part of a comprehensive inflow assessment, it is required to account for all loads. The loads analyzed are both low-cycle (braking/control, extreme loads) and high-cycle (gravitational, turbulent loads).

SCADA data along with maintenance records help in operational assessment. The aim should be to incorporate the maximum amount of field experience to assess site-specific risks.

Data of interest are (i) availability losses due to grid management and (ii) component maintenance activities. Commissioning record, inspection reports, failure reports and other field experience for turbine-type also form useful documentation. Non-destructive testing (NDT) may be selectively used provide additional data for site factors.

Project Management

WTGs are designed with a target reliability level to be exceeded for the period of designed life. Structural site life always exceeds design life because incorporation of site-specific data helps reduce site load margins.

Assessment of remaining life may be completed as per DNVGL-SE-0263, which classifies methods as simplified, detailed and probabilistic. A simplified approach, which uses a generic turbine of similar type, may be adequate if parameter uncertainty is adequately handled. Alternatively, a full probabilistic assessment helps include both technical and managerial (maintenance strategy etc.) factors. Such a method is more systematic, even if a generic turbine is used for assessment.

It is recommended that uncertainty in parameters related to structural design be handled using access to manufacturer information. Model uncertainty needs to be handled if a generic turbine model is used.

The estimation of structural site life inclusive of all the above stochastic aspects is called structural reliability analysis (SRA).

The economic/useful life may be obtained by further evaluation of all risks involved in continued operation. All factors impacting project costs and revenues must be considered, including failure rates of components and supply chain risks.

The cost of repowering should be included. This considers the costs and revenues associated with decommissioning, disposal, BoP and other project development costs. The cost of repowering needs to be assessed with regulatory and commercial aspects in mind.

Decision to repower is taken if economic life is less than structural site life.

Certification

The process leading to a Repowering SoC has the following steps:

- Concept- Concept is developed for the repowering project based on due diligence.
- Design Basis Evaluation - Investigation of site (terrain, configuration) and environmental (soil, wind, waves, salinity) conditions. Comparison with past data is done.
- Design Evaluation - Effect of environmental and meteorological conditions on maintenance. Site load margins are reduced to help achieve better LCC/LCOE.
- Decommissioning (Optional Certification) - Planning and execution of decommissioning of existing project.
- Commissioning - Evaluation and inspections during implementation and at start-up of repowered project.

If decision for continued operation is taken over repowering, further applicable certifications are:

- In-Service Inspections (Recommended Certification) - Periodic monitoring and inspections for the in-service period
- Lifetime Extension (Recommended Certification) - Lifetime estimation and inspections to assure safety and reliability for project life. Centre Of Renewable Energy (CORE) provides Lifetime estimation and inspections service.

Snippets

Rajasthan: Wind Power Firms to Lose Government Land for Not Starting Projects

The wind power developers who had taken government land and have not been able to execute the projects are set to lose their land. Rajasthan Renewable Energy Corporation Ltd (RRECL) has written a letter to the revenue department to expedite the process for cancellation of the land saying that more than 3000 bigha land has been allotted to about 20 companies which has not developed projects. "The revenue land allotted to the projects in these cases was either not utilized by developers within the permissible period or excess land surrendered by developers had been recommended by RREC for cancellation as per Rajasthan Land Revenue (Allotment of Land for setting up of Power plant based on Renewable Energy Sources), 2007," said the letter.

Source: TNN, February 17, 2021

Andhra Pradesh Power Utilities Received INR 6,600 Crore Loan from Centre

The Centre has sanctioned INR 6,600 Crore to Andhra Pradesh state power utilities under the second tranche of the AtmaNirbhar loan. The Centre has released the final disbursement of INR 3,300 Crore to the state of INR 6600 Crore loan. The state has earlier received the first disbursement of INR 3,300 Crore. Andhra Pradesh Energy Secretary, Mr. N. Srikanth spoke about the achievements of the state power utilities, in this regard. He stated that the union government praised the state of Andhra Pradesh for the implementation of the direct benefit transfer scheme for the farmers. He also added that taking the step of power procurement at power exchanges has helped the power utilities of the state to save INR 1023.8 Crore.

Source: Power Insight, February 1, 2021

Tesla to Set Up Electric Car Manufacturing Unit in Karnataka

"The U.S. firm Tesla will be opening an electric car manufacturing unit in Karnataka," the state government said in a brief statement. Last month, the electric carmaker incorporated Tesla Motors India and Energy Private Limited with its registered office in the city of Bengaluru in Karnataka, a hub for global technology companies. To boost investment, India plans to offer $4.6 billion in incentives to companies setting up advanced battery manufacturing facilities.

Source: Reuters, February 14, 2021

India at UNSC Calls on Countries to Fulfil Pre-2020 Climate Change Commitments

India at the UN Security Council called for countries to fulfil their pre-2020 commitments on climate change adding that the idea of climate action should not be to move the climate ambition goalpost to 2050. Speaking at the United Nations Security Council Open VTC Debate "Maintenance of international peace and security: Addressing climate-related risks to international peace and security, Mr. Prakash Javadekar, Minister for Environment, Forests and Climate Change, said that there is no common, widely accepted methodology for assessing the links between climate change, conflict and fragility.

Source: ANI, February 24, 2021

Centre Signs $304 Million Pact with AIIB For Power Transmission Network In Assam

The Centre has signed an agreement with Asian Infrastructure Investment Bank (AIIB) for borrowing $304 million (over ₹ 2,200 crore) to improve power transmission network in Assam. The fund will be utilised for the 'Assam Intra-State Transmission System Enhancement Project', aiming to improve reliability, capacity and security of the power transmission network in the state. The project aims to strengthen Assam's electricity transmission system by constructing 10 transmission substations, laying transmission lines, upgrading 15 existing substations, transmission lines and the existing ground wire to optical power ground wire.

Source: PTI, February 23, 2021

Portable Wind Turbine Generates Energy to Power Your Electronics

Danish startup KiteX has created a new portable wind turbine that's lighter, more powerful, and easier to use than any other wind power system on the market — the Wind Catcher, with 10 kg weight and can produce up to 600W of power. It can be used even when traveling off-grid or in the outdoors, easily transportable and is set up in just 15 minutes, it can charge e-bikes, electronics, appliances thanks to backup batteries, it works day and night even if winds are only blowing at 12.8 kph. it's made up of recycled plastics and produces clean renewable energy, and it's compatible with a number of different portable generators.

Source: Interesting Engineering, Feb 25, 2021

Boosting turbine performance and profitability

SKF is designing and developing bearings, seals, condition monitoring systems, and lubrication systems that enable more cost-effective wind energy generation. Working together with original equipment manufacturers and wind farm operators, SKF engineers provide dedicated solutions that can optimize the reliability and performance of new and existing wind turbine designs.

SKF's dedicated wind turbine solutions can help both turbine manufacturers and wind farm owners to:

- Increase energy production
- Increase turbine performance and reliability
- Reduce operating and maintenance costs
- Reduce lubricant consumption
- Minimize environmental impact
- Reduce energy losses
- Decrease warranty claims
- Reduce time to market
- Customize solutions

For these and more solutions, visit www.skf.com/wind
or contact
Mahavir Kanwade
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An Overview of Wind Power Development in India

"As the third largest carbon emitter in the world, decarbonising India's energy system is crucial to achieve global decarbonisation targets and support international efforts to keep global warming under 1.5°C pre-industrial levels – and wind power will play a key role for India to achieve the country's climate targets."

Ashesh Shrivastava
Executive Director, Consolidated Energy Consultants Limited (CECL), Bhopal

1. Introduction

Global power sector is undergoing a significant change that has redefined the industry outlook. In India also a number of changes are taking place in power sector. The Government of India has set up a target of 175 GW for power generation by renewable energy sources by 2022, out of which 100 MW by Solar Power, 60 MW by Wind Power and 15 MW by Hydro Power. The key element of the wind power industry remains its sustainability; this however is determined by long-term policies, goals and incentives defined by the government. A capital intensive industry also requires large international lending platform and a vibrant business climate with ease of doing business for long sustainability.

Due to rapid depletion of fossil fuel which has limited stock on the earth and also to save atmosphere from pollution created by utilization of fossil fuel, whole world is looking for environmental friendly cleaner renewable energy sources. Among various renewable energy sources, wind energy has been emerged as one of the most promising option for generation of electricity. For many centuries, globally, wind energy has been used for water lifting and grinding purpose but for its utilization towards generation of electricity started somewhere in the second half of 20th century and in India it started somewhere late eighties to beginning of nineties of 20th century.

2. Basic Principle of Generation of Electricity by Wind

Air in motion is called wind. Kinetic energy available in wind is converted into mechanical energy and then electrical energy using a wind machine which is called wind turbine generator or wind electric generator or wind energy conversion device. A wind turbine generator can be broadly divided into the following major parts:

i. Rotor comprising of 3 blades
ii. Nacelle containing hub, main shaft, gear box, generator, braking system, yaw system, sensors
iii. Tower
iv. Power & Control system

3. Major Constituents of Wind Power Project

A Wind Power Project or a Windfarm has the following major constituents:

i. Wind Turbine Generator(s)
ii. Internal Roads/Crane Platform and Office cum Control room Building
iii. Internal Transmission Lines, Unit Substations and Pooling substations

4. Major Advantages & Limitations of Wind Power Project

Following are the major advantages of wind power projects:

i. The technology of electricity generation from wind has been developed fully for smooth and trouble-free operation as well as for its economic viability.
ii. It is pollution free and eco-friendly.
iii. Low gestation period – less than six months from concept to commissioning, enabling fast bridging of power gap even in remote areas.
iv. With no fuel consumption, power generation becomes almost free after recovery of capital cost. O&M cost is nominal.
v. It can be developed in modular form with facilities for extension at a later date.

Following are the major limitation of wind power projects:

i. Adequate wind is not available at all the places. It is very much site specific.
ii. Wind is variable in nature and so is generation from wind power projects.
iii. Wind alone cannot give firm power.

