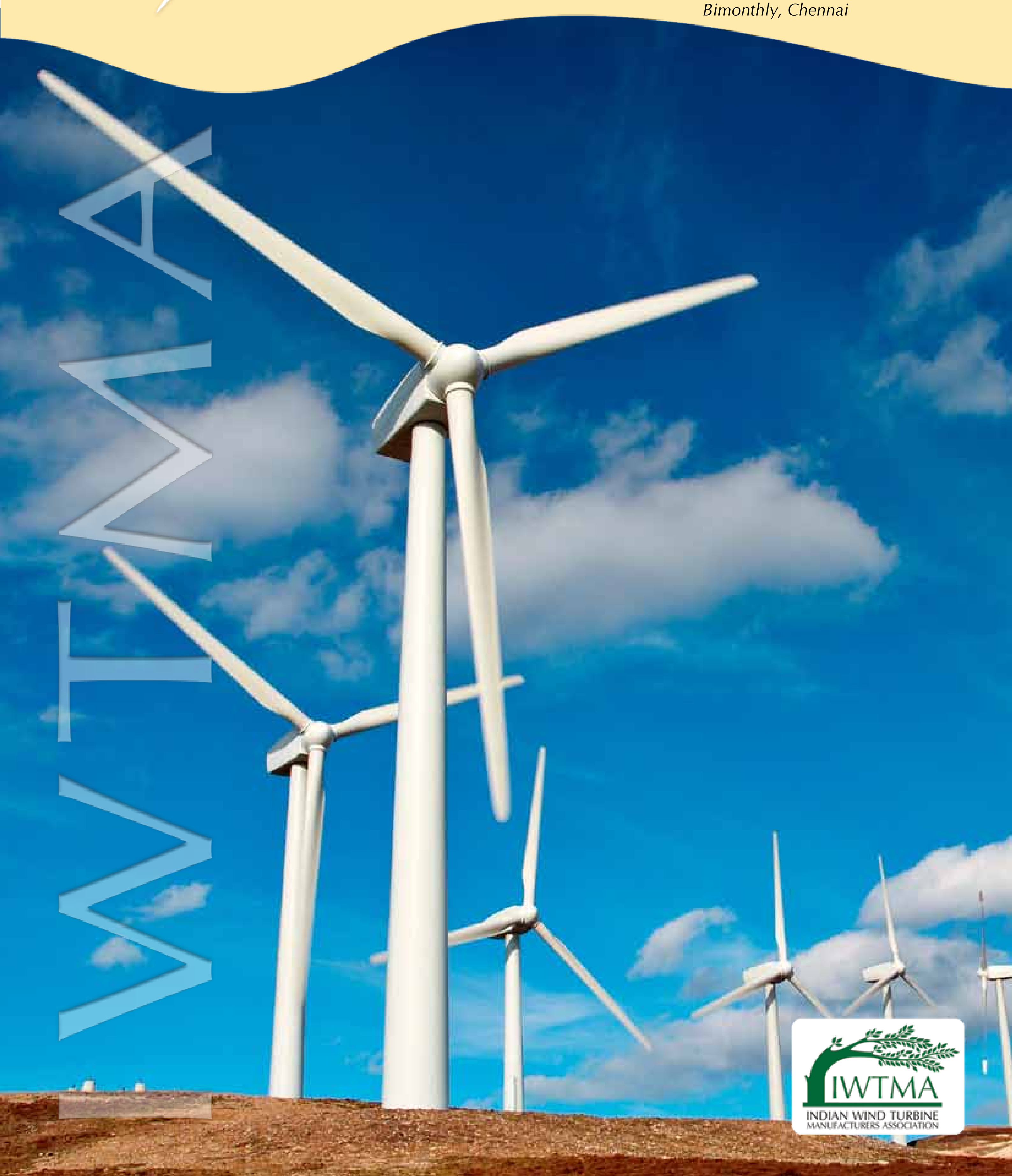
Indian Wind Power

Volume: 7 Issue: 1 April - May 2021 ₹ 10/-
Bimonthly, Chennai



Expertise and Research & Development for Wind and Solar Energy Stakeholders

Resource Assessment

Wind Energy

- 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
- Analysis of wind data to identify Wind Farmable locations
- 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 Offshore Wind Energy development in India
- Met-Ocean Measurement
- Demarcation of Offshore Wind Energy Blocks
- Geophysical and Geotechnical Studies

Solar Energy

- Solar Radiation Resource Assessment
- Investor & bankable grade Solar / Meteorological data
- GIS enabled Indian Solar Atlas
- Calibration of solar sensors as per International Standards
- Consultancy on Solar Energy Projects

Forecasting

- Wind Power Forecasting Services
- Solar Power Forecasting Services

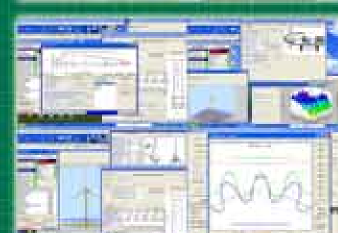
Testing (Large & Small)

- Power Performance measurements
- Load measurements
- Power Quality measurements
- Safety and function tests
- Yaw efficiency test
- User defined measurements
- Duration Test

The services are as per internationally accepted procedures & stipulations and certified as per the requirements of ISO 9001 & NABL accredited as per the requirements of ISO/ IEC 17025 : 2005

Standards & Certification

- Preparation of Indian standards on wind turbines
- Accord Type Certification to Wind Turbines. Type Certification Services are certified as per ISO 9001
- Issue the recommendation for grid synchronization to facilitate installation of prototype wind turbines
- Technical Due Diligence for Wind Farm Projects



Training

National, International and Customized Training on:

- Wind and Solar Resource Measurement & Analysis
- Wind and Solar Energy Technology
- Testing and Certification of Wind Turbines
- Installation, Commissioning and Operation & Maintenance of Wind Turbines
- Grid Integration of Renewable Energy System
- Forecasting of Wind and Solar Energy Production
- Seminar / Workshops on Wind and Solar Energy

नीवे NIWE

NATIONAL INSTITUTE OF WIND ENERGY

An Autonomous Research & Development Institution under the Ministry of New and Renewable Energy, Government of India

Velachery - Tambaram Main Road, Pallikaranai, Chennai - 600 100

Phone : +91-44-2246 3982 / 83 / 84 Fax : +91-44-2246 3980 E-mail : info.niwe@nic.in Website : http://niwe.res.in

IWTMA
INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

Indian Wind Power

A Bi-monthly Magazine of Indian Wind Turbine Manufacturers Association

Volume: 7 Issue: 1 April - May 2021

Executive Committee

Chairman

Mr. Tulsi Tanti
Chairman and Managing Director
Suzlon Group, Pune

Honorary Secretary-cum-Treasurer

Mr. A. Gurunathan
Head - Public Affairs
Siemens Gamesa Renewable Power Pvt. Ltd., Chennai

Executive Committee Members

Mr. Amar Variawa
Senior Director, Public Affairs, India & SE Asia,
Vestas Wind Technology India Pvt. Ltd., Mumbai

Mr. K. R. Nair
Director
Emergya Wind Turbines Pvt. Ltd., Chennai

Mr. Milind Kulkarni
Chief Executive Officer
Envision Wind Power Technologies India Pvt. Ltd., Bengaluru

Mr. Hemkant Limaye
Senior Director - Sales & Marketing
APAC & ME & Africa, LM Wind Power, Bengaluru

Mr. Deepak Pohekar
Executive Director
ZF Wind Power Coimbatore Limited, Coimbatore

Secretary General

Mr. D.V. Giri, IWTMA, New Delhi

Associate Director and Editor

Dr. Rishi Muni Dwivedi, IWTMA

Views expressed in the magazine are those of the authors and do not necessarily reflect those of the Association, Editor, Publisher or Author's Organization.

Contents

Indian Wind Turbine Manufacturers Association
4th Floor, Samson Tower, 403 L, Pantheon Road, Egmore
Chennai - 600 008.
Email : secretarygeneral@indianwindpower.com
associatedirector@indianwindpower.com
Website : www.indianwindpower.com

(For Internal Circulation only)

From the Desk of the Chairman – IWTMA

Dear Readers,

Greetings from IWTMA!

The onset of southwest monsoon in our country is vital to our agrarian economy. However, this period also witnessed landslides in Uttarakhand which were devastating. Similarly, the summer of 2021 has changed our understanding of the extreme hot weather. This phenomenon has not been restricted to India alone. There have been floods wreaking havoc in Turkey, Germany, China, The Netherlands, Brazil, and Japan. All these points draw our attention towards the devastating effects of climate change. Global leaders have echoed the same concerns.

Researchers are beginning to unravel the complexity of climatic effects contributing to the catastrophe. Man in his quest to conquer the universe has disregarded nature and slowly degraded the environment to a point where catastrophic effects can be seen. Limiting Greenhouse Gases (GHG) emissions, reduction in carbon footprint and use of renewable energy are undeniably some of the key solutions to mitigate climate risk and are the top agenda for global leaders and governments. Our government too has fixed laudable targets for renewable energy to be reached by 2030 and this fits well with our industry slogan "WIND IS THE ANSWER".

Wind, which is seasonal and intermittent and a contributor towards pollution free power, enjoys 'must run' status. Interestingly, there was a recent landmark judgement of APTEL that any curtailment of Renewable Energy generated power by DISCOMs other than for grid security, would be considered as deemed generation and would be compensated by the DISCOMs to the generator at the full PPA tariff. This judgement of APTEL is welcomed by the entire fraternity.

The current procurement model in the country is majorly dependent on central procurement i.e., Solar Energy Corporation of India (SECI) through reverse bidding. This has restricted the market to the high wind states of Gujarat and Tamil Nadu. There is a need to evaluate ways so as to include low wind states as well to enable the overall growth of the industry.

In a recent interaction between our Association and the Government of Tamil Nadu, steps on Repowering Tamil Nadu were discussed. Tamil Nadu holds one of the largest installations of turbines dating back to the 90's and a recent order of TANGEDCO will further help to initiate the Repowering in Tamil Nadu. This will bring to the State new investment, revenue from taxes and duties, employment generation and overall boost to rural economy of Tamil Nadu covering tertiary business segment.

The recent meeting of the Danish Ambassador with Government of Tamil Nadu will take steps forward for the first offshore project. Our association plans to interact with various wind states for an all-inclusive growth which was there prior to 2017.

Turbine certification is the order of the day under the international schemes of IEC and GL. It is a matter of pride that Ministry of Power, Union Government of India, will shortly release Indian Wind Turbine Certification Scheme (IWTCS). This move will further strengthen safety and performance of turbines at par with international standards.

Wind power development which includes installation and commissioning is a complex matrix involving a number of agencies and clearances which can delay project execution. It is encouraging to note that MNRE is floating a scheme of Wind Parks similar to the Solar Park Scheme. This when implemented will de-risk the projects from cost and time overruns as the Wind Parks would be ready with all statutory clearances of land and connectivity making them ready for installation of turbines with near accurate prediction of Annual Production Estimate (AEP). It will strengthen the bidding process and emergence of a sustainable tariff as all cost parameters would be well known.

The pandemic ravaged India especially during the second wave of Covid-19. There are warnings of a possible third wave in October 2021. It is our prayer that we balance 'Life and Livelihood' and maintain protocols that are necessary to keep all of us safe and healthy. The vaccination programme will help minimize the risk.

