Indian Wind Power

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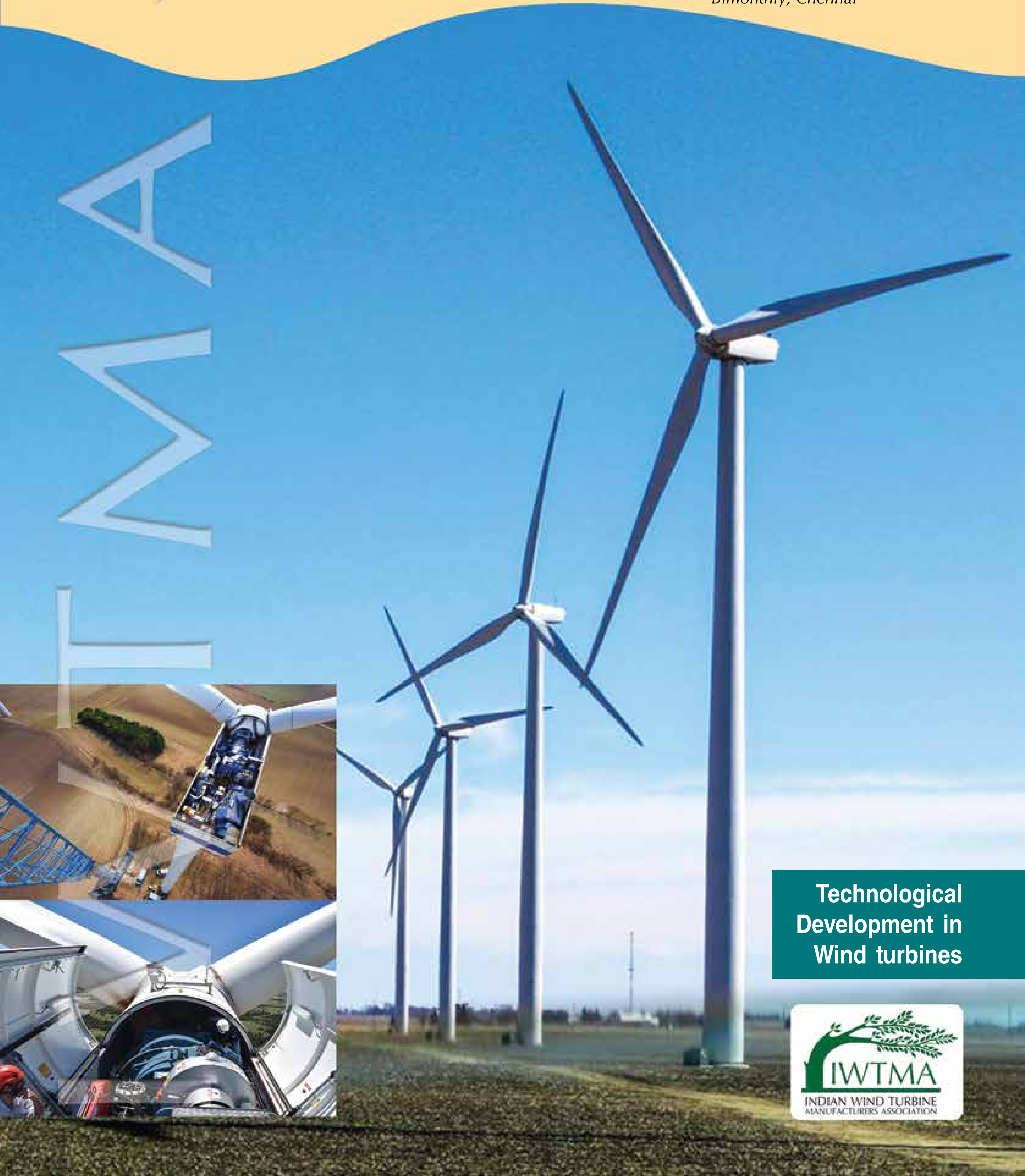

Technological Development in Wind turbines

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INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

Expertise offered to Wind & Solar Energy Stakeholders

Wind Resource Assessment

- Carry out Nationwide Wind Resource Assessment
- Estimation of Wind Potential in the country through Wind Atlas preparation
- Design and implement the comprehensive Resource Assessment Programme
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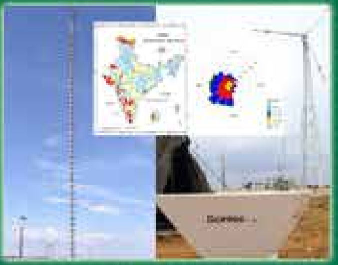
- Verification and vetting of wind data generated by private entrepreneurs
- Consultancy services for Feasibility Studies, Technical Due Diligence, Micro siting and preparing DPR for Wind Farming and Repowering assessment

Offshore Wind Energy

- Nodal Agency for facilitation of clearances for Offshore studies and surveys
- On-site wind measurement campaign
- Demarcation of potential Offshore wind blocks
- Call for proposal for development of Offshore wind energy blocks
- Promoting indigenous research for technology development



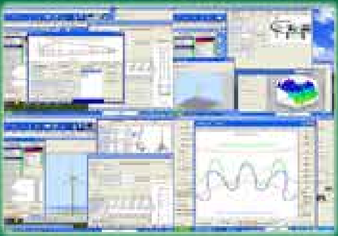
Testing (Large & Small) & Forecasting

As per Internationally accepted procedures and stipulations for

- Power Performance measurements
- Load measurements
- Power Quality measurements
- Safety and function tests
- Yaw efficiency test
- User defined measurements
- The services are not limited by type or size of the Wind Turbines

The services are certified as per the requirements of ISO 9001: 2008 and accredited as per the requirements of ISO/IEC 17025 : 2005

- Wind Power Forecasting Services
- Duration Test



Standards & Certification

- Preparation of Indian standards on wind turbines
- Accord Type Approval / Type Certification to Wind Turbines. Type Certification Services are certified as per ISO 9001 : 2008
- Issue the recommendation for grid synchronization to facilitate installation of prototype wind turbines
- Supports Multi institutional research on Wind Energy

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- Wind / Solar Technology

Solar Radiation Resource Assessment

- Solar Radiation Resource Assessment
- Consultancy on solar energy projects
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- Consultancy on solar resource assessment
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- Calibration of solar sensors
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Indian Wind Power

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Indian Wind Turbine Manufacturers Association

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From the Desk of the Chairman - IWTMA

Dear Readers,

Greetings from IWTMA!

The recent unprecedented development by Andhra Pradesh Government on renegotiation of the signed PPAs is not desirable and questions the sanctity of the contracts. Time, cost and energy are lost in legal battles instead of concentrating on moving forward to achieve the ambitious target of the Government. On the positive note, the land issue in Gujarat, where majority of the projects are being developed, is slowly getting resolved.

While the target of the Government is 3,000 MW for 2019-20, it is a tough challenge to complete the projects with number of unpredictable external factors. Equally worrying is curtailment of power especially during high wind season for technical reasons or otherwise, and the generation lost is a loss forever which cannot be re-engineered.

We sincerely appreciate and congratulate our Hon'ble Minister Shri R. K. Singh and our Administrative Ministry, MNRE, for taking proactive steps for DISCOMs to establish Letter of Credit (L/C) and to consider the entire tariff as a fixed charge. This, if implemented, will be a big relief to the generators, comfort to the bankers and a positive signal to foreign equity lenders.

The Government has come out with yet another office memorandum that renewable energy projects must be accorded 'MUST RUN' status and curtailment would be allowed only for technical reasons and violation of this rule should not occur.

Strict compliance of Non-Solar RPO both by wind and non-wind states will accelerate capacity addition. We are sure that the slowdown in the industry will end and we will witness high volume growth aligned to the government target of 60 GW wind by 2022.

State-of-the-art technology and one of the lowest costs of turbines in the world gives us a tremendous opportunity for exports across the globe, both for turbines as well as critical components manufactured in the country. It is a well known fact that the Indian wind fraternity has always championed the cause of 'Make in India' with 80% localization.

This issue of Indian Wind Power is devoted to the theme of 'Technological Development in Wind Turbines' as the technology plays a major role in higher efficiency and better Levellised Cost of Energy (LCoE).

Happy Reading!

With regards,

Tulsi Tanti
Chairman

How to Build a 160 Meters Wind Tower without Large Cranes

Miguel Turullols Sanz
Nabrawind Technologies, Spain

Last summer, Nabrawind Technologies installed the tallest iron wind tower in the world. It was a 160 meters height tower and it was the confirmation that this prototype was no longer a prototype but a reality.

This tower, named Nabralift, consists on a three columns structure installed under the uppermost part of a WTG tubular tower. It integrates the Self-Erection System (SES) that allows the installation of a full WTG without using large-size cranes regardless of the final hub-height.

Figure 1: Final Look of 160 Meters Tower in Eslava

The installation of the tower was completed in August 2018, taking advantage of the key characteristics of this tower. These are:

- Minimum assembly platform.
- Self-erecting system, avoiding the use of large cranes.
- Easy logistics. Transportation of the tower components by standard trucks.
- Reduction of concrete and iron in the manufacturing of the tower.
- Elimination of frequency resonances.

The reason for this new prototype relies in the industry's urgent need for developing higher and more powerful wind turbines.

As current market analysis shows, present trends indicate a solid growth in rating power for low wind sites, which will be more than 90% of the future market.

According to the current development, as soon as next year the average hub heights in Europe will reach 125 meters, a lot of them will be significantly higher, most likely over 160 meters. Although, it might still take a couple of extra years, the global wind market is reaching a consensus about this trend.

Figure 2: Tower Trends

Subsequently, some companies are already offering towers that fulfill these requirements. There are some examples of towers reaching 166 or even 178 meters.

The problem comes when facing the construction of these XXL towers without exponentially incrementing the LCOE. That is one of the main challenges that the wind industry has to solve if doesn't want to get its natural development cut out.

All in all, the underlying cause for more powerful wind turbines development lies in the necessity of lower the LCOE. Actually, this is the main driver for the fast growing of the wind turbine's size generators over the last decades. Accordingly, the industry is now facing the installation of enormous WTG not only in the offshore market but also in the onshore one.

Consequently, this trend leads to the necessity of developing XXL towers that no one would have dared to dream about just a few years ago.

However, this dizzying progress also comes with certain risks. Progress is being so rapid that threatens to overwhelm the current logistical capabilities. This would mean that the technological capacity would be truncated by logistical constraints associated to manufacturing, transport, installation and maintenance. Even more, these technical barriers are the culprits for hindering the viability of many wind farms when the existing technology is used.

This concern has been the main driven to develop the prototype of Eslava. This tower is equipped with a self-erecting tower able to reach the 200 meters while reducing significantly the LCOE. This is a matter of the upmost importance, given that the most expensive component of a full WTG is, precisely, the tower.

This tower, made of iron, consists on a three columns structure installed under the uppermost part of a WTG tubular tower. It also integrates the Self-Erection System (SES) that allows the installation of a full WTG without using large-size cranes regardless of the final hub-height.

The simplicity of this structure makes it a cost saving tower. In detail, the three columns structure is constituted by vertical columns and diagonals and horizontal nexus.

Figure 3: Self-Erecting System

The vertical columns are, basically, one meter diameter tubes, a technology largely and successfully incorporated by the Oil & Gas industry. The flanges incorporated are just conventional flanges made of ring rolling, while the outer joints are traction bolts.

Regarding the diagonals, these are 400mm tubes, standardized and commonly used in several industries whereas the steel terminals have been specifically designed. Joints are accomplished by friction using lock bolts, which are maintenance free.

The other capital aspect of this tower is the transition piece between the jacket type structure and the tubular tower. It is

Figure 4: Vertical Tubes Used for the 160 meters Tower

Figure 5: Diagonals Tubes

based on several iron-casted parts assembled on site. This modular concept is cost-effective and light, and removes all welds.

Figure 6: Installation of the Transition Piece for the Eslava's Prototype

But how does the installation process work with a self-erecting system and no large cranes? This is an exceptionally brief process which has been successfully proved during the installation of the first prototype of this kind of tower in Eslava, a village near Pamplona, an important wind industry hub in Spain.

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- **Increase annual energy production:**
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Learn more: **WeKnowBlades.lmwindpower.com**

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a GE Renewable Energy business

The tower reaches 160 meters, which makes it the tallest iron tower of the world. The following designs already come to 200 meters and, in fact, they will be operational next spring 2020, when they will break the height record for a wind tower.

The standardized system installation for this tower, and obviously the one followed and polished during the Eslava project, is conceived so as to install the lowermost sections of the tower at the last step of the assembly process. For this purpose, the self-erecting system is able to hoist the WTG in intermediate stages.

The self-erection process consists of the following steps:

1. The tower transition is assembled and fixed on the foundation interfaces by means of a small crane.
2. The tubular tower sections are installed on top of the tower transition by means of a standard crane.

Figure 7: Tubullar Tower Installation

3. The WTG nacelle and rotor are installed by means of a standard crane.
4. The SES is installed (SES include an independent foundation to distribute load in the terrain surface).
5. A frame module to be installed is assembled close to the WTG structure.
6. The SES jaws clamp the tower transition, that is then detached from the foundation. The SES elevates the WTG tower up to a height slightly higher than the frame tower module.
7. The frame module is guided to the lowermost part of the structure by means of a group of rails, and fixed to the foundation interface.
8. The WTG tower is lowered by the SES and fixed to the lowermost frame tower module columns.
9. SES jaws unclamps the tower and descend to the lower part of the frame module.
10. Steps 5-9 are repeated for every frame tower module.
11. The SES is uninstalled and moved to the next wind farm position.

Figure 8. The self-erecting system working during the Eslava installation

Figure 9: A Frame is Installed Ready to be Integrated

Going through the specific benefits of this tower, the concrete foundation is one of the parts in which the savings are great.

The Eslava's prototype has confirmed that the assembly platform can be reduced to its minimum. In fact, compared to other solutions, this kind of tower only requires 1000 m^2 of assembly platform, reducing the foundation volume between 30-50%.

The outcome is that the assembly platform is finished in a record time of just one week. On the other hand, the concrete requirements are minimum, avoiding, thus, the emission of thousands of CO_2 tones.

Apart of this gravitational foundation, a pile foundation can be also used as a natural connection between the three columns structure and the ground. The savings with this pile foundation are 60% of the conventional tower foundation cost.

Besides the reduction of the assembly platform, it is worthy of note that the components of the tower can be fully transported in standard trucks, which highly reduces the transportation cost. It is also installed without large cranes, which are precisely the most expensive component of any WTG installation process.

On the other hand, the installation process in serial production will allow to install a +160m tower each 4 days. As a clear


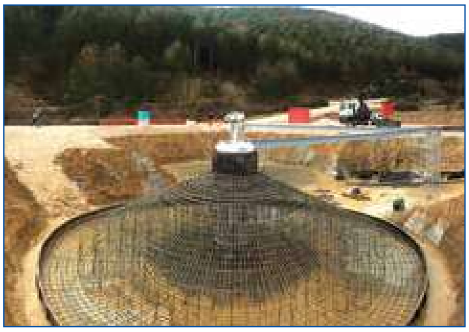


Figure 10: Foundation Process during Eslava Prototype's Installation

Figure 11: Components can be Transported in Standard Trucks

demonstration of that, this first prototype installation is concluded in just ten days, thanks not only to the fast assembly process at floor level, but also to the fact that the Self-Erecting System can work at higher wind speeds than conventional cranes (up to 15 m/s).

Finally, but not last, the enormous rigidity of the lower part of the tower moves the natural resonance frequency of the tower away from the rotor speed or blade passing frequencies, eliminating the risk of frequency resonance.

All in all, and fortunately, the technology for the new age of wind energy is already available. Now, the responsibility for bringing wind energy to never-known limits falls on all of us. Are we ready for the 21th century?

Snippets on Wind Power

Spot Electricity Price Drops to Re 1 at Power Exchange on Higher Supply

Spot electricity prices have fallen to Re 1 per unit after a gap of nearly two years because of higher supply from renewable energy sources as well as conventional plants as they have adequate fuel stocks. Analysts say prices will remain low, which is likely to reduce electricity bills for some consumers. On 4th June, prices at the exchange between 6:45 am and 9 am hovered between Rs 1.05 per unit and Rs 1.09 per unit, said Rajesh K Mediratta, director, business development at Indian Energy Exchange. Power traded between 8 am and 8:15 am was sold and bought at 99 paise per unit, he said, and average traded price of power on Tuesday was Rs 2.45 for the day as power was traded at higher prices during peak demand hours.