5. Essential Requirement of Wind Power Project

Following are the essential requirements of establishment of wind power projects:

i. Availability of adequate wind resources
ii. Availability of land
iii. Availability of strong grid for power evacuation
iv. Availability of suitable logistics

6. Global Scenario of Wind Power Projects

As per the information available from Wind Power Monthly, Denmark, aggregate global installed capacity of wind power projects as on 31.12.2020 is 6,88,869 MW and the top 5 countries are as follows:

Rank	Country	Installed Capacity of Wind Power Projects as on 31.12.2020 (As per Wind Power Monthly)
1.	China	2,38,500 MW
2.	USA	1,19,259 MW
3.	Germany	63,231 MW
4.	India	38,684 MW
5.	Spain	27,355 MW

It may be seen from the above information that India stands 4th in the world with respect to installed capacity of wind power as on 31.12.2020.

7. Government Initiative for Development of Wind Power Projects in India

Government of India has formed an independent ministry for renewable energy called Ministry of New & Renewable Energy (MNRE). MNRE has been formulating policies/guidelines for development of wind power projects in India. MNRE has formed a funding organization for renewable energy projects named Indian Renewable Energy Development Agency (IREDA) acting as financing arm of MNRE.

MNRE has also formed a research & development organization for wind power projects named National Institute for Wind Energy (NIWE) formerly known as Center for Wind Energy Technology (C-WET) as technical arm of MNRE for Wind Power. There are State Nodal Agencies for promotion of renewable energy program in every state formed by state government working in coordination with MNRE.

8. Estimated Wind Power Potential in India

As per the preliminary assessment of NIWE, estimated wind power potential of India is at different heights above ground level is as follows:

Sl. No.	Height (magl)	Estimated Wind Power Potential
i	50 m	49,130 MW
ii	80 m	1,02,788 MW
iii	100 m	3,02,252 MW
iv	120 m	6,95,509 MW

Major states having good wind power potential are Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Rajasthan, Tamil Nadu and Telangana.

9. Wind Resource Assessment in India

The most important aspect for a wind power project is assessment of wind resource of the site. For assessment of wind resource at any particular site, wind monitoring masts are installed and comprehensive wind data are collected from these masts for a minimum period of 1 year. In the beginning of eighties and nineties 20 m high wind mast were installed then gradually new masts of higher height viz. 25 m, 50 m, 65 m, 80 m, 100 m and 120 m were installed and currently the tallest mast installed in India is 150 m.

In India wind monitoring at government level has been done mostly by Ministry for New and Renewable Energy (MNRE), Government of India earlier through Indian Institute of Tropical Meteorology (IITM), Bangalore and subsequently through National Institute of Wind Energy (NIWE) (Formerly known as Center for Wind Energy Technology (C-WET)), Chennai.

Presently, WEG manufacturers and windfarm developers have also started wind monitoring on their own. MNRE/NIWE has also formulated a guideline for wind monitoring by private developers.

As on 31st March 2020, wind masts have been erected at 914 locations in the country by MNRE through IITM/NIWE, out of which 249 locations have shown minimum wind power density of 200 W/m^2 at 50 m height which was earlier considered minimum criterion for setting up wind power projects. In view of new generation WEGs with higher rating, higher rotor diameter and higher hub height and advanced technology, MNRE withdrew the earlier qualifying criteria of minimum wind power density (WPD) of 200 W/m^2 at 50 m above ground level in the year 2011.

Generally for flat terrain, an area within 10 km radius of the wind mast is considered under the influence zone of the mast. However, for complex terrain, this may get reduced depending on terrain condition.

10. Available Wind Electric Generators in India

In India Wind Electric Generators from 55 kW to 3000 kW ratings of different makes have been installed.

Currently, there are more than 15 WEG manufacturers offering WEGs from 225 kW to 3000 kW rating.

Earlier National Institute of Wind Energy (NIWE) (Formerly C-WET) used to issue Revised List of Model and Manufacturers (RLMM) of WEGs having valid Type Certificates from recognized international testing agency. Now RLMM list is issued directly by Ministry of New and Renewable Energy (MNRE).

The latest RLMM list issued by MNRE is provided on www.indianwindpower.com.

11. Manufacturers, Component/Spares Suppliers & Service Providers

In India WEG manufacturers have established manufacturing plants. There are ancillaries and component/spares suppliers

for the WEGs. There are also service providers for various related works/services like WEG transportation, erection, civil works, electrical works, wind resource assessment, operation & maintenance, repairs, liaisoning, scheduling & forecasting, consultants, etc.

12. Installed Capacity of Wind Power Projects in India

As per the information available from MNRE, aggregate installed capacity of wind power projects in India as on 31.03.2020 is 37837.50 MW and 38624.56 MW as on 31st December 2020.

Due to availability of good wind resources, wind power projects have been mainly established in south India covering Tamil Nadu, Karnataka, Andhra Pradesh, Telangana, Kerala, west India covering Gujarat, Maharashtra, Rajasthan and central India covering Madhya Pradesh.

The top 5 Indian states in terms of installed capacity of wind power as on 31.03.2020 are as follows:

Rank	State	Installed Capacity as on 31.12.2019	Installed Capacity as on 31.12.2020
I	Tamil Nadu	9304.4 MW	9428.43
II	Gujarat	7630.8 MW	8192.51
III	Maharashtra	5005.3 MW	5000.38
IV	Karnataka	4790.8 MW	4868.80
V	Rajasthan	4298.4 MW	4326.75

As per the available information there are more than 35,000 WEGs of different make ranging from 55 kW to 3000 kW have been installed in India. MNRE has set a target to achieve 60,000 MW wind power capacity by 2022.

13. Government Initiatives for Promotion & Development of WPPs in India

Following are the major initiatives taken by central and state governments for promotion/development of wind power projects in India since beginning till now:

i. Carrying out wind monitoring by installing wind monitoring stations
ii. Setting up demonstration wind power projects
iii. Formulating guidelines for setting up wind power projects
iv. Introducing 100% Accelerated Depreciation (AD) benefit in the beginning which was subsequently reduced to 80% and is currently reduced to 40%.
v. Introducing Generation Based Incentive (GBI)
vi. Introducing option of sale to utility at predetermined tariff, captive use and third party sale of electricity generated by wind power projects
vii. Guidelines for enlistment of WEGs in Revised List of Models and Manufacturers (RLMM)
viii. Guidelines for acquisition of forest land for setting up of wind power projects
ix. Planning of green energy corridor for power evacuation of wind power projects
x. Declaration of Preferential Tariff/Feed in Tariff by Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs)
xi. Introducing Minimum Renewable Purchase Obligation (RPO)
xii. Introducing Renewable energy Certificate (REC) mechanism
xiii. Formulating guidelines/policy for Repowering of old wind power projects
xiv. Formulating guidelines/policy for wind-solar hybrid wind power projects
xv. Formulating guidelines/policy for offshore wind power projects
xvi. Wind Resource Assessment for offshore wind power projects
xvii. Introducing Scheduling & Forecasting mechanism for wind power projects
xviii. Making NIWE as internationally recognized testing agency for WEGs
xix. Introducing national level auction scheme for wind power projects for connecting to central transmission utility (CTU)/ Inter State Transmission System (ISTS)

14. Development Trend of Wind Power Projects in India

Initially private investors having other industries got attracted by Accelerated Depreciation (AD) benefit. They opted for sale to utility as well as for captive use and in some cases also sale to third party. Subsequently investors opting for sale to utility got attracted by generation based incentive (GBI) scheme. Textile industries also got attracted by Technology Upgradation Funding (TUF) Scheme.

CERC and SERC also adopted determination of preferential tariff/feed in tariff based on cost plus approach which also attracted investors. RPO and REC mechanism could not attract expected development.

The highest annual capacity addition of 5502.8 MW occurred in financial year 2016-17. Main reasons of this high addition were (i) AD Scheme was to be withdrawn (ii) Generation Based Scheme was to be withdrawn (iii) Wind power auction scheme was to be introduced and (iv) Income Tax benefit (10 years tax holiday) under 80 IA was to be withdrawn.

After introducing wind power auction scheme by MNRE through SECI, all the states stopped giving preferential tariff for new projects and capacity addition mainly got confined to projects allotted to IPPs through SECI auction excepting few captive users. The retail investors having small capacities of projects almost withdrew from the wind power.

Until FY 2016-17 preferential tariff/feed in tariff declared by CERC and SERC are summarized below:

Sl. No.	Agency/State	Tariff (₹/kWh)
i	CERC	3.68/kWh to 6.60 /kWh as per CUF and with/without AD
ii	APERC/Andhra Pradesh	4.35/kWh and 4.76/ kWh with/ without AD benefit

Sl. No.	Agency/State	Tariff (₹/kWh)
iii	GEREC/Gujarat	4.19/ kWh
iv	KERC/Karnataka	4.50/kWh
v	Kerala	5.27/kWh to 6.58/kWh as per CUF
vi	Madhya Pradesh	4.78/kWh
vii	Maharashtra	3.29/kWh to 4.78/kWh as per CUF
viii	Rajasthan	4.87/kWh to 5.52/kWh as per Districts and with/without AD
ix	Tamil Nadu	3.70/kWh and 4.16 with/without AD

As per the information available from different sources, from February 2017 to August 2020, SECI has conducted following auctions for wind power to be connected to CTU. Auction wise allotted capacity and lowest tariff is as follows:

Sl. No.	Auction	Date	Capacity (MW)	Lowest Tariff (₹/kWh)
i	SECI-I-Wind	February 2017	1050.00	3.46/kWh
ii	SECI-II-Wind	October 2017	1000.00	2.64/kWh
iii	SECI-III-Wind	February 2018	2000.00	2.44/ kWh
iv	SECI-IV-Wind	April 2018	2000.00	2.51/kWh
v	SECI-V-Wind	Sept. 2018	1190.00	2.76/kWh
vi	SECI-Hybrid-I	Dec. 2018	840.00	2.67/kWh
vii	SECI-VI-Wind	February 2019	1200.00	2.82/kWh
viii	SECI-Hybrid-II	May 2019	600.00	2.69/kWh
ix	SECI-VII-Wind	May 2019	480.00	2.79/kWh
x	SECI-VIII-Wind	August 2019	440.64	2.83/kWh
xi	SECI-IX-Blended	August 2020	970.00	2.99/kWh
	Total		11770.64	

As per the information available from different sources, in addition to above mentioned SECI auctions, TANGEDCO, GUVNL, MSEDCL and NTPC have also conducted auction from August 2017 to May 2019. Auction wise allotted capacity and lowest tariff is as follows:

Sl. No.	Auction	Date	Capacity (MW)	Lowest Tariff (₹/kWh)
i	TANGEDCO	August 2017	450.00	3.42/kWh
ii	GUVNL-I	December 2017	500.00	2.43/kWh
iii	MSEDCL	March 2018	500.00	2.85/ kWh
iv	NTPC	August 2018	1200.00	2.77/kWh
v	GUVNL-II	May 2019	191.00	2.80/kWh
	Total		2841.00	

All India annual capacity addition of wind power in last three financial years from 2017-18 to 2019-20 is as follows:

Sl. No.	Financial Year	Capacity Addition
i	2017-18	1865.20 MW
ii	2018-19	1481.00 MW
iii	2019-20	2017.80 MW
iv	2020-21	940 MW (up to Jan. 2021)

15. Current Situation of Wind Power Sector in India

Current situation of wind power sector in India is not encouraging. Most of the stakeholders including Wind Turbine Manufacturers, Ancillaries, Spares Suppliers and Service Providers are passing through all-time worst period. The main reason of the poor condition is auction; in which people due to various reasons known to them quoted practically unviable rates and in view of these low rates all states have stopped buying through preferential or feed in tariff.

In addition to the above, in most of the states investors are not getting timely payment from DISCOMs. There are no preferential/Feed-in tariffs and DISCOMs are discouraging captive use and third party sale by imposing many penal charges. In some states DISCOMs are trying to revise/re-negotiate the existing PPAs to reduce the tariff and in some states where tariff was applicable for a limited period, tariff is being revised to very low rate for balance period.

This has stopped the growth of sector and has adversely affected the stakeholders. Many industries had to close down operations, impose job curtailment and delay the payments. Many people had to lose jobs and many are on the verge of losing.

Wind is very much site specific and need not be put in competitive bidding or auction. My opinion is that the only way to revive the wind industry is to immediately reinstate preferential or feed in tariff.

16. Stand-alone Small Wind Energy Systems in India

There appears to be a large scope of stand-alone small wind energy system with battery storage combined with solar power and emergency standby DG set for assuring reliable power supply. This will be very useful for remote locations where electric supply is not available from utilities and also for mobile towers and charging stations for electric vehicles. However, this requires quality system and adequate post sales services.

MNRE earlier promoted a scheme on "Small Wind Energy and Hybrid systems (SWES)", under the scheme Central Financial Assistance (CFA) @ Rs 1.00 lakh per kW was provided to the community users for installation of small wind and solar hybrid system. However, currently this scheme is not available.

Conclusion

In view of the climate change happening all over world, wind power needs encouragement owing to its non polluting feature. As the third largest carbon emitter in the world, decarbonising India's energy system is crucial to achieve global decarbonisation targets and support international efforts to keep global warming under 1.5°C pre-industrial levels – and wind power will play a key role for India to achieve the country's climate targets.

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Source: TNN, February 17, 2021

IBC Prevails Over Power Purchase Agreements, Supreme Court Says

A power purchase agreement cannot be terminated during the moratorium period under the Insolvency and Bankruptcy Code, the Supreme Court has held. A two-member bench of Justice Dhananjaya Chandrachud and Justice MR Shah observed that a buyer cannot terminate a power purchase agreement even if it contains a clause allowing such an action if an insolvency application is admitted against a power supplier. As such, the insolvency tribunals correctly stayed the termination because any action otherwise could have resulted in the corporate death of the company, the apex court observed.

Source: Bloomberg Quint, Mar 09 2021

Bill for Amending Electricity Act Sent for Consultation

The Union power ministry has circulated the proposed Electricity (Amendment) Bill, 2021, for inter-ministerial consultation and has also sent it to the law and justice ministry for vetting, a government official aware of the development said. The proposed amendments aim to de-license power distribution and increase competition, unleashing next-generation power sector reforms in India. The amendments also propose appointing a member with legal background in every electricity regulatory commission and strengthening of the Appellate Tribunal for Electricity (APTEL). They will also spell out penalty for not meeting renewable purchase obligations that require power distribution companies (discoms) to buy a fixed amount of renewable energy to reduce reliance on fossil fuels. In addition, Electricity (Amendment) Bill may also prescribe power consumers' rights and duties, as the government plans to ensure round-the-clock supply.

Source: Mint, 15 Mar 2021

Basic Customs Duty Expected to Increase Solar Bid Tariffs by up to 50 Paise Per Unit: ICRA

According to ICRA ratings, Basic customs duty (BCD) is expected to result in an increase in the capital cost for a solar power project by 23-24 per cent, which in turn would result in an increase in tariff by about 45-50 paise per unit. "However, the bid tariff trajectory is likely to remain well below ₹ 3 per unit and thus, would continue to remain cost-competitive from the off-takers' perspective. This step would have a positive impact on domestic equipment manufacturers though the extent of benefit would depend upon the imported PV module prices, especially from China. For the state-owned utility off-takers, average power purchase cost and variable cost of power purchase remain in the range of Rs 4-5 per unit and Rs 3-3.5 per unit, respectively, in many states.

Source: ET Energy World, March 11, 2021

Adani Renewables Bids Rs 2.77 for Wind Projects

Wind power tariffs dropped to two-and-half year low to Rs 2.77 per unit with Adani Renewables Energy Holding emerging as the lowest bidder in auction conducted by Solar Energy Corporation (SECI) on 15th March 2021. It quoted Rs 2.77 per unit for 300-Mw capacity, while Ayana Renewable Power quoted Rs 2.78 per unit for a similar capacity. Evergreen Power Mauritius quoted Rs 2.78 per unit for 150-Mw. JSW Future Energy quoted the same bid for 450-Mw, data available with MSTC showed. Other bidders who participated in the auctions are Azure Power India, O2 Power SG PTE, Shirdi Sai Electricals, AMP Energy Green, Tunga Renewable Energy, ReNew Vyan Shakti, AMP Energy Green and Halvad Renewable.

Source: ET Bureau, March 16, 2021

Debt worth Rs 30,000 Cr for Wind Power Projects Faces Risk

Debt worth Rs 30,000 Crore for wind power projects may face stress due to payment risks from power distribution companies (discoms). The problem predominantly pertains to four key states – Madhya Pradesh, Maharashtra, Rajasthan and Andhra Pradesh. The dues run into over Rs 5,400 crore for 156 renewable energy projects as of January 2021, according to CRISIL. Wind power projects, constituting nearly three-fourths of the total private renewable (wind and solar) capacity of these four states, have borne a larger share of the payment delays.

Source: Business Standard, March 13, 2021

Regulatory Update on Wind Power

Public Procurement (Preference to Make in India) for Purchase Preference (linked with local content) in respect of RE Sector

In the light of the various orders issued by the Government of India, Department for Promotion of Industry and Internal Trade (DPIIT) for Public Procurement (Preference to Make in India), Ministry of New & Renewable Energy, Government of India has issued the order no. F. No. 283122/2019-GRID SOLAR dated: 09th February, 2021- Public Procurement (Preference to Make in India) to provide for Purchase Preference (linked with local content) in respect of Renewable Energy (RE) Sector.

This order shall be applicable in respect of the procurements made by all attached or subordinate offices or autonomous body under the Ministry of New & Renewable Energy, Government of India including Government Companies as defined in the Companies Act, and/or the States and Local Bodies making procurement under all Central Schemes/ Central Sector Schemes where the Scheme is fully or partially funded by Government of India. The aforesaid order shall also be applicable in respect of funding of capital equipment by IREDA, PFC and REC, for all RE projects, for which the bids are issued on or after 1st April, 2021.

Subject to various provisions of the order, the list of items for wind power, in respect of which, local capacity with sufficient competition exists as per Annexure-1, will be reviewed at regular intervals with a view to increase number of items in this list.

Annexure-1: B. Wind Power: 1. Gear box, 2. Blades, 3. Rotor, 4. Generator, 5. Tower, 6. Hub, 7. Parts of controller, 8. Bearings, 9. Yaw mechanism components and 10. Nacelle

Further Time Extension in Scheduled Commissioning Date of RE Projects

Grid Solar Power Division, Ministry of New & Renewable Energy (MNRE) Government of India has issued an office memorandum F. No. 283/18/2020-GRID SOLAR dated: 09th February, 2021 for time extension in scheduled commissioning date of renewable energy (re) projects considering disruption due to lockdown due to COVID-19.

Reference is invited to this Ministry's O.M. No. 283/18/2020-GRID SOLAR dated 13.08.2020, wherein, a blanket time extension of 5 (five) months from 25th March 2020 to 24th August 2020 was given, if invoked by the RE developers without case to case examination and no documents /evidence will be asked for such extension. Requests were received by MNRE for further extension beyond 5 months on account of COVID-19. The requests have been examined in the Ministry. Further extension beyond 5 months can be granted by implementing **agencies in exceptional cases, after due diligence and careful consideration of the specific circumstances of the case,** and if allowed in terms of the provisions of the relevant contract. This further extension beyond 5 months will not be granted in a routine manner.