We salute the frontline health workers for keeping the nation safe from Covid-19 as much as our brave soldiers for gallantly keeping our borders secure in hostile conditions.

I, on behalf of the association, would like to emphasize the importance of following the protocols of Covid-19 and hope that our readers, their families and all other dear ones stay healthy and safe.

With regards,

Tulsi Tanti

Chairman

INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

Indian Wind Turbine Manufacturers' Association

Welcomes

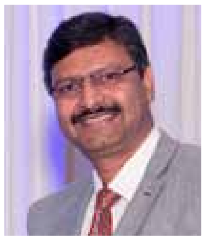
Shri Bhagwanth Khuba

Hon'ble Minister of State
Ministry of New and Renewable Energy and
Minister of State, Ministry of Chemicals and Fertilizers
Government of India

Advanced Maintenance Tools and Technology in Wind Turbines

Britt Lightbody
Marketing Coordinator
Svendborg Brakes,
Denmark

Brittany Kennan
Key Account Manager
DMA Europa Group
Worcestershire, UK



Milind Sule
National Business & Sales
Manager - India
Altra Industrial Motion India
Private Limited, Pune, India

As with any rapidly adopted technology, wind power presents distinct challenges for which solutions need to be developed to short-time frames. Innovative wind turbine solutions that can overcome problematic maintenance procedures reduce local environmental impact and maximise reliability for onshore wind turbines. These advantages help fulfil energy potential of onshore wind power, while further improving sustainability.

Onshore wind turbines present multiple challenges with regards to maintenance; tall, large and often installed in remote locations. Maintenance and repair services for power transmission assemblies located in the nacelle are particularly difficult to schedule and costly to achieve. For turbine operators, it is imperative to have access to a specialist who can provide turnkey solutions quickly and with minimal disturbance to energy production. Furthermore, operators and service providers must be sympathetic to local residents and the surrounding eco-system.

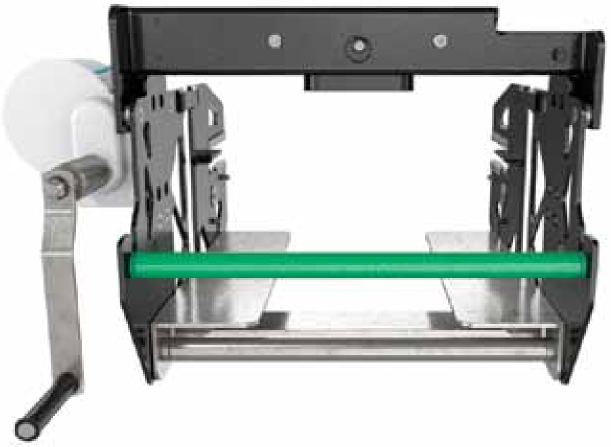
Onshore Wind Turbines

Overcoming Problematic Maintenance Procedures

As the modern development and adoption of onshore wind power has increased exponentially, the tools required to carry out turbine maintenance have struggled to keep pace. Every operator wants maintenance to be completed quickly and safely. However, maintenance teams are required to work at height repairing or replacing heavy equipment, which is a risky and difficult work.

The Yaw Brake Lifting and Installation Tool

For example, a small yaw brake calliper can weigh up to 60 kg, whereas a large yaw brake can reach up to 200 kg. With some turbines featuring up to twenty yaw brakes to control their position, this places great strain on maintenance personnel, especially given the scale of modern wind farms. Many turbines

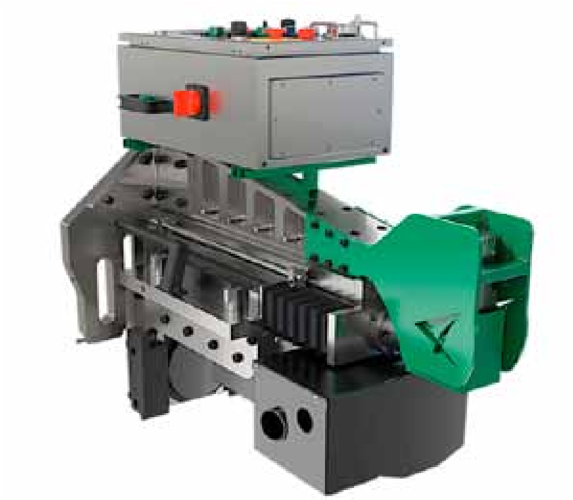


The Yaw Brake Lifting and Installation Tool (Patented) do not have inbuilt elevators either, so maintenance personnel may have to climb a 100 meter high ladder before repairs can even commence.

To improve the speed and ease of yaw brake replacement, yaw brake lifting and installation tool is available. This enables the easy interchange of yaw brakes in-situ. Brakes can be attached to the tool and lowered down to the floor for maintenance work, and then reassembled units are raised and installed quickly. This condenses several repair steps, while also eliminating the need for heavy lifting by personnel. Personnel work conditions and speed are consequently improved. The tool is available in various configurations to suit multiple turbines. Weighing in at around 40 kg, it can be easily transported too.

Resurfacing Brake Discs

Yaw brake discs are large in size and weight. In the past, servicing them required the complete disassembly of the large turbine nacelle. Discs naturally suffer wear and tear as the turbine turns to face the wind and small imperfections can grow to compromise the smoothness of the disc surface. Braking performance then deteriorates until failure occurs. Replacing the disc can be a time-consuming procedure involving cranes, which increases costs, downtime and reduces energy output. Resurfacing the disc is another option, but that requires specialist equipment.