Solar and wind generation increased 55% in recent weeks while hydropower supply went up 30%. In all, supply of renewables increased 40% in recent weeks, leading to a softening of power prices at the exchange.

Source: ET Bureau, June 05, 2019

Power Firms Welcome RBI Notification on Stressed Assets

The Association of Power Producers (APP) was one of the parties that have fought a legal battle for 14 months with the RBI over a February 12, 2018 circular, which had put very stringent guidelines for banks to treat stressed assets, including compulsory referral to the bankruptcy court on defaults. Power companies have welcomed a fresh notification issued by the Reserve Bank of India on stressed assets, calling it a workable framework.

The Director General of the Association of Power Producers (APP) Ashok Khurana has said. "There is no mandatory referral to the Insolvency and Bankruptcy Code, the discretion of referral or bank-led resolution now rests on bank boards through inter-creditors agreements. Consent thresholds- 60% by number and 75% by value, as compared to earlier 100% by number are practical and will help resolution of bad loans," "The circular provides for a way forward for dealing with dissenting bankers too. Overall, it is a holistic and workable framework."

Source: ET Bureau, June 08, 2019

Ultra-Long Blades: Challenges and Opportunities

John Korsgaard, Senior Director
Engineering Excellence, LM Wind Power, Denmark

Overview

Wind turbine blades today are more powerful, productive and also much longer. And these unprecedented lengths bring an array of new challenges; from manufacturing to transport, handling and testing of these modern-day engineering marvels that sometimes exceed 80 meters in length. The benefits of long blades are clear, with a 10% increase in rotor diameter providing a 10% increase in Annual Energy Production (AEP) from a wind turbine. Increasing rotor performance, and thus AEP, is the most direct way to decrease the cost of wind energy. John Korsgaard, Senior Director of Engineering Excellence, LM Wind Power, explores the trend toward ultra-long blades to take on the ultimate question: Is there a limit to the size of a wind turbine?

Introduction

Wind turbine blades are key components in the wind industry's continuous pursuit to reduce the levelized cost of energy (LCOE). Before diving into the challenges that come from ultra-long blades, let's start with a look back at where the industry started and why the trend towards long blades came to be.

Breaking Records

In 1991, LM Wind Power produced 16-meter blades for the world's first offshore wind farm. Turbines at Denmark's Vindeby Wind Farm generated 450 KW of energy, with blades that were considered state-of-the-art at the time. We've come a long way since then. Today, our latest record-breaking offshore blade, at more than six times the length of the the Vindeby blades, is designed to power a gigantic 12MW turbine.

The blade size trend is even more apparent when you study the industry over the last 15 years. The record for the longest blade in the world has been broken repeatedly, but over time the records are broken more quickly and by further leaps forward. In the eight years between 2004 and 2012, the longest blades went from 61.5 meters to 73.5 meters (a 12 meter increase). Then, in the four years between 2012 and 2016, blade size went from 73.5 meters to 88.4 meters (a 15 meter increase). And most recently, in the three years between 2016 and 2019, the longest blade in the world is now 107 meters in length, supassing the previous record by 19 meters!

Ratings Rise

Offshore wind turbine ratings have also increased significantly over the past few years, with specific ratings ranging between 300 to 500 W/m2. A wind turbine is often upgraded in turbine rating, for instance with a Siemens 6 MW platform being upgraded from 6 to 7 and finally to 8 MW and a Vestas platform upgraded from 7 to 8 and finally 9.5 MW. We will see similar upgrades for future large offshore wind turbines.

Today, we are proud that our 107-meter blade is set to capture the wind for GE's Haliade-X 12 MW offshore wind turbine, the world's most powerful wind turbine to date. This turbine has a rotor diameter of 220 meters- the swept area is 38000 m^2, which is more than five times the size of a European football field or seven times the size of an American football field. One of the biggest single components ever built, this 107-meter blade represents an achievement for the entire wind industry. It is a game changer.

While the largest turbines and blades are developed for the offshore market, the size trend also applies onshore. We now see significant increase in the rotor diameter of wind class III (IEC III) turbines to increase capacity factor. Next generation onshore wind turbine blades will approach 80+ meters in length.

Designing Ultra-Long Blades

A key challenge when designing longer wind turbine blades is to increase the size of the blade while keeping its mass as low as possible. Blade mass and static moments are important design drivers. The goal is to beat the "square-cube law" which states that blade mass scales to the third power of the rotor diameter. New technologies and materials are introduced to lower the blade mass, while increasing blade length. For instance, LM Wind Power has introduced an innovative Carbon Hybrid Technology as well as new aerodynamics and structural design elements to create long, lightweight blades. The company also uses a new, full carbon technology in the design of 77-meter blade for the GE Cypress Platform. This high-tech carbon technology provides a blade weight trend line which is even lower than the trendline for our most recent advanced blades for offshore turbines.

“Ready for Serial Production” Technologies

As blade length increases, various challenges arise around the industrialization of blade production. To put this challenge in perspective; today’s largest blades amount to more than 50 tons of material that have to be put into place and processed! Manufacturing of wind turbine blades is still, to a large extent, a manual process. To continue to reduce costs, manufacturing processes have to be standardized and automated. At the same time, all equipment and test facilities need to be scaled to support the production and certification of ultra-long blades.

LM Wind Power announces the production of the LM 107.0 P, the world’s first wind turbine blade beyond 100 meters! A feat made possible by our highly passionate engineering and manufacturing teams, it is all set to revolutionalize the wind industry- capturing more wind and ultimately delivering even lower levelized cost of energy!

Logistic Challenges

Particularly for next-generation onshore wind turbines, a special challenge is the logistics around transporting a blade from the factory where it was produced, to the site where the turbine will be installed. We have seen logistic companies finding innovative solutions for transporting these ultra-long blades. To overcome onshore transport constraints, a two-piece segmented blade concept will simplify logistics to site locations which were previously inaccessible.

Challenges Can be Overcome

Back to the original question: Is there a limit to wind turbine size? History has shown that challenges are to be overcome. From an engineering perspective, a 20 MW turbine with a 250-meter rotor diameter is perfectly feasible, provided some key innovations are developed.

Through innovations in aerodynamic, material and manufacturing technologies, it is possible to design a wind turbine blade beyond 100 meters which is highly efficient and beats the scale of blade mass to blade length. Two-piece, segmented blade technology simplifies logistics to site locations which were previously inaccessible and offer greater flexibility to address different wind site conditions and requirements. Advanced aerodynamic blade control features and control systems are being developed to reduce loads on wind turbines.

Innovative, ultra-long rotors are key drivers of an industry-wide effort to reduce the levelized cost of energy. Cost models, rather than technological limits, will determine how big wind turbines will become.

Steady State Analysis Considerations for Wind and Solar Power

Rashmi Shekar
Manager, Utility Power System Solutions

Dr. R. Nagaraja
Founder & Managing Director

Power Research & Development Consultants Private Limited, Bengaluru

Introduction

Prior to the integration of new renewable generations in a power system, it is necessary to assess the grid adequacy in long time scales and associated implications to system balancing and dynamic system analysis in short time durations. In order to integrate large amounts of wind/solar power successfully, a number of issues need to be addressed at different time scales as well as system wide/national level, regional/state level and local effects as shown in Figure 1. With the substantial flexibility in the power system i.e., ability of the system to respond to changes in different time scales, challenges associated with variability and uncertainty can be addressed. The approach to conduct grid integration studies depend on the penetration level to be accommodated in the grid.

High or low penetration is defined based on the power system characteristics: typically, 5% is considered a low penetration level in most systems; 10% can be considered a high or moderate depending on the system. High penetration levels generally refer to penetration levels exceeding 20% of gross demand.

Study Aspects of Renewable Grid Integration

Grid integration study is comprehensive analyses that involve data validation, assessing transmission and generation adequacy, production cost simulation and flexibility assessment. Integration studies can be considered in phases. The first phase usually aims at the short-term impacts for lower shares of wind/solar for the existing/immediate future power system—mainly impacts on local distribution/sub-transmission networks.

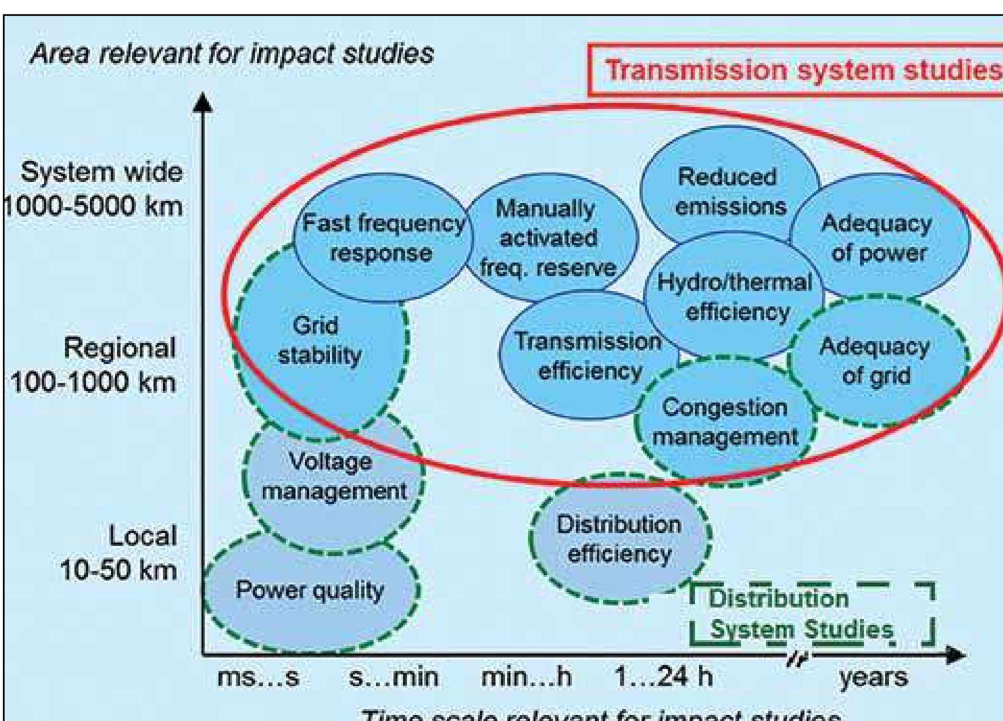

Figure 1. Impacts of Wind/PV Power on Power Systems[1]

1 Expert Group Report on Recommended Practices on Wind Integration Studies, IEA wind


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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.
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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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Assessing large scale integration of wind and solar usually requires conducting studies with network and generation capacity additions and demand projections for 10–30 years in the future. Such simulation results can illustrate ways to prepare for possible impacts of adding wind/solar. The results indicate transmission system reinforcement, reserve requirement, revisiting operating procedures, network code requirements, and market structures to facilitate reliable and economic systems.

Of the various components in integration studies, key components are presented in Figure 2. Depending on the system requirement and penetration levels, studies are carried out.

In this article, to investigate the impact with wind and solar on the grid, considerations for steady state analysis are discussed.

Data Validation
- Wind and solar generation data
- Transmission network data, demand, generation, conventional power plant data

Network Scenarios
- Scenario development - load generation balance analysis at various layers in the transmission system
- Probable network operational scenarios
- Conventional generation scheduling & disptach
- Production cost simulation and flexibility assessment (optional)

Transmission System Adequacy
- Identification of bottlenecks and network reinforcement through system studies
  (a) Steady state powerflow analysis and N-1 contingency criteria; fault analysis
  (b) Dynamic system analysis
- Techno-economic evaluation

Generation Adequacy
- Long-term plan for enhancing flexibility-generation planning, reserve requirements;
- Techno-economic evaluation

Figure 2: Critical Components of Renewable Integration

Data Validation

System inputs envisaged for steady state power flow analysis at broad level are summarized in Table 1.

Table 1: Data required for Steady State Load Flow Analysis

Parameters	Steady State Load Flow Analysis
Wind/Solar	Wind/Solar capacity, location, generation profile, active and reactive power capabilities
Demand	Demand – local level – substation wise, zone wise, state and entire system wise (regional/ country level), demand profile during various seasons of renewable generation;
Network	Network configuration for relevant study years, line parameters, shunt reactors/capacitors details
Other Conventional Plants	Active and reactive power capabilities, generation scheduling, dispatch, maintenance scheduling, etc.

Scenario Development

During 8760 hours of the year, the load varies on diurnal, monthly, and seasonal basis. The correlation between demand, wind, and solar production, specific to a particular system or region, should be taken into account. For instance, at Pan India level demand variations are associated with seasonality and also there are distinct hours of peak (peak load) and off-peak (base load) during a year. Further there is diversity of demand at regional level and state levels. Again at local level or districts (i.e., sub-transmission level (132kV/66kV)), demand variation is distinct which might be due to predominant agricultural or commercial or residential or industrial loads, etc. Thus, for studies confined to local network, the network data collection therefore has to include the wind/solar generation pattern month on month and local sub-station loads for the corresponding periods so as to evacuate wind/solar power to nearby grid substations.

Depending on the study objectives, capacity of generation and area of the network under study/interest, voltage level at the interconnection points, scenario development has to be evolved at different layers. In addition, for the steady state network adequacy analysis, seasonality of hydro generations, if any in the area, or conventional generation dispatch from gas or coal based sources are to be looked into as in Figure 3.

This approach usually leads to six to nine scenarios, out of which the critical scenario would be minimum demand, maximum wind/solar generation and minimum committed generation from conventional generation sources.

Capacity Factor: To have the economic viability of renewable projects with lesser PLF, transmission planning should consider capacity factor as a parameter. Capacity factor of wind and solar farm is the ratio of maximum generation available at an aggregation point to the algebraic sum of capacity of each wind machine/solar panel connected to that grid point. This can be arrived based on the real time data or as defined in grid code

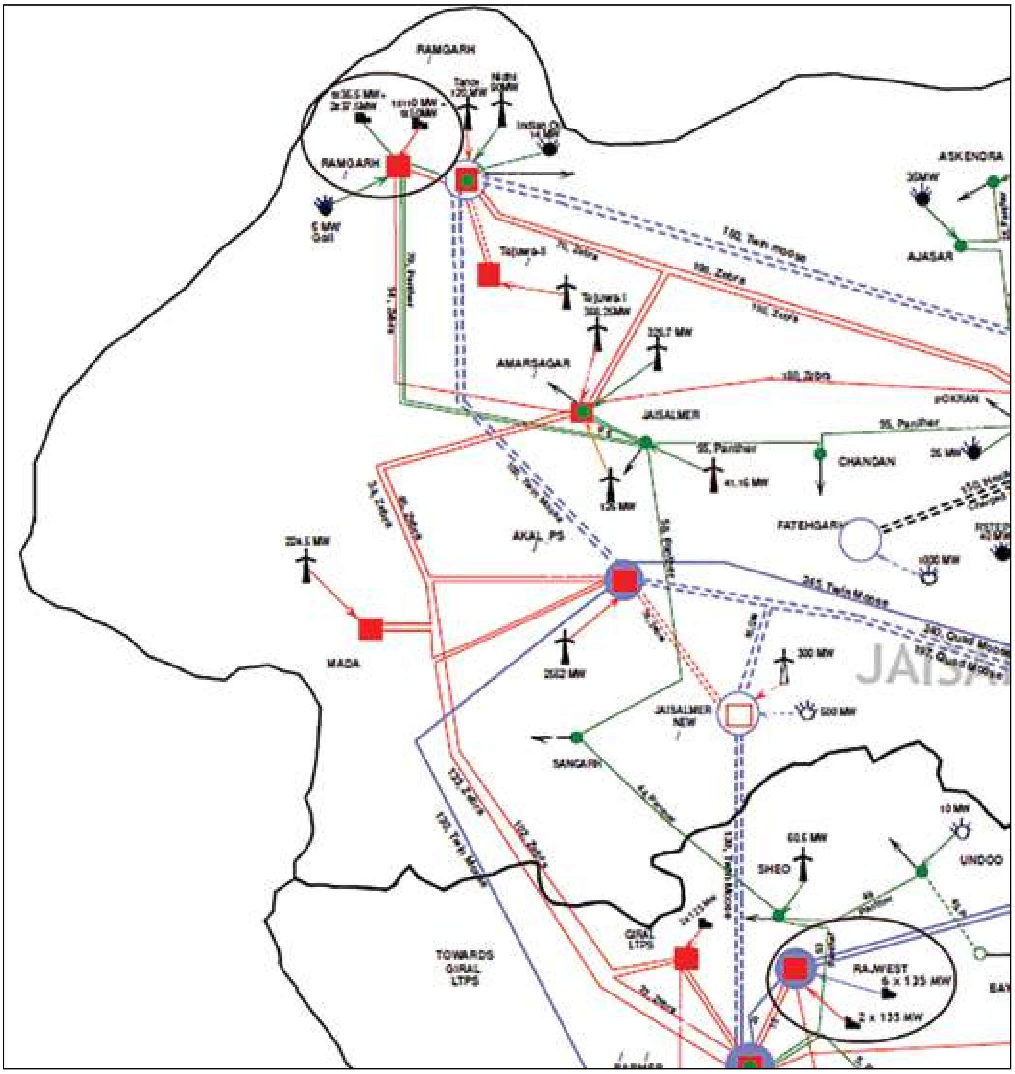

Figure 3: Thermal & Gas Based Generations (Encircled) in Jaisalmer Region of Rajasthan