Electricity (Late Payment Surcharge) Rules, 2021

Ministry of Power, Government of India vide its Notification No. CG-DL-E-23022021-225360 dated 22nd February, 2021 has made the Electricity (Late Payment Surcharge) Rules, 2021 in exercise of powers conferred by Section 176 of the Electricity Act, 2003 (36 of 2003) as follows:

These rules shall be applicable for payments to be made in pursuance of---

(a) Power Purchase Agreements, Power Supply Agreements and Transmission Service Agreements, in which tariff is determined under section 62 of the Act; and

(b) such Power Purchase Agreements, Power Supply Agreements and Transmission Service Agreements that become effective after these rules come into force, in which tariff is determined under section 63 of the Act.

Late Payment Surcharge

1. Late Payment Surcharge shall be payable on the payment outstanding after the due date at the base rate of Late Payment Surcharge applicable for the period for the first month of default.
2. The rate of Late Payment Surcharge for the successive months of default shall increase by 0.5 percent for every month of delay provided that the Late Payment Surcharge shall not be more than 3 percent higher than the base rate at any time: Provided that the rate at which Late Payment Surcharge shall be payable shall not be higher than the rate specified in the agreement for purchase or transmission of power, if any: Provided further that, if a distribution licensee has any payment including Late Payment Surcharge outstanding against a bill after the expiry of seven months from the due date of the bill, it shall be debarred from procuring power from a power exchange or grant of short term open access till such bill is paid.

Adjustment towards Late Payment Surcharge: All payments by a distribution licensee to a generating company or a trading licensee for power procured from it or by a user of a transmission system to a transmission licensee shall be first adjusted towards Late Payment Surcharge and thereafter, towards monthly charges, starting from the longest overdue bill.

Contributed by: **Om Prakash Taneja,** Advisor, Renewable Energy

CRANELESS TECHNOLOGY
A Boon to WTG Asset Management

Vasanth Balasubramanian
Business Development Department

Anderson Samuel
Head – Wind Business

Windcare India Private Limited

Utilization of wind resources and power generation from wind is increasing at a faster rate in recent times. Due to the huge investment, investors are in still grappling with the slowing economy, low tariffs, tariff caps, curtailment, infrastructure constraints, and a plethora of duties and tariffs. India has set an ambitious target of having 175 GW of renewable energy capacity by 2022. India's energy situation had changed significantly. We have transitioned a country which had a deficit, so far as energy production capacity was concerned, to a country which is now a surplus and we are able to produce more energy than we consume and we are exporting energy to our neighboring countries. The country has aggressively expanded its wind and solar energy capacity in the past five years, helped by aggressive bidding by companies.

Figure 1: *Conventional Rotor Replacement Technology*

In this article, we will like to share the most effective alternate system for big cranes to reduce cost of the wind farm maintenance in case of replacement of heavier component like – rotor, main bearings/shaft on account of failure.

The state-of-the-art alternative technology for up-tower lifting solutions for wind turbine corrective repairs is safe, reliable, and less costly as compared to using large conventional cranes. In addition to lowering O&M costs, up-tower lifting technology reduces ground preparation and reduces downtime by allowing safe operation of major components in higher wind speeds.

The need of the hour is the cost optimization, effective use and ensuring the availability of the wind turbine assets all the times. The predictive and preventive maintenance techniques for the sub parts & small equipments/component are built in well-groomed manner as plug and play. Whereas in case of unplanned major component failure; obviously the asset becomes non available for the power generation.

The modern wind farms are now coming up with the larger and larger rotor diameter in size to be efficient and reduce the Levellized cost of Energy.

Some of the common failures in rotor occur in rotor blade, bearings in main bearing housings and weather-related e.g. lightning, design, installation and maintenance issues. Above 7% of wind turbine rotor failures, main shaft and main bearing failures are recorded every year which consumes the major operating expenses and lead to downtime.

For the satisfaction of all asset owners, OEMs, IPPs, big power players, ISP's, a new and innovative technology in the name of Craneless technology is available, which replaces the traditional technique of use of heavy duty cranes for lowering and re-erecting the rotor, main bearings, etc. The incurring expense for mobilization and demobilization, fuel consumption, access of pathway, endangering of environment comparatively

Figure 2: *Craneless Technology – Rotor Replacement*

makes the investor think on using these alternative technologies. The Craneless Technology solutions will drive down O&M costs, improve turbine uptime, increase safety, and reduce the reliance on larger, more expensive traditional cranes. This technology will set a new standard for main bearing and generator exchanges. This is a big step forward for the industry where continuous innovation and lowering the cost of energy continue to be market drivers.

Craneless technology (as shown in figures 2, 3 and 4) can be used for lowering and raising the major heavier components such as rotor, main bearings and main shafts from nacelle with a quick assembly of derricks structure in nacelle with customized tools & technical experts.

Major components failures are directly proportionate to the financial losses due to using cranes to replace the same. Cost for such heavier component replacement by crane method (as shown in figure 1) consumes the major portion of the expenditure from crane including mobilization/demobilization, fuel consumption, access of pathway, Right of Way (ROW) etc. If it is of the rotor repair, 40% of cost alone is the actual repair cost, 60% cost will be the crane cost. Main bearing and main shaft replacement activities consume 30% of actual repair cost and whereas the 70% of balance cost to be paid for crane hiring cost.

Therefore, creating and applying strategies that improve the reliability of their failed components replacing is a significance

Figure 3: *Craneless Technology –Rotor Replacement*

need in pertaining business condition. As a result of craneless technology implementation it will result in 60% of overall maintenance cost reduction and minimizing the machine downtime up to the mark than exiting methodology.

The forthcoming maintenance of a wind turbine depends on this technology which will enlighten the society and plays a major role on Asset Management Technique. Such an emerging technology will undeniably fulfill the need of the investors like OEM's, IPP's, ISP's in India and internationally by being competitive against all the existing technologies which comprise of all international standards and quality in it.

Benefits of CranelessTechnology

- Increase the machine availability of wind farm Asset.
- Reduce the downtime due to major failure.
- Lowers the Asset Management cost.
- Suitable and adaptable to all WTG capacity and working.
- Can operate at high wind speeds.
- Offers alternative lifting services to exchange and repair gearboxes, generators, blades, and fully-assembled rotors using a variety of specialized up-tower lifting devices.
- These devices are designed to increase efficiency and save cost for clients in the wind turbine maintenance market, by creating opportunities to replace major components from wind turbines without the need for large cranes.
- This new technology is not only swift, efficient, safe, and reliable; it is intended to lower O&M costs, reduce ground preparation requirements, and increase the working window for these types of maintenance activities by allowing safe operation in wind speeds up to 18 meters per second.
- The demand for lighter lifting solutions is rooted in steep crane prices. Larger wind turbines typically require larger and therefore more expensive cranes; a cost that increases exponentially in hard-to-reach areas.
- With the next generation of turbines beginning to experience component failures, this new technology is a logical step

"As a result of craneless technology implementation it will result in 60% of overall maintenance cost reduction and minimizing the machine downtime up to the mark than existing methodology."

Figure 4: *Craneless Technology – Main Bearing Replacement*

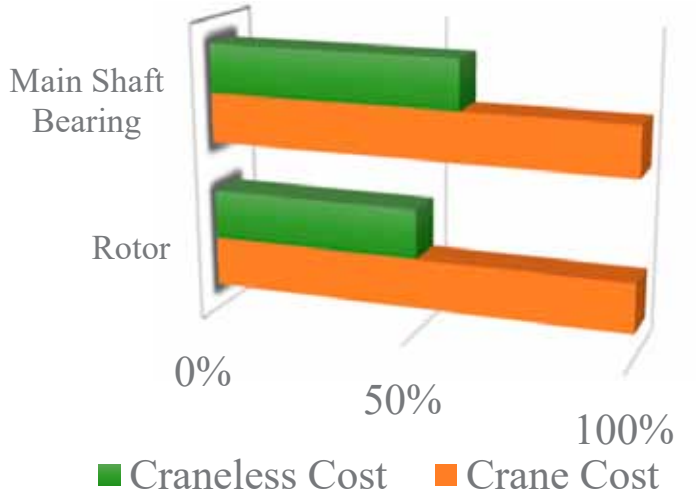

Figure 5: *Cost Comparison*

component of a wind turbine to and from the nacelle. Here, the net moment act on the tower remains zero.

d. The Centre of Gravity of the entire tower remains within its limit and the lowering and raising operation can be performed by maintaining the stability of the tower itself. Therefore, the system described setup is balanced in the existing portion of the nacelle base within the allowable limit.

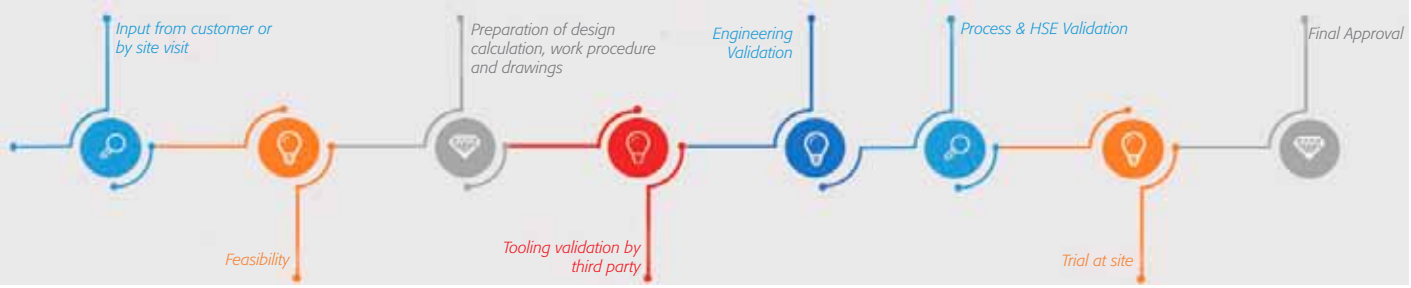

Figure 6: *Engineering Development*

towards a more flexible industry for large correctives and will help to further reduce the operational expense of the wind energy industry.

