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announce

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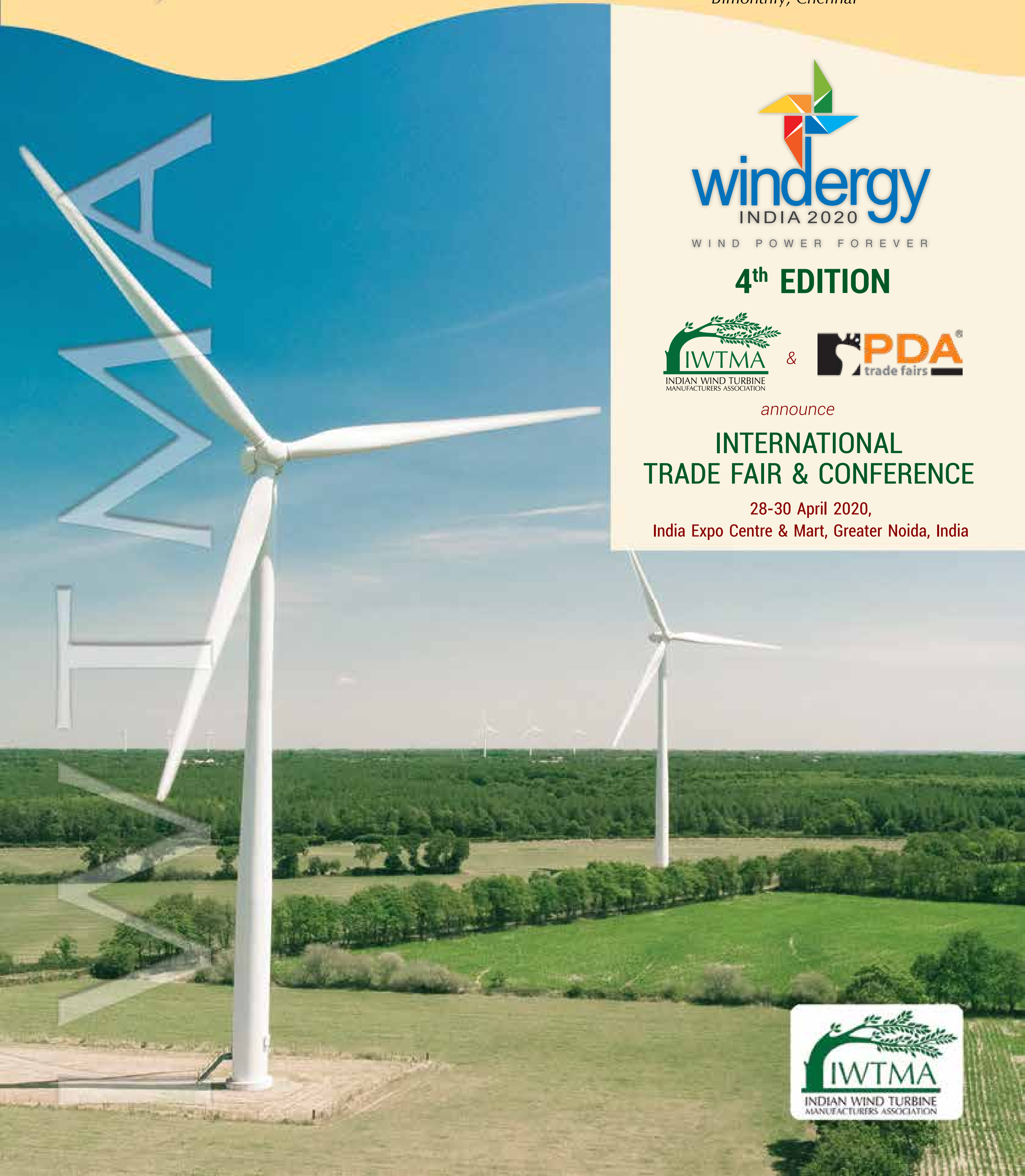

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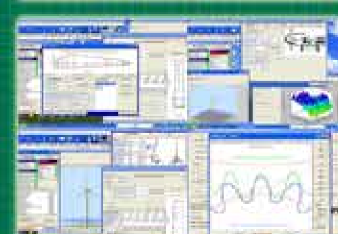

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IWTMA
INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

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Contents

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IWTMA
INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

From the Desk of the Chairman – IWTMA

Dear Readers,

Greetings from IWTMA!

We are ready to ring out 2019 and ring in 2020.

COP-25 Summit just concluded in Madrid and it failed to make an impact. There was no consensus on issues like carbon markets, compensation for climate change induced 'loss and damage' to vulnerable countries and enhancing nationally determined contribution (NDCs) by parties to meet the Paris Agreement goals. The international community lost a vital opportunity to increase determination on mitigation, adaptation and finance to tackle the climate crisis. Climate Scientists have stated that the carbon emission reduction pledges for 184 countries by 2030 are really not enough to bring down global warming well below 2 degree Celsius. The failure to reduce carbon emission will cost the world, a minimum of $2 billion per day in economic losses from weather events and made worst with human induced climate change. We had in the past written on declaration of climate emergency and the dark clouds of global warming are tearing the trust.

Closer home, the sector is facing headwinds in project execution on ground on account of some policy issues but installations have shown a healthy growth over last year. The land allocation & allotment issues in Gujarat are slowly getting sorted out and issues of reopening of PPAs in Andhra Pradesh sent a very bad signal to all stakeholders and especially to the international investor community. Viability and sustainability of wind projects is becoming a question mark. Repeated postponement of bid submission and auction does not augur well with the image of the country's Renewable Energy target. The answer may lie that we cannot sustain on a single procurement model as being down now. The time has come for multi-procurement models which will include state bids for intra and interstate, open access for captive and bilateral transaction with CTU waiver or CTU on kWh basis. The huge potential of retail investment of projects below 25 MW remains in deep slumber and it is the responsibility of the Centre and State Governments to offer an investment platform to the retail investors who built the initial 20 GW in the country.

IWTMA has submitted a report on Export which is currently at USD 500 Million per annum which can be rapidly accelerated to USD 2 to 3 Billion per annum considering the state-of-the art technology of the turbines and perhaps one of the lowest costs in the world.

The wind industry along with MNRE and NIWE had the first interaction in Ladakh. Initial Wind Resource Assessment shows an opportunity for investment to harness wind energy. It would require the involvement of multiple stakeholders as the terrain is complex. Wind energy development will bring positive social impact to the people of Ladakh.

We are happy to inform our readers that your Association (IWTMA) and PDA Trade Fairs Pvt. Ltd., Bangalore are jointly organizing WINDERGY INDIA 2020, an International Trade Fair & Conference to be held from 28th to 30th April 2020, at India Expo Mart & Centre, Greater Noida, India. This event is 'by the industry and for the industry' and we invite our readers and all stakeholders to come together, share knowledge with experts, thought leaders and witness the technology being showcased at the expo. Please treat this as our personal invitation.

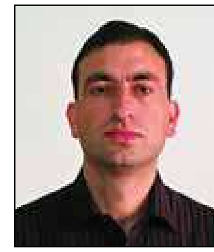
I, on behalf of IWTMA wish our readers Merry Christmas and a great year in 2020.

Happy Reading

With regards,

Tulsi Tanti
Chairman

Emerging Issues in Large-scale Wind Integrated Power System-I: Diminishing Inertia



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I. Introduction

The rising electricity demand due to rapid global economic growth, fossil fuel depletion, climatic concerns associated with conventional electricity generation sources, and necessities to develop sustainable energy system are the major critical factors for paradigm shift towards green energy, with wind and solar PV power being the front runners. The global cumulative installed capacity of wind power has risen to 591 GW by the end of the year 2018, with around 52 GW installed in 2018 only, as shown in Figure 1. Among all renewable resources, global wind power installed capacity is the second largest after hydropower, which is expected to be the largest ever among all the renewables due to rapidly growing wind power installation[1]. Most of the countries, including India have set ambitious targets of renewable energy (RE) integration at regional/national level to reduce carbon emission from various fossil fuel based unclean energy sources. During the past decade, India has experienced a rapid increase in wind power installed capacity, with current (as of September 2019) installed capacity of around 36.9GW. With current RE (wind, solar and small hydro) installed capacity of little over 82.5 GW, India has set a promising goal of RE integration target of 175 GW by the year 2022.

Wind energy conversion technology is broadly classified into four types, Squirrel Cage Induction Generator (SCIG) based wind turbine (Type 1), wound rotor induction generator based wind turbine (Type 2), Doubly-Fed Induction Generator (DFIG) wind turbine (Type 3), and full-converter wind turbine (Type 4)[2], with their respective diagrams shown in Figure 2.

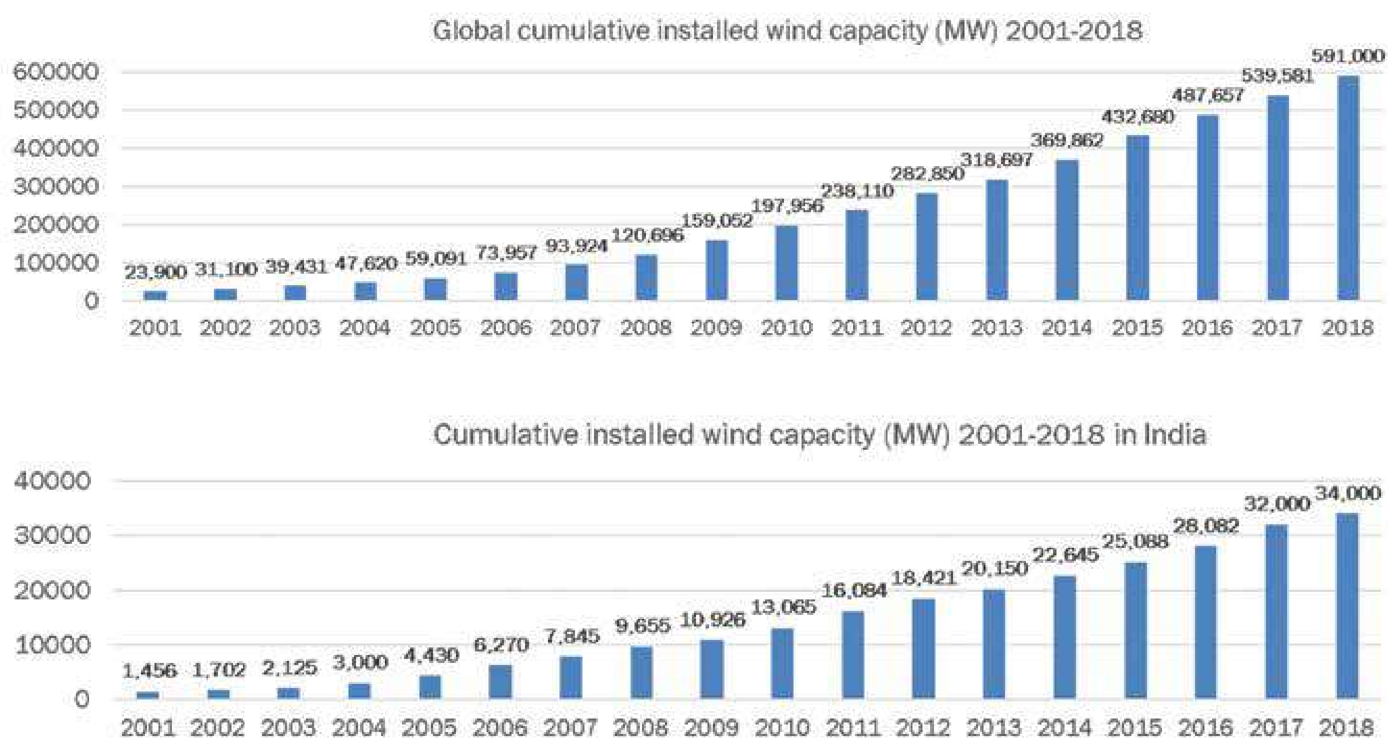

Figure 1: Global and Indian Wind Power Installed Capacity[1]

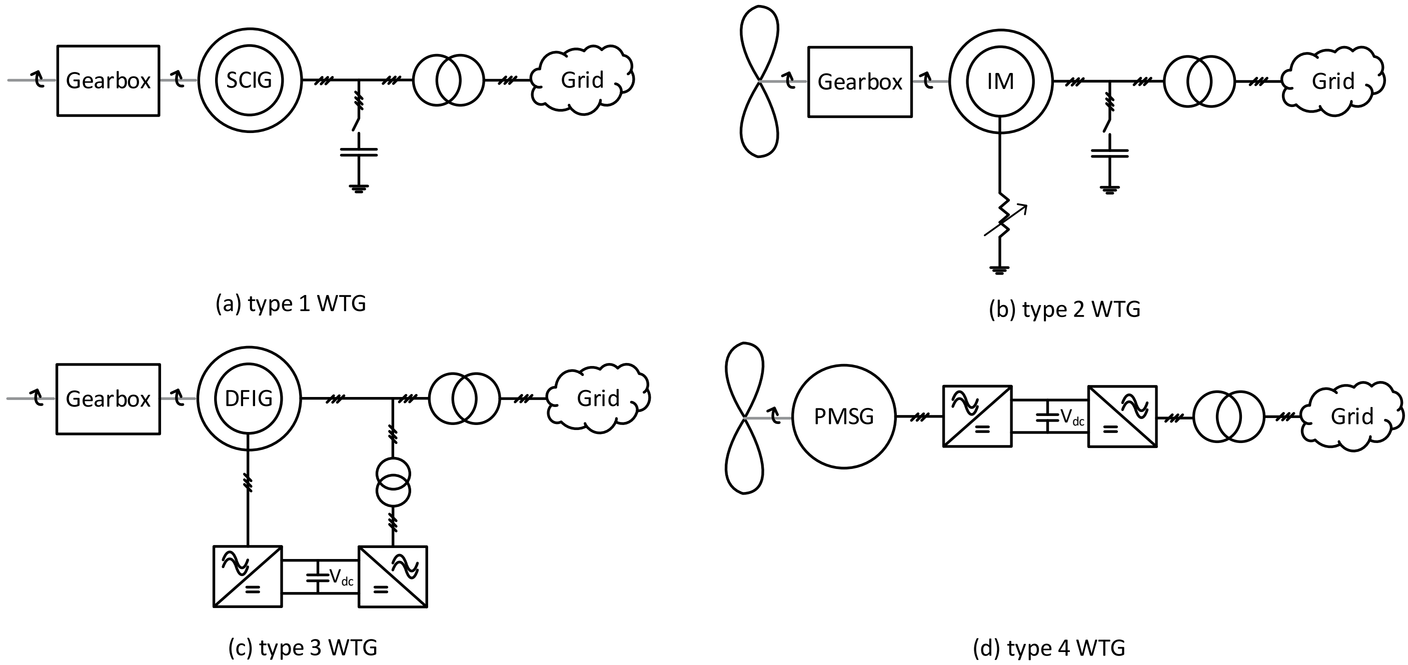

Figure 2: Wind Turbine Generator Types

Lack of the controllability of Type 1 and Type 2 wind turbine generators (WTGs), fixed speed operation and poor grid support performance have been the main reasons for WTG technology evolution into power electronic interfaced Type 3 and Type 4 WTGs, also known as Variable Speed WTGs (vsWTGs). Type 3 WTG has highest market penetration currently, primarily due to its lower cost compared to Type 4 WTGs. However, due to various advantages of Type 4 WTG, such as, optional gearbox, low maintenance and more control flexibility, offshore WPPs are generally based on Type 4 WTG technology, and type 4 WTGs are foreseen to dominate the WTG market in the future.