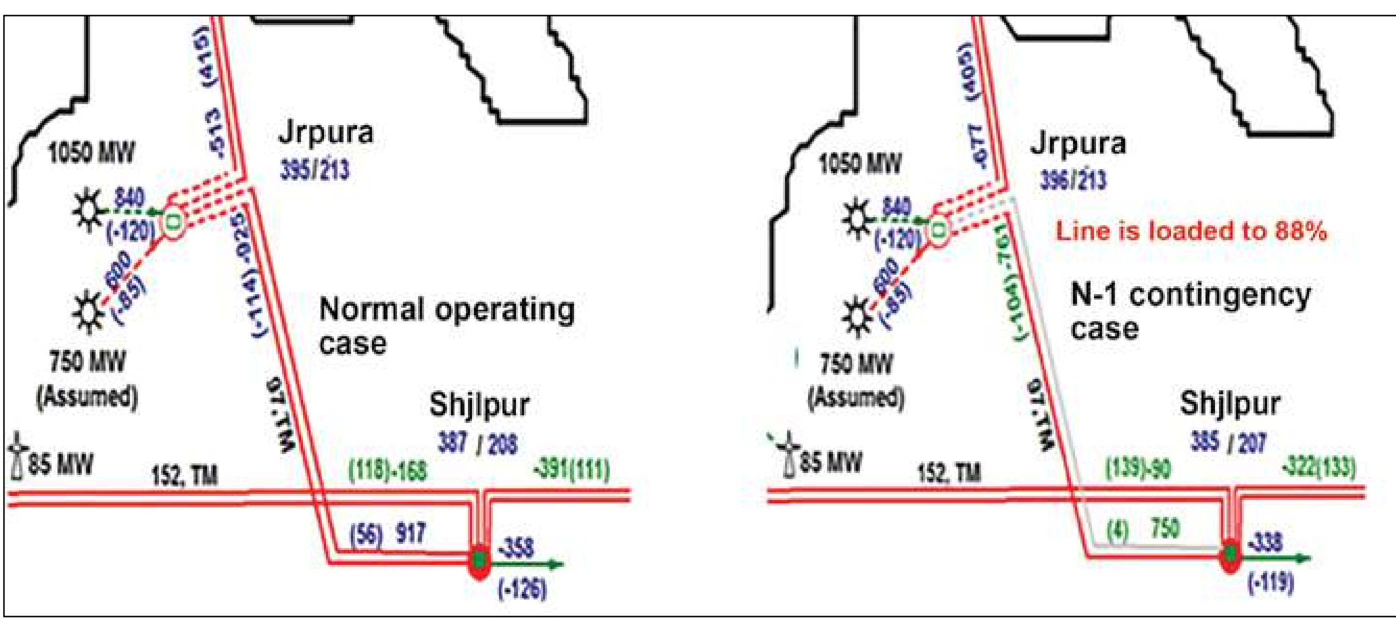

Figure 4: 400kV Twinmoose Conductor Existing Line

in Indian context [as tabulated in Table 2, (Source: Manual on Transmission planning criteria, CEA)].

Table 2: Capacity Factor for Renewable Energy Source (Wind/Solar Generation)

Voltage level / Aggregation level	132kV / Individual wind/solar farm	220kV	400kV	State (as a whole)
Capacity factor (%)	80%	75%	70%	60%

Steady State Power Flow Analysis at Different Levels and Timescales

Power flow analysis is an integral part of system planning and operation. The electrical system is modeled by buses with generators and loads that are interconnected by branches and transformers. The steady-state solution of the network determines the bus voltages from which the active and reactive power flow in branches can be calculated.

System impact analysis can be segregated in two– project specific and network wide planning.

Project Specific Analysis at Different Levels

- If renewable project sites of smaller capacities are planned to be connected at sub-transmission level (132kV or 66kV) and situated far from load centers or agricultural predominant load areas then local light load during peak wind/solar generation dispatch can be considered to assess the transmission system loading for worst case scenario.
- If the renewable project sites of hundreds of MWs are planned to be connected at transmission voltage level i.e., 220kV or 400kV, corresponding demand during peak wind/solar generation time along with respective hydro generation (if any) and thermal generation dispatch are to be looked into as presented in Figure 3.
- Further considering few GW scale projects on 400kV and 765kV level, pocket wise high renewable generation scenario (considering about 80%[1] generation from the project under study), to be looked into to assess the adequacy of the transmission corridors. In addition, during lean renewable generation scenario, as these high voltage transmission corridors would be lightly loaded, reactive power compensation to control high voltages across these corridors are to be analyzed.

While conducting project specific study to assess the transmission system adequacy, sensitivity analysis considering the future renewable generation potential to be looked into. This is illustrated in Figure 4, for a case study carried out using MiPower® software. In this study area, as there is further potential of solar project expansion, instead of twin conductor, higher ampacity conductor, or HTLS conductor can be explored for evacuation. As gestation period of renewable projects is lesser compared to development of new transmission infrastructure, at the planning stage these factors are to be considered.

System Wide Planning

While carrying out system wide long-term planning, projected demand for future years, generation capacity additions, and transmission expansion plans, seasonality of renewable generation profile are to be looked into. In India, some of the states have potential for development of large wind/solar parks along with large hydro generation complex like J & K or renewable generations with thermal generations like states of Gujarat, Rajasthan, etc., as shown in Figure 5.

Under such a scenario with due consideration of ATC limits, reserve requirements, the load generation balance in the grid and power flow across the inter-regional corridors are to be carefully assessed. Alternatively, for the case of high wind/solar (60% generation from renewables can be considered due to spatial diversity) and minimum load, transmission-level operational constraints may be alleviated through utilizing/strengthening cross-border transmission capacity for export of (excess) generation.

In this case, while assessing the impact at larger area of network or at state level, impact on conventional generations is to be assessed. For instance, during minimum demand and maximum wind/solar generation scenario, which generators must be shut down and which generators must run at minimum capacity, while complying to necessary reserves requirements, in order to achieve load-generation balance in the grid.

In future scenario during all India peak demand (months of September and October) at evening time i.e., between 18:00hr – 20:00hrs, solar generation would be zero and wind generation would be nominal. Demand will be catered by conventional generation sources like thermal, nuclear, hydro and gas. In this case, Northern region will be importing power from other regions, North eastern region is observed to import power from Eastern region and export to Northern region. Southern region is observed to import power from Eastern region, as shown in Figure 6 (a).

Eastern region being surplus with thermal generation and Western and Southern regions having large scale renewable generation, power flow directions in these corridors depends on the scheduling of thermal generations and renewable generation seasons as presented in Figure 6(b). Considering 175GW renewable power in the grid, to have the load generation balance in the grid, gas, hydro and thermal based generations are scheduled accordingly to comply for reserve requirements as presented in Figures 7 & 8.

1 Based on real time data

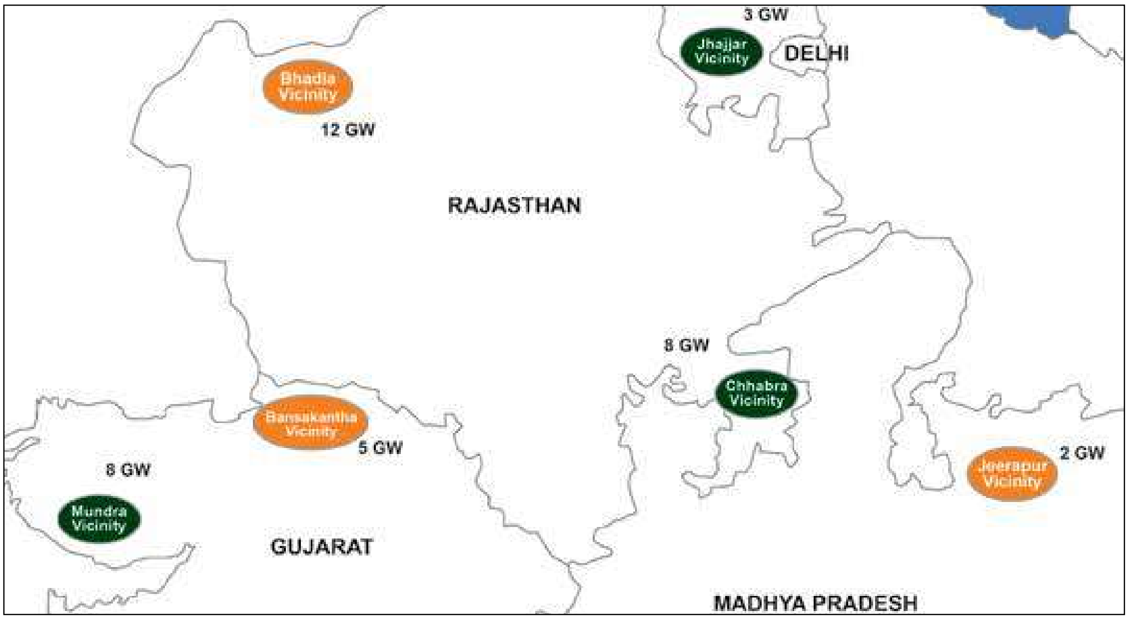

Figure 5: Solar & Thermal Generation Complex in Various States

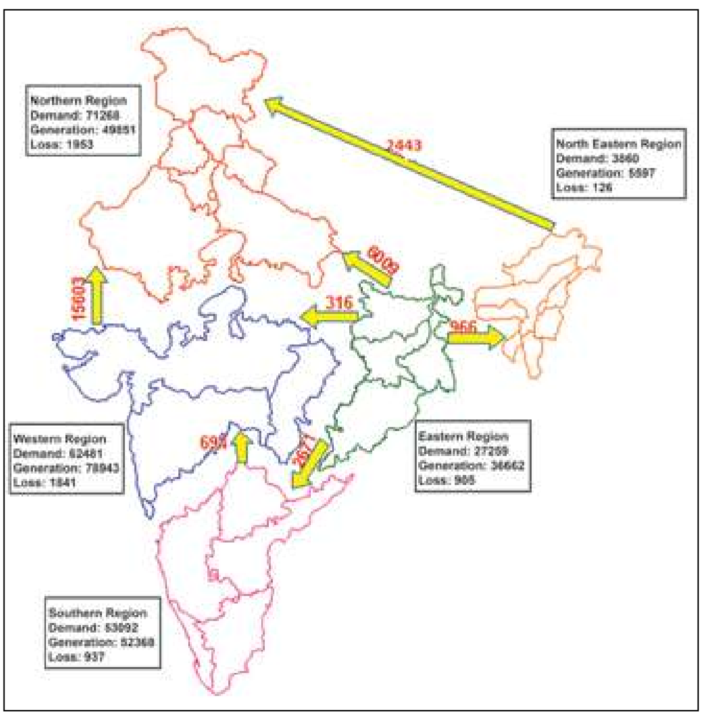

Figure 6 (a): Net Power Flow Exchange Across Regions Peak Demand and Lean Renewables

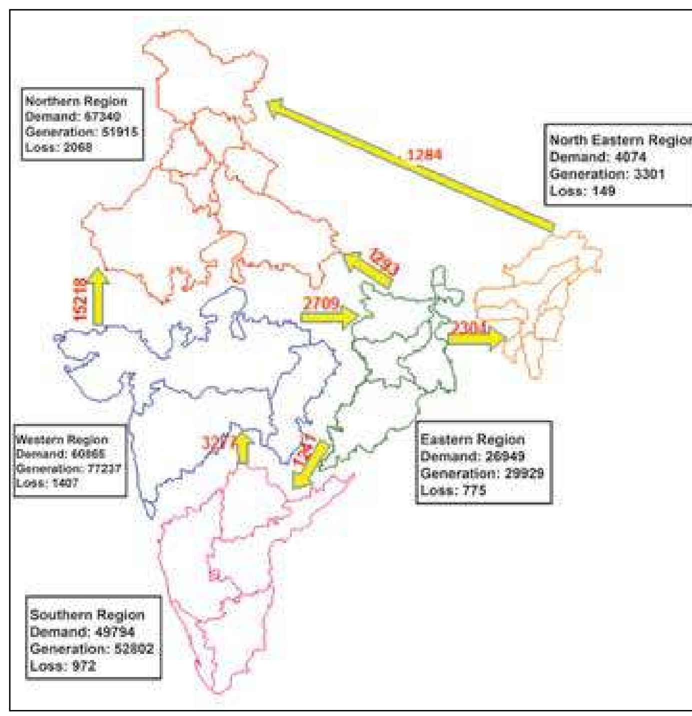

Figure 6 (b) : Net Power Flow Exchange Across Regions Maximum Renewable Generation Season and Corresponding Demand Scenario

(All figures in MW)

Contingency Analysis: Transmission grid network should also be assessed for contingency (N-1 and N-1-1) situations as per the grid code criteria. Bottlenecks can be identified in a probabilistic manner, so that by analyzing the overload risk, planners can identify whether bottlenecks should be considered severe or whether they can be solved (temporarily) via operational measures.

Possible Solutions and Way Forward

At certain instants problems associated with wind/solar power integration would be critical for small period of the total operating time. In these cases, wherever network investments can be avoided or postponed by maximizing the utilization of existing transmission lines can be explored. This can achieved through some of the options like FACTS devices to control the power flow, dynamic line

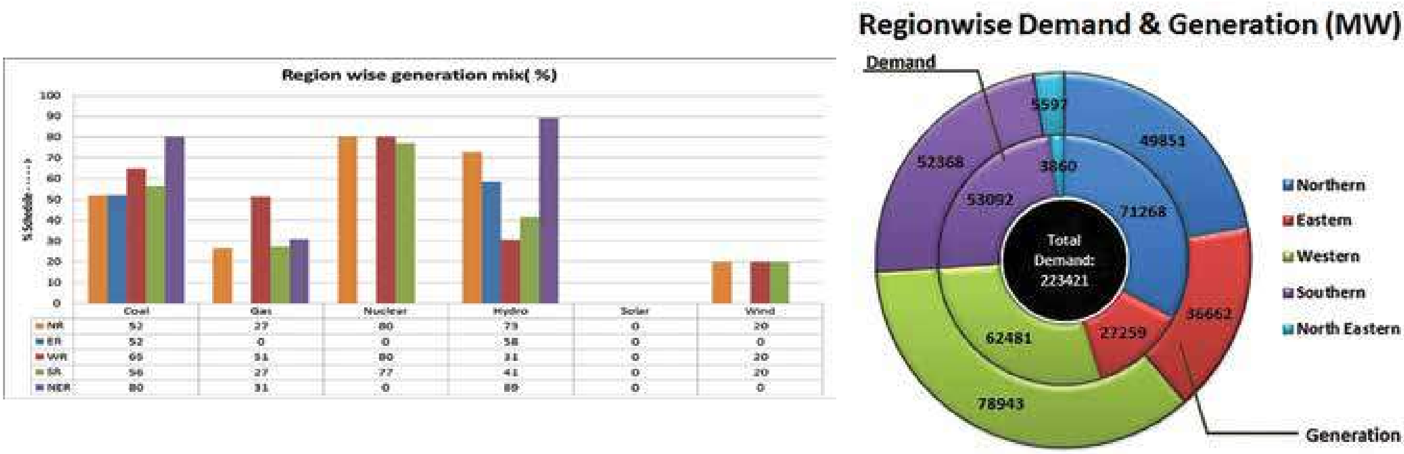

Figure 7: Generation Mix during Maximum Demand Condition and Lean Renewable Season

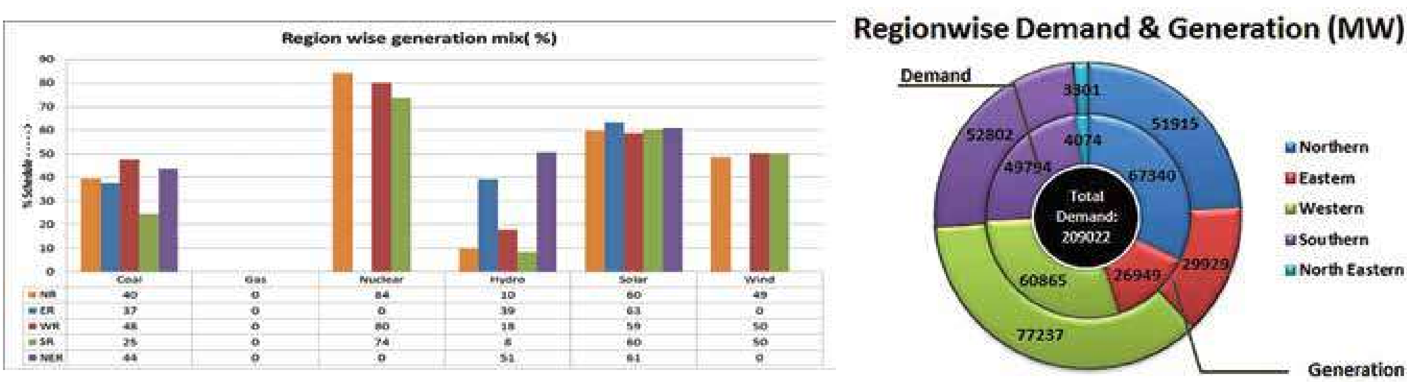

Figure 8: Generation Mix during Maximum Renewable Generation Season and Corresponding Demand Scenario

rating (DLR), reconductoring existing line to high-temperature low sag conductors and network reconfigurations.