Craneless Process & Implementation

The stage wise progress on the Engineering Development of Craneless solution upon customer requirement is as follows.

Principle

a. The system includes an electrical winch which is disposed of on ground, a pulley which is fitted at the base of the tower, a derrick structure which is fitted in the existing hook point and provision of the nacelle base, a pulley system, a jig and a rope. Thus, the assembly setup over the nacelle has negligible amount of change in CG position of the nacelle with respect to the tower.

b. The pulley system includes a set of fixed pulleys fitted to derrick structure and a set of movable pulleys fitted to fixed pulleys and is also coupled to the jig which holds the rotor of the wind turbine.

c. The method for actuating the controls in the winch system, thereby raising from and lowering to the ground level a

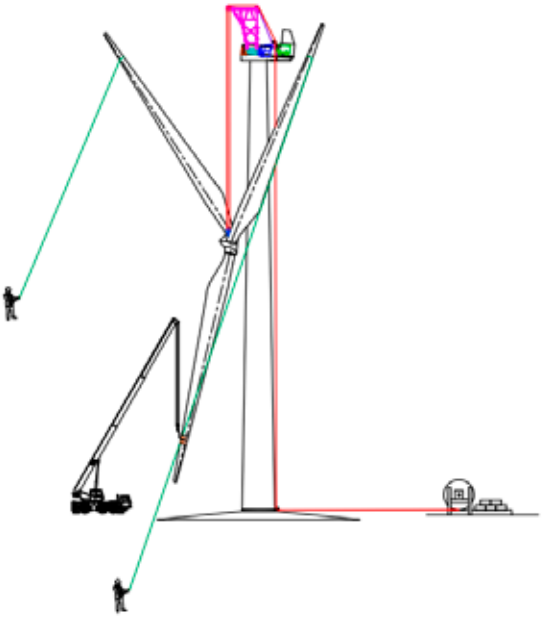

Figure 7: *Craneless Rotor erection*

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For more information, please contact

C R Anbalagan at: anbalagan.ramasamy@arcvera.com

Or Visit us online: www.arcvera.com

Snippets

PM Receives Ceraweek Global Energy and Environment Leadership Award

Prime Minister Shri Narendra Modi has been conferred Cambridge Energy Research Associates Week (CERAWeek) Global Energy & Environment Leadership Award on 5th March 2021 for commitment to energy sustainability, environment. Mr. Daniel Yergin, Vice Chairman of IHS Markit and conference chair has said that India has emerged at the center of global energy and the environment, and its leadership is crucial to meet climate objectives for a sustainable future while ensuring universal energy access.

Source: ET Now, Mar 05, 2021

U.S. Readies $40 Bln in Loans to Boost Clean Energy

U.S. Energy Secretary Ms. Jennifer Granholm has said that she is ready to reactivate her department's loan program office that went mostly unused in the last four years and has more than $40 billion in funds to boost the transition to clean energy. She added that I am ready to rev those engines back up so that we can spur the next generation of innovation and deployment.

Source: Reuters, March 04, 2021

India Opens Energy Office in Moscow to Expand Investments and Procurement

India has opened India Energy Office (IEO) in Russia on 3rd March 21 with a goal to push an already burgeoning energy partnership between the two strategic partners. The IEO will cover five top Indian entities -- Oil India Limited, ONGC Limited Videsh Limited, GAIL (India) Limited, Indian Oil Corporation Limited, and Engineers India Limited. IEO has been opened for promoting the interest of Indian oil and gas PSUs in Russia and of Russian companies in India in the energy sector. The key objectives of IEO is to make all-out efforts for supporting the current assets, finding new business opportunities, involved in capacity building, tying for new technologies for skill development, import & export of petroleum products and services.

Source: ET Bureau, March 03, 2021, 07:21 IST

Many African Countries have Not Yet Tapped into their Wind Power Potential

According to the Global Wind Energy Council, Africa and the Middle East region installed 821MW of new wind power capacity in 2020, pushing total capacity in the region over 7GW. However, this is still just a fraction of the total wind power potential. African continent alone has more than 59,000GW of technical wind resource potential. This is enough to power the continent's energy demand 250 times over. But, the current installed wind power capacity in Africa only accounts for 0.01% of this potential.

Solar Start-Up Launches Online Job Portal for RE Sector

Oorjan, a solar energy start-up has said that it has launched an online portal to help find jobs and upgrade skill sets in the renewable energy sector. Under the portal, the company has launched two platforms -- Greenjobs and Greenstitute to provide more suitable jobs and giving them access to various certification courses, respectively.

Source: ET Energy World, March 08, 2021

Indigrid Invit to Acquire Northeast Power Transmission Project for ₹ 4,625 Crore

India Grid Trust (IndiGrid), an infrastructure investment trust (InvIT), inked an agreement to acquire a power transmission project in the northeast for ₹ 4,625 crore from Sterlite Power. The 830 circuit-km long NER-II Transmission Ltd project is spread across Assam, Arunachal Pradesh and Tripura and post the deal completion, will raise IndiGrid' assets under management to $2.8 billion.

Source: Mint, 06 Mar 2021

Monitor, Aid Implementing Agencies to Achieve 175 GW Renewable Energy by 2022: Parliamentary Panel to MNRE

A parliamentary panel has asked the Ministry of New and Renewable Energy (MNRE) to monitor working of the implementing agencies on a real-time basis and aid them help achieve a target of having 175 GW of renewable energy capacity by 2022. "The ministry (MNRE) should ensure continuous real-time monitoring of the working of the implementing agencies, support them vigorously in sorting out the glitches and take corrective action so that the physical targets set for the FY22 under various heads of the grant are successfully achieved," the Parliamentary Standing Committee on Energy said in a report tabled in Parliament. According to the report, the MNRE has continuously failed to achieve its yearly physical targets.

Source: PTI, March 09, 2021

New Generation DFIG Power Converters for 6-8 MW Wind Turbines

"The new generation of power converters applies the most advanced control strategies, state of the art semiconductor technologies and cooling strategies that solve the main constraints of the DFIG topology, allowing for an increase in the power rate of the new wind turbines above 6MW."

Jokin Aguirrezabal
Power Converter Manager

Álvaro Miranda
DFIG Product Leader

Iker Esandi
Control & Software Senior Engineer

Ingeteam Wind Energy

Doubly-fed induction generator (DFIG) topology wind turbines have been widely used in the wind energy market during the last years to cover the medium and lower power ranges, between 2 and 4 MW. Nowadays, this fact has changed and the OEMs are developing DFIG wind turbines that could go above power rates of 6MW.

The wind sector is globally focusing its efforts on reducing the Levelized Cost of Energy (LCoE) of the technology in order to prove itself as a profitable option in the energy mix regarding electrical generation. In response to this market outlook, OEMs are working hard to develop wind turbines with a power range exceeding 6MW, which potentially enable the reduction of the LCoE of the wind farm.

In addition, the increasing penetration of wind power capacity into the grid creates new challenges for the Transmission System Operators (TSOs) in order to keep the stability of the transmission system. As a consequence, grid codes around the world are strengthening their requirements to meet more demanding conditions such as FRT (Fault Ride-Through) behavior or harmonic distortion compliance.

The main constraints of the DFIG topology, such as short-circuit peak currents or grid code compliance have been in the past a limitation for a power increase. Deep knowledge of wind industry features, DFIG generators and core components of a power converter are the key factors to ensure a robust and reliable solution regarding the different events that could occur (harmonic fulfilment, FRT, weak grids, SSR, etc.).

The new generation of power converters applies the most advanced control strategies, state of the art semiconductor technologies and cooling strategies that solve the main constraints of the DFIG topology, allowing for an increase in the power rate of the new wind turbines above 6MW.

State-of-the-art Technology for High Power Converters

The upgrade of the power converter to power rates above 6MW requires a deep knowledge of DFIG features, especially the main design constraints of this topology, like the peak currents during FRT events or the mechanical behavior of the whole converter inside the wind turbine. The design process covers all these aspects and the new generation products ensure the reliable operation of the system.

Regarding FRT events from the HW perspective, the semiconductor is one of the most critical points regarding product lifetime. High peak currents, generally ranging from 8kA to 14kA, can constraint the design, and thus, a deep knowledge of each module under this operation mode is required. Taking advantage of high-tech laboratory and specific test benches, the semiconductors can be tested under all operation ranges, including different FRT profiles with real voltage and current conditions.

The following figure shows a peak of up to 12kA introduced in one FF1400R17IP4 IGBT, followed by the blocking voltage of the real application:

This kind of semiconductor characterization is essential to know the real application limits of each semiconductor module. This knowledge is also relevant to adapt and optimize the power converter design depending on the FRT specification and generator characteristics. In this sense, the modular solution for the new generation of power converters complies with two main