Various countries such as Denmark, Ireland, Germany and the UK are already experiencing significant wind power penetration, and are expected to experience further increase in wind penetration level. Similarly, in the context of 2022 renewable energy targets of India, some of the Southern and Western states, such as, Tamil Nadu, Andhra Pradesh and Maharashtra are also expected to experience high volume of wind power penetration.

While renewable energy integration has many advantages, its integration introduces several technical challenges in grid operation, hence, warrants addressing such issues for secure and stable renewable energy integration. These challenges associated with wind integration range from short-term frequency, small signal, transient and voltage stability, to long-term issues, such as, unit commitment and scheduling framework related concerns. Besides the known concerns, there are some emerging, yet critical issues associated with large-scale wind integration that warrant attention and potential countermeasures for secure and stable operation of power system under high penetration of wind power. **In this backdrop, the focus of this article series is to identify such emerging issues, discuss their potential impact on system operation during high wind spells, such as, during monsoon months in India, and highlight potential countermeasures to address such emerging issues.**

The first emerging issue of this article series is diminishing system inertia in RE integrated power systems, associated issues and potential countermeasures.

II. Diminishing System Inertia in RE Integrated Grid

Initial (maximum) Rate of Change of Frequency (RoCoF) $\frac{df}{dt}$ due to a power disturbance of ΔP in a grid can be typically expressed as given below.

$$\frac{df}{dt} = \frac{-\Delta P}{2\, E_{sys}} \times f_o$$


LM OFFSHORE

It can be observed from the above equation, that the kinetic energy, E_{sys}, stored in the rotating mass of generator play a critical role in limiting the system RoCoF, and consequently frequency nadir, see Figure 3. For a sudden infeed loss in the system, E_{sys} is released inherently to maintain power balance initially. Rotational Kinetic Energy (RKE) stored in a synchronous machine is characterized by inertia constant H, which is defined as time duration for which the generator is able to supply its rated power solely from its stored RKE[2].

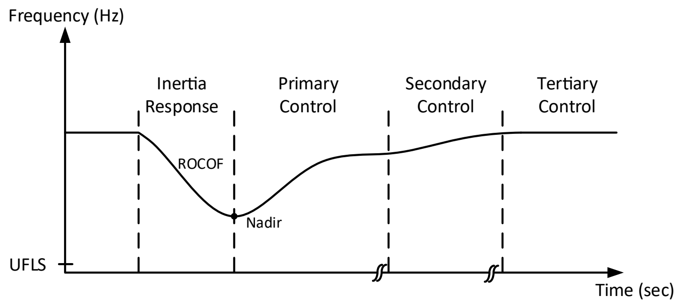

Figure 3: Typical System Frequency Response

In large-scale wind integrated system, conventional synchronous plants are displaced by WPPs. Such wind driven displacement of conventional power plants can be either permanent due to phasing out of conventional plant, or temporary due to non-commitment of conventional plants in a given unit commitment interval under high wind penetration. Therefore, due to less conventional plants synchronized to the grid, the aggregate system inertia from connected rotating mass is diminished. On the other hand, power electronic interfaced variable speed WTGs lack inherent inertial contribution, required for frequency stability during a dynamic event. It is important to note that due to higher energy capture from wind, reactive power generation/consumption capability, improved power quality, and grid code compliance capability, only vsWTGs are currently being installed while old WTGs (Type 1 and Type 2) based wind power plants are no more built[3].

The main reason for vsWTG inability to inherently contribute to the system inertia is DC bus in back-back converter, which decouples the network frequency and the WTG speed[4-5]. To illustrate the impact of wind penetration on system inertia, IEEE 9 bus benchmark system was developed in DIgSILENT PowerFactory platform, and was studied for various wind penetration levels. Figure 4 shows system frequency response to an infeed loss for three different wind penetration levels and corresponding net system inertia. It can be observed that even though the system is subjected to the same disturbance, reduced system inertia has a significant impact on system RoCoF and nadir value. Therefore, under high penetration of wind/solar PV power, for a dynamic event, power system is prone to breach acceptable limits of RoCoF and frequency protection set points, and in the worst cases may lead to cascaded events resulting in under frequency load shed and tripping of generation. To avoid such scenarios, it is imperative to have adequate countermeasures in place.

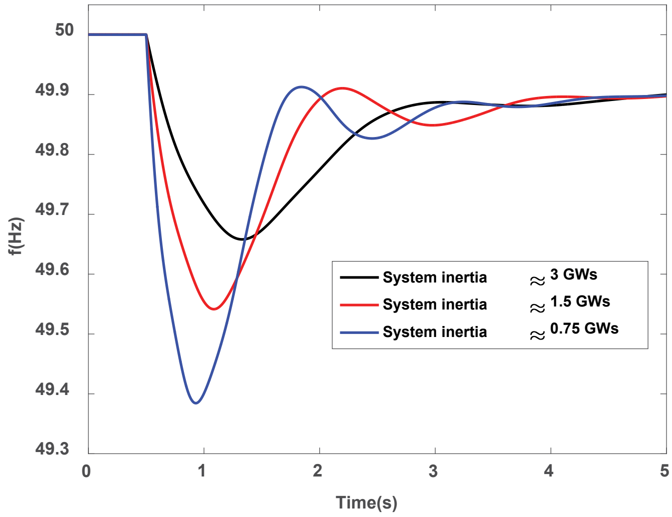

Figure 4: IEEE 9 Bus System Frequency Subjected to the Same Disturbance for Different Total System Inertia

III. Potential Solutions

Wind power penetration at higher level, as described above, may introduce new and emerging issues that warrant countermeasures to ensure secure and stable operation of large scale wind integrated system. It is important to ensure that a system should have adequate inertia to ensure secure and stable system operation. Therefore, alternative sources of inertia to compensate diminishing synchronous inertia should be in place. Various alternative sources of non-synchronous inertia are listed below.

- Emulated inertia from variable speed wind turbine generators
- Emulated inertial support from energy storage system
- Emulated inertia support from solar PV system with energy storage
- Inertia support from controlled demand
- Emulated inertial support from HVDC links
- Reducing the size of the largest generating unit/import/export (partial loading)

Besides non-synchronous sources, alternative sources of synchronous inertia, such as, synchronous condensers, pumped hydro storage power plants etc. are also being considered for addressing the issue of diminishing inertia in RE integrated power systems.

Since vsWTGs have a rotational mass behind interfacing power electronic converter, it can be used to support the grid during frequency excursion by releasing the stored rotational energy, if the WTG through a supplementary controller senses grid frequency measured at point of connection. A 500 MW hybrid wind (400 MW) and solar PV (100 MW) plant was modified to provide emulated inertia support to the grid under different control schemes. For a sudden generation shortfall in the system, frequency response of the grid under different inertial support schemes is shown in Figure 5. It can be observed, that with emulated inertial support from the hybrid plant, RoCoF and frequency nadir of the grid improves significantly, however, with delayed recovery of grid frequency to the nominal/prefault value. The delay in frequency recovery is due to wind turbine speed recovery from its decreased speed (due to release of RKE) to its prefault value, which in turn results in lower net output power from WTG following inertial support. Therefore, it is important to consider delayed frequency recovery while utilizing inertial support service from wind turbine generators, as, boosted inertial support from WTGs during a frequency excursion can potentially lead to second frequency nadir and longer delay in frequency recovery. It is worth to note that the issue of delayed frequency recovery does not occur due to conventional synchronous generators, as unlike WTGs, they are not required to quickly bring their speed to maximum power point tracking value. Further, in case of synchronous generators, governor control kicks in quickly in 2-3 seconds from the onset of frequency disturbance to support fast speed (frequency) recovery.

Solar PV power plant on the other hand cannot provide inertial support while operating at their maximum power point, as there is no RKE available in such plants. However, solar PV plant operating at suboptimal value, which may be necessitated by other factors, such as, transmission congestion, grid stability constraint etc., can provide inertial support from the reserved margin. Moreover, solar PV system augmented with energy storage can also be used to provide inertial support from the storage system.

On the other hand, the recent rapid development in power electronics and energy storage technologies has improved efficiency, reliability, time response, life cycle and more importantly cost of energy storage system. However, the capacity of installed grid-scale energy storage is still in the range of tens of MWh, which limits its grid-connected applications to support frequency response. Nevertheless, there are already some large-scale storage system in place, for example, 500 MW grid connected battery energy storage system in South Korea. Moreover, distributed energy storage embedded in distribution system in conjunction with solar PV or wind turbine generator can also be tapped to provide inertial support to the grid.

HVDC interconnections connecting two AC systems or offshore wind power plant can also be used to supply inertial response for stabilizing grid frequency. In several countries, such as, Denmark, Norway and Sweden, HVDC links are used for cross border interconnection, and such HVDC links can be used to provide inertial support to the disturbed grid under a mutual contract/agreement between the two countries/system operators. While, it has been proposed that and HVDC link with super capacitor or overrated DC link capacitor can be potentially used to supply inertial support from stored energy in the capacitor, the amount of inertial support from such arrangement may not be significant, particularly, for a large power system.

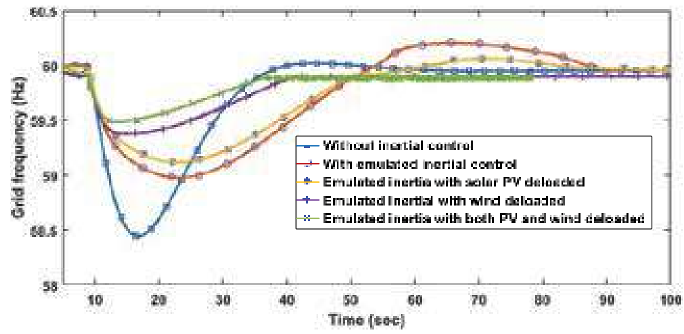

Figure 5: Grid Frequency with Inertial Support from Wind and Solar PV Plant

IV. Challenges with Estimation and Monitoring of Inertia in Renewable Energy Integrated Systems

In the context of diminishing inertia, it is important to maintain adequate inertia for secure and stable grid operation, particularly during high RE scenarios, for example, during off-peak load condition and high wind spell. Therefore, it is becoming very important to estimate and monitor system inertia in RE integrated power systems to ensure minimum required inertia is in place. While aggregate system inertia from the entire set of synchronous machines in operation can be directly calculated from individual values of inertia constants of synchronous generators, there are two major limitations of this approach. The first limitation is that the values of inertia constants available with system operators tend to be less accurate and unreliable due to several reasons, for example, historically this particular parameter 'H' has little significance and was not considered a critical parameter for power system studies. Further, a power plant might be retrofitted and its actual value of 'H' might change. The second issue with this estimation approach is that not all the generators communicate their circuit breaker status with the system operator; therefore, inertia contribution from such generators cannot be directly accounted for in calculation of the net system inertia. To avoid such limitations, alternate approaches of estimating system inertia from recorded frequency response of the system to an infeed loss is used to estimate the system inertia. However, such approach is an offline estimation method and cannot be used for real time estimation, and besides the approach may provide less accurate results as several below mentioned factors affect the accuracy of the estimation method.

- Frequency measurement errors
- Number and location of frequency measurement points
- Filtering of frequency and RoCoF signal
- Frequency and voltage dependency of demand
- Actual onset the event/infeed loss
- Net power imbalance

Moreover, the above mentioned estimation methods primarily assume the system is conventional generation based system, and does not separately consider RE generation. In 2015, one of the first real time RKE estimation approach has been developed by the Nordic Analysis Group (NAG) and implemented in the Nordic grid for monitoring aggregate RKE of the synchronously connected systems of Denmark, Norway, Finland and Sweden[6]. Under this set up, each TSO of the Nordic region estimates RKE of their respective control areas and the total estimation is made by aggregating all the four TSO estimated values. In Norwegian system, total RKE is estimated based on the total generation corresponding to different load scenarios. However, in Swedish and Finish system, more accurate approach is adapted where the total RKE is estimated based on the circuit breaker status and inertia constant of each generator. However, it is important to note that not all the generators communicate their circuit breaker status to the system operator; therefore, to assess the overall RKE of the system, estimate of the missing machines is based on the generator technology and the system load. Thus, the net EKE estimate is not fully accurate, yet the estimation is of good accuracy.

In the Eastern Danish system, circuit breaker positions of power plants of more than 1.5 MW rating is used to calculate RKE of the system. Wherever circuit breaker position is not available, power measurement data is used to estimate their RKE. However, generating units of smaller capacity (less than 1.5 MW) are not included in the overall RKE calculation, as the aggregate inertia contribution from such units is assumed too low to influence the total RKE of the system.

The real time estimate of RKE for each TSO and the aggregate RKE for the Nordic region over a week 23 in 2015 is shown in Figure 6.

In the backdrop of reduced inertia due to RE integration, alternative sources of inertia, with power electronic interfaced energy sources (WTG, solar PV system, energy storage system, etc.) being the front runners are being projected as the main contenders to countermeasure the diminishing inertia. Such

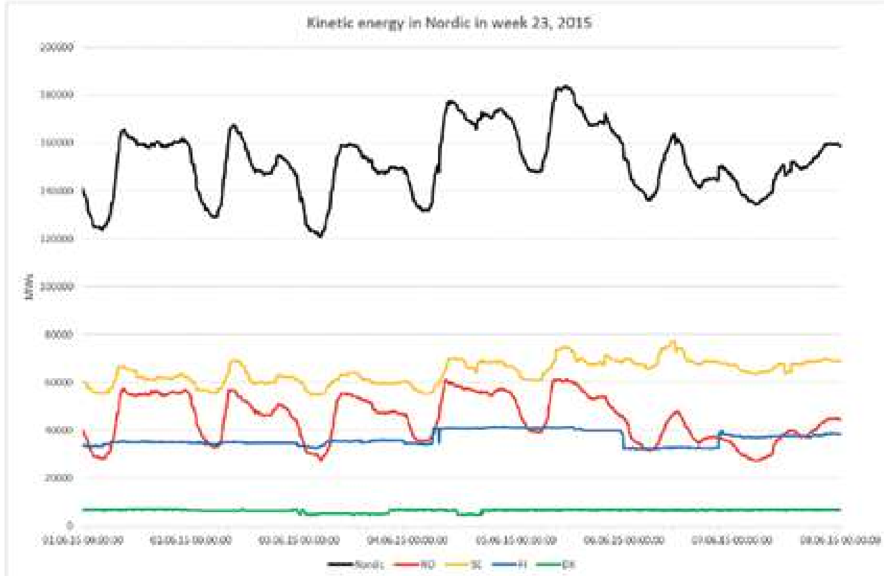

Figure 6: Nordic System Rotational Kinetic Energy in Week 23, 2015[6]

sources, however, can provide emulated inertia rather than synchronous inertia, and the supplementary inertial controller used will significantly influence their inertial response. Therefore, there is need to recognize different inertial response characteristics of power electronic interfaced energy sources (non-synchronous inertia) and inertia from synchronous plants (Synchronous inertia). Hence, the conventional methods of inertia estimation may not provide accurate estimate of net system inertia, therefore, appropriate method would be required to capture both the non-synchronous and synchronous inertia.