Also grid reinforcements at few occasions should be compared against the option of curtailing wind/solar or adjusting the operation of other generation, in cases where grid adequacy is insufficient for only part of the time, or only for some production and load situations[2]. Co-ordination of hydropower and wind/solar power in a region with limited export capability is another option which can reduce the need for grid upgrades[3].

For large scale wind/solar projects with dedicated high voltage transmission corridors, reactive power compensation techniques are to be looked into. Going forward, critical contingencies observed in the steady state studies should be cross checked and remedial measures should be arrived based on dynamic studies. Inertial and governor response, as well as reserves, provide flexibility to the grid in responding to demand supply variations. Often these renewable generations provide less or no inertial and governor responses during under-frequency events. Fast response is conventionally provided by gas & hydro based generations, pumped storage, and interconnection with neighboring grids. With technological developments options like refurbishing of conventional power plants for flexible operations, utility-size battery storage, flywheels are to be explored to enhance flexibility.

In order to assess the capacity values of wind/solar generation, generation adequacy analysis can be taken up in the subsequent phase. Also, depending on the system requirement, impact on scheduling and dispatch of the conventional generations and operational costs of the power system are to be analyzed as part of production cost simulations.

In order to ensure proper protection operations, protection coordination analysis to be looked into with the increased generation due to the reverse power flow with increased generation addition at sub-transmission/lower voltage levels.

Although, the grid code regulations exist, new policy requirements to imbibe technological advancements and revisiting the regulations from time to time based on the previous experience would help in increasing the penetration levels.

2 Expert Group Report on Recommended Practices on Wind Integration Studies, IEA wind

3 Matevosyan, J. (2006), Wind power integration in power system with transmission bottlenecks.

Artificial Intelligence Makes the Life of Transmission System Operators (TSOs) Easier

Exploring the Concept of an Intelligent Energy Management System

Dino Esposito
Digital Strategist, BaxEnergy Europe and Powercon India

The Transmission System Operator (TSO) is the entity entrusted with the physical transportation of energy from any regional power plants to local households. The TSO has two main responsibilities. First, it has to ensure the security of the power lines through which the electricity is transferred. Second, it has to ensure the constant balance of demand and supply of energy throughout the grid. This last issue has never been so crucial and delicate as it has become recently.

For years, in fact, all power plants have been sized and built to match the demand of energy statistically expected to come from a given area. All the energy produced out of conventional sources such as coal, oil, atomic, geothermal, hydro or natural gas is fed to the nearest branch of the national or regional grid and from there it reaches the actual households. A number of patterns have been identified over the years to guarantee a constant inflow of energy to the grid in order to balance demand and supply and subsequently prevent both excess and shortage of energy. In the wholesale energy market, the TSO operates to avoid large fluctuations in the energy supply and does that through a number of behavioral codes that all participating companies are called to enforce.

The provisioning model developed out of established practices and, around the 2000s, the introduction of smarter power grids brought the risk of blackouts significantly down thus solving the long-time problem of ensuring grid balance. However, in only a few years, the bold advent of renewable sources radically changed such an idyllic scenario. Renewable sources are uncontrollable by nature and with a growing percentage of uncontrollable energy possibly flooding the grid the risk of damage is unbearably high. Software comes to the rescue and, more specifically, artificial intelligence technologies come to help predicting production and controlling distribution. What the TSO does manually, some artificial portion of code can do automatically.

Intelligent Software to Make Life Easier

A continuously reliable power forecast is all that power plant managers need to know to comply with TSO guidelines and energy traders wish in order to seal better deals. Predictions, however, are possible only in two ways. You have a fortune teller at hand or you're good at using machine learning algorithms.

The role of artificial intelligence is crucial for accurate predictions and to step up the interaction between energy companies and TSOs.

As mentioned, in fact, the biggest difference between a renewable and conventional power plant is the predictability of the output that goes to the power grid. A conventional power plant provides a nearly constant output whereas a renewable power plant is subject to the vagaries of the weather. This is just where the intelligence of software kicks in. Once connected together, a number of independent generation units - even based on different technologies may be operated as a single, virtualized power plant. Software is used to orchestrate the work of the various generation units, to implement power control and start and stop units as appropriate for the business and as it may be requested by the local TSO. However, the concept of a virtual power plant goes beyond smart power control.

By combining together generation units and technologies for energy storage, it is conceivable to extend the orchestrating software to make it intelligently store energy in excess and release stored energy in case of shortage. Such software is required to make some calculations and guarantee that only a contracted amount of energy is produced at any time and that any energy in excess is stored in some way. Such as software would be based on some advanced form of machine learning and crunch weather forecasts, production analytics, price forecasts to produce a nearly constant output in spite of the renewable sources used to produce energy.

Similar software would be a breakthrough for the energy industry and a game-changer for TSO operations. The TSO will keep on doing the usual job of deciding the numbers that would keep the grid in balance. But TSOs will now have a partner that can reliably contribute just the requested amount of energy in any specified timeframes.

Let us have a closer look at this orchestrating software and the artificial intelligence in it.

Virtualizing Power Production

The term Virtual Power Plant (VPP) is not new in the industry and refers to a closed network of (mostly heterogeneous) generation units whose production is treated and traded collectively as if it were a single power plant. The glue that aggregates assets together is a special algorithm able to automatically adjust collective production to the commands from TSOs so that a larger amount of energy can be delivered from a single subject just as if it were a big, conventional power plant. At the same time, though, such a virtualized power plant doesn't lose any of the typical, and highly reactive, capabilities of a renewable power plant and can still quickly and efficiently raise or lower delivery of electricity to the grid. As in the figure, a virtualized power plant can turn the behavior of multiple renewable power plants into the typical behavior of a conventional power plant, at least from the perspective of a TSO.

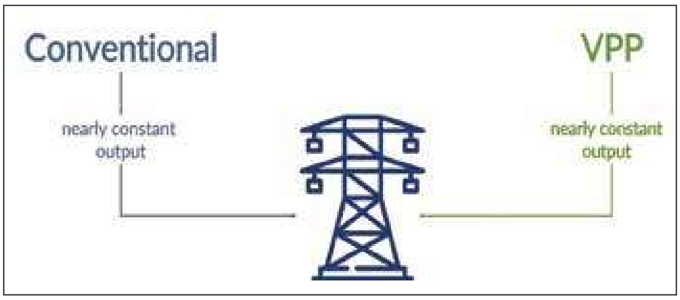

Figure 1: A Virtual Power Plant Groups Together Multiple Generation Units Even Based on Multiple Different Technologies and Make it Look Like a Larger, Conventional Power Plant.

In literature, however, the concept of a Virtual Power Plant (VPP) has a few slightly different flavors. It is always a pool of power plants but the size may vary typically from small to medium sizes. Another aspect that differentiates virtual power plants is that some of the aggregated assets may be producing energy and others may be consuming energy. Typically, a Virtual Power Plant (VPP) is created because taken individually all of the participating assets may not be able to connect directly to the power grid because of the lack of flexibility in production which results in insufficient capabilities of support abrupt outages and also often because of their too small size which is too small even for the smallest market size.

Just putting multiple small and medium-sized power plants together is not enough. They need to be heterogeneous and combine together wind and solar, hydro and battery storage. Renewable sources are the key to have because of their reactivity to power commands. It takes a short time, in fact, to take a turbine up or down to avoid overloading of the grid. The grid does not have abundant storage capabilities so it is crucial that it is fed, at any time, nearly the same amount it is demanded. At the same time, nobody can stop the wind or the sun so any excess of renewable energy to some extent can be produced and stored in batteries or even in hydro plants through pumped hydro storage. The portfolio of a virtual power plant must then be ample, not necessarily in the number of assets but primarily in the number of involved technologies to compensate any fluctuations of production both in negative and positive directions.

From VPP to Energy Management Systems

So far, virtual power plants have been implemented just securely connecting together existing power plants to a central control system that reports to the grid and TSO. The new frontier, instead, is building ad hoc compound power plants specifically designed to be operated as virtual power plants. The idea is setting up a new type of power plant that although based on renewable sources is operated as a conventional power plant and can contribute to the power grid a contracted amount of energy. From the TSO perspective, this is no less than ideal as in this way the TSO may order a large amount of energy in line with current supply and demand. Instead of dealing with multiple energy feeds, the TSO deals with a much smaller number of providers and, better than anything else, can even tell them how much to contribute on a timeline.

To turn a small group of renewable power plants into a virtualized power plant that outputs a nearly constant, and contracted, amount of energy a software orchestrator is a must. The next figure summarizes the vision behind the energy management system. At the center of operations is the software orchestrator module, which receives the actual production data and telemetry from the physical power plants and forecasts data from a number of external modules. The overall architecture can be outlined as in Figure 2.

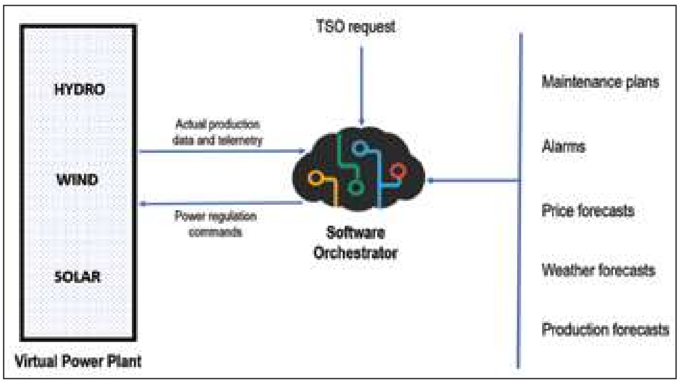

Figure 2: The Software Orchestrator of an Energy Management System Balances Actual Production Data with TSO Request and Additional Operational Information and Forecasts

What would be a reasonable composition of the virtual power plant? It is given in Figure 3.

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RENEWABLE ENERGY

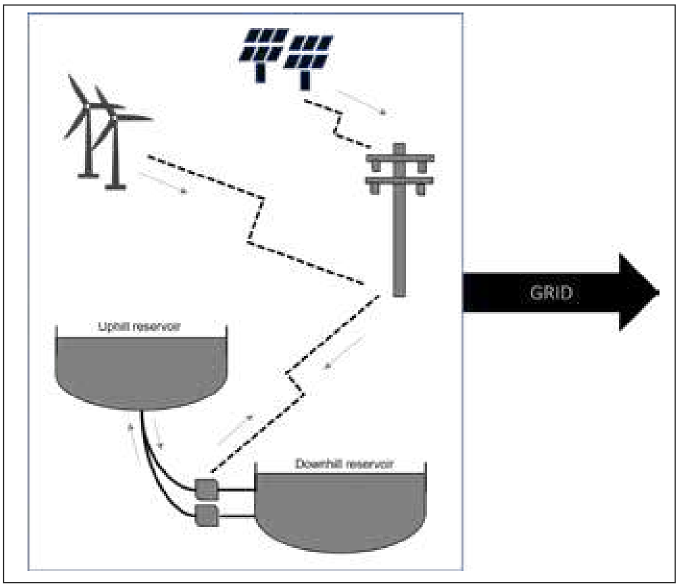

Figure 3: A Common Internal Structure of a Virtual Power Plant

For sure, it will include a wind farm and a solar farm, possibly in nearby areas though this is not a strict requirement. All that matters, in fact, is the ability to receive telemetry data and the availability of a software interface to send start/stop power commands. Sometimes, solar power plants also come with some basic storage capability to preserve excess solar electricity instead of sending it back to the grid. Solar panels generate electricity when the sun shines and wind turbines produce electricity when the wind is blowing. There are moments, though, in which the amount of renewable energy produced cannot just be increased - no solar overnight for example or in cloudy days. This sets an additional requirement for the power plant; the need of large storage capability. As of today, this can hardly be achieved with batteries. Well beyond the small scale of personal installations, energy storage is far from being a solved problem.

As of today, the most battle-field tested form of energy storage is pumped hydroelectric storage. As surprisingly as it may sound, it has been doing the job for well over a century and it is the technology that allows handling the largest amounts of energy. As of 2017 pumped hydroelectric storage still makes up for over 90% of the world energy storage. A pumped hydroelectric storage station consists of two reservoirs, one downhill and one uphill, connected to form a closed loop. Within a hydro power plant, low-cost off-peak electric power in excess is used to pump water uphill to fill the upper reservoir. The power to pump water uphill comes from connected nearby power plants that finds themselves in the need of saving surplus of energy. In the end, a combination of wind, solar and hydro power plants with some orchestrating software to manage the flow of energy towards the grid is the formula of a new power plant that the grid can perceive as a single generation unit.

Each power plant in Figure 3 will be connected to IoT edge components (i.e., via a first-level SCADA module) which will forward data to the central software orchestrator. The core software is then called to crunch numbers coming from actual and forecast production and the curve of expected outcome that determines the expected amount of energy on a daily or even hourly basis. (See Figure 4)

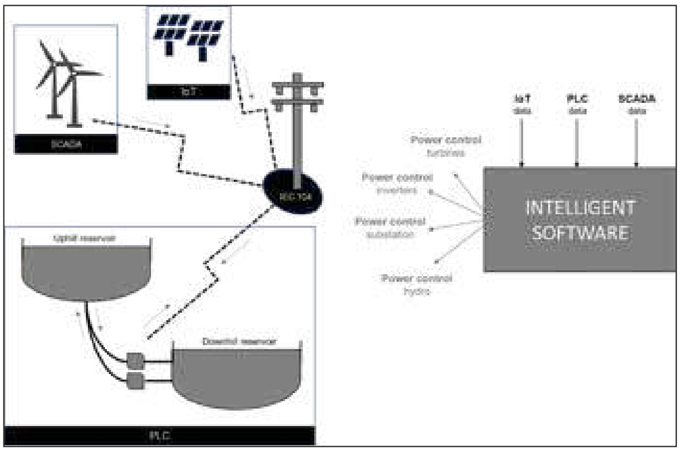

Figure 4: Electronic Components Connecting Physical Power Plants to the Orchestrating Software

If wind and solar are not sufficient to produce the required amount of energy in the considered timeframe, the software can compensate by releasing water from the top reservoir. In alternative, the software can command to use any energy in excess to move water from downhill to the top reservoir to store energy for a later time.

The primary purpose of artificial intelligence is coordinating hydro actions so that there will be enough water to release in case of need and enough water to move up to save energy in excess. In addition, the underlying neural network must be able to deal with a number of other factors such as maintenance plans to the hardware or sudden and unexpected faults that could alter the forecast production level. Put another way, artificial intelligence is called to set operational margins to guarantee the results.

The orchestrator must ultimately comply with a compound curve as that in Figure 5.

The new virtual power plant is physically connected via power line to a local substation. The energy that flows through these power lines is controlled by the power regulations commands issued by the software orchestrator.