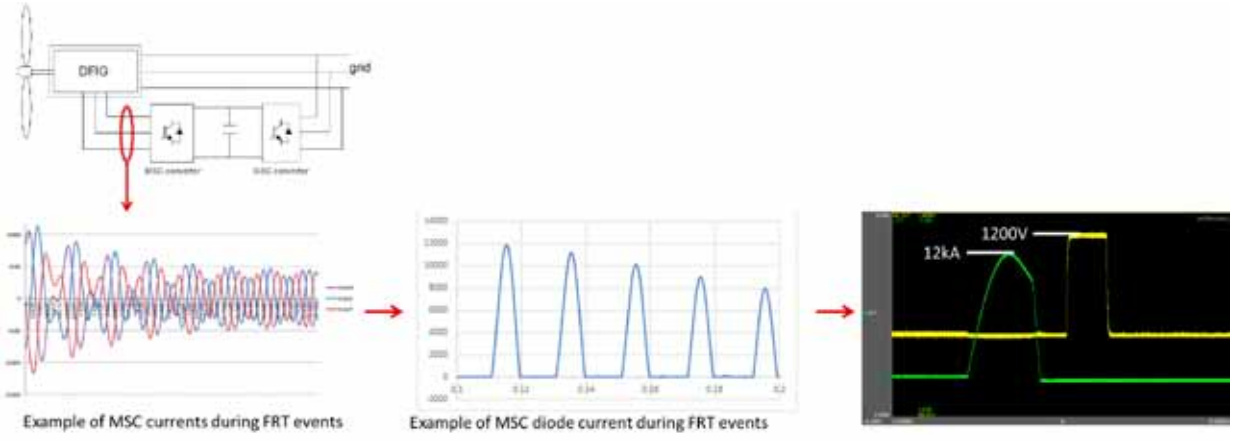


Figure 1: *FRT Peak Currents Injected to A FF1400R17IP4 Infineon Module*

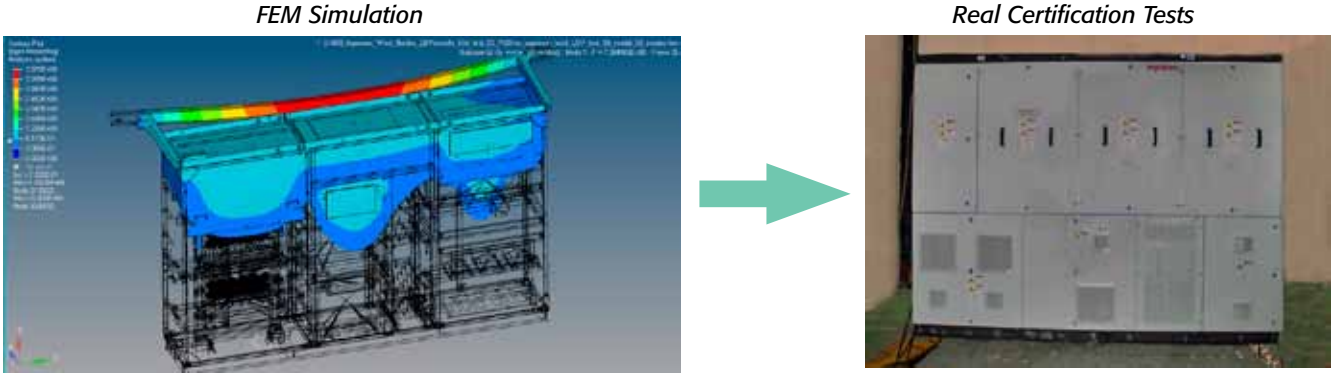


Figure 2: *Finite Element Analysis Results and Real Pictures of Certification Tests*

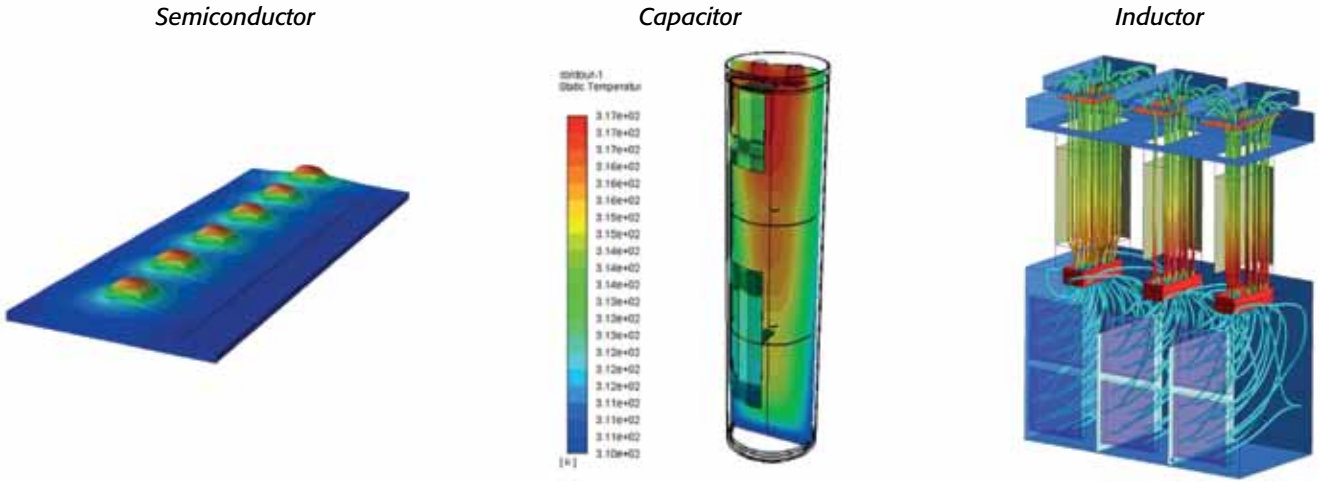


Figure 3: *CFD Analysis of the New Generation Converters*

goals, reliability and cost optimization for each application. This is the key to keeping the competitiveness in wind markets.

The mechanical performance is also fundamental to reach a successful design. Finite element analysis (FEM) of the whole converter cabinet is always performed before real certification tests. The two-step validation process guarantees a lower time to market of compliant solutions.

Another important design criterion is the cooling of the whole converter cabinet. At the end, improving the cooling has a direct impact on the final power rate of the converter. Computational Fluid Dynamics simulations (CFD) are necessary to reach the best cooling performance. These analyses are performed, starting directly from the junction of the semiconductor and reaching the whole converter cabinet, including the air and liquid cooling of passive elements such as filters.

Depending on the wind turbine design different cooling strategies apply. Full liquid-cooled options allow an extraction of all the losses through the liquid, avoiding heat exchange with the internal ambient of the wind turbine. This option becomes more interesting for high power wind turbines, where the heat generated by all the components can constraint the design of the wind turbine (the nacelle for example). In any case, independently of the cooling strategy, the management of the internal heat of the converter needs to be simulated so as to guarantee that all the internal components work inside the specification limits.

The new generation power converters have gone through a complete ambient qualification process in order to correlate the simulations and real test results. The main advantage of the correlation process is that the operation in different locations (higher ambient temperature for example) or further power upgrades can be easily analyzed.

In order to offer always the most optimal solution, a wide variety of ambient kits is offered to adjust the converter design to the final location.

High Performance Control Techniques

Along with the HW design, control strategies are also necessary to assess the successful solution. Considering the newest grid codes and the different grid types that can be found all over the world, a deep knowledge in the control algorithms that manage the power converter is necessary.

To do so, advanced SIL and HIL models have been developed. These models reduce the qualification and certification time of the wind turbine and are in continuous evolution in order to replicate the real behavior of grids and wind turbines.

Regarding FRT compliance, advanced control algorithms have been developed that provide the converter the capability of injecting reactive current to the grid in very short times, keeping the active power of the turbine under control. In this way, the converters can fulfill the most restrictive Grid Codes both from the point of view of reactive current injection and also to control the active power required for manufacturer's drive train damping algorithms.

SIL and HIL simulations performed internally allow analyzing in detail the real behavior of the power converter.

The above results show a response time under 30ms with a settling time of less than 50ms. The dynamic shown allows for the system to comply with the most sever grid codes, such as German VDE 4120.

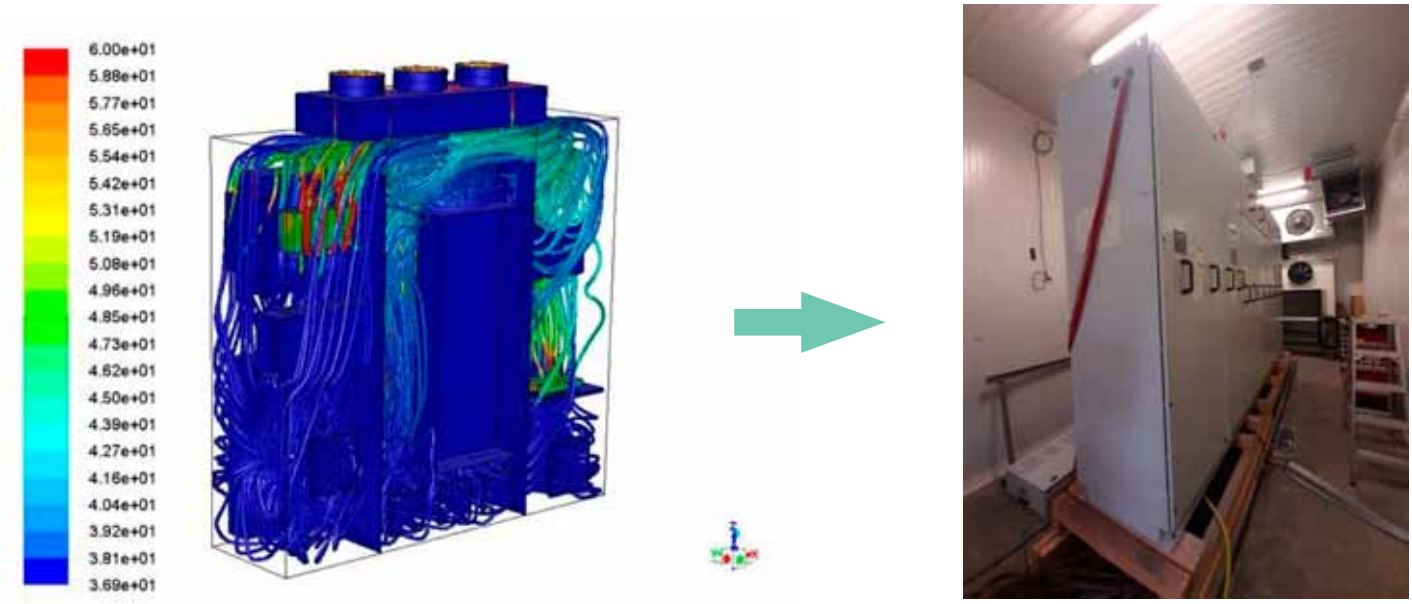


Figure 4: *CFD Analysis Results and Real Pictures of Certification Tests in an In-House Climatic Chamber*

Other important field of study regarding grid integration is SSI/SSR (sub-synchronous interactions). The converter is providing the capability of coexisting with long series-compensated line, where most DFIG turbines have sub-synchronous stability issues.