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Lubrication of Wind Turbines

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As global concerns over climate change become more prominent, there is a worldwide push for cleaner and greener energy sources. Wind, solar and geothermal energy are all examples of energy sources that are of interest, since they are not harmful for the environment. Although, these non-renewable energy sources are appealing, there are multiple technological challenges to the greater use of non-renewable energy. When considering wind turbines, one of the main concerns revolves around the lubricants used for various components in the wind turbine. This paper will focus on the role of lubricants in wind turbines, and lubrication challenges encountered in wind turbine operation.

Figure 1: Wind Energy
(Source: https://www.nationalgeographic.org/encyclopedia/wind-energy/)

Wind turbines convert wind into electricity, and an example of what a wind turbine looks like is shown in Figure 1. Wind turbines vary in sizes, designs and power output. The most common wind turbine system configuration consists of a three blade rotor mounted on a horizontal shaft driving a horizontally mounted generator, which is shown in Figure 1.

There are three main sections to a wind turbine: the tower, the rotor blades and the nacelle. The tower is what holds the rotor blades and nacelle high up in the sky, height of which varies as per turbine design. The rotor blades can vary in size and are crucial to the efficiency of power output. The rotor blades capture wind energy from air and transfer it to rotational energy. The size and shape of blades are designed in a way to extract maximum energy from the air and achieve best possible aerodynamic performance. Majority of the wind turbines currently in operation contain three rotor blades as they are more efficient and cost effective.

The energy from the rotors is transferred to the main shaft connecting the gearbox which is further connected to the generator to convert electricity. The gearbox and generator are enclosed in a box placed uptower, called the nacelle. The gearbox converts low speed input from the main shaft to high speed output to generator. The generator is located next in line to the gearbox, and converts the rotational energy from the high speed output from the gearbox into electrical energy, which can then be transmitted into the power grid.

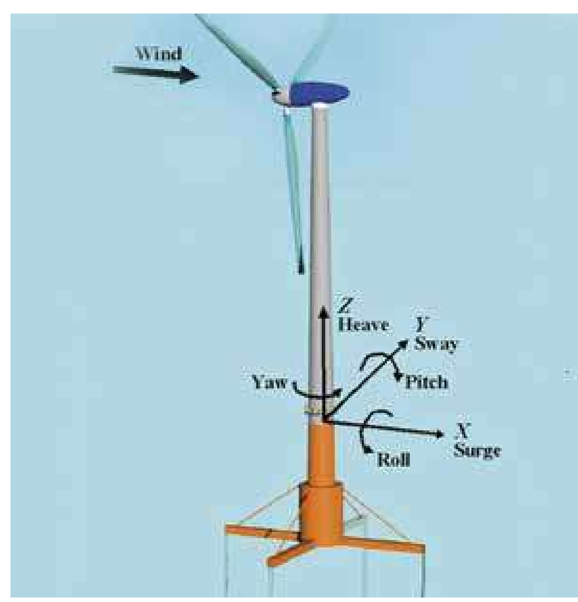

Figure 2: Rotational Movements of a Wind Turbine

There are many mechanical systems that compose the entire wind turbine, with numerous moving parts that oscillate, vibrate and rotate under high loads, and high and low speeds, such as yaw, pitch, gearbox, generator. The yaw drive turns the nacelle so that the rotor blades are always facing into the wind when it changes directions. The rolling motion occurs as the rotor blades rotate. The pitch control angles the rotor blades such that the rotors meet the wind at an angle for optimum energy harvesting. Additionally, the pitch and yaw controls can be used as a safety control, to prevent the rotors from moving too fast. The yaw, pitch and roll movements can be visualized in Figure 2.

The high number moving mechanical assemblies in the gearbox, main shaft, pitch system and the yaw systems require adequate lubrication for efficient operation of the wind turbines. The rotating components such as bearings and gears used in yaw, pitch, generator and gearbox must be properly lubricated to increase reliability and to reduce wind turbine downtime.

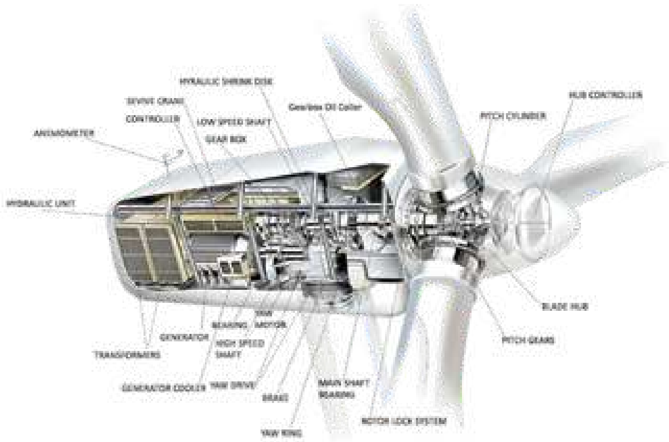

Figure 3: Mechanical Components of a Wind Turbine (Source- https://www.renewableenergyhub.co.uk)

Greases and oils are essential for efficient operation of wind turbine systems. The wind turbine components that experience friction and wear and require lubrication are the following:

- Pitch bearing (grease)
- Main shaft bearing (grease)
- Gearbox if any (oil)
- Yaw drive (grease)
- Generator bearing (grease)

For proper functioning of wind turbines there are various grease property requirements to help reduce wear and corrosion. Some properties include low friction behavior, high oxygen stability, high scuffing load-carrying capacity and high temperature operating life[1]. The lubricating grease would need to pass the standardized bearing grease tests and the Riffle test. The Riffle test is a new test that measures wear and corrosion under quasi-static loading. Also, there is a desire to use common grease for all components in a wind turbine to reduce maintenance cost and simplify lubrication practices; however, that would require cooperative performance of multiple turbine parts[2].

Components of a wind turbine that requires grease lubrication include the main bearings, pitch bearings and yaw bearings. Spherical roller bearings (SRBs) and tapered roller bearings (TRBs) are two types of main bearings used to support the main shaft and help counter the wind force. Two different greases are required for the SRBs and TRBs due to sliding of the rib-roller interface of the TRBs. The pitch bearings support the individual blades and the yaw bearings support both the nacelle and blade structure. Pitch bearings use the same bearing types as yaw but in a smaller size so both typically use the same grease lubricant. The goal would be to develop the grease that is applicable for both the main bearings and pitch and yaw bearings. Looking at the application elements of the three bearings, there are many similarities such as humid temperatures, fretting conditions, false brinelling protection and long-life durability. These similarities pose a pragmatic possibility of developing a common grease lubricant.

Greases are put through numerous standardized tests. Tests include lubricating grease consistency, dropping point, shear stability and 4-ball EP weld point and load wear index. Each test needs to be passed for the grease to be applicable for industrial use. There are many contingencies between tests which causes problematic dilemmas. For example, a test show that lowering anti-wear and anti-fretting additives in the grease fail the fretting test but increasing the additives fail the Emcor and Riffle test. However, a solution was found when lubricity aid was tested and shown to improve Riffle and Emcor tests. Another problem was the discovery of sodium chloride in the Riffle test which called for the need of water-resistant polymers. Water resistant polymers dissolved in mineral oil were a possible solution, but mineral oil material cannot be used because it was insoluble in high viscosity causing Riffle test to fail. Synthetic oil greases are preferred over mineral oil products because it has higher temperature range, longer traction and longer grease life[1]. Therefore, the problem was solved by dissolving the polymer in low kinematic viscosity PAO fluid, synthetic hydrocarbon oil. The final grease product was found to have good performance in all tests and pass industry standards. Overall, it was critical to balance wear and salt water rust resistance to develop a viable grease product.

Gearbox is another component that is critical in wind turbines. Viable lubricants should have qualities such as high viscosity, high heat capacity for heat transfer, and better lubricity for greater power output[2]. Wind turbine gearboxes being placed in desolate locales, at steep heights, and under harsh conditions are some of the major challenges that counterbalance wind power's many advantages. In addition, routine maintenance, such as compulsory gearbox oil changes to protect components from the corroding effects of micropitting and wear also requires substantial upkeep. In light of these dilemmas, sufficient equipment lubrication is mandatory, as it can aid in safeguarding


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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.
With end-to-end business solutions Suzlon has led the green energy revolution to power India's social, economic and ecological development sustainably.
SUZLON
POWERING A GREENER TOMORROW
More than 18 GW of installations | Footprint across 18 countries | Largest product portfolio | R&D across Netherlands, India, Germany and Denmark
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system components, diminishing unscheduled downtime, cut costs, prolong oil drain intervals and reduce the risk of injury, or even fatality, through lessened human-to-machine interaction.

Wind turbine gearbox manufacturers are compiling new lubrication specifications which are more stringent than those for industrial gear applications, which more accurately reflect the true operating condition including low oil temperatures. It should be kept in mind, when it comes to choosing which lubricant will be most appropriate, that one of the most overlooked aspects is finding a balanced formulation. Employing optimal base stocks and a customized additive package, which meets or exceeds, the specific needs of the wind industry, such as aiding in life extension of oil in spite of difficult operation factors is a critical component to successful wind equipment reliability.

Case in point, a quotidian wind turbine lubricant will have an oil drain interval of three to four years, while a superior synthetic lubricant, orchestrated specifically for wind, can facilitate the longevity of those intervals even more dramatically. Certain lubricants derived especially for wind turbine gearbox and bearings has been demonstrated to increase oil drain intervals in turbine applications for as long as 7 years. For this reason, and for many more, lubricant formulation is the single most important ingredient to cogitate when choosing a lubricant.

Figure 4: Wind Turbine Market Analysis

In order to adequately parse the importance of a balanced constitution, it is necessary to consider a few salient equipment stumbling blocks that wind operators are grappling with today.

Firstly, let's consider a predictable stumbling block for wind turbine operators: micropitting. Micropitting can form on surface-hardened gears within the initial several hours of operation, should the gearbox not be adequately lubricated; thus, resulting in lessened gear tooth exactitude. To mollify this effect, operators should look for oils formulated with a micropitting additive package, like typical extreme pressure additives, in addition to employing a gear finish as specified by American Gear Manufacturers Association's AGMA 6006 standard. After which, an oil formulated with advanced base fluids that offer a high viscosity index – typically 160 or higher – and lower traction coefficient, can also help. The higher viscosity index can provide a thicker lubricant film at operating temperature, and the lower traction coefficient can help improve energy efficiency.

Another factor which must be taken into account is water contamination; this can have a profound effect on wind turbine performance, most notably in offshore environments where water exposure is greatly increased. Water, when found in oil, can result in additive depletion, stable emulsions and higher viscosity; and lowers the fatigue life of bearings. It can also cause equipment issues, like filter blockage and faster wear of system parts. Lubricants concocted with particular additives can help mollify the effects of these contaminants by strengthening the oil's defense against water contamination and also bettering its wet oil filterability. ASTM D1401 and ASTM D2711 are used to evaluate the demulsibility of gear oil lubricants. Lubricants with poor water tolerance could result in emulsion formation or oil breakdown, ultimately leading to lubrication failure.

Foaming is yet another wind turbine issue which must be tackled by operators. As foam bubbles up and crashes through a shaft seal, it leaks inside the nacelle (the generator and gearbox "shell" with rotator shaft on a horizontal axis wind turbine), creating a safety hazard for slippage. Furthermore, as foam forms on the surface of the oil, it may cause a problem with the oil level float switch, causing a faulty reading which could even set off an alarm. Also, if foam enters the oil circuit, a temporary decrease of oil pressure or flow can transpire, also engendering alarm. All these occurrences would likely result in costly loss of time which could have otherwise been avoided. The air release properties are of interest as well, since excessive encapsulated air in the lubricant can interrupt proper lubrication. ASTM D892 and ISO 12152 are used to evaluate the foaming characteristics, and ASTM D3247 evaluates the air release properties.

When selecting a wind turbine lubricant, one with a balanced formulation will be the most effective, especially for the gearbox. Micropitting, water tolerance, and foaming are just a few important factors to consider for a lubricant. In addition, a balanced lubricant will protect bearings and gears from scuffing, which is critical for long-term equipment lifetime. Gear protection performance can be evaluated using the FZG Scuffing Test, as described in ISO 14635-1. The FAG FE8 4-Stage Test is also useful when assessing the efficacy of wind turbine gearbox and bearing lubricants.

Oxidative stability is another essential parameter for wind turbine lubricants, as it promotes extended oil life and longer oil drain intervals. ASTM D2893 is used to evaluate the oxidative stability of these lubricants, where the lubricant is heated to a designated temperature for an extended amount of time in the presence of air. The change in certain parameters before and after the test time, such as the percent change in kinematic viscosity and acid number increase, will indicate how stable the lubricant is under extreme oxidation conditions. Ideally, the measured properties of the lubricant do not change, or only slightly, to ensure the performance is unaffected.

Wind turbine lubricants must also have tailored viscosity properties across a wide operating temperature range. The viscosity index, tested by ASTM D2270 and the Brookfield viscosity, tested by ASTM D2983, are measured to explain the lubricant's viscometric behavior. The Brookfield viscosity measures the low temperature viscosity, which cannot be too high, to ease turbine start up processes. Generally, higher viscosity indexes are desired, since a stable viscosity allows longer oil lifespans and improved equipment protection at wide temperature ranges. Other low temperature properties may be of interest, including the pour point and cloud point, for reasons similar to that of the Brookfield viscosity.

Furthermore, rust and corrosion performance is considered for wind turbine lubricants. Lubricants with strong rust and corrosion properties will be able to protect metal parts of the turbine from rust and corrosion. To test the copper corrosion properties of the lubricants, ASTM D130 is used, and ASTM D665 is used for the Rust Test.

To further complicate the lubrication process for wind turbines, each lubrication point in the entire wind turbine requires a different type of lubricant, with different properties that are specific for their purpose. Various types of lubricants are used, such as gear oils, hydraulic oils, and lubricants. Gear oils are used in the gearbox, one of the main components of a wind turbine and also one of the most demanding sites for lubrication, as gear oils makes up around 70% of wind turbine lubricant consumption. Greases are used on the main rotor shaft bearing, yaw bearing, pitch drive gears, blade bearing and generator bearing. Hydraulic fluid is used in hydraulic systems, like the blade pitch control system.

A wind energy system, as would be expected with any mechanical system, requires sufficiently-tailored lubrication to function optimally. Vibration, heavy mechanical loads, dampness and contamination are all hazards to bearing and gear service life. Wind turbines can also be difficult and exorbitant to service since they extend more than 100 meters off the ground in addition to being situated in remote locations. A possible solution to these predicaments is implementing an automatic lubrication system. Automatic lubrication systems, unlike manual ones, provide unctuousness more predictably and accurately to moving components in the nacelle. By delivering the most minimal, yet effective, dose of lubricant reliably to all friction points, while the machine is running, automatic lubrication systems decrease friction inside bearings and help prevent contamination.