Fine-tuning a Smart Energy System

When it comes to concretely planning such a composed system, much like with a piece of machine learning software, training, measurement and fine-tuning of parameters are

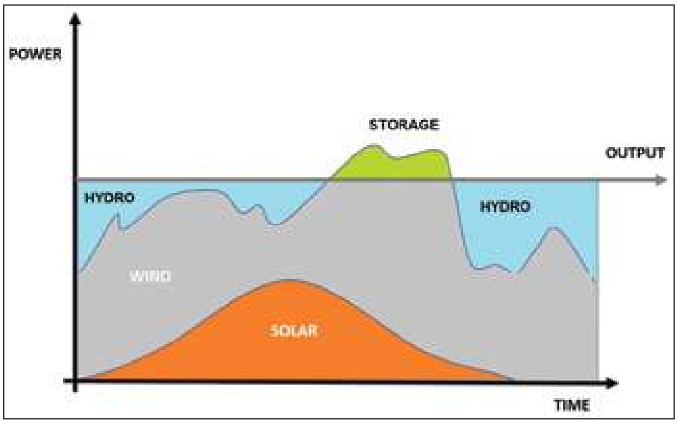

Figure 5: The Output Curve (Flat in the Example) Represent the Output To Guarantee. The Amount Produced by the Various Technologies Sum up and Excess is Stored.

crucial activities that not just must provide reliable results to confirm effectiveness before the actual system is built but also need to work as a continuous reference to check reliability of a working system. To fine-tune performance and behavior, another software component may be required to simulate the system behavior as some parameters are modified. The system must be simulated using models and sizes of wind turbines, inverters, hydro pumps and generators, number of generators and capacity as well as geographical parameters such as wind analysis, irradiation and rain distribution. Armed with this data, the software should simulate the performance and match it to some sample curves of expected outcome, surviving simulated anomalies and downtimes and trying different optimization algorithms.

Summary

Electric utilities and Transmission System Operator (TSO) grid managers face a complex task. On one hand, they need to guarantee reliable access to electricity. At the same time, though, they also have to ensure that there is just enough electricity on the grid to meet demand. The grid receives energy from conventional as well as renewable sources but while the input from a conventional power plant is nearly constant, the input from a renewable power plant may be highly fluctuant. This makes the task of grid managers particularly hard. For this reason, an intelligently software able to flatten the fluctuations and intelligent store and forward input according to an outcome curve may really make the life of TSOs and energy utilities easier. Tailor made software is crucial though and that's the major challenge.

Snippets on Wind Power

U.S. Renewable Energy Generating Capacity Has Now Surpassed Coal

According to an analysis by the SUN DAY Campaign of data just released by the Federal Energy Regulatory Commission (FERC), U.S. electrical generating capacity by renewable energy sources (i.e., biomass, geothermal, hydropower, solar, wind) has now - for the first time - surpassed that of coal. FERC's latest monthly "Energy Infrastructure Update" report (with data through April 30, 2019) notes that the renewable energy's share of total available installed U.S. generating capacity up to 21.56%. By comparison, coal's share dropped to 21.55% (down from 23.04% a year ago). *FERC's data also reveal that the nation's renewable energy capacity has been adding, on average, a percentage point each year. That is, a year ago, it was 20.66%; three years ago, it was 18.16%.

Source: EE Online, June 10, 2019

Governments 100-Day Plan Aims to Re-Energize India's Power Sector

The Union power ministry has proposed a "power sector council" headed by the Union power minister and have the Union finance minister and power ministers of all states as members. "to address issues between the Union and state governments as part of the ministry's 100-day action plan of the government. Other proposals by the power ministry include separation of the wire and electricity supply business, setting up of a pan-India power distributor and building Renewable Energy Management Centres (REMCs) across India. Earlier the government had promoted the separation of distribution aspect and content to power. The ministry's 100-day plan also includes setting up a national electricity distribution company.

Source: Livemint, June 12, 2019

SREI Infra and PTC India Financial Services Sign Pact for Energy Projects Financing

Kolkata-headquartered SREI Infrastructure Finance Ltd announced on 13th June 2019 taht it has signed an agreement with PTC India Financial Services (PFS) to facilitate financing, syndication and advisory services for energy projects across industries in India. PFS offers financial products to infrastructure companies in the energy and other infrastructure sectors and also provides fee-based services including loan syndication and underwriting.

Source: ET Energy World, June 13, 2019

Voltage Ride through requirements for Grid Connected Renewable Power Plant in India

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Abstract

The Low Voltage Ride Through (LVRT) and High Voltage Ride Through (HVRT) are the most desired capabilities for Renewable Power Generation Sources (RPGS) like wind and solar generating unit to remain connected with Grid at the time of Voltage Sag or Voltage Swells. The voltage sag may occur in the electrical system because of sudden increases in grid connected load, short circuits, line faults and starting of magnetic loads like induction machine or heater. Whereas the voltage swells may occur in the electrical system due to sudden loss of large grid connected magnetic loads like induction machines, single phase to ground fault, generation losses combined with dynamic variations in loadings and vast transmission line capacitances. As the penetration of renewable power plants in electrical grid network continuously increasing year on year due to their unavoidable importance in environment, technical and economical advances and their associated significant share of power supply creates necessities for manufacturing the RPGU with Voltage Ride Through (VRT) capability for ensuring quality of generated power supply and to ensure the grid stability. This article discusses about the technical significance of Voltage Ride Through (VRT) requirements of RPGU and VRT requirements in India and the technical requirements to be fulfilled at Renewable Power Generation Unit (RPGU) level by comparing with advanced grid code requirement also describing the VRT configuration setup for testing.

Introduction

With enormous support from the Indian Government and its continuous guidelines the installed capacity of Renewable Power Generation Sources (RPGS) has reached 78GW as of March 2019, which constitutes 22% of total electricity installations of 356GW of India (source: powermin.nic.in). As the RPGS accumulation in public gird is increasing day by day, the Voltage Ride Through requirement becomes mandatory. Hence, the Central Electricity Authority of India first introduced the LVRT requirement for RPGS by amending the grid code regulation 2007 in the year 2013. At the time, all stall regulated and most of variable power RPGS installed so far were not having the VRT capability. By considering the potential impact of RPGS and the serious complications associated with its outages in local distribution system, the CEA ordered the wind turbine manufacturers to take extensive retrofitting measures to implement the LVRT requirements in their RPGS Units.

Today, India's transmission system operators and renewable power producers have to deal with new challenges while requirements become more advanced and more stringent. In addition to that sophisticated services are needed to maintain security of electrical power supply. In this context, overvoltage is an issue and increasingly discussed in the CEA's Draft Grid Codes regulations 2014. Finally, the CEA introduced HVRT requirement in the amendment regulations 2019.

Causes and Consequences of HVRT

The overvoltage at PCC of renewable power generating station occurs due to sudden disconnection of utility loads, single phase to ground fault, increased capacities of transmission lines in combination with generation losses because of deficient low voltage ride through capability of Renewable Power Generating Unit, which causes temporary load rejection particularly in remote areas. Also, the overvoltage exists in the power system when the system voltage recovers following a fault clearing because of stalling and subsequent massive tripping of grid connected magnetic loads like induction machines and due to the acceleration and inertia of the generators which force reactive power oscillations with low damping. These phenomena for voltage variations differ in terms of time duration, ranging from a few milliseconds to some minutes depending on fault location and network propagation.

At the time of over voltage, the RPGU should absorb a certain amount of reactive power from grid in order to make the voltage at PCC become lower. The reactive power absorption capacity of RPGU is depending on the capacity of power electronic converters. The power converter of RPGU is having capability to absorb reactive power from grid without disturbing the generated active power. However, very short and local voltage surges do not threaten the system stability in any case. But the

wide-spread overvoltage in the transmission and distribution network is much more serious and causes permanent damages to the electrical components.

VRT Requirements in Indian Electricity Grid Code Regulations

Worldwide all nations have developed their own voltage ride through requirements for electrical power system depending on its electrical system characteristics and grid network propagation. As on date, there are no common grid code requirements on VRT between countries particularly for RPGU to use across globe. But the VRT capability for RPGS becomes mandatory in all renewable power enriched nations to avoid generation losses and critical grid fault.

In India, the Electricity Authority of India has introduced the VRT requirements for grid connected RPGS in the year 2013. Compared to the situation in 2013 when CEA published the first grid code amendment including a generally valid LVRT capability profile for RPGS; it can be expected that the HVRT capability for RPGU also will become mandatory in the next few years, since the voltage sags will create voltage swell at the time of fault recovery. The newly published version of the Indian Grid code Regulation 2007 as amended in the year 2019 introduces HVRT requirement for grid connected Renewable Power Generation Systems. It describes the required dynamic system support of RPGS with specifications in terms of a combined LVRT and HVRT capability. Figure 1 illustrates the low voltage and high voltage ride through requirements as per the latest regulations of Central Electricity Authority of India.

The HVRT profile of RPGS requires resistance against overvoltage up to 130% Un (nominal voltage at grid connection point) for 200ms and following 120% Un until 2s. The fault is defined by the appearance of a sudden voltage change or by the criteria that the voltage increases to values of more than 110% of Un. As long as all phase to phase voltages at the Point of Common Coupling (PCC) remain within the illustrated thresholds of the HVRT profile, the RPGS is supposed to ensure a stable operation without disconnection from the grid. Therefore, in terms of overvoltage consideration a simulation study is required to identify the highest of the three-phase to phase voltages that has to be evaluated in this context. Similar HVRT profiles can also be found in German and Puerto Rica (a Caribbean island) grid codes. As the HVRT requirement in grid code was first introduced in Germany, we can take reference from their grid code to understand the dynamic reactive power support requirement from the RPGU as illustrated in Figure 2. In contrast to the events of voltage dips, the RPGS should absorb reactive power in case of voltage boosts by injecting a capacitive reactive current (under-excitation).

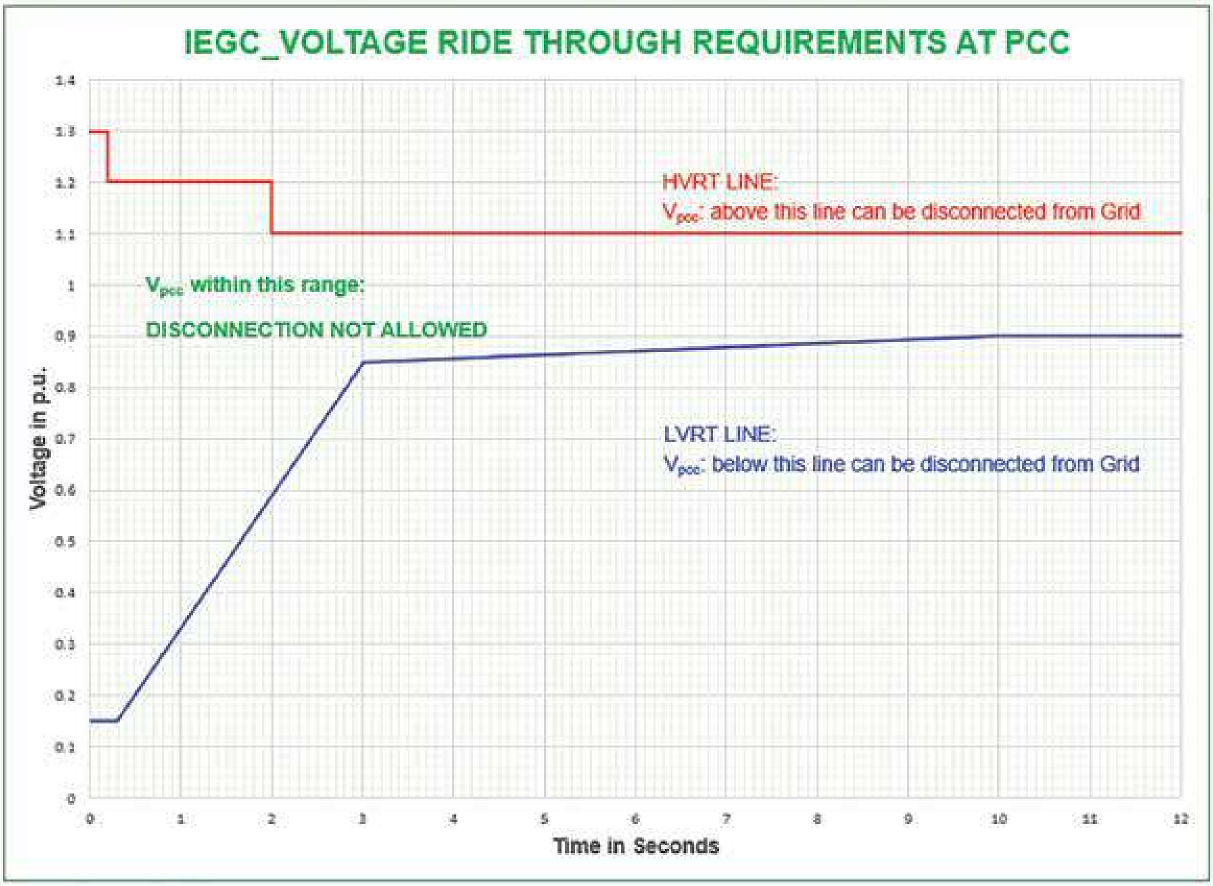

Figure1: Voltage Ride Through Requirements in India at PCC Level

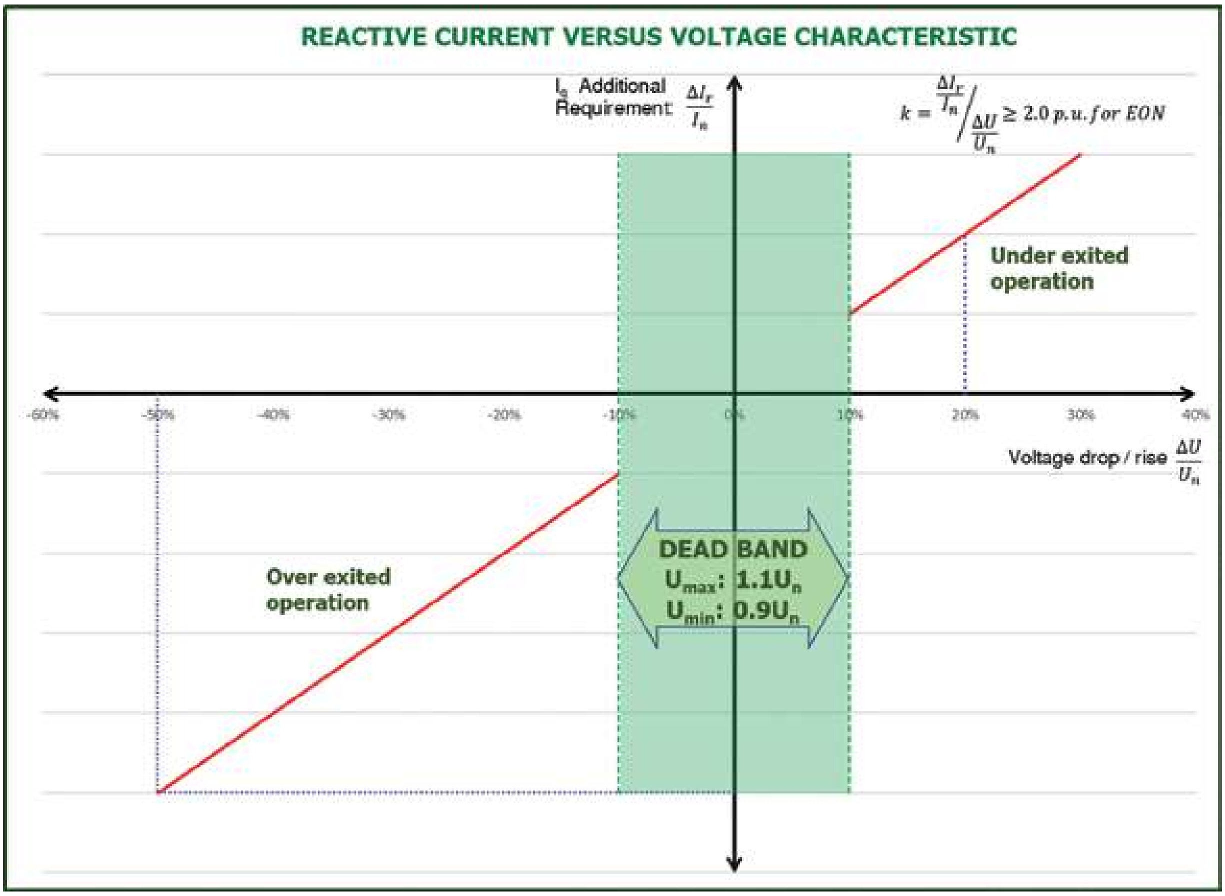

Figure 2: Reactive Current-Voltage Characteristics

The measurement of the voltage deviation and calculation of the resulting reactive current ΔI_r is usually located at the low voltage terminals of the RPGUs Power Transformer. The magnitude of the additional reactive current is predefined and proportional to the voltage deviation ($\Delta I_r = k^* \Delta U$).