This kind of grids have the particularity of having series capacitors connected to compensate the line. The inclusion of these capacitors generates zero impedance at certain frequencies that can generate grid resonances. This resonance/oscillation is characterized by a frequency value lower than the grid rate frequency, hence the sub-synchronous naming.

Standard dual currents control used in most DFIG wind power converters use to be unstable in this kind of grids.

A deep knowledge of control theory and grids allows to develop an algorithm that provides DFIG turbines with the capability of coexisting with the most extreme series compensated lines.

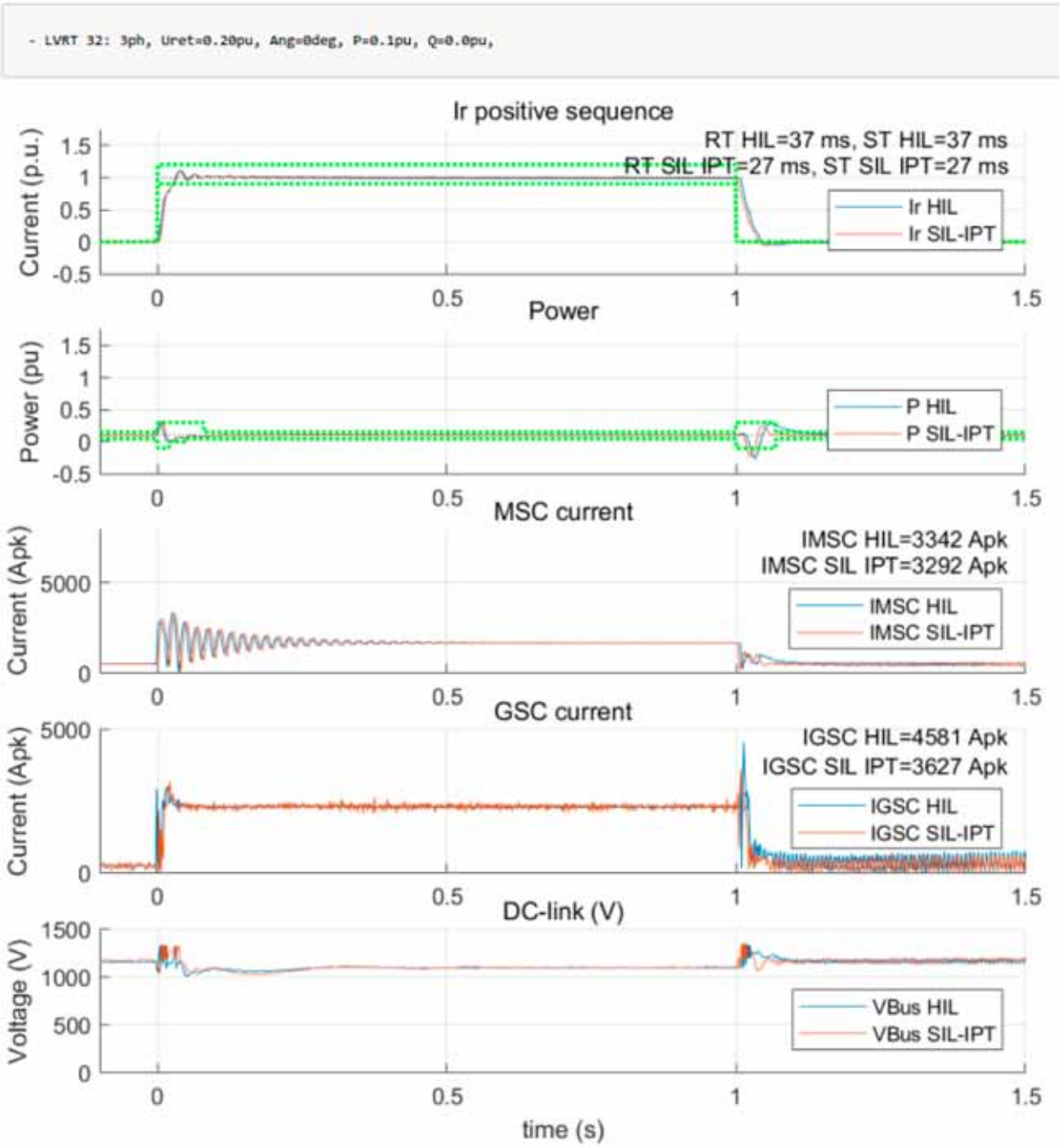


Figure 5: *Dynamic Response under SIL & HIL Simulation for a Three Phase 20% Retained Voltage Dip*

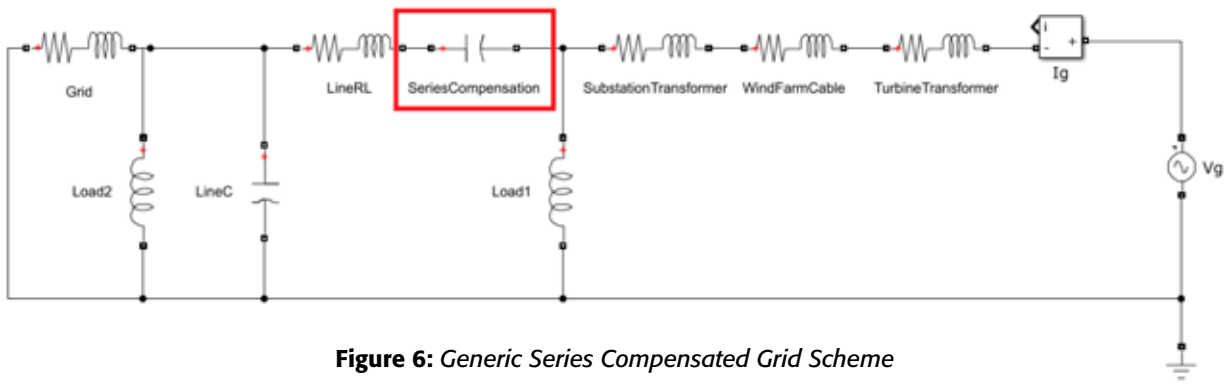


Figure 6: *Generic Series Compensated Grid Scheme*

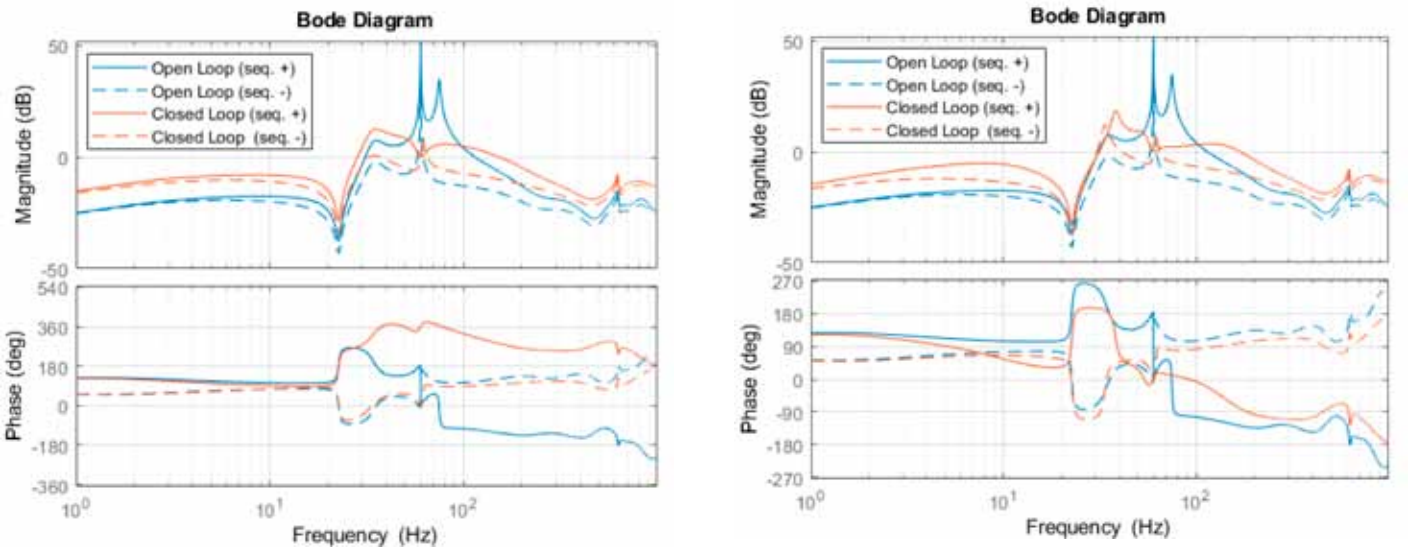
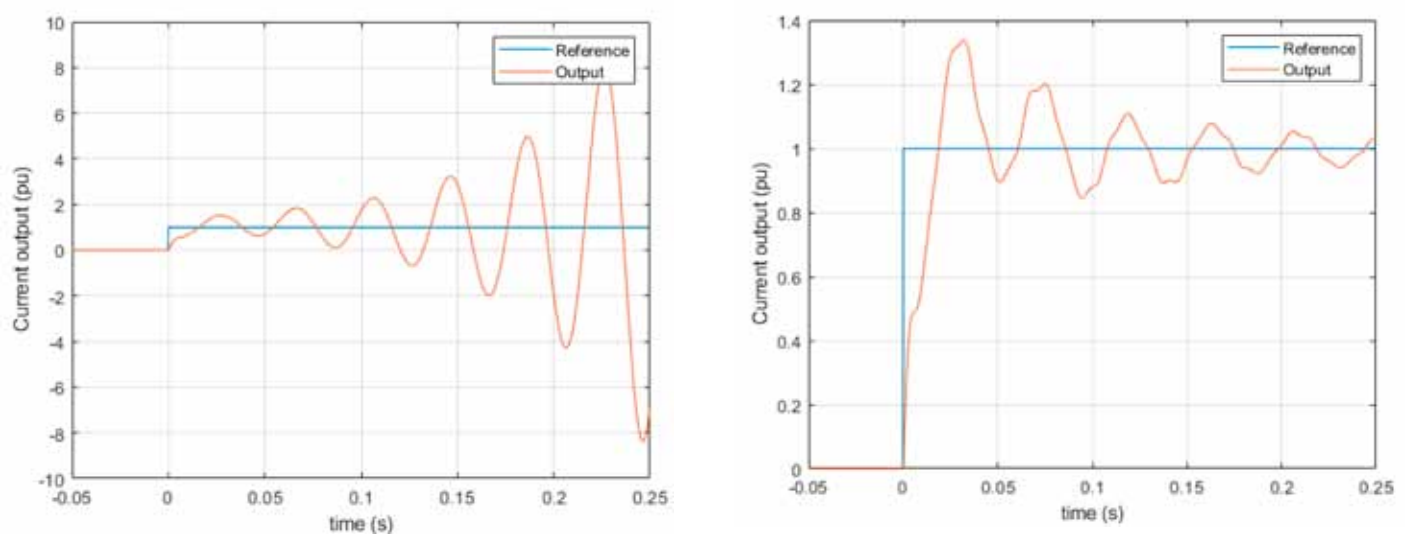