Wind turbines have been used in one way or another for more than 7,000 years, and while that is unlikely to change any time soon, wind turbine lubrication exists at the far extreme of industrial gear applications in terms of temperature, load weights, bearing wear, maintenance, accessibility and basic lubricant performance. Increasingly, for offshore applications, synthetic and biodegradable fluids are being developed. Furthermore, turbine gear oil specifications are starting to mirror the demand for higher lubricant performance through testing for enhanced oxidation and corrosion resistance, and greater bearing and long-range operational performance.

There are several advantages of this form of power. For example, land-based utility-scale wind is one of the lowest price energy sources available today, and wind creates jobs. In fact, the U.S. wind sector employed more than 100,000 workers in 2018, and wind turbine technician is one of the fastest-growing American jobs of the decade. Wind also enables U.S. industry growth and competitiveness. Wind is a clean fuel source since wind energy doesn't pollute the air. It's a domestic source of energy and sustainable, as well.

Paradoxically, wind power harkens back to the dawn of civilization, yet still manages to be an intriguing growth-oriented and ever-evolving industry at the vanguard of renewable energy advancements. Developments of cutting-edge lubricants and maintenance strategies for this extreme application are making tremendous strides toward a new standard in gear and bearing lubrication, which may even one day blow away the competition in the sphere of alternate energy.

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Snippets on Wind Power

MNRE Misses Capacity Addition Targets; 175 GW by 2022 in Peril: Parliamentary Panel

The renewable energy ministry has continuously failed to achieve its yearly targets of clean energy capacity addition, which may hamper the mission of having 175 GW of renewables by 2022, said a Parliamentary panel. This is the panel's first report, which was tabled in Parliament on 6th December 2019. The Parliamentary Standing Committee on Energy has also asked the ministry to take up the issue of ambiguity and disputes related to GST on renewable energy devices with the finance ministry at the earliest.

The panel also noted that banks are reluctant to finance renewable projects as there are lot of bad loans or NPAs in power sector and at present, both conventional power sector and renewable energy sector are clubbed together for their loan basket. It also noted that about Rs 9,700 crore dues are owed by states and discoms towards renewable energy developers or generators. If the same is not paid back, many of the solar and wind project will turn into non-performing assets.

Source: PTI, December 06, 2019

Tata Power Creates New Arm to Set up 10,000 Microgrids in India

Tata Power said on 4th November 2019 that it will create an arm, TP Renewable Microgrid, to set up 10,000 microgrids to provide power to five millions homes across the country. collaboration with Rockefeller Foundation (equity stake), which will provide technical support to the offshoot for achieving its objective. It will be implemented in collaboration with Smart Power India (SPI) and the Institute for Transformative Technologies. The TP Renewable Microgrid is expected to reduce carbon emissions by one million tonne per year as well as diesel consumption by 57 million litres yearly.

Source: PTI, November 05, 2019

Most Countries aren't Hitting 2030 Climate Goals, and Everyone Will Pay the Price

The majority of the carbon emission reduction pledges for 2030 that 184 countries made under the Paris Agreement aren't nearly enough to keep global warming well below 3.6 degrees Fahrenheit (2 degrees Celsius). Some countries won't achieve their pledges, and some of the world's largest carbon emitters will continue to increase their emissions, according to a panel of world-class climate scientists. Their report, "The Truth Behind the Paris Agreement Climate Pledges," warns that by 2030, the failure to reduce emissions will cost the world a minimum of $2 billion per day in economic losses from weather events made worse by human-induced climate change. Moreover, weather events and patterns will hurt human health, livelihoods, food and water, as well as biodiversity.

Source: National Geographic, November 5, 2019

CECL, Directory Indian Wind Power 2019

Consolidated Energy Consultants Limited, Bhopal has brought out the 19th edition of "Directory-Indian Wind Power 2019" covering various areas of wind power in India.

The (Super?) Powers of Prediction in the Renewable Energy Industry

Bending the intermittent nature of renewable energy to our advantage

Dino Esposito
Digital Strategist for BaxEnergy Europe & Powercon India

As a matter of fact, the intermittent nature of most renewable energy sources (e.g., wind, sun) makes operating the power grid ineluctably more complex. It is a challenge that started small and negligible but has grown relevant as the global share of energy produced from renewable sources, and then delivered to the grid, reached the threshold of 10%. However, that was a few years ago. Today, the situation is more serious, with the world production of energy from renewable sources that steadily marches towards 20% and slated to grow even bigger in the next decade.

Sudden and unpredictable changes in the amount of power released to the grid, inevitably puts the grid itself at serious risk of unbalance and it is interesting to notice that the risk is twofold. Shortage of energy is problematic because it may result in blackouts and instability, but excess of energy is even worse because it also poses the problem of how to quickly deal with the additional energy for which the current demand is not sufficient.

How could we tackle the problem of ensuring a constant grid balance as more and more renewable energy is produced and delivered? Frankly, there are not that many options. Probably just one: intelligent behavior.

Past and Future of Intelligence

So far, the necessary intelligence has been provided by human operators and experts. Human operators act at the transmission level. They guess trends, receive estimates and numbers, make their calculations and issue the commands necessary to maintain the balance. Human operators work at the speed of humans, in a mostly reactive way.

Investigations conducted over major recent blackouts- from New York 2003 to Argentina 2019-showed that the trigger was a relatively small fault that, unhandled, cripples down the grid tripping all power lines it finds along the way. All these major blackouts are the result of a perverse and borderline sequence of events. One of these events is always the late reaction of (or lack thereof) some humans. It is not about replacing humans with machines, but it is about having machines to do some of the monitoring work of humans in a fully-focused way all the time regardless the calendar, weather or the time of the day. The more the industry manages to speed up the process of controlling the uncontrollable aspects of renewable energy, the better for the industry itself and the population. But this calls for another, artificial, form of intelligence-faster and deeper than humans to understand and prompt to identify trends and trigger alarms.

In this article, we will review the state-of-the-art of artificial intelligence in the realm of renewable energy and the state-of-the-art of the industry in making intelligent solutions available.

Uncontrollable Aspects of Renewable Energy

An overall look at the space of renewable energy reveals that three aspects of it appear critical and, ideally, in the need of control. They are: levels of production, prices and faults. (See Figure 1)

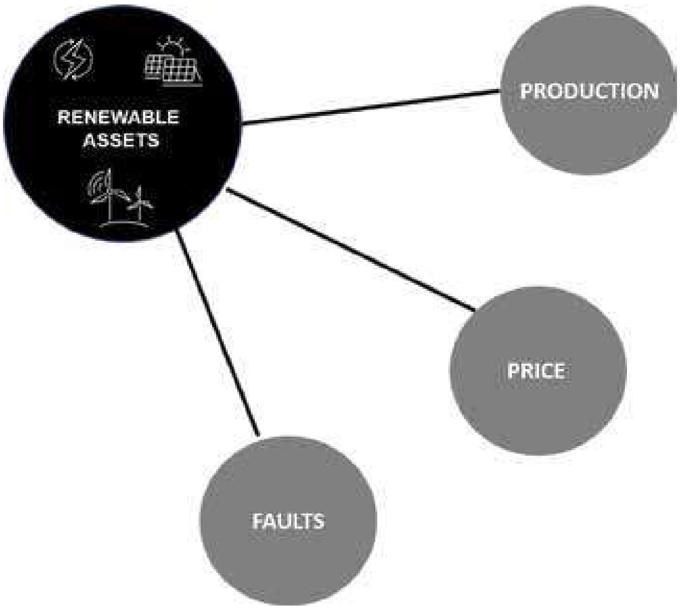

Figure 1: Uncontrollable Aspects of Renewable Energy

Being able to predict the amount of energy being produced helps keeping the grid in balance because the transmission operators can plan in advance how to compose the final energy acquisition plan on a daily and hourly basis. Being able to control the prices of energy helps traders to seal better deals and ultimately end customers to get better prices. Finally, being able to predict faults helps asset owners to reduce costs of maintenance letting them build optimal schedule plans to perform fix and repairs in a proactive, rather than reactive, way.

There is not a single tool that can do the whole magic. The three aspects needs be addressed separately though they are related to each other as production in some way determines prices and faults may affect production and on a smaller scale also prices. Let us start to see what it means to predict production.

Predicting Production of Energy

The fundamental equation of energy systems is that production equals consumption plus losses. An energy system is made by three layers-generation (power plants), transmission and distribution. (See Figure 2)

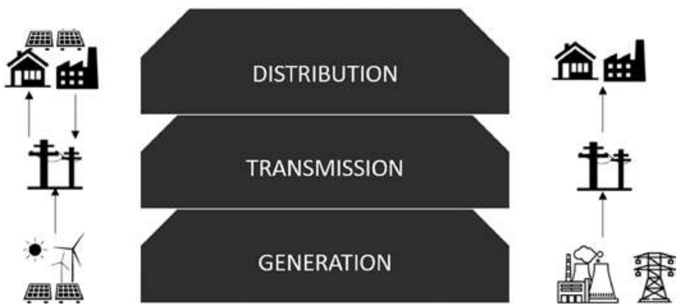

Figure 2: Layers of an Energy System

The bottom layer is the layer of the power plants where the generation units operate and produce energy. It is also the layer where cross-border power lines interconnections arrive. The whole amount of energy is then forwarded over power lines through substations and the local distribution grid until it reaches end customers, whether households or industrial plants.

The interesting thing is that the flow of energy has always been unidirectional, going from production up to billed consumers. Recently, though, and thanks to renewable technologies (mostly, roof-top solar) the flow has become bidirectional: from the grid to end customers and back. In other words, some customers have also become producers of energy and are contributing some excess energy back to the grid. This factor just increases the uncertainty about the overall production and raises the need for solid statistical analysis at support of grid balance.

The first step on the way to predicting production is collecting tons of data along the pipeline. (See Figure 3) This requires monitoring platforms, analytical tools and fast telecommunication systems. An effective monitoring platform can capture data right at the source of generation units every few seconds and build up a valuable data lake for further analytical use of the information. A monitoring platform is primarily meant to recapture production losses during the cycle and to detect issues promptly, reduce the reaction time and sometimes event foresee future issues. Monitoring data save historical data about the generation units and also provide real-time data in the form of time series.

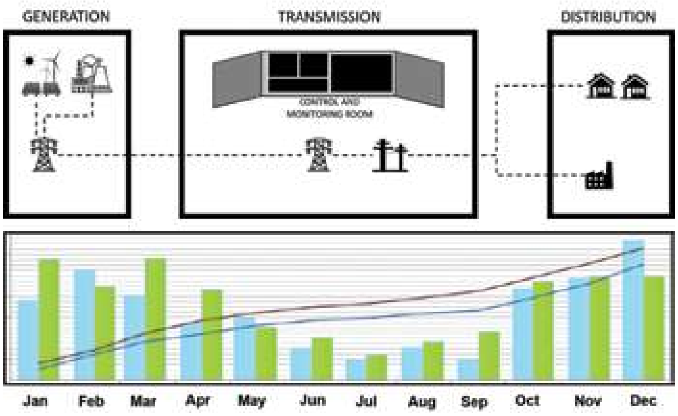

Figure 3: Collecting Production Data in Real-Time and Showing in a Control Room

Another important part of the data needed to build up machine learning pipelines is weather forecasts. The usual weather forecasts we get from TV and web sites are computed out of numerical prediction systems that reproduce a mathematical model of the atmosphere and oceans. The model uses a system of differential equations and a coordinate system that divides the globe in a 3D grid. Just the size of each cell of the grid makes this numerical form of weather forecasting acceptable for the news, but not for energy production forecasting. Canonical weather forecasts have a resolution of about 30 KM whether other more accurate models arrive for specific areas even a precision of 3 KM, which is much better for production forecasts, though it is not enough. The accuracy of the forecast is high if the model can effectively predict the wind flow near the ground. This information, though, is hard to get via physical models especially in the complex terrain where wind turbines are commonly located. For this reason, a

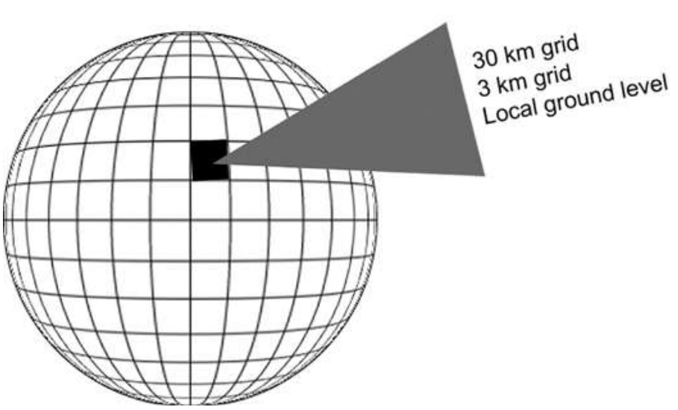

Figure 4: Weather Forecast for Production Forecast

NGC Professional in Wind Gearbox and Transmission System Solutions

NGC is a global leader in wind gearbox development and production with high performance product which provides complete main gearboxes, yaw and pitch drive product for wind turbine. NGC high reliability products are adapted to various working conditions, low/high temperature, low wind speed, high altitude, offshore and others. By far, over 65,000 NGC main gearboxes have been operating globally with excellence performance, contributing to the continuous power supply for green energy.

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probabilistic model is built on top of canonical high-resolution weather forecasts to guess predictions at a specific geographical point. (See Figure 4)

A comprehensive model for production forecast would not be complete without specific client's knowledge. In order to predict the production level of a given turbine the direct knowledge of operators and technicians can't be ignored as it can explain the whys and wherefores of a particular set of outliers or the relevance of a set of feature values that are crucial to engineer a machine learning model that predicts numbers effectively.

From an algorithmic perspective, it should be noted that often a production forecast engine is not a fully trained model because the huge amount of real time data (telemetry data and weather data) would make any (expensively) trained model obsolete soon. For this reason, most real-world products tend to use a lean pipeline in which training is minimal, but processing of live data occurs for every forecast. This is acceptable performance-wise if a proper hardware/software (cloud) platform backs you up and provides parallel computing power.

Predicting the Price of Energy

Most of the energy in the world is traded in the so-called day-ahead market. In this arena, contracts are made between sellers and buyers for the delivery of power to occur on the following day. Buyers estimate how much energy they will need to meet customers' demand on the coming day and assess how much they are willing to pay. Estimated volume and prices are set hour by hour. Upon a daily deadline, all submitted bids are evaluated by a trading software, hourly prices are determined and deals are finally sealed. In the end, electricity retailers buy power at the wholesale market based on how much electricity they estimate their clients will consume. If estimates don't fall close to reality, then retailers are forced to either sell the excess power they may hold or buy more power from the market. Hence, further trading also takes place intraday.

How would you try to predict the price of energy and plan accordingly maintenance of power plants?

Predicting prices can be many different things. It can be hourly prices for the intraday market, prices for the day ahead and for a particular, regional market. In addition, it can be for longer periods: daily, monthly, annually, for the years to come.

As you may guess, the price of energy depends on many types of data to be available. First and foremost, it depends on the hour of the day and day of the month in a particular geographical area and time zone. It is not surprising that energy is cheaper at night time and more expensive in the middle of the day. The price depends on how much energy is being produced and how much it is expected to be consumed. There is no need to long-term forecast here; a short-term prediction is enough. Because of the dynamics of the energy market and business rules that govern the behavior of most TSOs, to predict the price of renewable energy you should also look into the price (and related forecasts) of conventional energy and even the prices of commodities such as oil, gas and coal. Finally, agents bidding strategies and market rules and restrictions have their role as well.