The Portable Disc Resurfacing Tool

The portable disc resurfacing tool enables operation to be carried out on site with increased speed while not compromising the refurbishment. Featuring a milling machine that quickly replanes the disc; the tool can operate inside the turbine nacelle, thanks to a compact and lightweight design. Simply mounted onto a yaw brake mounting position, the tool eliminates the need for nacelle disassembly. This eases maintenance work, while maximising energy output via reduced downtime and minimising cost.

Reducing Local Impact

One of the barriers to the widespread adoption of onshore wind turbines has been local resistance to installations. While an exceptionally green technology, wind turbines do have an environmental impact. Problem areas include noise and dust from turbine yaw brakes. Solutions are available to tackle these issues.

Removing Glazing

Noise created by onshore wind turbine brakes can disturb both local residents and wildlife. Often this noise is a result of the glazing phenomenon. Like the brakes on a car, when there is no wind and low usage, yaw brake discs begin to collect dirt, rust and moisture as temperatures fluctuate. When the wind returns and braking begins again, this detritus is collected by the brake pad. Under braking force, it is pressed tightly into the pad, creating glazing. Eventually, the friction coefficient of the brake pad itself is compromised, while the disc becomes contaminated and slippery. Braking performance is greatly reduced and potentially produces excessive noise in operation.

Once accrued, this glazing is difficult to remove. In the past, removal would require complete brake disassembly, with the manual cleaning of each pad carried out by an angle grinder. This highly inefficient method also carries the penalty of producing even more noise. The other option is pad replacement, but with the disc already contaminated, this is only an expensive interim solution.

A device is available which reduces yaw brake noise. This device cuts grooves in the yaw brake disc, which acts like a razor as the turbine moves to meet the wind, cutting detritus from the brake pad. A brush located between brakes removes debris from the grooves, allowing the disc to clean itself, helping to safeguard braking performance.

The Groove Cutting Tool

This permanent solution is adapted to meet the specific needs of any given turbine taking into account wind direction, turbine diameter and disc material. Data has to be fed into computer programmes to ascertain the optimal number of grooves, groove position, shape and angle. This ensures that the technology is equally effective for preventing glazing on coastal turbines with two wind directions or turbines in the mountains where wind can come from any direction.

Cleaning Up Yaw Brake Dust

Reducing harmful dust produced by braking systems has been a focus of the automotive industry for many years. Until now, the onshore wind sector has been slow to catch up. Brake dust can contain potentially harmful substances that present a contamination risk to the local environment. The dust also presents a risk to maintenance personnel who come into close contact with it. At large installations with multiple turbines, choosing an environmental friendly brake pad material can deliver a large improvement with regards to protecting the local environment and on-site personnel.

Specially developed brakes are available to solve this problem. The specific yaw brake friction material meets restriction of use of hazardous substances standards adhered to by the automotive industry. The material is asbestos free, while

Specific Yaw Brake Friction Material

containing less than 0.1% mercury, less than 0.1% chromium 6+, less than 0.1% lead and less than 0.01% cadmium. Furthermore, it is corrosion resistant and produces inherently less dust than traditional friction materials. This ensures that environmental impact and risks to maintenance personnel from yaw brake dust are greatly reduced.

Maximising Reliability

Onshore wind turbines can only provide best return on investment (ROI) if they operate reliably. Therefore, a capable and responsive global service partner is imperative for maximising electrical output and safeguarding profitability of installations.

The Benefits of Partnership with OEMs

All these products are to be developed in close partnership with onshore wind turbine original equipment manufacturers (OEMs), shaping its components and assemblies to suit designs from the initial prototype phase. All braking systems should undergo a rigorous testing regime in cold, hot and humid weather conditions to guarantee performance.

While this helps to promote turbine reliability in the first instance, it also guarantees that replacement components and assemblies will be of OEM quality, adhering to brake specifications, thus delivering the utmost reliability in application. A truly turnkey approach, enabled by involvement in all aspects of the turbine lifecycle, is necessary to provide exceptional product performance and quality assurance. The end result is extended service intervals, allowing for onshore turbines to spend longer producing valuable energy.

Responding Quickly

As early installations grow older and the installed wind turbine fleet increases, responsive maintenance support is incredibly important for reducing unforeseen downtime. Dedicated service app is needed for 24/7, 365 days onsite maintenance support. Maintenance engineers should be able to message or call experts at any time to get access to key technical information and guidance for critical repairs. This will allow the maintenance companies to react quickly, leveraging innovative service tools and solutions to solve issues fast. Solutions and services should be compatible with various companies' components and products too, ensuring that servicing, retrofitting and replacement is straightforward.

Industrial Internet of Things (IIoT)

The service platform should be available to monitor uptime, with full 24/7 IIoT solutions in cooperation with customers. This is to optimise preventive maintenance work and suggest service visits, allowing maintenance personnel to make fast decisions before unforeseen breakdowns.

Smart technology service tools enable remote monitoring of product performance and provide important insights to maintenance assessment. Collected data are easily accessed via computer, allowing in-depth diagnosis of brake behaviour. This promotes turbine uptime by helping to prevent brake system failures.

Thus by using various advanced maintenance tools and technology in wind turbines maintenance, the investors can save a lot of money not only in reducing the downtime but also on the cost of replacement or repair of various components and can increase the return on investment to a great extent.

Guterres Urges Global Partnership for Green Growth

UN Secretary-General Mr. Antonio Guterres has called for global partnership to tackle climate change and strive towards inclusive green growth. He made the appeal at the Partnering for Green Growth and the Global Goals 2030 Summit hosted by South Korea.

"The title of this initiative expresses exactly what the world needs now, global partnership: partnership to beat Covid-19 and build a better recovery, partnership to achieve the Sustainable Development Goals, and partnership to address climate change," he told the summit.