Figure 7: *Unstable Standard Control Loop Bode Diagram vs IPT's Advance Control Loop Bode Diagram*



a. Standard current step response in case of series compensated line - Unstable control.

b. Advanced current step response in case of series compensated line - Stable control.

Figure 8: *Current Loop Step Response Comparison in Case of Series Compensated Line*

Internal tools based on full-control modeling and advance control theory has allowed designing full-frequency range stable control loops. The next two figures show an unstable control loop Bode diagram (left) and the advanced control loop Bode diagram:

With this advanced control loop, the unstable current step response is improved and can be considered as stable now.

Continuing with the control stability, another important topic is the operation of wind turbines connected to low SCR (short-circuit ratio) grids. As aforementioned, the advanced tools developed allow to design full-frequency range stable control loops. In case of low SCR, the instability problems use to appear from 500 Hz to 1500 Hz.

The advanced control allows wind turbines to be installed in weak grids with an equivalent SCR below 1. In the following picture, the Bode diagram of the current control loop (left) with a stable control architecture for weak grids and its step response (right) for an equivalent SCR of 1 are shown.

In overall, SIL & HIL platforms allow the qualification of control algorithms in a very precise way. Moreover, these platforms also allow to continuously evolve and adapt the existing control algorithms, being able to answer customer's requirements very rapidly and with high quality standards.

Lowering Wind Energy's LCoE

In onshore applications, DFIG wind turbine topology is market leader thanks to a lower lifetime product cost that guarantees

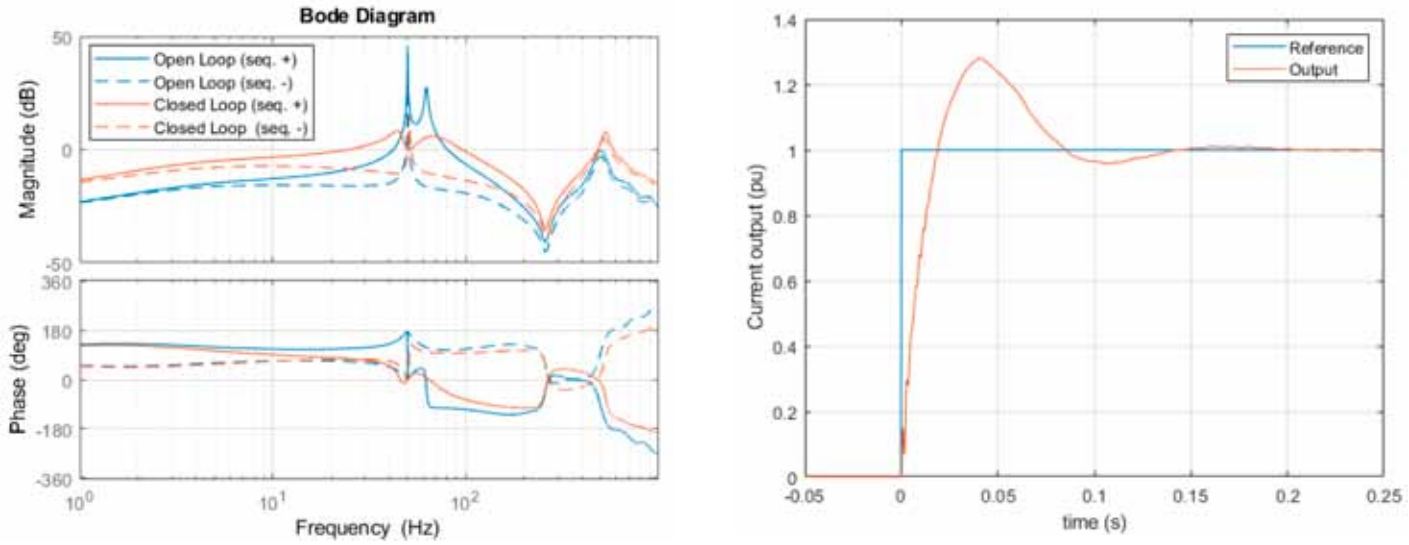


Figure 9: *Advance Control Architecture for Weak Grids Bode Diagram and Current Step Response in Case of SCR=1*

the most effective return on investment for most existing wind profiles.

Deep knowledge and good techniques of HW and FW development and validation are a key factor to guarantee reliability and optimize cost in the high power DFIG wind turbine solution. Thanks to dedicated test benches (both HW and FW), the power converter performance is fully characterized, allowing the extension of its capability up to its limits. RAMD metrics (MTBF & MTTR) of the product are also evaluated in order to ensure the fulfillment of the high standards requirements of the wind industry.

All these elements, together with an extensive experience of DFIG application and partnership collaboration with customers, have led to optimized power converters for DFIG wind turbines beyond 6MW. The new solutions will drastically minimize the on-site validation and certification phase, reducing the time to market, and at the end, reducing the overall cost of the wind turbine.

Letters to the Editor

Dear reader,

It is our endeavour to make IWTMA Magazine Indian Wind Power, 'The Magazine' for the Indian Wind Industry. Your feedback on the general impression of the magazine, quality of articles, topics to be covered in future, etc. will be of immense value to us. We are thankful to your response. Kindly address your mail to 'associatedirector@indianwindpower.com.' All earlier issues are available on our website.

Thank you,

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SnipPets

Shell to Invest $5-6 Billion Annually in Green Energy

Anglo-Dutch oil giant Shell will invest up to $6 billion (4.9 billion Euros) per year in green energy after its oil output peaked in 2019. The energy major outlined extra cash for biofuels, electric car charging and renewables and said the group's crude oil production was gradually declining. "Shell today set out its strategy to accelerate its transformation into a provider of net-zero emissions energy products and services," it said in a statement.

Source: AFP, February 11, 2021

Chandigarh: Administration Sets Ball Rolling for Power Dept Privatisation

The Supreme Court has vacated the Punjab and Haryana high court stay on the privatisation of the UT electricity department. Thereafter, a meeting was convened and discussions were held on the issue. It has been decided to restart the sale of tender documents, which was earlier stopped due to the high court order. A senior official of the UT engineering department, who is closely associated with the privatisation project, said, "The infrastructure is already in place. Selection of a firm after the tender process and transition are likely to be completed by June-end. The department will also take care of interests of UT electricity department employees."

Source: TNN, January 15, 2021

Taking Steps to Prevent Cherry Picking; States on Board for Discoms Delicensing

The government is taking steps to ensure level playing field for state-owned electricity distribution companies and dissuade cherry picking of supply areas by private companies, when the sector is delicensed, power secretary Mr. Alok Kumar told ET in his first media interaction. Power and renewable energy minister Mr. R K Singh, Mr. Kumar along with senior officials in the ministries and attached PSUs held four zone-wise meetings with chief secretaries and energy secretaries of all states.

Source: ET Bureau, February 18, 2021

India Needs $500-bn Investment to Reach 450-GW RE Target By 2030: IEEFA

India will need to deploy $500-billion in investments to reach its 450GW capacity RE target by 2030, according to a recent report by the Institute for Energy Economics and Financial Analysis (IEEFA). This would include the cost of adding more than 300 GW of new renewables infrastructure, firming low-cost renewable power generation, and expanding and modernising grid transmission and distribution. Of the $500-billion investment, $300 billion would go for wind and solar infrastructure, $50 billion for grid firming investments, and $150 billion on expanding, modernising transmission. The country has received more than $42 billion in investment since 2014. According to the report, a huge global capital pool is mobilising to invest in renewable energy and grid projects in India, with pull factors including solar power tariffs hitting record lows, plunging solar module costs, record low interest rates, and the security of government-backed, 25-year power purchase agreements. It added that the sources of capital range from private equity, global pensions funds and sovereign wealth funds, to oil and gas majors, multinational development banks and Indian state-owned enterprises and power billionaires.

Source: ET Energy World, February 16, 2021

Electric Vehicles Usage Should be Made Mandatory for All Govt Officials: Gadkari

Transport Minister Mr. Nitin Gadkari made a case for making it mandatory to use electric vehicles for all officials in government ministries and department. He also suggested that government should give subsidy to buy electric cooking appliances instead of giving support for buying cooking gas to households. He said that use of 10,000 electric vehicles in Delhi can alone save Rs 30 Crore per month.

Source: PTI, February 19, 2021

Directory Indian Windpower 2020

Consolidated Energy Consultant Limited (CECL), Bhopal has brought out the latest edition of Directory Indian Windpower – 2020 in print form and also in soft version. It is a comprehensive wind energy publication being published since 2001 providing useful details and data on wind power in India for the sake of information and guidance to the entrepreneurs venturing in the wind power sector.

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