From a pure data perspective, price forecast is even more problematic than production forecast as it depends on way too many different types of information. This means that any machine learning effort has to put aside a relevant share of the budget to clean data and select the right set of features. All the needed data, in fact, come from different holders and likely in different format often unstructured and scheme less formats. Machine learning techniques for dimensionality reduction such as principal component analysis and preliminary clustering are necessary as well as with often manual check of data quality and completeness. Here is a possible outcome.

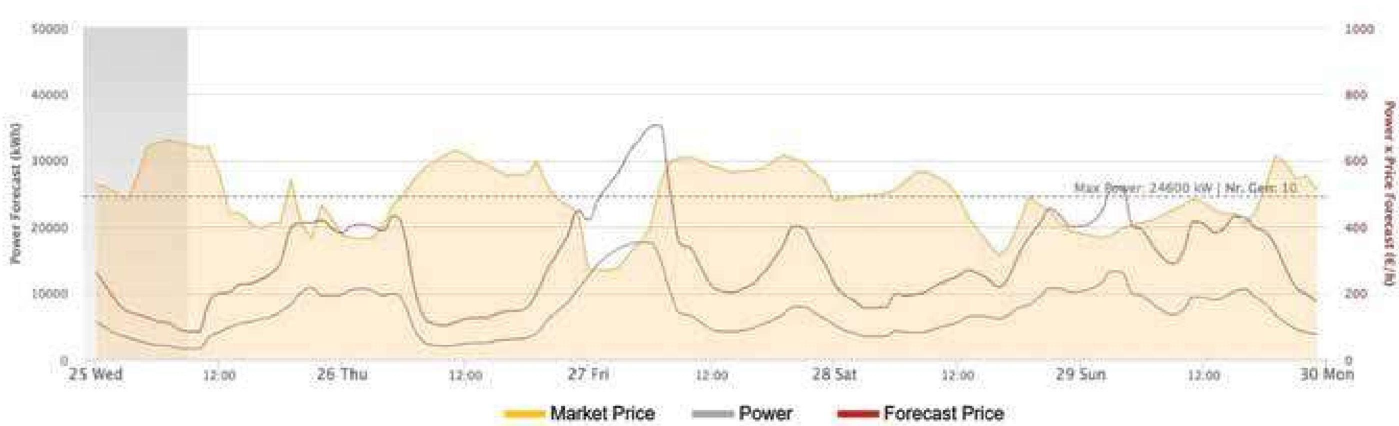

Figure 5: Energy Price Forecast

Finally, to make price prediction even more challenging is the need to be continuously on the edge of results. In machine learning this means introducing in the model also elements of reinforcement learning, namely the ability of the model to adapt dynamically to data as it is presented. In other words, a price prediction model is not simply trained on relevant data and deployed as-is to production. Instead, it is also a model that knows a way to catalog its responses and learn from its own mistakes.

Predicting Machinery Faults

Predictive maintenance is the philosopher's stone of renewable energy: everyone wants it; everyone claims they are so close to it, but nobody has yet an effective model. It doesn't mean, however, that optimizing maintenance on generation units (like wind turbines) is not possible. It only means that machine learning may be problematic to use or, more simply, that nobody yet has found the magic recipe.

Today, components are checked periodically according to a predetermined schedule that doesn't necessarily take into account the actual state of the component, weather conditions or exceptional situations. It's a good-enough approach with a number of drawbacks. For example, maintenance may be scheduled when it is not necessary given the workload of the component.

A more modern approach consists of using condition-based rules to calculate the ideal time for maintenance. Rules take into account a huge number of raw and calculated signals that indicate the actual status and wear of components as reported by embedded sensors. Typically, a control and monitoring room software would allow to trigger alarms based on KPIs calculated out of the raw numbers returned by sensors. The good news is that no unnecessary maintenance is carried out and by fine-tuning alarms one can reserve a margin to postpone or anticipate maintenance according to volatile conditions such as bad or good weather. The weakest point of condition-based maintenance is that alarms parameters must be set by the rule of thumb and are subject to the highly variable human ability to learn from numbers and mistakes.

This has created some hype in the industry under the name of predictive maintenance.

Predictive maintenance aims at hunching the ideal time to intervene right before the component could fail. At first, it seems the right tool for the job except that most attempts to make it happen are still far from delivering the magic the industry expects. The point is that machine learning - the segment of artificial intelligence involved with this sort of predictions - is not magic. It is, instead, a computing machinery based on the laws of calculus and statistics. It looks at data available and tries to learn a model for it so that predictions can be made when live data is presented.

For a predictive maintenance model to work, we need a lot of measurements - high-frequency multivariate time series with a no less than 10-min rate for no less than two years. This is the raw input coming directly from turbines. This data represents a snapshot of the device taken at some time T. However, a fault usually takes a few minutes (or seconds) to develop. This is the sore point. At a minimum, we need to bring in past data referring to some interval (Fixed? Elastic?). A common solution - far from perfection - consists in bringing in some aggregated values, typically through an exponential mobile mean, of the past snapshots. Aggregated values refer to a selection of most critical signals grouped for the time window reckoned sufficient. Finally, you might want to include the records of the repairs physically performed on devices with the clear indication of the root cause, as the expert eye of the technicians reported it. (See Figure 6)

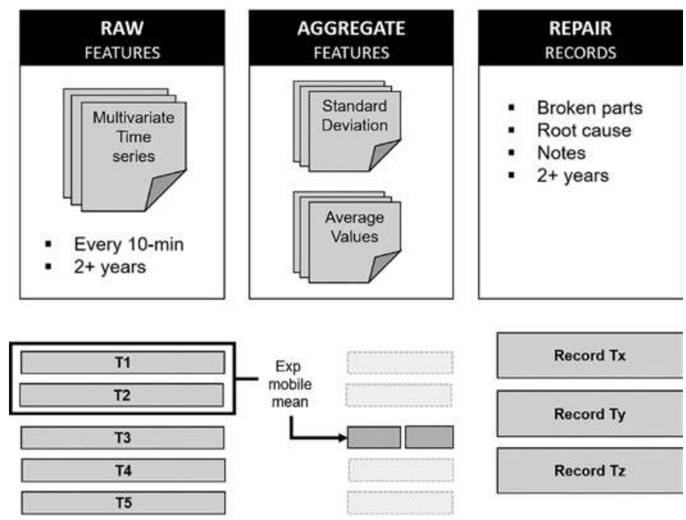

Figure 6: Data Collection for Predictive Analysis

It is quite unlikely that a one-size-fits-all solution for predictive maintenance will ever be found. However, nothing is impossible unless proven! For sure, predictive maintenance is not a basic problem of classification or regression. It likely needs a recurrent neural network to be properly addressed and on a per farm basis, at the very minimum, if not on a per-turbine basis taking into account the geographical position and vendor specifications.

Arranging a data model that result in an alarm in presence of certain measurable conditions is not a trivial task and it's a good challenge for data scientists rather than for businessmen. All this said, if predictive maintenance in a pure machine learning perspective is definitely an arduous problem it doesn't mean that a pragmatic solution that anyway saves good money is not possible. Again, it passes through deep monitoring, detection of deviated values, domain knowledge and some flexible tool to configure alarms.

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The Bottom Line

Artificial intelligence is not a service and let alone it is a commodity. It is not something that can be bought just putting money on the table. Artificial intelligence is just software - but a rather delicate and intricate type of software that for the most part results in a machine learning project. Subsequently, any machine learning project is a software project and doesn't escape the common and well-known issues of software projects. In addition, it is a tricky software project. The general advice is to avoid embarking on a machine learning project if you are not ready to face error and trials. Putting money on the table is not enough.

In energy, machine learning typically applies to three forecasting problems: production, price and faults. For the first two, acceptably tested and close to commodity solutions exist in the industry and some of them are also integrated with monitoring tools so that they collect data and develop models. For fault prediction, we are far from a consolidated solution but intelligent (and pragmatic) approaches are still possible. On the foundation of everything though there is data collection and monitoring.

Wind Energy Projects Stall as NTPC Fails to Get Tariff Nod

Yet another developer has withdrawn its winning bid for wind power projects that NTPC auctioned last year, after it failed to get regulatory approvals for those, revealing further signs of a slowdown in this segment. NTPC last year auctioned 1200MW of projects where the winning tariffs were in the range of Rs 2.77-2.83 per unit. Entities like NTPC, which conduct the auctions, are subsequently required get sanctions from the states where the projects would be set up. This time, however, NTPC was has not been able to secure tariff approval from various state power regulatory commissions, and therefore had given the winners the option to withdraw their offers.

Source: ET Energy World, November 27, 2019

Maharashtra DISCOM to Pay Rs. 7 Million as Delayed Payments to Three Wind Generators

The Maharashtra Electricity Regulatory Commission (MERC) has directed the Maharashtra State Electricity Distribution Company Limited (MSECDL) to clear its outstanding dues with three wind developers in the state, including interest for delayed payment charges (DPC). A penalty of 1.25% per month will be charged if the payments are not made in time. The petition was filed by the Windmill Owners Welfare Association of India (WOWAI).

Source: Mercom India, NOV 29, 2019

India, ADB Sign $451 Million Loan to Strengthen Power Connectivity in Tamil Nadu

Chennai-Kanyakumari Industrial Corridor (CKIC) is a part of East Coast Economic Corridor (ECEC) in Tamil Nadu and ADB is the lead partner of government for developing ECEC. India and Asian Development Bank (ADB) has signed a 451 million dollar loan to strengthen power connectivity between southern and northern parts of Chennai-Kanyakumari Industrial Corridor (CKIC) on 28th November 2019. "The project will help Tamil Nadu state government to meet the increasing demand for power supply from industry and commercial enterprises in the state through transfer of power from new generation facilities, including renewable energy in southern CKIC to industrial hubs in the state's northern region.

Source: ANI, November 29, 2019

Centre, Andhra Reach a Compromise on Green Contracts

The Centre and Andhra Pradesh have reached a compromise to end the impasse over the state government's controversial decision to reopen renewable energy contracts inked by the previous state government. The compromise was struck during a meeting attended by Union and state government representatives earlier this month. The formula includes non-revision of those power purchase agreements (PPAs) whose tariffs have been fixed by the state electricity regulator; concessional loans to the Andhra Pradesh government by state-run firms such as Power Finance Corp. Ltd, (PFC), REC Ltd and Indian Renewable Energy Development Agency (IREDA) to clear outstanding dues; and waiver of interstate transmission charges for green energy to help reduce the state's financial burden.

Other decisions reached at the meeting included the state power utility paying the generators for curtailed wind or solar power if done for reasons other than grid safety, waiving off the interstate electricity transmission charges for sale of clean energy over and above the RPO limit to other states. Andhra Pradesh has installed 4,092MW of wind power and 3,230MW of solar power projects with investments of around Rs. 60,000 crore.

Source: Live Mint, 29 Nov 2019

Wind Resources Assessment - Practical Aspects

Mohammad Ziaulhaq Ansari, Wind Energy Expert
TÜV Rheinland (India) Private Limited

Wind energy is mainly determined by the wind speed in a specific area. Even after various potential assessment and research in core areas of wind assessment cycle, there are still areas where there might be promising wind resources available, but these are as yet undiscovered. Discovering these areas is very important for future market expansion.

The fuel is free for wind energy and will be free for the project lifetime and beyond. The main economics of any wind project is thus crucially dependent on the site wind resource.

Wind resource at any region of interest is not static. It is much influenced by the topography, complexity and slope obstacles of that area. In case of onshore windfarms it is influenced by structures in the surroundings and the wind resource can be significantly affected by the proximity of very large wind farms. All these factors need to be repeatedly explored and new analytical methods are to be employed to evaluate their impact.

Determining the resource in a larger area like country level/ state level wind speed maps is of big interest now-a-days and is a time-consuming activity which comes with a big cost. It is traditionally recorded using long tower met mast structure with sensors and data loggers installed at various heights. However, innovative measuring techniques like LiDAR (Light Detection and Ranging) etc. are proving its ability to provide wind measurements as reliably as met masts. Experts claim that LiDARs are typically faster, easier and cheaper to deploy, enabling significant development and operational cost reductions. The LiDAR allows the rotor speed and other operational control parameters to be adjusted to an approaching wind field before it reaches the turbine. Using this technique, the wind-induced load can be reduced, turbines could be constructed using less material, and the energy yield could be increased. It also reduces your measurement uncertainty by measuring higher than a met mast and by mobilising measurements across a whole site.

LiDAR system is designed to measure atmospheric characteristics including wind speed and direction at a number of heights from ground level. The system transmits a laser beam into the air, receives the light backscattered by aerosols. These aerosols are tiny dust particles with diameters of 1/10 to several microns in the atmosphere. The received signals are used to analyse the atmospheric properties. The signals from moving objects have a Doppler shift proportional to their speed, which enables the velocity of the aerosols to be calculated. The frequency of the received light is shifted due to the movement of aerosols and is referred as Doppler Effect. This Doppler shift, which corresponds to the velocities of the aerosols, is extracted using heterodyne detection. Applying high-speed signal-processing technology, the LiDAR systems accurately calculate Doppler velocity and the resultant wind speed and direction.

Typically, the LiDAR system measures the radial velocity of the wind, however the local magnitude and direction of the wind is known through Velocity Azimuth Display (VAD) technique, which for decades has been used for vertical wind profiling with Doppler radars. The principle of LiDAR system is described in Figure 2, where the wind sensor performs a vertical conical scan of the atmosphere, assuming a locally homogenous wind. Due to the angular dependence of the wind projection along the measurement axis, the Doppler velocity shift of a homogenous wind follows a sine curve. The principle of VAD can also be extended for the wind field reconstruction of horizontal scans. Components of the wind vector are obtained through an ordinary least-square algorithm, as illustrated in Figure 3.

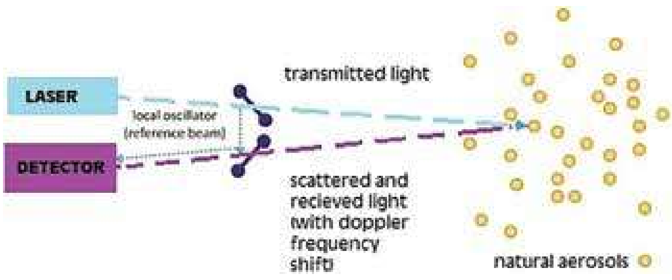


Figure 1: Basic Principle of Working of a LiDAR System

The economics of a windfarm is mainly dependent over its energy yield, which in turn is highly sensitive to the wind speed. In today's scenario when modern high capacity wind turbine having larger rotor diameter and higher hub heights are being used to capture maximum wind from a low wind regime site, a minor percent change in wind speed makes an huge difference in energy yield in financial terms for both debt and equity.