Source: IANS, May 31, 2021

Telangana: National Green Tribunal Stops NTPC Plant Expansion

The National Thermal Power Corporation (NTPC) suffered a temporary setback when the National Green Tribunal south zone bench in Chennai on May 27 kept the environment clearance (EC), issued to NTPC for its new thermal power plant in Ramagundam, in abeyance for seven months. The NGT bench wanted a re-appraisal done as per the additional terms and conditions of the Union Ministry of Environment and Forest. It announced this verdict in a petition filed by a local from Karimnagar district identified as Uma Maheshwar Dahagama, who alleged that the NTPC had initially applied for 2X600 MW thermal power plant and later enhanced it to 2X800 MW capacity in violation of the terms. The EC was granted to the NTPC in 2016 and it got amended clearances in 2017 and 2020.

Source: TNN, May 28, 2021

GLOBAL PRESENCE SEEDS LOCAL GROWTH

With 13 factories, in 10 countries, on 4 continents, we operate in established and emerging wind energy markets all over the world

We know what it takes to:

- **Produce high-quality blades, anywhere:**
  Uniform processes ensure reliable blades, enabling our customers to launch their new wind turbine in several markets at the same time

- **Secure on-time delivery:**
  Our global supply chain ensures economies of scale, and our customers count on our flexible and responsive manufacturing set-up

- **Offer fast and reliable onsite assistance:**
  Our network of highly skilled service teams is ready to assist with any technical issue

Learn more: **lmwindpower.com/weknowblades**

LM WIND POWER

a GE Renewable Energy business

Adani Enterprises Incorporates Manufacturing Firm for Wind Turbine Generators

Adani Enterprises Ltd (AEL) has said that it has incorporated a wholly-owned subsidiary company namely Mundra Windtech Limited (MWL) on June 7, 2021 for manufacturing wind turbine generators. On the objects and effects of acquisition/ incorporation for the acquisition of MWL, it said the company has been incorporated "to carry on business as manufacturers of wind turbine generators and other auxiliaries." MWL is incorporated in India and registered with the Registrar of Companies, at Ahmedabad, Gujarat, AEL said.

Source: PTI, June 09, 2021

Proposed Global UN Roadmap Shows Universal Access to Clean Energy by 2030

Everyone in the world could have access to clean, affordable energy within the next nine years if countries modestly increase investments, according to new UN reports released. Annual investments of around $35 billion could bring electricity access for 759 million people who currently lack it, and $25 billion a year can help 2.6 billion people gain access to clean cooking between now and 2030. The reports indicate that a just and inclusive energy transition can create 30 million new jobs in sustainable energy by 2030 and 42 million by 2050.

Source: IANS, June 19, 2021

Wind Could Produce Affordable Green Hydrogen by 2030

Wind power could make it possible to produce hydrogen without emitting greenhouse gases as cheaply as is currently feasible with fossil fuel energy by 2030, turbine maker Siemens Gamesa said in a white paper. Policymakers see green hydrogen, which is made with renewable power without emitting carbon, as a vital tool to help shift economies away from planet-warming energy sources and to stave off climate change, but want to reduce its sky-high costs.

Source: Reuters, June 10, 2021

Suzlon Bags Order to Set Up 252-MW Wind Power Project in Gujarat

Suzlon Group has said that it had secured an order for developing a 252MW wind power project from CLP India for the project located at Sidhpur, Gujarat and expected to be commissioned in 2022. Suzlon will be involved in the supply, foundation, erection, and commissioning of the project and will also provide comprehensive operation and maintenance services after commissioning. According to the release, a project of this size can provide electricity to about 1.83 lakhs households and curb about 8.28 lakh tonnes of carbon dioxide emissions per year.

Source: ET Energy World, June 01, 2021

Foreign Investors Keen on Funding Indian Renewable Projects: Scatec

Despite a host of regulatory and legal issues challenging the Indian renewable energy industry, international investors remain keen on investing in Indian projects, a top executive at Norwegian renewable energy developer Scatec said. Scatec recently bought into 50% of a 900 MW project by Acme Solar in Rajasthan, scheduled for completion in 2022. Although financial details of the investment were not released, ET has understood that Scatec invested $50 million for the deal.

Source: ET Bureau, June 17, 2021

Earth's Energy Imbalance Doubled in 14 Years: NASA

Raising an alarm over human-caused climate change, NASA-led research has revealed that the amount of heat trapped by Earth's land, ocean and atmosphere has doubled over the course of only 14 years. Scientists at NASA and the National Oceanic and Atmospheric Administration (NOAA) in the US found that Earth's energy imbalance approximately doubled during the 14-year period from 2005 to 2019. Unless the rate of heat uptake subsides, greater changes in climate than are already occurring should be expected.

Source: IANS, June 19, 2021

California Grid Hits Record High of 95% Renewable Energy

According to supply data from California Independent System Operator (ISO), renewable energy sources dominated California's power supply throughout the day of Saturday, April 24, and just before 2.30pm local time reached a share of 95 per cent renewables as natural gas and imports plummeted. California actually began exporting electricity to other states – and, according to Sammy Roth at the LA Times, this was due to a surge in solar generation.

Source: Renew Economy.com, 13 May 2021

Ikea Foundation, Rockefeller Foundation to Set Up $1 Bn Platform to Fight Climate Change

The Ikea Foundation and The Rockefeller Foundation has said that they will join forces to set up a USD 1 billion global platform to fight climate change and energy poverty. This will empower 1 billion people with distributed renewable energy (DRE) generated from sources such as mini-grid and off-grid solutions, located near the point of use, rather than centralized sources like power plants.

Rajiv J Shah, President of The Rockefeller Foundation said big, bold, and pioneering collaboration and investment is required not only for the short-term, but also the long-term, to galvanize a better future. That is why we are announcing our largest commitment to date and joining forces with IKEA Foundation to double that investment.