Testing of VRT Capability

Vide IEGC Amendment Regulation 2019; the CEA initiated the requirement of dynamic reactive support capability for the RPGS to stabilize the system voltage during the fault by injecting a fast acting dynamic reactive current. Also specified that the HVRT requirement shall be applicable at generation station level i.e. PCC level. As the non-availability of massive test equipment to check the VRT capability at PCC due to high fault MVA, the voltage ride through behavior should be tested at individual Renewable Power Generator Unit level. Normally, the voltage at the connection point of RPGS (i.e. PCC) and connection point of RPGU will not be at same level. If overvoltage exists at PCC, then the voltage at RPGU will be higher than the voltage at PCC because of network spread and transmission line capacitance. For example, in worst case situation, if the voltage at PCC is at 1.3 p.u. then the voltage at RPGU connection point may increase up to 1.47p.u. at that instant due to line capacitance. Hence the overvoltage resistance capability of RPGU connected with RPGS must be measured and analyzed. As the overvoltage level at RPGU will vary depending on network propagation, the high voltage level to be tested at RPGU connection terminal has to be evaluated for each renewable power plant by using simulation software. But due to the complication of HVRT testing, we can test the RPGU by considering highest possible voltage level, otherwise the RPGU can be tested at particular possible over voltage level for a long duration and post analyzed the results for analyzing the compliance of RPGS at PCC level by using simulation tools like DigSilent power factory, PSCAD, PSSE and etc.

For the purpose of adequate testing appropriate test equipment is needed. Recent approaches and ideas were related to special transformers with diverse tapping, or transformers combined with specific power electronics; unfortunately, these solutions do not use standard components. So, it causes high costs in development and implementation.

The required VRT testing equipment and procedure has become state of the art not only in India but worldwide. The methods of application and performance have been given in detail in the IEC standard for wind turbines 61400-21.

Configuration of the VRT Testing Setup

For testing VRT behavior of a RPGU, a mobile testing equipment containing an inductive voltage divider and power electronic devices along with resistor and capacitor is used. With this electric circuit overvoltage can be provoked by making use of capacitive charging (Ferranti effect). The setup and corresponding testing guideline are specified in the Standard IEC 61400-21.

For VRT testing, a serial connection of an inductance and a capacitance is commonly used as absorption circuit to filter undesired frequencies, such as harmonics. To reduce a voltage of a specific frequency the resonance frequency of the circuit has to comply with that frequency. When doing so, the inductive and capacitive reactance deletes each other. If there are no other ohmic resistances connected, the circuit behaves like a short circuit for the undesired frequency. Although the voltage of the entire circuit is low, the voltage at the circuit components can be very high. This behavior has to be considered, if the recommended HVRT test circuit is used for testing. The operating range of the circuit's resonance frequency is always higher than the power system's nominal frequency. For a power system's frequency of 50 Hz the operating range of the test circuit is in the range of the third and fifth harmonic frequencies, corresponding to the circuit amplification (voltage gain) of 1.12 and 1.05p.u.

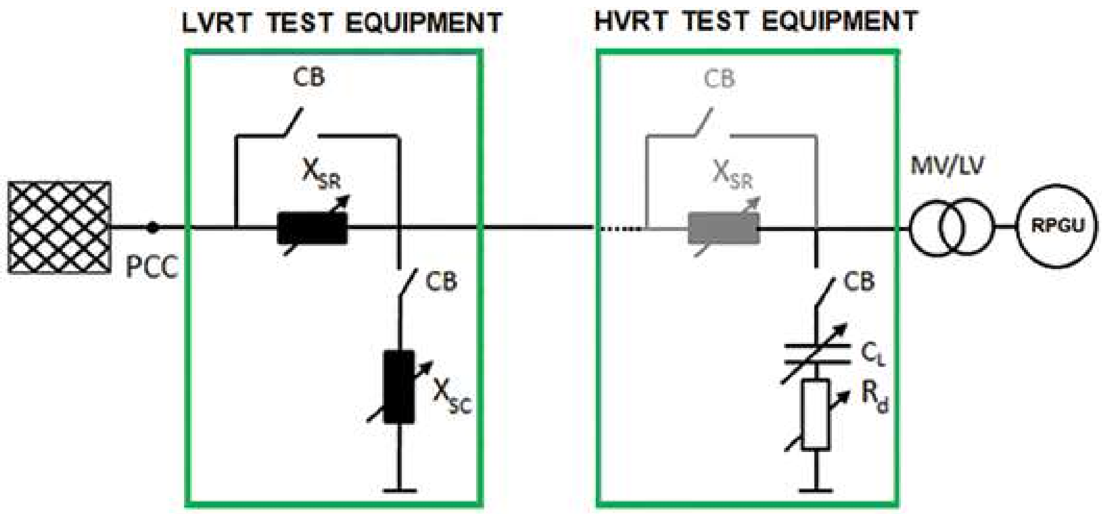

Figure 3: LVRT, HVRT and Combined Setup

Conclusion

The VRT compliance and formulation for grid code requirement are very critical. Relevant power systems are categorized by not only high penetration in electrical network but also long transmission circuit lines, where capacitive overvoltage can occur easier in case of load shedding or generator tripping. The described phenomena justify the resistance of RPGS against such faults under predefined conditions and testing for the verification of its compliance is needed. This paper has discussed an appropriate solution for the VRT testing configuration and testing guidelines by comparing with the German grid code standard.

Snippets on Wind Power

Government to Invoke Special Powers, Save RE Projects of Rs 40,000 Crore

The government is set to use special powers under the Electricity Act of 2003 to ensure regulatory passage for a clutch of inter-state transmission lines with the objective of preventing solar and wind power projects worth Rs 40,000 crore from getting stranded. Top government sources told that the power ministry will invoke Section 107 of the Electricity Act to ask Central Electricity Regulatory Commission (CERC) to allow central utilities to build the transmission lines for evacuating power from 8 GW of green energy projects slated to be commissioned from October 2020. The sources said the directives will cover transmission lines required by the end of 2020 in Phase - I for 12.5 GW, including the 8 GW under way, of renewable projects under implementation or tendered as well as 16.5 GW projects approved under norms prevalent till June 2018. The ministry's hand was forced after CERC refused to clear these transmission lines on the ground these were finalised under the process followed before new norms, 'Regulation for Transmission Line Planning', was notified last June. When approval was sought for transmission tariff of these lines, CERC sent them back for approval under the new process.

Source: TNN, June 20, 2019

Regulatory and Policy Priorities of Future Power System

A. Velayutham
Former Member, Maharashtra Electricity Regulatory Commission

1. Introduction

The electricity sector is experiencing its most dramatic transformation globally attributable to climate goals. Reliable, affordable, clean and sustainable power has to be ensured to all end consumers. To meet the above objective, Government of India, as one of the developing economy, is taking measures to accelerate renewable energy growth and to conserve energy consumption without minimising comfort level, also improving energy efficiency. India's Intended Nationally Determined Contribution (INDC) targets under the Paris Climate Agreement, targets include: reducing the emissions intensity of its GDP by 33% to 35% by 2030, from 2005 levels. The Committee on Optimal Energy Mix in Power noted that INDC targets can be achieved with a renewable energy installed capacity of 1,25,000 MW by 2027 (1,00,000 MW by 2022). With such renewable capacity, carbon intensity will reduce by 53% from 2005 levels to 2027. This target is achievable taking into account the solar and wind power potential available in the country. However the renewable energy growth depends on fund availability to invest in renewable energy generation and transmission, variable renewable energy grid integration and grid operation with associated issues, development of power market, also the financial health of government distribution companies. The future grid operation scenario is bound to change with predominantly inverter based variable renewable energy power.

Ministry of Power notified proposal for the Electricity Amendment Act 2003 for comments, Standing Committee on Energy have reviewed National Electricity Policy, also Hydro Power development. They have also indicated about the poor financial health of Discoms .NITI Aayog issued draft National Energy Policy. CERC is reviewing Ancillary service Regulations. CEA have notified Grid Standards. Regulatory review on the above would be helpful to address future Power System issues.

To ensure reliable power at affordable cost, keeping in view the accelerated renewable energy growth, Electricity Act needs to have relevant provisions, along with the policy and regulatory guide lines. The Act is supreme. The policy provisions have to be in line with Act provisions. Both the Act and the policy are in government domain. Regulatory agencies have to formulate regulations based on Act provisions and policy guide lines.

2. Regulatory Review and Observation

2.1 Draft Electricity Amendment Act 2003

Extracts from the Draft

Section 7 - Generating Company and requirement for setting up of generating station

"1. Any generating company may establish, expand, operate and maintain a generating station without obtaining a licence under this Act, if it complies with the technical standards relating to connectivity with the grid referred to in clause (b) of section 73.

--------------------------------Provided further that any generating company establishing or expanding the generating station, after a date as notified by the Central Government for the purpose, shall build and maintain reserve including spinning reserve of such capacity as may be specified by the Authority………………….

(a) Notwithstanding anything contained in sub-section (1), any generating company, establishing a new or expanding an existing, coal or lignite based thermal generating station, after a date as notified by the Central Government for the purpose, shall be obligated to meet Renewable Generation Obligation, as may be notified by the Central Government from time to time…………………………."

Section 59 - Information with respect to levels of performance

"Section 59A. In case any complaint is filed before the Appropriate Government and if the Appropriate Government is satisfied that any licensee has not discharged any of the functions assigned to him by the Act, including the standards of performance specified by the Appropriate Commission, the Appropriate Government may recommend for the revocation of licence of the said licensee."

2.1.1 Observation and Comment

2.1.1.1 Obligation of Generator to Provide Spinning Reserve

'Spinning reserve' or 'Regulation reserve' is very much required to ensure quality, security and reliability of the power system by the system operator. Generators, apart from regular power supply, may provide ancillary support services. There may not be any obligation on the part of generator to provide spinning reserve. Spinning reserve may be made available through Ancillary support services. The same may be addressed through Ancillary service regulation.

2.1.1.2 Renewable Energy (RE) Generation Obligation by Thermal/Lignite Based Generators

More Renewable Energy (RE) Generation has to be added to the system. However, Renewable Energy Generation Obligation by Coal/Lignite based generator may not be in the interest of system development. The Thermal/Lignite based generators may be encouraged/incentivised to generate RE and it may be made optional .This may help attract investment. Policy may have to be investor friendly.

2.1.1.3 Dilution of Regulatory Power

In the principal Act, section 59, refers to 'Information with respect to levels of performance'. Inserted section 59A refers to revocation of license. As the license issuing authority is the appropriate commission, the revocation also may be done by the appropriate commission. Regulator may be strengthened and not weakened.

2.2 Poor Financial Health of Government Distribution Companies

Standing Committee on Energy reviewed National Electricity Policy. The view is furnished in its report (Thirtieth Report of Standing Committee on Energy (2016-17).

Extracts from the View of the Committee:

"The Committee were apprised that poor financial health of India's power distribution companies (Discoms) is reported to the biggest concern in the Indian Power Sector. The situation has worsened over the years due to non- remunerative tariffs set by the State Commissions and high AT&C losses."

2.2.1 Observation and Comment

2.2.1.1 Poor financial health affects the growth of Indian Power Sector including RE growth. We are talking about the financial turnaround of Discoms for the past two decades. The Electricity Act 2003, National Tariff Policy and National Electricity Policy have provisions to improve the financial health. Earlier APDP, APDRP, R-APDRP and the present UDAY Schemes have all measures to improve the performance of Discoms. APDP Scheme, launched prior to the notification of Electricity Act 2003, had emphasised 100% metering. What is the present status on metering? 100% metering have to be achieved on top priority.

2.2.1.2 Annual Revenue Requirement (ARR) evaluation identifies Average Cost of Supply based on net sales expected. Tariff is computed to recover total ARR. Through Demand Side Management and Energy Efficiency (EE) measures, Discoms may bring down power purchase cost. There is scope for bringing down cost in other areas through better performance. Electricity Regulatory Commission and Bureau of Energy Efficiency give monetary award for their performance. There is no case for the poor financial health of Discoms.

2.2.1.3 Some of the government Discoms and Electricity Departments have managed their distribution losses with in permissible limits; also their financial performance is better. Private Discom licensees are also performing well.

2.2.1.4 Subsidy is a policy decision by the Government and the government is to pay the subsidy as per Act provisions. Subsidy shall not be paid at the cost of Discoms.

2.2.1.5 Poor financial heath is partly attributable to non-payment of subsidy by government, bill non-payment by government offices, mismanagement of fund etc. Managing Director should be given functional freedom and be made accountable for the performance. We have enough provisions in the Act, Policy and Regulations to improve the performance of Discoms including the finance management. We should have the will to implement the same.

2.3 National Grid Operation under Single Organisation

NITI Aayog in its draft National Energy Policy (Version as on 27.06.2017), as a part of 'Grid Integration of Renewable Electricity and More Efficient Grid Operation' policy, have expressed the following view:

"Expand Balancing Areas: *Larger balancing areas can help reduce variability by offering more balancing resources/ demand, making it easier to manage. However, due to jurisdictional issues, regulation and management is currently being done at state level. A single national-level load dispatch centre that is non-profit, independent, and regulated by CERC would be empowered for managing the entire national grid as one, with appropriate markets and regulatory frameworks in place."*

2.3.1. Observation and Comment

The above cited view of NITI Aayog is in the interest of Indian Power Grid operation. To support the view, the following observations are added.

2.3.1.1 National Load Despatch Centre (NLDC), Regional Load Despatch Centre (RLDC) and State Load Despatch Centre (SLDC) have been established as per sections 26, 27 and 31 respectively, of The Electricity Act 2003.

2.3.1.2 For historical reasons, initially Indian Power System had established control area at state level. Later for optimal utilisation of resources and to share Central Sector power, control area was established at Region level combining more than one state system. Now we have established National grid. Considering RE growth, power market development, Ancillary services for controlling power system parameters and Smart Grid development in Indian Electricity System, it is recommended to operate the power system under one load despatch organisation.

2.3.1.3 It is suggested to rename the State Load Despatch Centre (SLDC) as Area load Despatch Centre (ALDC). NLDC and RLDC are working under POSOCO (Power System Operation Corporation Limited) .ALDC may be attached to POSOCO as a part of the organisation. NLDC, RLDC and ALDC have to work under one hierarchical set up.

2.3.1.4 The concurrent character of subject power, as envisaged in the constitution is not affected by the observation made at Para 2.3.1.3 above. State government/State government companies may continue to do all activities relating to power as at present. As SLDC is already ring fenced, it may not make any difference.

2.3.1.5 Many hurdles faced by present operating arrangement would be overcome by the proposed new System Operation framework. The enquiry Committee Report findings of Northern Region Grid Disturbance on 30th July, 2012 and Northern, Eastern and North Eastern Region grid disturbance on 31st July 2012 exposes gaps in grid management as the load despatchers reporting to multiple organisations.

2.3.1.6 The idea of operating Indian Power System under one organisation was given as comments to the draft bills of 'The Electricity Act 2003' and 'The Electricity (Amendment) bill 2014'.

2.3.1.7 It is suggested again to operate all load despatch centre under one hierarchical organisation. The view expressed by NITI Aayog , in this regard is fully supported.

2.4. National Electricity Policy (NEP) & National Tariff Policy (NTP)

2.4.1. Observation and Comment on Policy

2.4.1.1 In the National Electricity Policy and National Tariff Policy guidelines, the following terms have been used, partly to indicate the loss reduction performance of Transmission and Distribution sector.

1. T & D (Transmission & Distribution) loss
2. AT&C (Aggregate Technical & Commercial) loss

2.4.1.2 It is suggested to use the term 'Transmission loss' and 'Distribution loss' separately in the place of 'T & D loss'. The usage of the term 'T & D Loss' is fine with earlier vertically integrated State Electricity System under 1948 Supply Act. Under the Electricity Act 2003, the systems are unbundled and the Transmission and Distribution systems are managed by different licensees. It is more meaningful to define losses of the respective system separately .Transmission loss data is required by Electricity Regulatory Commission while computing ARR. Load despatch Centre uses transmission loss data for the system scheduling and settlement purposes.

2.4.1.3 The term 'AT & C loss' may be replaced with 'Distribution loss'. Distribution loss has to represent only technical loss. Commercial component, if any, excluding collection efficiency, may be addressed by SERCs during performance evaluation. It is suggested that collection efficiency may not be included under commercial loss as this has to be dealt separately in a Regulator governed system. SERCs need Distribution loss data at the time of ARR. Bureau of Energy Efficiency (BEE) needs distribution loss data for their Perform Achieve and Trade Scheme as Discoms are the Designated Consumers. Presently BEE have quoted 'T & D loss' in the place of 'Distribution loss 'target, necessitating further computations. Ministry, CEA and Planning Agencies need both Transmission loss and Distribution loss data.