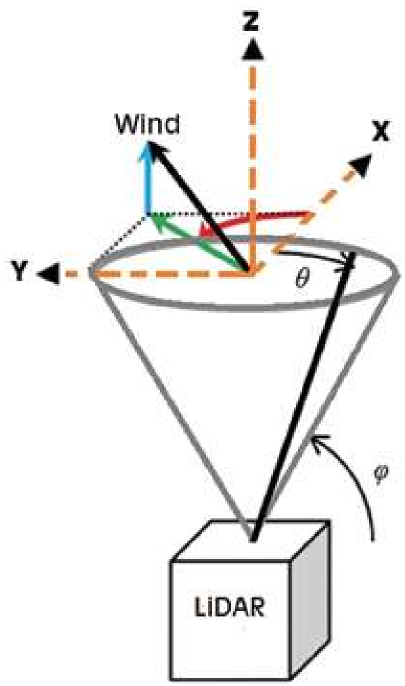


Figure 2: The Principle of a Wind Vector

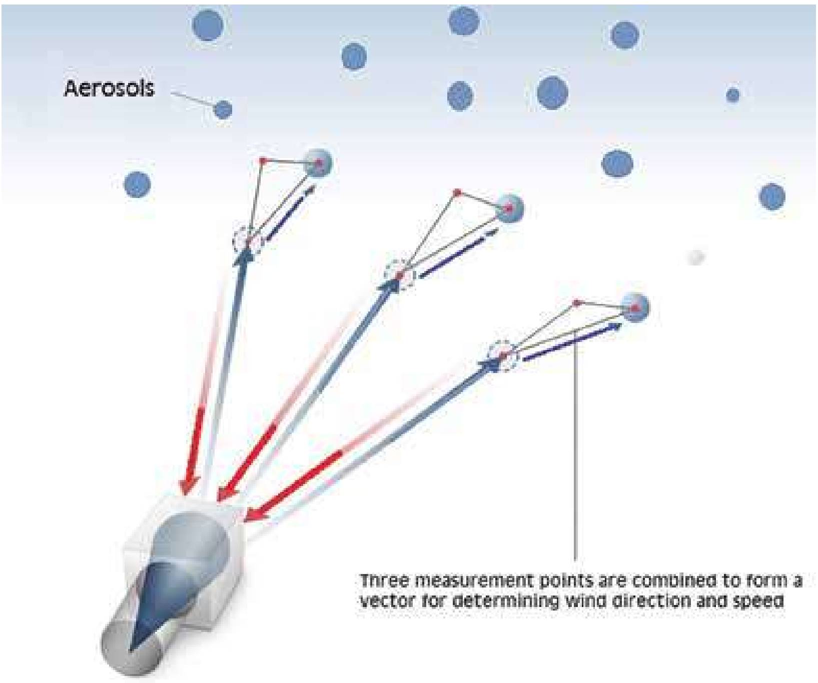


Figure 3: Components of the wind vector are obtained through least-square algorithm.

The strong competitive of this LiDAR technology has lead industry to choose it over traditional masts for feasibility studies as well as power curve verification tests.

In summary, the most important characteristic of a wind farm is the wind speed and wind measurement is undertaken at the very beginning of the project. Hence, it is very important to maximize the length, quality and geographical coverage across the wind farm site of the data collected.

Snippets on Wind Power

Asia Poised to Become Dominant Market or Wind Energy: IRENA

Asia could grow its share of installed capacity for onshore wind energy from 230 Gigawatt (GW) in 2018 to over 2,600 GW by 2050, a new report by the International Renewable Energy Agency (IRENA) said on 21st October 2019. By that time, the region would become a global leader in wind, accounting for more than 50 per cent of all onshore and over 60 per cent of all offshore wind capacity installed globally. China would take the lead with 2,525 GW of installed onshore and offshore wind capacity by 2050 within Asia, followed by India (443 GW), Korea (78 GW) and South-East Asia (16 GW). Low-cost renewable energy technologies like wind power are readily-available today, representing the most effective and immediate solution for reducing carbon emissions. The global wind industry could become a veritable job motor, employing over 3.7 million people by 2030 and more than six million people by 2050, IRENA's report finds.

Source: IANS, October 21, 2019

100 Percent Renewable Energy Deal Struck For Sydney

A new agreement with innovative energy company Flow Power will ensure all City of Sydney operations, including pools, sports fields, depots and buildings, including the historic Sydney Town Hall, will be powered by 100 percent renewable energy. The largest standalone renewables deal for an Australian council to date will see three-quarters of the City's power sourced from wind generation and one-quarter from solar. The new commitment will see the Australian city cut its emissions by around 20,000 tonnes a year – equivalent to the power consumption of 8,000 households. It's also projected to save up to half a million dollars a year over the next 10 years.

Source: Saur Energy, October 22nd, 2019

Focus on Renewables at Sustainable Action Dialogue, New York

As a second international pre-event of the World Sustainable Development Summit 2020 to be held on 29 - 31 January, 2020 at New Delhi, India; a Sustainable Action Dialogue (Leadership Coalition on Energy and Industry Transition) was organised at New York on 24th September 2019. The event was organised by Energy Transitions Commission (ETC), Rockefeller Foundation and The Energy and Resources Institute (TERI).

The Energy Transitions Commission (ETC) brings together a diverse group of individuals from the energy and climate communities: investors, incumbent energy companies, industry disruptors, equipment suppliers, energy-intensive industries, non-profit organisations, advisors and academics from across the developed and developing world. The ETC is co-chaired by Lord Adair Turner and Dr Ajay Mathur. The ETC members agree on the importance of cutting carbon emissions, and share a broad vision of how the transition to a low-carbon energy system can be achieved.

Vision and Role of ETC in India to Enable Decarbonisation

ETC India aims to foster the adoption of low carbon pathways in India through intense and informed discussions between Indian partners, key policymakers and others concerned with technology options and investment opportunities for evolving policy. ETC India is led by TERI as the secretariat. In its first year, ETC India focused on decarbonising the power sector. Whilst that work is still continuing, in the second year, ETC India has initiated research on decarbonising industrial sectors, with a particular focus on the 'harder-to-abate' sectors such as iron and steel, cement and petrochemicals. In this work, TREI will liaise with industry representatives to understand the challenges with decarbonising Indian industry. Future decarbonisation strategies for industry will need to adopt a 'clean growth' approach, whereby economic growth, competitiveness, and job creation go hand-in-hand with a low carbon transition.

A document was prepared after the New York Dialogue. The full document contains two thematic papers, which provide a summary of the work carried out in these areas to date. The first paper covers India's electricity sector and the transition to renewables, whilst the second outlines the status of India's heavy industry sectors and the possible options for emissions reduction. The conclusion puts the focus on the renewables.

1. Understanding India's Electricity Sector Transition to Renewables

By Mr. Thomas Spencer, Fellow, TERI

Conclusion: Transition in a Challenging Context

The purpose of the paper is to give an overview of the emerging transition of the Indian power sector. Importantly, it is crucial to understand this with the Indian context firmly in mind. India is still a lower middle income country, and improving the lives of its people means that its economy must grow rapidly. Evidence within India and from cross-country comparison shows that increasing the level of electricity consumption is crucial to this growth. The key question is how to cater to this growing demand, without exacerbating, and if possible, substantially mitigating, the challenges of resource scarcity, import dependence and environmental degradation.

The Indian electricity sector, thanks to the policy push given by the Government of India and the economic competitiveness of renewables, is firmly embarked on a trajectory of transition. However, this transition is occurring in a still-challenging context, where the performance of the electricity sector, while substantially improved, still leaves much to be desired. Improving the technical and financial performance of the electricity sector is important to deal with the challenge of integrating variable renewables securely into the Indian grid.

The problems faced in the sector are deeply entrenched in India's political economy, and addressing them will not be easy. In the future, the pace of the growth of renewables will be determined not by the cost of solar or wind electricity, but rather by the rate at which the operation and installed technology of the electricity system can be made more flexible. There is no quick fix here: costeffectiveness requires that a portfolio of flexibility options are developed (Udetanshu et al., 2019). While battery storage can be a crucial component of this portfolio, under no reasonable scenario can it be a panacea by 2030. India will still need to improve the flexibility of its coal fleet, activate large scale demand shifting, develop an even more integrated grid infrastructure and operation to support large-scale power transfers across the country, and develop more sophisticated electricity markets. If this can be achieved in the years to come, a substantially lower carbon, cost-effective electricity system would start to emerge by 2030.

2. Enabling Decarbonisation of Indian Industry

By Mr. Will Hall, Associate Fellow, TERI

Conclusion: Future Framework for Decarbonising Indian Industry

This paper has set out the current status of Indian industry and its need to transition to resource efficient, sustainable and low carbon production in order to support future growth. We then discuss a number of challenges that need to be overcome for the HTA sectors, which are specific to the Indian context. The paper then outlines the steps that can be taken to reduce emissions in these sectors, covering energy efficiency, increased material efficiency and step-change technologies, such as hydrogen and CCUS. To conclude, the policy framework in the harder-to-abate sectors, to facilitate an industry transition, must focus on:

- Continued improvements in energy efficiency, whether that be near-term international benchmarks or future step-change technologies;
- Achieving a high degree of material circularity, understanding scope for material substitution and reducing material intensity where possible and
- Developing longer-term technology roadmaps and collaborative RD&D programmes at the global scale for the HTA sectors and associated technologies.

Courtesy: TERI

Versatile Monitoring for Rotor Bearings

Identification of Critical Operating Conditions, Preventing Bearing Damage and Reducing Operating Costs

Devkumar Davesar, Vice President
Industrial Sector Management, Schaeffler India

How can typical rolling bearing damage in wind turbines, particularly in their rotor bearing supports, be identified early and even prevented altogether? A complex challenge like this requires a combination of sensors that are capable of monitoring the critical influencing variables for these types of damage.

Real operating data offer immense potential for improving drive trains' rolling bearing supports and the system as a whole, as well as for optimizing wind turbine operation. Evaluating and interpreting the gathered data makes it possible to more accurately define safety factors and adapt them for new developments. Currently, there are many pilot collaborations within turbine manufacturers and key technology players for developing sensor concepts for recording variables that influence bearing damage and have previously not been monitored.

For example: In the case of a flanged rotor bearing, multiple sensor combination can be used together, such as temperature and vibration sensors together with the grease sensor, load sensor pin, and an equally new roller set sliding distance sensor. Functions of each of these sensors are further elaborated.

Grease Sensor

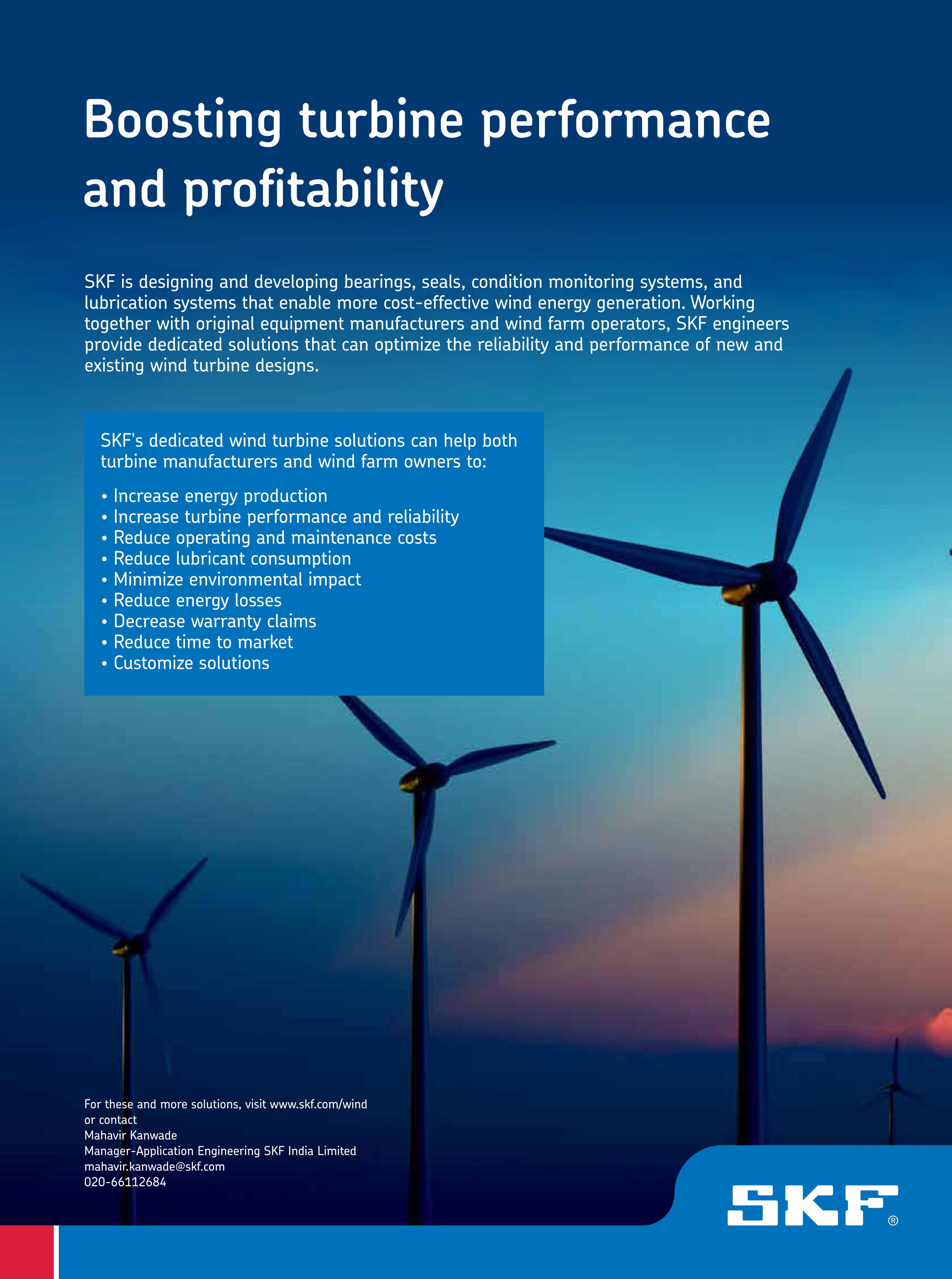
Typically, the grease sensor is an optical sensor system that allows changes in the condition of the grease to be detected early. The sensor head is just 5 mm wide and records three parameters: turbidity, water content and grease temperature. Customers can classify the condition of the grease during operation as good or bad by setting individual threshold values for turbidity and water content. A particular benefit is that wind farm operators can use the sensor to determine relubrication intervals for new turbines without having to go through the costly process of taking and analyzing grease samples. Because the condition of the grease is continuously monitored, operators can respond by initiating maintenance measures when changes are detected, in some cases even before bearing damage occurs. If a sufficient number of turbines are installed, the relubrication intervals can be scheduled based on requirements and the maintenance outlay reduced even further in the medium term.

Schaeffler GreaseCheck

Load Sensing Pin for Monitoring Bearing Preload

In the case of pre-assembled rotor bearing systems that are flange-mounted to the adjacent construction, the preload of the screw connections that are used partially determines the bearing's load distribution and thus has a direct effect on its performance capability and operating life. To monitor this screw preload a load sense pin can be installed uses the measurement method

Schaeffler LoadSense Pin


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
Manager-Application Engineering SKF India Limited
mahavir.kanwade@skf.com
020-66112684
SKF®

employed by strain gauges. The sensor is pressed into a bore for which it is slightly oversized on the component on which measurements are to be made, and thus experiences the same expansion as the material that surrounds it. This means that, unlike conventional adhesive strain gauges, the pin can be integrated directly into the bearing ring.