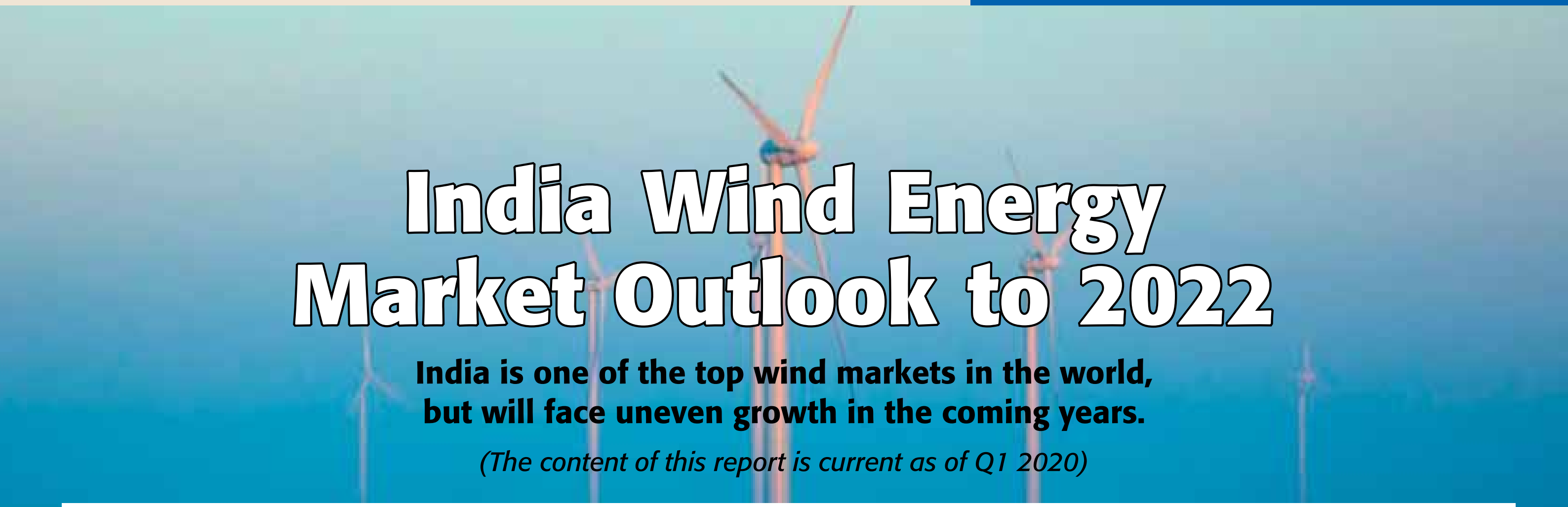
Source: PTI, June 21, 2021

Green Hydrogen Purchase to be Made Mandatory: Power & Renewable Energy Minister R K Singh

Green hydrogen would be brought under renewable purchase obligation (RPO), Power and New & Renewable Energy Minister Mr. R K Singh said on 22nd June 2021 in a virtual curtain raiser press conference on 'India's role as a Global Champion for the Energy Transition theme at the UN High Level Dialogue on Energy 2021'. The minister also expressed dismay over under-achievement of RPO targets by states.

Source: PTI, June 22, 2021


Innovations for
a better tomorrow
Manufacturing wind turbines and
its components in India since 1996
With 14 manufacturing units and wind farms across 8 states, Suzlon creates local jobs at the grass-root level, energizes micro-economies, supports a local supply chain and reduces imports by making India more 'Aatmanirbhar' in the manufacturing of Wind Turbine Generators and its components. Suzlon is also a flag bearer of the ambitious 'Make in India' program for Wind Energy and a key partner in the nation's Renewable Energy mission. We are committed to energy security and low-carbon economy for the country by providing sustainable and affordable energy to power a greener tomorrow, today.
SUZLON
POWERING A GREENER TOMORROW
More than 18.8 GW of installations I Footprint across 18 countries I Largest product portfolio I R&D across The Netherlands, India, Germany and Denmark
Leading global renewable energy player offering end-to-end solutions. To know more visit us at: www.suzlon.com I Join us on



India Wind Energy Market Outlook to 2022

India is one of the top wind markets in the world, but will face uneven growth in the coming years.

(The content of this report is current as of Q1 2020)

Note on the impact of COVID-19

GWEC and MEC+ recognise the impact of the on-going COVID-19 pandemic may be far-reaching across the wind industry and the wider economy in India and beyond. The content of this report is current as of Q1 2020; due to the dynamic nature of the pandemic, the forecasts and market outlook herein have not been adjusted to factor in the potential consequences of the virus. However, the report should be read with a view to the following points:

- **Outlook for 2020:** The impact of COVID-19 will impose a drag on market growth in 2020, due to extended project timelines and supply chain disruptions, compounded by the non-availability of grid and land challenges already impacting installations. Beyond 2020, uncertainty around new tendering and the overall business environment may prolong the impact.

- **Project timelines extended:** All renewable energy projects under construction will be granted an extension of commissioning deadlines, due to the nationwide lockdown imposed on 24 March 2020. The total active pipeline under implementation is around 8.6 GW. Nearly 3 GW of this was scheduled to be commissioned in 2020, 5.2 GW in 2021 and the remaining 0.4 GW in 2022. The extension is expected to be more relevant for projects due to be commissioned in Q3/Q4 2020.

- **2020-2021 installations:** We estimate nearly 0.7-1.1 GW of projects due to be commissioned in 2020 may shift forward to 2021, which shrinks the base case forecast from 3.3 GW to 2.2-2.6 GW in 2020, much closer to the earlier low case. We expect that projects to be commissioned in 2021 will remain on-track, as most have power supply agreements.