2.5 CEA Grid Standard Regulation 2010

***Extract "3. Standards for Operation and Maintenance of Transmission Lines** - (1) All Entities, Appropriate Load Despatch Centres and Regional Power Committees, for the purpose of maintaining the Grid Standards for operation and maintenance of transmission lines, shall,-*

(a) make all efforts to operate at a frequency close to 50 Hz and shall not allow it to go beyond the range 49.2 to 50.3 Hz or a narrower frequency band specified in the Grid Code, except during the transient period following tripping."

2.5.1 Observation and Comment

2.5.1.1 It is suggested to amend para 3(1)(a) above as *'operate at a frequency close to 50 Hz and shall not allow it to go beyond the range 49.95 to 50.05 Hz except during the transient period following tripping.'* The phrase 'make all efforts to', may be deleted and the frequency band may be reviewed in line with the nominal frequency 50 Hz.

2.5.1.2 Authority is obligated to specify grid standard as per section 73 of the Electricity Act 2003 and as per Section 79 (1) (h) of The Electricity Act 2003, CERC as part of their function have to specify Grid Code having regard to Grid Standards.

3. Unscheduled Interchange (UI) Charges and Related Matters

3.1 Prior to year 2000, Indian Power System operating frequency was 48.0-48.5 Hz, in the lower side during peak hours and 50.5-51.0 Hz, in the higher side during off-peak hours, against the nominal frequency of 50 Hz. In 10 minutes interval 1.0 Hz frequency variation was observed.

3.1.1 To bring grid discipline UI mechanism was proposed by ECC consultant, as a third part of Availability Based Tariff (ABT). Fixed cost and Energy charges are other two parts of ABT. Draft ABT (3 parts) proposal was presented in one of the Regional Conference on 'Power pool arrangements and Economic load despatch', organised by CIGRE, India, at New Delhi during 13-14th October 1995. It was mentioned in the paper, in India, frequency stability of +/- 0.1 Hz was not a priority, but to operate in the frequency range of 49.0 -50.5 Hz with UI charges and merit order operation.

3.1.1.2 In the same meeting another paper was presented listing all issues of frequency fluctuation in the grid. The recommended solutions (in the paper) includes:

- Implementation of Automatic Generation Control (AGC) with Tie-line bias control and Economic Despatch and sufficient regulation reserve.
- Primary Control (Governor) shall have to be kept in operation.
- For Governor and AGC to be on, there is a need to operate the system at 50 Hz (with deviation of +/- 0.2 Hz)
- The individual member system should draw only entitled power.

The Special correspondent of 'The Economic Times' highlighted the suggestions made in the paper, in their (Delhi Edition) dated 22 Oct. 1995, considering the interest of conference participants.

3.2. UI charges as a part of Tariff Regulation was notified by CERC in 2001. This was to get implemented by various Regions in 2001. The Southern Region was to implement with effect from 01/04/2001.NTPC and some of the southern state systems filed petition in the Court against implementation of CERC tariff order. However Western Region implemented ABT in July 2002, based on Western Regional Electricity Board decision. The other Regions implemented the same later. UI charge mechanism was helpful initially to contain the wide band of frequency 48.0 - 51.0 Hz to 49.0 - 50.5 Hz. Utilities, instead of adding generation to the grid based on their demand, used to draw extra power requirement from grid using UI mechanism. There is no scheduling culture. When the system operated closure to 50 Hz, utility preferred to draw more than schedule occasionally, as the over drawal charge is less, overloading the line more than Surge Impedance Limit (SIL) resulting in low voltage, leading to grid collapse, as it happened in 30th July 2012 in Northern Region.

In the year 2009, UI mechanism was taken out from ABT and a separate regulation with the name 'UI Charges and related matter' was issued. Later the name 'UI 'changed to Deviation Settlement Mechanism (DSM) and the DSM Regulation was issued by CERC in the year 2014.

3.3 UI Mechanism and Grid disturbance

3.3.1. UI mechanism was first implemented in Western Region from July 2002. On 30th July 2002 Western Region Grid collapsed partly attributable to UI mechanism. Overdrawal was not curtailed by despatcher assuming the UI mechanism may take care of the same.

Exactly after 10 years, 30th July 2012 Northern Region grid collapsed partly attributable to UI mechanism. When the frequency is closure to 50 Hz, the power deficit State Systems has overloaded the line more than its limit to draw cheap power utilising UI mechanism provisions.

3.3.2. One of the recommendation of the Enquiry Committee of Northern Region grid disturbance on 30th July, 2012 and Northern, Eastern and North Eastern Region grid disturbance on 31st July, 2012 is furnished: *"9.2.2 A review of UI mechanism should be carried out in view of its impact on recent grid disturbances. Frequency control through UI may be phased out in a time bound manner and generation reserves/ancillary services may be used for frequency control.*

Appropriate regulatory mechanism needs to be put in place for this purpose. POSOCO should take up the matter with CERC."

3.4 CERC's Ancillary Service Regulation 2015 had better provisions to improve grid performance. As the participating generators are limited in the Regulation, the participating generator base can be expanded. Ancillary services can be used by operators as well as market, day ahead/real time. The generating and drawing utilities have to generate/draw only as per schedule. The extra requirements if any may be met through ancillary services as suggested earlier.

3.5 As the objective of the CERC's Deviation settlement Mechanism is *to maintain grid discipline and grid security as envisaged under the Grid Code through the commercial mechanism for Deviation Settlement through drawal and injection of electricity by the users of the grid,* the same can be achieved by Ancillary services, as the suggestions made in para 3.4 above.

Based on the above observations, as recommended by the Enquiry Committee of 2012 Northern Region grid collapse, the UI mechanism may be phased out. This may also minimise number of regulations to meet the same objective.

4. Future Power System Issues and Suggestions

4.1. Conventional System: The main objective of Power System operation is to control its parameters frequency, voltage and the line loading within its permissible limits. Nominal frequency is maintained by continuously matching real power generation and real power demand. Generation and demand mismatches will result in frequency deviation .Shortage of generation compared to demand will result in low frequency than nominal and vice versa,. To ensure the reliable operation of the interconnected power system, the system frequency is tightly regulated through a combination of fast-acting closed-loop controllers at each machine (primary frequency response through governor controls) and slow, centralized controllers (Automatic Generation Control (AGC)). The synchronous generators used in conventional power plants have stator and rotor. The turbine system and rotating components inside each machine exhibit mechanical inertia, and as such they are capable of storing kinetic energy in this rotating mass. Because that energy can be extracted from or absorbed into these rotating masses during system frequency fluctuations, an interconnected system of machines is able to withstand fluctuations in net load and generation. A system with high inertia can manage load and generation variation with less frequency deviation compared to system with low inertia. Low inertia system is vulnerable to larger and undesirable frequency deviations.

4.2 Variable Renewable Energy Sources: Solar and wind power utilise a fundamentally different set of technologies for energy conversion and interfacing to the grid. Variable renewable energy sources typically connect to the grid through a power electronics interface called an inverter. The inverter converts DC electricity to AC power and manages the flow of energy. In contrast to generator, an inverter is strictly electronic and does not contain any mechanical components or rotating masses, often described as having zero inertia. A closed-loop controller is required to regulate the energy flow from the DC input, through the power electronics, and ultimately to the AC grid. These controllers have to manage the power system dynamics.

4.3 The existing power system is predominately powered by synchronous generators. Nuclear, coal, gas, and hydropower systems all utilise synchronous generators to connect to the rest of the electric grid. The abundance of inertia and synchronous torque from synchronous machines along with their controls allows for the mitigation of the large active power imbalances, transients in the grid ensuring stability. This fundamentally important characteristic of power systems would change dramatically with growing penetrations of inverter-based generation. The future grid may become an inverter-dominated grid. In between, during the transition, we may have to operate the grid, in the same day, synchronous generators domination to inverters domination may interchange.

4.4 The inverter controller ability to meet the power system requirement in terms of primary response, synthetic inertia may help accelerate renewable energy growth.

4.5 Solar and wind power output is variable, require balancing power. The balancing can be performed by the existing pumped hydropower fleet, compressed air energy storage systems, or various battery technologies. Demand-response technologies, use of electric vehicles, advanced renewable energy and load forecasting techniques, all may help to minimise the issues associated with renewable energy variability.

4.6.1. To meet the peak power demand and meeting balancing power requirement of infirm renewable energy power, hydro power plant including pumped storage hydro plants would be very much required. In the country, the hydro power potential is about 1,45,320 MW and pumped storage potential is about 96,524 MW, as per Central Electricity Authority data. 45,399 MW Hydro capacity has been harnessed so far. Pumped Storage projects in operation are about 4785 MW. Therefore, the Hydro Power including pumped storage have to be harnessed on priority.

4.6.2. Nuclear power plants, being the only base load power source offering green energy, needs to be promoted.

4.6.3. Considering the coal potential available in India, based on techno-economic consideration, washed coal/clean coal thermal units could be part of future generation mix. Policy may have to be tuned for the same.

4.6.4. Hydro power development, nuclear power development and EHV Transmission Projects may need public/local people support. Local people concerns have to be studied by a third party/social scientist. Getting local people support for infrastructure projects has to be addressed by policy authorities.

5. Final Observation

1. The Indian Grid shall have to be operated at a frequency close to 50 Hz and shall not be allowed to go beyond the range 49.95 to 50.05 Hz except during the transient period following tripping.
2. The loss in the Transmission System may be termed as 'Transmission loss' and the loss in the Distribution System may be termed as 'Distribution loss'. The usage of 'T&D loss' and 'AT&C loss' may be dispensed with.
3. It is suggested to rename SLDC as Area load Despatch Centre (ALDC). ALDC may be attached to POSOCO as a

part of the organisation. NLDC, RLDC and ALDC have to work under one hierarchical set up.

4. UI/Deviation Settlement mechanism has to be phased out. The objective of DSM can be managed through Ancillary Services. Merit order based AGC with tie line flow control, operator/Market controlled Ancillary support service with sufficient regulation reserve have to be implemented on priority.

5. Generators shall not be obligated to keep spinning reserve. Regulation reserve/spinning reserve can be met from Ancillary services. Renewable energy generation by fossil fuel based generators may have to be optional and not under obligation.

6. Hydro power potential including pumped storage power potential may have to be harnessed on priority basis. Green, base load, nuclear power may be developed on faster phase.

7. Governor has to be on in all synchronous generators linked to the grid. During grid disturbance defence mechanism is ensured by conventional synchronous machine based power sources, attributable to effective primary response and inertial response. Inverter based variable renewable energy sources have to ensure the same response through power electronic controllers. This may help accelerate renewable energy growth.

8. Financial health of Discoms has to be addressed on top priority. 100% metering is to be completed without any further delay. Managing Director should be given functional freedom and be made accountable for the performance .Cost of supply has to be recovered fully and there is no reason for the poor financial health of Discoms.

9. Regulatory Agency has to be strengthened, not weakened by clearly honouring the role of Act, Policy and Regulatory agencies.

10. The Act, Policy and Regulations have to address the identified/suggested future power system priorities.

Separate Funding Sources and Financing Regulations for Renewables on Cards

The Ministry of New and Renewable Energy (MNRE) has asked for separate funding streams and financing regulations for the sector even as investment is becoming dry in the conventional energy space and renewable energy is taking over. A senior government official said the ministry asked the Reserve Bank of India (RBI) to separate renewable energy (RE) from thermal power in its regulations in order to have different sectoral caps.

Lately banks have become wary of investing in power projects.

Business Standard, June 10, 2019

Centre Firm on 175GW RE Target, Flexible on Sources

The government has agreed to allow flexibility in the mix of sources for achieving the target of 175 GW renewable energy capacity by 2022, power and renewable energy minister Mr. R.K. Singh said on 11th June 2019. "The overall target of 175 GW remains the same. But flexibility in the capacity mix will help tap the potential of each renewable energy source to the full instead of being bogged down by stated targets," Mr. Singh said. He said the 100 GW capacity envisaged for solar power need not be sacrosanct. It could be 110 GW or 90 GW, depending upon the potential. If wind energy appears to have higher potential, more of that capacity will built instead of being limited by the envisaged target of 60 GW.

Source: TNN, June 12, 2019

Centre, State Discuss Renewable Energy Issues

Power Minister Shri R.K. Singh met the energy ministers and senior officials of renewable energy-rich states to discuss the challenges of meeting the target of achieving 175 GW of renewable energy capacity by 2022 on 11th June 2019. Addressing the issue of delayed payments by discoms to renewable developers, the participants deliberated on bringing information on outstanding in the public domain to ensure transparency. Renewable developers had complained that some discoms clear outstanding dues to conventional players well before solar and wind projects. Singh requested states to adopt the 'first in first out' principle to clear dues, without any sector-based disparity. The Union minister said that the solar energy corporation of India (SECI) is coming up with a payment security mechanism for renewable developers and some policy changes are also in the works to ensure disciplined payment. The ministry also asked the states to consider issuing advisories to state electricity regulators to expedite the process of adopting tariffs arrived through competitive bidding. He also asked the states for ensuring RPO compliance.

Source: Financial Express, June 12, 2019

Wind Power Regulatory Updates from May to July 2019

Central Updates

Central Electricity Regulatory Commission (CERC)

a. Final order on calculation of **Average Power Purchase Cost (APPC)** at the national level was announced on 6th June 2019. The APPC rates applicable for FY 2019-20 are **Rs. 3.60/kWh.**

b. Final order dated 12th June 2019 on Petition filed by Suzlon on LVRT where Honorable Commission ordered that **LVRT Retrofitting** is not required and directed all the Wind Turbine generators to comply with the CEA (Technical Standards for Connectivity to the Grid) (Amendment) Regulation, 2019.

c. Commission invited comments/suggestions on the changes/modifications to be made in existing **Indian Electricity Grid Code (IEGC).**

Ministry of Power

a. Order on **Opening and maintaining of adequate Letter of Credit (LC) as payment security mechanism under Power Purchase Agreements by Distribution Licensees** dated 28th June 2019. It is further clarified in that in the event if power is not dispatched for any reason, the distribution licensee shall continue to pay the fixed charge in case of conventional power and PPA tariff in case of Wind, solar and Small Hydro (also Refer MNRE Office Memorandum dated 31st July 2019).

b. **Amendment to the Guidelines for Tariff Based Competitive Bidding** Process for Procurement of Power from Grid Connected Wind Power Projects dated 16th July 2019. The summary of amendments is as under:

1. **Clause 5.2 (a):** Removed the seven month time line for land acquisition from the date of PPA and now the land acquisition can be given on or before Scheduled Commissioning Date (SCD).
2. **Clause 7.2.1:** CUF can be revised once within three years, earlier it was within first year of CoD.
3. **Clause 7.2.2:** Penalty will be calculated @ 50% (fifty percent) of the PPA tariff for the shortfall in energy terms; earlier it was @ 75% of the PPA tariff. Penalty shall be passed on by the Intermediary Procurer (SECI) to the End Procurer (DISCOM), after deducting losses of Intermediary procurer.
4. **Clause 16.1:** In case of part-commissioning of the Project, land corresponding to the part capacity being commissioned, shall be required to be demonstrated by the WPG prior to declaration of commissioning of the said part capacity.
5. **Clause 16.2:** In case of early part commissioning, the procurer may purchase the electricity at the PPA Tariff (100 %), which was earlier @ 75% of the PPA tariff.
6. **Clause 16.3:** SCD may be within the 18 months from the date of signing the PPA or PSA.
7. **Additional Amendment:** Commissioning/part commissioning of the Project will not be declared until the WPG demonstrates possession of land in line with Clause 5.2.(a).

State Updates

a. **Andhra Pradesh:** Power Minister Shri R.K. Singh wrote a letter to Chief Minister of Andhra Pradesh and Chief Secretary Govt. of AP on revisiting of old PPAs, where he has mentioned that a PPA is only revisited if a case of conspiracy and undue gains is proved and cannot be revisited without any reason but A.P. government has not shown any interest in this letter and gone ahead with revision order to generators.

b. **Maharashtra:** Maharashtra Electricity Regulatory Commission (MERC) has come out with final order on Determination of Generic Tariff for RE for FY 2019-20 dated 30th April 2019, where it is mentioned that Wind Energy Tariff adopted by the Commission is Rs 2.52 /kWh for MSEDCL. Any subsequent Order of adoption of Tariff shall be considered at the time of signing of EPA.

c. **Gujarat:** Gujarat Electricity Regulatory Commission (GERC) has come out with final order dated 29th April 2019, where No additional surcharge is payable to the consumers of MGVCL, UGVCL, PGVCL and DGVCL who avail power through Open Access from any source other than their respective DISCOMs for the given Control Period (1st April 2019 to 30th September 2019).