This pin allows the preload of the flanged bearing's screw connections to be monitored during operation, which means that the screws can be tightened as required and eliminates the need for preload inspection at fixed intervals. This increases the reliability of the bearing system and reduces the maintenance costs at the same time.

Roller Set Sliding Distance Sensor Indicates Unfavorable Rotor Bearing Operating Conditions

This inductive sensor records the number of times that a rolling element passes the sensor head during a fixed number of rotor shaft rotations. The rolling motion of the contact partners in the bearing always means sliding movements – which are small when the design is correct. This micro-slippage between the driven bearing ring and the rolling element set changes the circumferential speed of the rolling element set and thus the frequency with which the rolling elements pass the sensor head. When the inner geometry of the rolling bearing is known, the mean sliding distance and micro-slippage can be very accurately calculated as an average over time from the number of rolling element passes – even when the rotor speed fluctuates – which allows various load, friction and lubrication conditions to be deduced. This measurement is simple, extremely reliable and allows conclusions to be made about operating conditions (including kinematics) in the rolling bearing.

Competitive Advantages for Customers

Adopting such innovation early gives customers the opportunity to determine the critical influencing variables for their rotor bearing supports based on the measurement data that are recorded. Aside from the mid-term objective of enabling defined damage mechanisms in rotor bearings to be predicted, this combination of sensors already makes it possible to detect several unfavorable operating conditions in the bearing and, using an adapted maintenance and operating strategy, prevent these or initiate countermeasures at an early stage. Unfavorable conditions for the bearing that can be rectified by relubrication, for example, are also detected before bearing damage begins to occur. In this way, the rotor bearings' operating life can be increased and their operating costs reduced just a short time after installation.

Sensors like the Schaeffler GreaseCheck, Schaeffler LoadSense Pin, and roller set sliding distance sensor are tested and validated on Schaeffler's Astraios large-size bearing test rig

Regulatory News

Updates on Wind

Bids:

a. **SECI-VIII:** Out of 1800 MW Bid announced only 440.64 MW awarded.

b. **SECI-IX** for 1200 MW was announced with an upper cap of Rs. 2.85 (Upper Cap is revised to Rs. 2.93 per unit). As there was no participation the bid submission was extended to 20th November 2019.

c. **NTPC – II** for 1200 MW the ceiling tariff was revised from Rs. 2.85 to Rs. 2.93 but no one participated in the bid submission.

State Updates:

Maharashtra: Maharashtra Electricity Regulatory Commission (MERC) came up with two Draft Regulations on the Following:

1. Under Terms and Conditions for Determination of Renewable Energy Tariff Regulations, 2019 MERC has come up with the new clause of **Repowering with the following conditions:**

   a. The older wind turbines shall have been operational for at least 15 years of Useful Life since their commissioning.

   b. The older wind turbines shall be replaced by newer wind turbines having either a higher name-plate capacity or higher CUF, and should result in a net increase in power generated from the same site.

   c. Detailed Project Report shall also clearly explain the rationale and benefits of Re-powering vis-à-vis setting up of a new project.

   d. Provided that based on cost economics, contracting Parties may agree for repowering of wind turbine, which has been operational for lower than 15 years.

2. Under Renewable Purchase Obligation, its Compliance and Implementation of Renewable Energy Certificate Framework Regulations, 2019 MERC has come up with the new clause of **Incentives and Penalty with the following condition:**

   a. Obligated Entity will get incentive of **Rs 0.25 per kWh** for RE procured above the minimum percentage and shall be subjected to penalty of **Rs. 0.10 per kWh** for shortfall in total RE procurement target for each year.

Central Updates:

Ministry of Power:

MOP has come up with new order dated 6th November 2019, on Waiver of inter-state transmission charges and losses on transmission of the electricity generated from Wind and Solar sources of energy. **According the order the waiver is extended upto 31st December 2022.**

AP Government Amends in Wind and Wind Solar Hybrid Policy 2018.

Andhra Pradesh has come up with Amendments in Wind and Wind Solar Hybrid Policy 2018. A summary of the policy is given below:

1. Transmission and Distribution charges is applicable for wheeling of power generated from wind power projects to the nearest Central Transmission Utility(CTU) via State Transmission Utility (STU) network for inter- state wheeling of power **(previously it was not applicable).**
2. Banking Withdrawn **(previously it was 12 months)**
3. Any supply of power from synchronization & COD shall be treated as inadvertent flow and no cost shall be paid to generators.
4. The tariff shall not exceed diff b/w pooled variable cost & balancing cost (to be decided by APERC annually).
5. Govt. Land shall only on lease hold basis

Compiled by IWTMA Team

Snippets on Wind Power

Power Regulator Refuses to Fix Trading Margin for SECI

Central Electricity Regulatory Commission (CERC) has refused to approve the trading margin of 7 paise/unit to the Solar Energy Corporation of India (SECI), which is the nodal agency for implementing central government's renewable energy projects across the country. In its latest orders for approving the tariffs discovered in the recent solar and wind power auctions, CERC said that it is not in its purview to fix trading margin for long-term transactions, and "it is up to the contracting parties to mutually agree on trading margin".

Source: Financial Express, November 23, 2019

Streamlining Forecasting, Scheduling and DSM Regulations for Wind in India

Saloni Jain
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Manager

CEEW Centre for Energy Finance (CEEW-CEF), New Delhi

India is committed to commissioning 160 GW of wind and solar power plants by 2022. To accelerate deployment, several policies have been designed and implemented to create a conducive environment for power generated from renewable energy sources. One of the key support regulations is the ***'must run'*** status accorded to renewable energy power plants which mandates grid operators to absorb 100 per cent of the power generated. However, renewables and other power plants have been curtailed in case grid stability is threatened. Currently with an installed capacity of 83.4 GW of grid interactive power, India ranks 5th globally in installed renewable energy capacity.[1] However, installed capacity is only as good as the power it generates and its contribution to the electricity mix. Given the intermittent nature of renewable energy generation (due to its dependence on weather), it can potentially have a much greater adverse impact on the stability of the grid than conventional energy sources.

The grid disturbance and blackouts of 2012 resulted in a tightening of regulations, and the grid has to now operate at frequency lying between 49.95 to 50.05 Hz. Maintaining constant frequency is important for reliable and secure operations of the grid. With increasing share of renewables in the grid, it has become important to have forecasting, scheduling and deviation settlement mechanism (DSM) regulations for solar and wind power plants in India. These provisions provide visibility in the quantum of electricity injected into the grid from renewable energy sources and also regulate the market by penalising deviation from the scheduled generation beyond the permissible limit. Thus, in its original form, these regulations provide for both preventive and protective measures to facilitate large scale grid-integration of renewable energy sources. In 2015, the Central Electricity Regulatory Commission (CERC) shared model regulations. However, till date, only 15 State Electricity Regulatory Commissions (SERCs) have designed policies for their states. On analysis of these state regulations, we found a few inherent flaws.

Power producers have to forecast their generation and submit a schedule to their respective load dispatch centres which can be revised when needed. For instance, in 10 out of 15 states, both solar and wind power plants are allowed to revise their schedules 16 times a day, despite wind power plants being operational throughout the day as compared to solar which operates during day time only. At 12:15 am on 8th September 2019, the share of wind energy in the grid increased to 85 per cent in Karnataka. With such high shares of the total energy mix (especially during monsoon), it becomes critical to forecast and schedule wind energy to ensure grid stability. Any excess or under generation can lead to imposition of penalties or curtailment by grid operators. This risk is particularly rampant in states like Tamil Nadu and Rajasthan which have experienced wind energy curtailment up to 50 percent and 45 percent respectively.[2] Given the developers factor in '***must run***' status in their financial models, they are adversely affected as they have to bear DSM penalty for over/under injection and at the same time bear the risk of technical curtailment. This not only sends poor signals to investors but also makes several existing wind energy projects financially unviable.

Error Band Percentage

From the above context, it is clear that steps must be taken to streamline the current regulatory and policy framework of forecasting and scheduling failing which grid integration of renewable energy will become a big challenge. It is true that grid stability is of utmost importance but at the same time developers should also not be unduly penalised for natural causes beyond their control. Erroneous forecasting and scheduling due to varied weather conditions, and ambiguity and inconsistency in the DSM regulations across states have created challenges for many generators. For example, there exists inconsistency in the permissible error band across states. Most states permit error of (+/-) 15 per cent deviation without penalty while in a few

1 MNRE (2019) "Physical progress (achievements)," available at https://mnre.gov.in/physical-progress-achievements, accessed on 18 November 2019.

2 CEEW (2019) "Grid integration guarantee - A Financial Buffer to Address Renewable Energy Curtailment," available at https://www.ceew.in/sites/default/files/CEEW-Grid-Integration-Guarantee-17ul19.pdf, accessed on 18 November 2019.

states, the error band is as limited to (+/-) 10 per cent. Even in the same region, states permit a variety of error bands. For example, Maharashtra permit an error band of (+/-) 15 percent while Gujarat permits an error band of (+/-) 12 per cent for wind developers. In this regard, one might question the setting of these error bands and why they vary across states? Further, stakeholders suggest that the error band of (+/-) 10 per cent is extremely difficult to achieve (particularly for wind) even with the most advanced forecasting methodologies. Tamil Nadu which has the highest installed capacity of wind power (9.2 GW as of October 2019) has permitted only 10 per cent error without penalty.[3] Thus, rationalisation of error band is important to prevent developers in few states from undue penalty.

Number of Revisions

The restriction in the number of revisions in the schedule is another point of contention in the DSM regulation for renewable energy since the same does not exist for conventional energy. A restriction of maximum 16 revisions (once in 1.5 hours ahead forecast) in 24 hours excessively penalises the renewable energy developers particularly in high variation season like monsoon or during low wind season, when in spite of having the accurate forecast, the developers are unable to revise the schedule due to regulatory restrictions. Such intermittency may not impact the grid stability since it is location specific but can have significant cost impact on the developers.

Way Forward

The forecasting, scheduling and DSM regulations were designed to regulate individual behaviour so that grid stability is maintained, but the design of the regulations is such that it puts excessive penalty on renewable energy developers for causes beyond their control. This needs to be streamlined and we suggest the following way forward:

- Currently, in most regulations, the deviation charges for solar and wind generators supplying power within the state are levied at a fixed rate. In consultations with the stakeholders, we found that this mechanism is particularly unfair as the PPA tariffs have declined considerably and therefore the DSM penalty levied makes several new renewable energy projects unviable. To correct for this market failure, we suggest that the DSM charges may be levied as a certain percentage of the PPA tariff or a fixed rate, whichever is lower.
- Achieving high accuracy in forecasts at small pool substation (PSS) level (a pooling substation size varies from 5 MW to >500 MW) is impossible even with advanced forecasting models and high-quality data. This variation is penalised by the regulation but at the same time such variation does not have any impact on the grid as most RE rich states have > 10,000 MW grid. Allowing aggregation of forecasts and deviation settlement at boundary (currently allowed by Karnataka and Andhra Pradesh) can lead to higher accuracy for day-ahead forecasts, and thus may also lead to better grid operations and planning at discoms' end.
- The DSM charges become applicable from the first day of operation. For a new project, forecasting is difficult due to paucity of historic weather and generation data. Keeping this challenge in mind, we suggest levying of DSM charges in a gradual manner so that enough breathing space is provided for a new project. This can be done in the following manner:

Time period of operation	DSM charges applicable
Within 1 year	50 per cent of DSM charge
Within 1 – 2 years	75 per cent of DSM charge
Above 2 years	100 per cent of DSM charge

Lastly, while this may not require regulatory intervention, enabling policies must be formulated for granular level data sharing between weather forecasting agencies such as the India Meteorological Department (IMD) and power generators. Further, deployment of more flexible conventional generation fleet which allows bundling of power with unused or underused thermal assets should be explored. With increased share of wind and solar power in the grid and decrease in energy storage costs, we expect new business models to evolve incorporating usage of mechanical, hydro and electro-chemical storage technologies.

In 2019, the maximum instantaneous solar and wind share was 19.4 per cent in the Indian grid and 47 and 24 per cent in southern and western regional grids. With more plants under construction in these regions, instantaneous share of renewable energy will only increase going forward. Clear and consistent regulations across the country will ensure that electricity generated from both solar and wind is absorbed by the grid and developers are not penalised for reasons beyond their control.

Annexure – Key Tables

(Source: CEEW-CEF Analysis)

Table 1: Permissible Error Band

Permissible Error Band	
Error %	Number of states
(+/-) 15 %	9
(+/-) 12 %	1 (Gujarat for wind)
(+/-) 10 %	5
(+/-) 7 %	1 (Gujarat for solar)

3 MNRE (2019) "Physical progress (achievements)," available at https://mnre.gov.in/physical-progress-achievements, accessed on 18 November 2019.

Table 2: Number of Revisions Allowed

Number of Revisions Allowed	
Revisions	Number of states
16 – Wind 9 – Solar	4
16 – Wind 16 – Solar	10
16 – Wind 8 – Solar	1

Table 3: Penalty Levied

Penalty Levied (Within state)	
Range (INR per unit)	Number of states
0.50 - 1.50	12
0.25 - 0.75	1
0.25 - 1.00	1
% of PPA rate	1

Table 4: Aggregation Allowed

Aggregation Allowed	
Yes/No	Number of states
Yes	2
No	13

PEC Delhi Signs Agreement with Bangladesh for Technical Consultancy

Power and Energy Consultants India Ltd. (PEC), Delhi has signed an agreement with Power Division, Ministry of Power, Energy & Mineral Resources, Govt. of People's Republic of Bangladesh for technical consultancy services for "Developing New Business Model and Feasibility Study in Allocated Sites for Wind Power Generation" under the project titled Bangladesh Power Sector Development and Capacity Building [ADB Loan 3523 BAN (COL)]. The assignment is to be completed within six months. PEC has won this contract against international bidding process initiated by ADB for EOI in November, 2018.

Source: PEC, 8th November, 2019

India's Power Generation from Renewable Energy Sources

Generation of power was 61.78 billion units from renewable energy sources in India during 2014-15. It has increased by 6.47% to 65.78 billion units during 2015-16 over 2014-15.

Source: ET Energy World, November 11, 2019

EU Finance Ministers Unite in Call for End to Fossil-Fuel Investment

Joint statement issued by the European Union (EU) finance ministers have called for the EU to phase out its funding of oil, gas and coal projects in a move that is hoped will effect a major shift in the bloc's efforts to combat climate change. A complete shutdown of fossil-fuel funding would see multi-billion Euro investment by the European Investment Bank (EIB), the EU's financial arm, redirected to more sustainable financial support to accelerate the EU's energy transition and progress to the Paris Agreement. The EIB funded nearly €2 billion ($2.10 billion) of fossil fuel projects in 2018, with funding totalling €13.4 billion euros since 2013, according to the bank.

Source: Smart Energy International, November 11, 2019

Focus on Renewable Energy, Afforestation As Gujarat SEZs Go Green

In a bid to lower carbon footprint, special economic zones (SEZs) across Gujarat will be made more environment friendly. Special initiatives including afforestation, shifting to renewable energy for power requirements and usage of electric vehicles and bicycles for internal transport will be introduced in these industrial clusters.