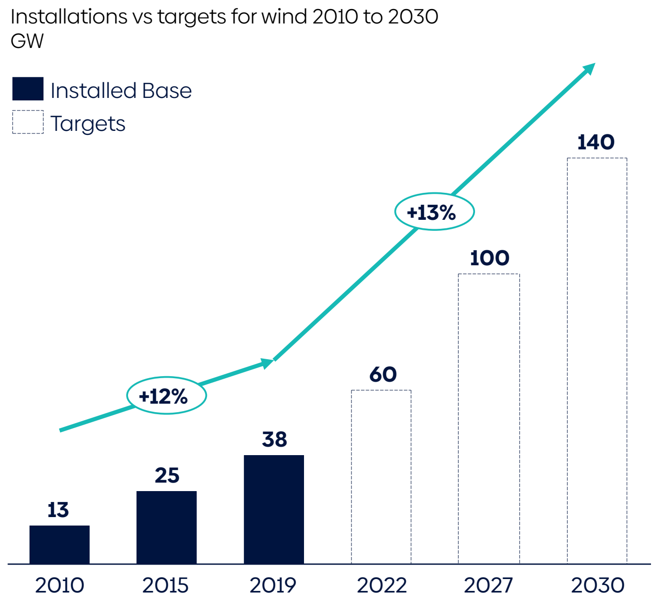
- **New volume at risk:** The lockdown is expected to impact new project tendering. In total, nearly 3.5-4 GW of wind capacity was expected to be tendered in 2020 and 2021. Currently, 3.2 GW of tenders have been notified by the government (2 GW SECI Wind Tranche IX and 1.2 GW Hybrid Tranche III); however, no closure date of the tenders can be ascertained. A delay in new tenders in 2020 could lower total forecast installations to 11.5-12 GW for the period to 2022, compared to 13 GW projections in the base case. In addition, India was struggling with weak balance sheets of its lending companies before the pandemic – which could now exacerbate the risks to new projects to be tendered in the coming few months or those yet to achieve FID.

- **Supply chain disruption:** Although limited O&M activities have continued amid the nationwide lockdown, in order to ensure security of supply, the manufacturing of wind power components has been suspended during this time. The MNRE has announced that supply chain disruptions due to the spread of coronavirus will fall under a force majeure clause; however, the enforceability and application of this clause is yet to be seen. As India is the largest wind turbine production base after China in the Asia-Pacific region, and is also a significant producer of gearboxes globally, the suspension of OEM activity will have adverse impacts beyond the Indian market.

- **Economic relief package:** The government approved an economic relief package for the power sector, focusing on state-owned electricity DISCOMs. The package includes a three-month moratorium on payments by DISCOMs and waives penalty fees for late payments. The government also issued guidelines to grant renewables 'must-run' status and instructed renewable power producers to issue electronic invoices to DISCOMs during the lockdown. This came after a number of state DISCOMs invoked 'force majeure' to suspend procurement of renewables and defer payments, increasing the risk of non-payment of dues and the potential for stressed assets.

1. India Wind Energy Sector: Background

India's electricity grid has a total installed base of 370 GW, as of March 2020. Of this capacity, 54% comprises coal-fired generation and 23% comprises renewable energy. In the last 10 years, the share of renewables in the power system has increased from 5% to nearly one-quarter of total capacity. Within the global wind energy sector, India has the fourth-largest installed base of wind power plants, reaching 37.5 GW at the end of December 2019. Nearly three-fourths of this capacity was installed in the last 10 years under a feed-in-tariff (FiT) regime, at an annual average of 2-3 GW and with installation peaking in 2017. In 2017, India introduced an auction mechanism in addition to FiTs. The market has been adjusting to the new procurement scheme in the last two years, and capacity deployment has since reduced.



Source: CEA; Newspaper articles; MEC+ Analysis

2 According to the draft optimal generation mix – 2030 published by Central Electricity Authority of India (CEA).

Figure 1: *High Growth in Wind Installations Expected*

High growth in wind installations expected

Looking towards 2030, India is among the world's fastest-growing electricity markets, with power demand expected to double. Plans are in place for a massive installation of 460 GW of new installed capacity to fulfil this upcoming demand. The new installation plans are heavily inclined towards renewables, with three-quarters of new power generation deriving from wind and solar and 100 GW exclusively from new wind installations. Under these targets, cumulative wind power installations would grow to 140 GW.

2. Wind Competitiveness

The competitive landscape for renewable energy in India will intensify in the future

The increasing role of renewable energy in fulfilling future demand is mainly driven by low costs.

An influx of both capital and technology within renewables has led to a steep decline in LCoE over the last four years. As of December 2019, wind is the second most cost-competitive resource on the grid after solar. Variation in wind LCoE is seen across the country due to variable resource availability and development costs. On average, wind LCoE is roughly 35% cheaper than the majority of coal plants present in the country.

3 Wind, solar and conventional costs are exclusive of the transmission and firming costs.

4 Optimal sites in the country have wind speed above 7.5 m/s, while wind-based plants are also located on sites with wind speeds between 6 to 6.5 m/s.

5 Referencing coal-based plants typically located 500 km from domestic coal mines but using domestic coal as fuel.

As illustrated in the graph below, the gap between the cost of generation from renewable energy and conventional sources widens towards 2022, due to the continuing decline in technology cost of wind and solar energy and the increasing cost of equipment and raw materials for coal-based power plants. The costs of wind and solar energy are expected to decline by 7% and 11% by 2022, respectively, driven by the reduction in technology costs and operating expenses. Solar costs are expected to experience a steeper decline due to the removal of import protection duties.