Compiled by IWTMA Team

Snippets on Wind Power

Offshore Wind Energy O&M Spending to Grow to 11 Billion Euro by 2028

The global offshore wind operation and maintenance (O&M) market is expected to grow by 17 per cent annually to 11 billion Euro by 2028. Europe is the largest contributor with €6.7 billion in value, while the Asia Pacific region is keeping up the pace in O&M market size and spends. The turbine O&M costs constituted the biggest portion of offshore wind OPEX spend. Uncertainty caused by key component failures is further pushing costs upwards. As such, a proactive approach is highly emphasised to replace key components to reduce turbine downtime and associated revenue losses. Blade erosion and repair remain a huge concern in the offshore space, causing an estimated 5,000 days cumulative downtime globally and resulting in 61 million euro of direct repair costs and lost revenue.

Source: ET Energy World, June 12, 2019

Niti Aayog: Privatise Power Distribution

Government think tank Niti Aayog has recommended privatization of power distribution to minimize line losses or waste of electrical energy owing to overheating of wires. Aayog has said distribution companies may adopt a franchisee, model for retail business in rural areas and stipulate minimum performance parameters, including the use of decentralised generation sources and storage systems for local reliability and resilience. The recommendations come at a time the UP government is grappling with line loss, particularly arising out of power thefts, to the tune of 25- -30% against an expected 15%.

Source: Times of India, 18 June 2019

Centre Advises AP CM not to Revisit Renewable Energy PPAs in Andhra

The new AP chief minister Shri YS Jagan Mohan Reddy has vowed to review all the PPAs, especially wind and solar. The union government has advised the Andhra Pradesh government to desist from the move to revisit the power purchase agreements (PPAs) in the renewable energy sector, viewing that such steps would affect the investor confidence and the country's renewable energy targets. In a letter to the AP chief secretary LV Subramanyam, the union new and renewable energy secretary Aanand Kumar aired serious concerns over the contemplated move of the Andhra government reported in the media. The union government's letter also comes days after the state government's orders to cancel all the infrastructure contracts awarded before April 1 by the erstwhile government estimated to affect around Rs 50,000 crore worth contracts.

Source: ET Bureau, June 09, 2019

MNRE to Set Up Dispute Resolution Committee for Solar, Wind Power Developers

The Ministry of New and Renewable Energy (MNRE) has decided to set up a three-member Dispute Resolution Committee (DRC) to look at unforeseen disputes that may arise in implementation of contractual agreements and also for issues beyond the scope of Contractual Agreements between solar and wind power developers and implementing agencies like SECI and NTPC. Solar and wind energy companies had earlier demanded setting up a dispute resolution mechanism to expeditiously resolve unforeseen disputes that arise beyond the scope of contractual agreements. The DRC will consider all cases of appeal against decisions given by SECI on Extension of Time requests based on the terms of contract and also all the requests of Extension of Time not covered under the contractual terms.

ET Energy World, June 19, 2019

Renewables to be the Primary Source of Energy by 2040 Surpassing Coal: BP Energy Outlook

By the mid-2020s, India is expected to outshine China as the world's largest growth market, accounting for over a quarter of the growth in global energy demand. Renewable energy is the fastest growing source of energy, accounting for around half of the increase in energy and is set to penetrate the global energy system more quickly than any fuel previously in history, according to BP Energy Outlook. The report points that in an evolving transition scenario, renewables account for around two-thirds of the increase in power generation, with their share in the global power sector increasing to around 30% by 2040. In contrast, the share of coal declines significantly, such that by 2040, it will be surpassed by renewables as the primary source of energy in the global power sector. The report highlights how the transition to a lower-carbon energy system is opening up a wide range of business possibilities.

Source: Mercom India, June 19, 2019

India Becomes Investment Darling for Renewable Energy to Airports

Sovereign wealth funds are piling into India, buying stakes in everything from airports to renewable energy, attracted by political stability, a growing middle class and reforms making it more enticing for foreigners to invest. Wealth and state pension funds are expanding their horizons to private markets, to complement an existing focus on stocks and bonds."Almost every jurisdiction in the western world is raising the bar for entry for foreign investors but in India it's the other way round. There's also the attraction of the demographics and a lot of assets that sovereign funds like, such as infrastructure, where there's a huge appetite for foreign funding."

Foreign institutional investor flows into Indian equities are $11 billion year-to-date, surpassing the total annual tally in each of the four previous years and setting 2019 on course for the highest annual inflows since 2012. India's benchmark BSE Sensex has soared nearly 10 per cent year-to-date. Private equity deal activity in India surged to $19 billion in 2018, the highest level in at least a decade, according to PitchBook data. Sovereign wealth funds and pension funds participated in about two-thirds of that amount.

Source: Reuters, June 21, 2019

World Will Get Half its Power from Wind, Solar by 2050

Europe is taking the lead on the shift to renewables, which will supply 92% of the region's electricity by 2050. Nearly half the world's electricity will come from renewable energy by 2050 as costs of wind, solar and battery storage continue to plummet. Since 2010, the cost of wind power has dropped by 49%, and solar has plummeted 85%, according to BNEF

Source: Livemint, 19th June 2019

Can Smart Meters Re-energise India's Crumbling Power Distribution Companies?

Taking the reading from dusty electricity meters in Indian household's power consumption is tedious, corruption-prone, and the distribution company has to invest heavily in the manpower required to read every meter, every month. Installations of smart meters can send real-time data on a household's energy consumption directly to the utility. Power can be instantly cut off if there are unpaid bills and it can also be restored as soon as the dues are cleared. Utilities can track the consumption of electricity in real time; they can also modify prices according to the time of day, inducing people to schedule any major power consumption, such as the use of water heaters, when supply is abundant. Dynamic pricing, therefore, helps balance the grid.

Source: Quartz India, June 18, 2019

NITI's New Road Map: Only Electric Vehicles to be Sold After 2030

NITI Aayog has proposed that only electric vehicles should be sold after 2030, expanding the scope of the clean fuel technology beyond two and three-wheelers. Transport minister Mr. Nitin Gadkari - who had once threatened to mandate EVs from 2030 - said that the roadmap will be decided after consulting the auto industry. Now, it has moved a Cabinet note, seeking to fix responsibility for different ministries, with the road transport and highways ministry proposed to prepare a framework to phase out the sale of diesel and petrol vehicles by 2030. It has also suggested that the ministry pilots an e-highways programme, with an overhead electricity network to enable plying of trucks and buses on select National Highways. The proposals are part of the plan to manufacture 50 Gigawatt hour (GWh) batteries by 2030. Niti Aayog has estimated that the sale of EVs will help save about Rs 3 lakh crore on account of the import of crude oil to meet the growing demand.

Source: TNN, June 18, 2019

World Trade Panel Sides with India v/s US in Renewables Tiff

A World Trade Organization dispute panel on 27th June 2019 has ruled in favor of India in its complaint against the United States over subsidies and rules applied by eight U.S. states in the renewable energy sector, such as for solar and wind power. The panel found that California, Connecticut, Delaware, Massachusetts, Michigan, Minnesota, Montana, and Washington had improperly given tax or financial incentives to domestic producers of renewable energy systems, components or "inputs" made in those states. It said the states' measures gave preferential treatment to domestic products over imported products.

Source: ET Energy World, June 28, 2019

Rajasthan: Wind power firms left in the lurch

Despite Rajasthan Electricity Regulatory Commission (RERC) reversing an order passed by the previous government last year and bringing in fresh norms to ensure continuity in renewable power purchase, Rajasthan Vidyut Utpadan Nigam Ltd (RVUNL) is yet to sign power purchase agreement (PPAs) with generators that expired in March this year. The wind power generators have also been facing liquidity crunch as the three discoms have failed to pay dues of Rs 843 crore that has accumulated since September 2018. While the RUVNL continues to consume the power generated by these companies even after March, the generators are unable to raise invoice as there is no new PPA.

Source: TNN, June 28, 2019

We regret to inform our readers the passing away of **Mr. Steve Sawyer,** Former Secretary General and Senior Policy Advisor of Global Wind Energy Council (GWEC).

Mr. Steve Sawyer championed the cause of Wind Energy and was a **"Green Ambassador"** across the globe. Mr. Steve Sawyer had several friends in India and worked closely with MNRE on the first offshore project titled **"FOWIND".** The industry has lost a great good friend and all who knew him would certainly miss him.

IWTMA would like to record its condolence to his family and bid farewell to our dear friend Steve.

May his Soul Rest in Peace.

States may Get Regional Power Regulators

The committee on integrated development of power, coal and renewable energy had recommended the 'establishment of regional regulators in consultation with states at an appropriate time and a mechanism for review of performance of regulatory commissions through Forum of Regulators, etc'. "We are studying the recommendation in the wake of the present situation when, in many states, there have not been tariff hikes or adequate tariff hikes or the regulators are allowing creation of regulatory assets," a government official said. Delayed tariff hikes cause loss of income and force the distribution companies, or discoms, to borrow heavily, although they are reflected in the balance sheet as 'regulatory assets'.

Regulatory assets are estimated to have increased by almost Rs 60,000 crore between FY14 and FY18, raising questions over the independent operations of electricity regulatory commissions and power distribution firms. Accumulated debt of distribution companies stood at Rs 3.52 lakh crore.

Source: ET Bureau, June 25, 2019

Vestas to establish new nacelle and hub assembly factory in India, quadrupling local manufacturing jobs

Vestas intends to establish a new nacelle and hub assembly factory in Chennai, Tamil Nadu. The new factory will combine Vestas' two existing facilities in the state of Tamil Nadu, creating an expanded, optimised and scalable production hub with four times as many local manufacturing jobs in the state. "By building this expanded production facility, we will serve our customers' needs in one of our key markets even better and generate hundreds of local jobs, while also improve our global manufacturing footprint and increase our export capabilities from India with the aim of making it a global renewable energy manufacturing hub", says Vestas Asia-Pacific President Clive Turton.

Compiled By: **Mr. Abhijit Kulkarni**
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Photo Feature

Global Wind Day 2019 Celebration at National Institute of Wind Energy, Chennai

National Institute of Wind Energy, Chennai celebrated Global Wind Day 2019 on 15th June 2019. To create awareness about wind energy among students and teachers, capacity building awareness workshops were conducted in and around the Chennai city on 12th June 2019. 74 Teachers and 140 students from 72 different schools have participated in the competition and workshops. At the Global day function Dr. P. Kanagavel, Director & Head SDT, NIWE welcomed the participants. Introductory Remarks were given by Dr. K. Balaraman, Director General, NIWE. Mr. G. Thangraj, Coordinator deliberated about the need for the clean energy. Special address and Prize Distribution was done by Shri. D.V. Giri, Secretary General, Indian Wind Turbine Manufacturers Association (IWTMA). Workshop Participants, teachers and winning students shared their learning experience. A few photographs of the events are given here.










Photo Feature

Annual General Meeting and Members Meet of Indian Wind Turbine Manufacturers Association

Indian Wind Turbine Manufacturers Association conducted its 15th Annual General Meeting and Members Meet on 28th June 2019 at Hotel Le Meridien, Delhi. Shri Tulsi Tanti, Chairman addressed the members. The Photograph of the event is given below.

NIWE Brainstorming Meeting on R&D and also Design and Development of Wind Turbines & Way Forward

National Institute of Wind Energy has conducted a Brainstorming meeting on R&D and also Design and Development of Wind Turbines & Way forward on 24th June 2019 at NIWE, Chennai. The discussions focussed on promoting R&D & role of NIWE and to develop practical strategies which would address design & development of Wind Turbine related issues, challenges, and potential solutions. Top R&D heads from industry attended the meeting. The photographs of the event are given below.

IWTMA Participation in Green Power 2019

Confederation of Indian Industry, Sohrabji Godrej Green Business Centre conducted International Conference & Exposition on Renewable Energy - Green Power 2019 on 23rd and 24th July 2019 at ITC Grand Chola, Chennai. On 24th July a session on "Creating a Wind-Wind Situation" was conducted. The photograph of the session is given below.

From left to right: Mr. S. Sivagurunathan, Counsellor, CII Godrej GBC; Mr. K. Bharathy, CEO, Windar Renewables; Mr. Hemkant Limaye, Senior Director, LM Wind Power; Dr. K. Balaraman, Director General, NIWE; Mr. D. V, Giri, Secretary General, IWTMA; Mr. Venkatachalam, MD & CEO, Orient Green Power; Mr. U. B. Reddy, MD & CEO, Enerfra Projects (India) Pvt. Ltd. and Mr. Deepak Pohekar, ED, ZF Wind Power

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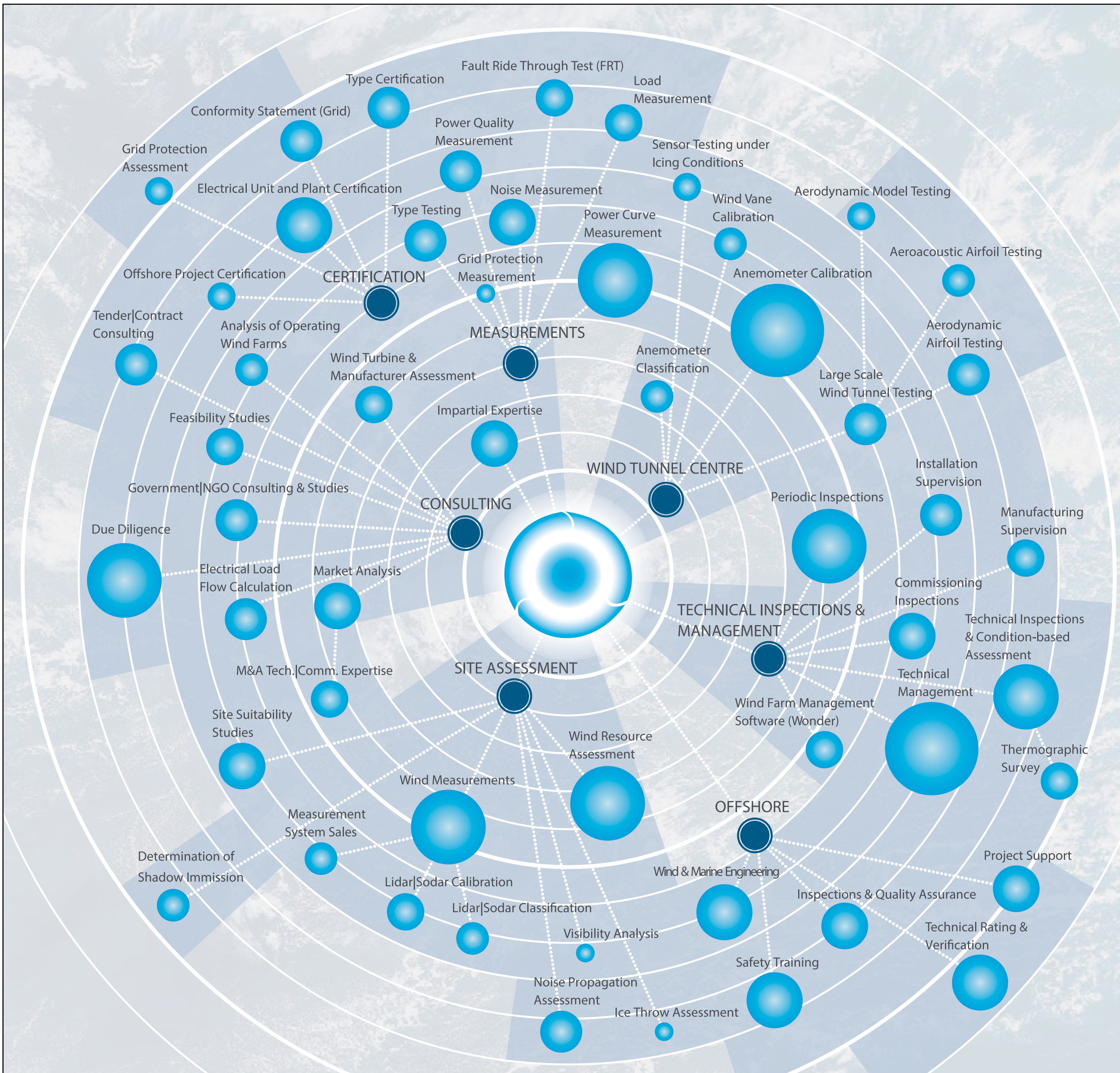
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