Global Renewable Power Capacity to Rise by 50% in Five Years - IEA

Global renewable energy capacity is set to rise by 50 per cent in five years' time, driven by solar photovoltaic (PV) installations on homes, buildings and industry, according to the International Energy Agency (IEA). Total renewable-based power capacity will rise by 1.2 terawatts (TW) by 2024 from 2.5 TW last year, equivalent to the total installed current power capacity of the United States. Solar PV will account for nearly 60% of this growth and onshore wind 25%. The share of renewables in power generation is expected to rise to 30% in 2024 from 26% today.

Source: Reuters, October 21, 2019

MNRE Issues Clarification on Hybrid Wind-Solar Projects' Contribution to RPO of Discoms

The Ministry of New and Renewable Energy (MNRE) has issued a clarification (MNRE) has said that the RPO contribution of obligated entities, or discoms, consuming power from hybrid wind-solar power plant will be based on the relative proportion of energy contributed by each source in case there is a variation in the capacity mentioned in the PPA and the actual capacity. "The Obligated Entities would have the option to choose the proportion of each source based on actual ratios of capacities installed by each source," the ministry said.

Source: ET Energy World, November 08, 2019

Siemens Gamesa Wins Prestigious Deming Prize for Quality Standards in India, a First for a Wind Energy Company

Siemens Gamesa was awarded the coveted Deming Prize for its industrial operations covering all four of its manufacturing units and other support functions in India. The Prize Award Ceremony took place on November 6, 2019 in Tokyo, Japan. The prestigious Deming Prize is awarded by the Union of Japanese Scientists and Engineers (JUSE), to companies that have demonstrated exceptional performance through Total Quality Management (TQM). The award means Siemens Gamesa becomes the first wind energy company in the world to have won this quality award. The picture after the event is given here.

Snippets on Wind Power

Great Indian Bustard Deaths: Power Firms Must Lay Cables Underground, Says Govt.

To protect the 'critically' endangered Great Indian Bustard, the Centre has asked electricity companies to consider underground laying of high-voltage wires as the birds have died after coming in contact with power lines. Noting that a miniscule population of less than 150 Great Indian Bustards was left in India, out of which around 90 per cent are in Rajasthan and Gujarat, and very few of them in Maharashtra and Madhya Pradesh, National Green Tribunal, has decided to have a time-bound action plan to implement mitigation measures such as installation of bird diverters and their regular maintenance, and monitoring by power agencies.

The committee, after the meeting, also directed the WII to furnish the details about power lines identified for mitigation in the GIB habitat area along with details of power line owners to the ministries of power and non renewable energy for necessary action. The NGT directed that a committee be constituted to look into it a plea of Bhanu Bansal, secretary of NGO Centre for Wildlife and Environmental Litigation (CWEL). Some of the demands the NGO has been making include declaring critical GIB habitat as inviolate area, disallowing new wind turbines at GIB areas, underground laying of power lines from 33 KV to 440 KV, and imposition of exemplary cost on power line companies which fail to comply.

Source: PTI, November 25, 2019

NGC Transmission Putting Up Manufacturing Plant at Sri City, Andhra Pradesh

NGC Transmission headquartered at Nanjing, China is putting up a wind turbine gearbox manufacturing Plant at Sri City, Andhra Pradesh. The Ground Breaking Ceremony for the manufacturing plant was performed at Sri City on 24th November 2019.

Snippets on Wind Power

India to Build 30 Gigawatts of Renewable Plants along Western Border

New Delhi: India is considering building 30 gigawatts of renewable energy capacity along a desert on its western border known for its sunny, windy and arid expanse, according to people familiar with the plan. The projects, which will be spread across the states of Gujarat and Rajasthan, are part of efforts to expand the country's renewable capacity and reduce the share of fossil fuels in its energy mix, the people said, asking not to be named as the discussions are private and at an early stage. The plan was discussed at a meeting in Gujarat in October, they said. Land for renewable projects is a key challenge in India and the high cost of acquisition weighs on the price of electricity. The nation is increasingly looking at barren lands for building renewable projects so its energy goals don't clash with its growing need for agricultural production.

Source: Bloomberg, October 18, 2019

Market to Watch: Africa

The African continent is set for growth; the population is expected to grow by 1.4% each year until 2030. GDP is expected to grow by 4%. This development is demanding huge investments in infrastructure including the energy markets to keep up with the growth, access to electricity being one of the main challenges African citizens consider to encompass and unlock their growth path. African governments have acknowledged that growth can only be supported through sustainable solutions, which means an obvious opportunity for wind energy. Offering a cost-competitive solution, wind energy has the potential to drive not only the electrification level in Africa (currently only 43% of people living in Sub-Saharan Africa have access to electricity according to the World Energy Outlook 2018 from IEA), but to also support the economic growth and development of African markets.

Source: GWEC Newsletter, By Mr. Karin Ohlenforst, Director of Marketing Intelligence, and Jon Lezamiz, Chair of GWEC Africa Task Force

Rs 1 Lakh Crore Bad Loans Ailing India's Power Sector: TERI

The amount of bad loans accounts for 0.6 percent of the country's GDP. Around Rs 1 lakh crore worth of loans extended to the thermal power companies in India have gone bad, comprising 18% of the total outstanding debt for the power sector, according to The Energy and Resources Institute (TERI). "The causes of these stranded assets were the imprudent capacity expansion that occurred in the period 2010-15; demand growth slowdown after 2012; and upstream (coal linkages) and downstream (Power purchase agreement tie-ups) challenges in the power sector value chain," the institute has said in a research paper. The stranded or stressed generation capacity includes 54,000MW of coal-fired plants and 7,000MW of natural gas-fired projects. The paper also said Aggregate Technical and Commercial (AT&C) losses in the electricity sector at 18.7 per cent remain very high as compared to other nations. "End-user prices are distorted by cross-subsidy with an aggregate gap between cost of supply and revenue realization still of about Rs 0.26 per kWh. This implies an annual revenue shortfall of around Rs 32,600 crore or 1.6 per cent of the total annual tax intake," the paper said.

The Indian power sector faces a huge challenge in the form of incomplete cross-subsidy on tariffs from high-paying industry and commercial consumers to tariffs from low-paying agricultural and residential consumers. In order to plug the gap in the tariff subsidy state governments also provide direct budgetary support to distribution companies. However, the gap in the tariff subsidy is not fully made up by such fiscal subsidies from state governments leaving distribution firms with large accumulated and growing losses.

Source: ET Energy World, October 23, 2019

Building a Sustainable Wind Industry for the Energy Transition

Mr. Ben Backwell, CEO, Global Energy Council (GWEC) has written in his Editorial: As participants in the wind energy sector, we find ourselves in a unique position as an industry and as people, faced with a unique responsibility. The world is waking up to the realisation that we now have only a short time to take action to head off a disastrous rise in global temperatures and to preserve a liveable planet. And in order achieve this, that a wholesale energy transition needs to be carried out on an urgent basis. "We have 10 years" to get things right and on the correct pathway of decarbonisation and deployment of renewable energy, GWEC's Chairman Morten Dyrholm pointed out to a recent Ministerial Conference on Renewable Energy Integration in Berlin. As the events during the UN Climate Summit in New York have shown, there is now unprecedented policy momentum behind taking more decisive action to stop dangerous climate change than ever before. In the past decade, wind energy has become the world's most important and fastest growing industries and has arguably done more than any other technology to replace CO2 emissions.

Source: GWEC Newsletter

Researchers Develop New Croissant-Inspired Energy Storage System

Researchers have developed a new dielectric capacitor- a device that stores energy like a battery -- taking inspiration from how the French pastry, croissant, is made by folding multiple layers of dough. The researchers found that by pressing and folding a polymer film capacitor (a capacitor with an insulating plastic film), they were able to store 30 times more energy than the best-performing commercially available dielectric capacitor. "Storing energy can be surprisingly tricky and expensive and this is problematic with renewable energy sources which are not constant and rely on nature. With this technique we can store large amounts of renewable energy to be used when the sun is not shining and it is not windy.

Source: PTI, 19 October 2019

Power Grid Seeks to Revive Chhattisgarh-Tamil Nadu Transmission Line

The Power Grid Corporation is trying to once again revive the transmission line project connecting Chhattisgarh and Pugalur in Tamil Nadu. In a statement sent to TOI, the corporation said it is safe to have the transmission towers in agriculture fields and there is no danger to either human beings or animals and plants. The project plans to bring 800 kilovolt (kV) ultrahigh-voltage direct current (UHVDC) system to Tamil Nadu and the power will be shared with Kerala. The 1850km transmission line project has been stalled in Tamil Nadu as farmers in the western districts are opposing setting up the towers on their land. The Power Grid Corporation would make efforts to convince the farmers, said an official. The electromagnetic fields (EMF) transmitted through the network of Power Grid is absolutely safe for mankind, animals, birds, vegetation, wildlife resources etc. and its emission limits are strictly in line with global standards.

Source: Times News Network, October 21, 2019

India Must Focus on Carbon-Taxing to Achieve its Climate Goals: Study

India must focus on carbon-taxing as a key policy instrument for its carbon mitigation strategy and meeting the committed climate goals, according to researchers. Carbon taxes aim to induce decision-makers to introduce changes in emissions by putting a price on carbon. A white paper prepared by Council on Energy, Environment and Water (CEEW) along with Environmental Defense Fund (EDF) and Shakti Sustainable Energy Foundation highlights the key aspects of a possible carbon mitigation strategy.

"Green house gas (GHG) emissions mitigation is the main stated objective of a carbon tax instrument. Generally, carbon taxes are used for mitigating carbon dioxide emissions. In principle, they can be used for mitigating non-CO2 GHG emissions as well," said the paper.

Source: ET Energy World, October 23, 2019

Renewables Break US Record as Coal Plummets says EIA

Renewable energy accounted for a record 18.49% of the US' domestic energy generation during the first 8 months of 2019. Wind-powered electricity increased by 4.4% for the period, representing a total of 6.94% of all electricity produced in the country. Nuclear declined by 0.6% year-on-year, with coal making the steepest dive, dropping 13.9%, with natural gas filling the breach and growing by 6.5%.

Source: Smart Energy International, October 30, 2019

Allocate 60,000 Hectares For Solar & Wind Park on Priority, Centre Tells Gujarat

The central government on Wednesday directed the state government to hasten the allocation of The central government on 6th November 2019 directed the state government to hasten the allocation of 60,000 hectares of land for the solar and wind park project in Kutch district. The project is expected to attract an investment of about Rs 1.35 lakh crore. The proposed solar and wind park is one of the projects of national importance that are reviewed every month under the PRAGATI (Pro-Active Governance and Timely Implementation) programme monitored by the Prime Minister. "There is a huge chunk of government land in Kutch district where acquisition is not an issue at all.

Source: TNN, November 07, 2019

Cabinet Approves Pact with Guinea on Renewable Energy

The Union Cabinet on 6th November 2019 gave ex-post facto approval to a pact signed between India and Guinea in the field of renewable energy. The objective of the MoU is to establish the basis for a cooperative institutional relationship and to encourage and promote bilateral technical cooperation in renewable energy on the basis of mutual benefit, equality and reciprocity between the parties. The areas of cooperation include solar energy, wind energy, bio-energy, and waste to energy, small hydro storage and capacity build.

Source: PTI, November 07, 2019

Compiled By: **Mr. Abhijit Kulkarni**
Business Unit Head - Energy Segment
SKF India Ltd, Pune and
IWTMA Team

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TPI Composites India has put up a blade manufacturing facility at Sriperumbadur, Chennai; which is planned to open in the first quarter of 2020 for India and export markets.

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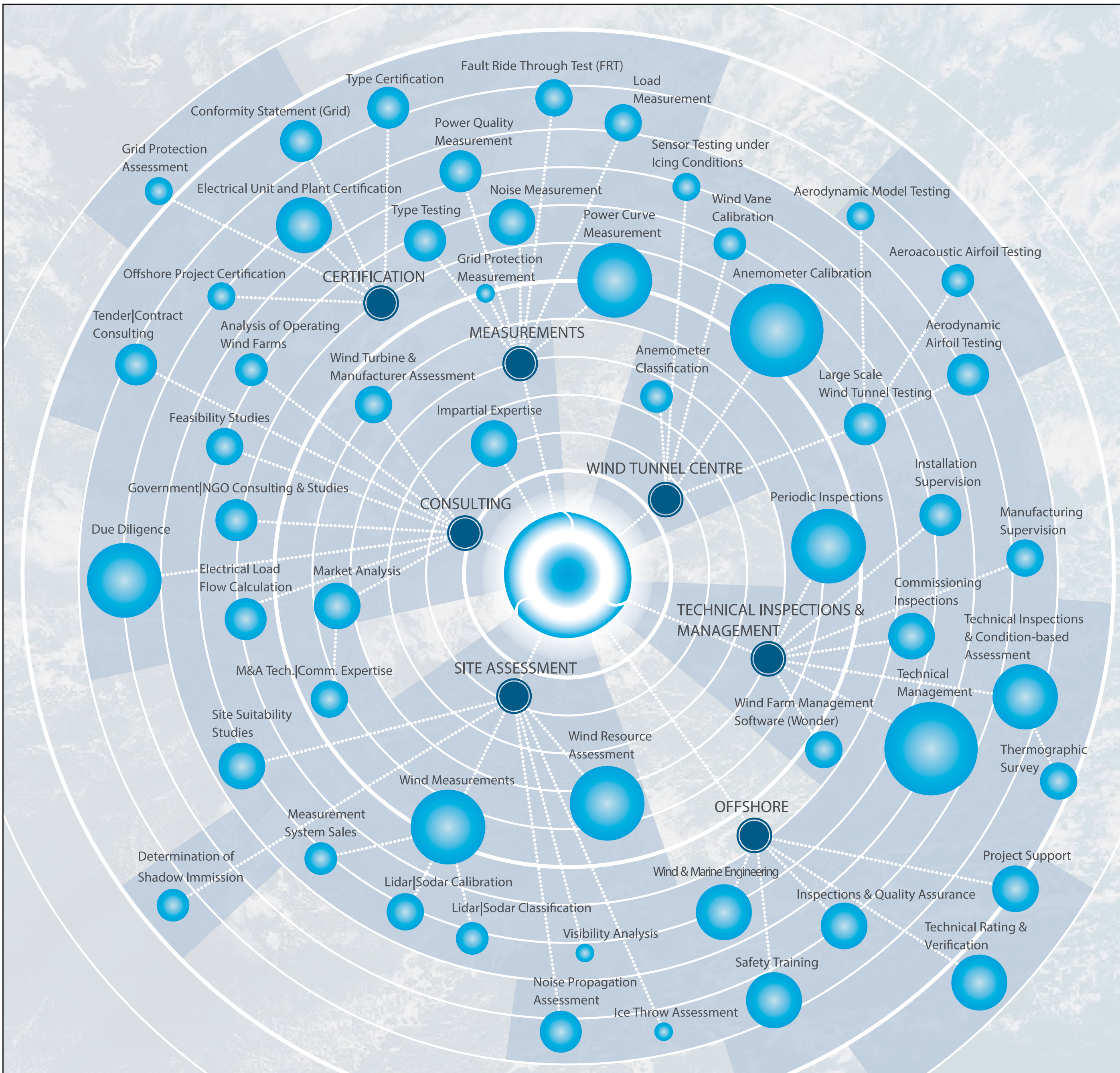
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