Coal, on the other hand, is expected to get costlier by 9% in the next three years majorly driven by increased equipment costs to meet new environmental standards and escalating domestic raw material costs. These dynamics put wind and solar energy in a preferred position in terms of market value, prompting the government to adopt a blended approach to coal and renewables.

3. Current Market Activity

Market activity has slowed down in recent years

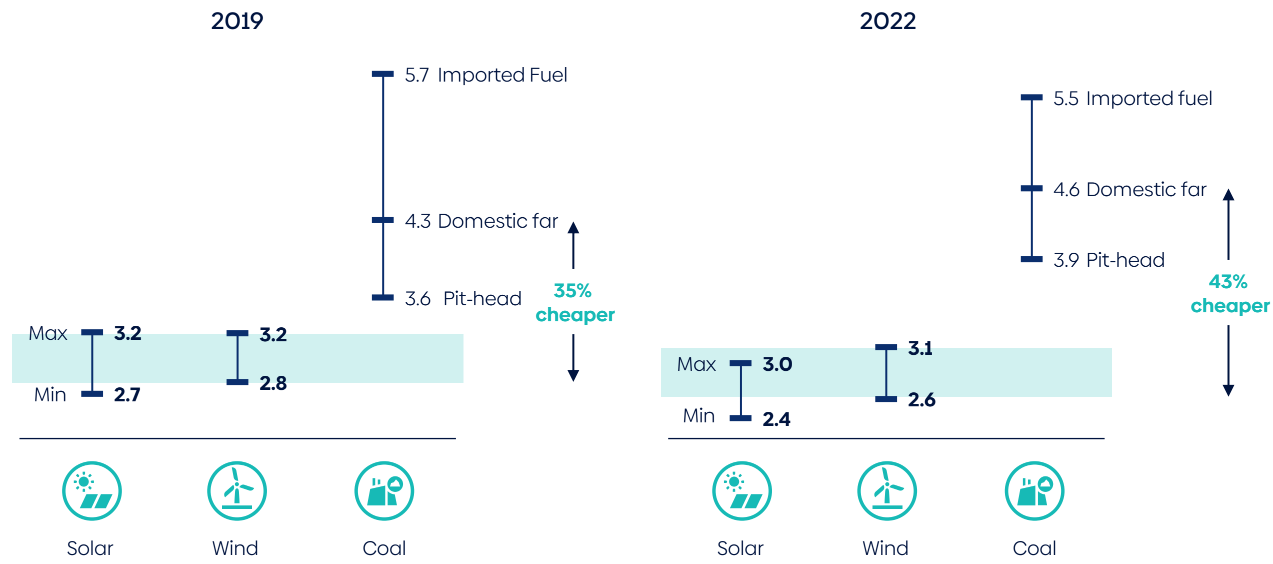
Despite high capacity targets for wind energy and its strong cost-competitiveness, new installations in the market have declined by 50% in the last two years. Government has put more than 17 GW of capacity up for auction since 2017; however, nearly one-third was either unsubscribed or cancelled/abandoned after being awarded.

From 2017 to 2018, auctions were oversubscribed by 30-35% on an average, and tenders fully awarded. However, activity has severely declined in the last year with nearly 60-70% of volume unallocated in auctions. By 2019, authorities decided to use the extremely low prices (INR 2.4-2.8/kWh) captured in the first six auctions as a benchmark for an upper price cap in the last two auctions. Developers were not able to meet these price expectations and issues around infrastructure availability held them back from participating in these recent auctions.

Of the 12 GW awarded within auctions in the last three years, 80-85% have been delayed by 6-12 months (as on 30 January 2020). These projects have either been granted extensions by government agencies or have applied for the same. On top of this, 1-1.5 GW of projects have been cancelled or are at risk of cancellation due to issues in the availability of land, grid or power purchase agreement (PPA) signing delays. Hence, the present installation pipeline is highly uncertain, with projects getting delayed or cancelled and new auctions being heavily under-subscribed.

Coal, on the other hand, is expected to get costlier by 9%… These dynamics put wind and solar energy in a preferred position in terms of market value, prompting the government to adopt a blended approach to coal and renewables.

LCoE comparison of sources (new vs new), 2019 and 2022
INR/kWh



Note: Wind and solar LCoE calculations done at 11% internal rate of return while coal calculations done at 16% return on equity
Does not include transmission and distribution charges for any source
Pit-head are coal plants using domestic coal and located near the mine; domestic far plants also use domestic coal but are located far from the mine (~500 km); Imported fuel plants make use of imported Australian coal

Source: CEEW; BNEF; Lazard; MEC+ analysis

Figure 2: *Renewables are Cheapest Resources on Grid, Today and in Future*

4. Future Installations

Installations are concentrated around 2022

India is expected to install 11-17 GW between 2020 and 2022, taking the cumulative installed base of wind power in India to 54 GW by 2022, in the best case. Demand is partially driven by non-solar renewable purchase obligations (RPO); within non-solar renewable resources, wind is the most cost-competitive resource. Beyond RPOs, there are three market mechanisms for the procurement of wind, each of which has separate drivers and challenges: central auctions; state auctions; and the commercial and industrial (C&I) market.

Seven states in India have availability of wind resource. These have been the traditional wind procurers and have been doing their own procurement. For the rest of 20+ states and Union Territories, the central government-initiated auctions for wind in 2017. Around 80-85% of new installations are expected from central procurement in the next three years.

On top of the demand for wind from states and central government, C&I are allowed to set up their own wind power plants. These entities usually have high demand and have the option of buying power from outside of DISCOMs, and will account for a small yet consistent market share of 5-10% between 2020 and 2022.

i. Central Auctions

Central auctions are driving the market, despite infrastructural challenges.

States without the availability of wind resource have never procured wind power, despite having the power demand and financial resources. Central auctions were introduced to activate this demand at an acceptable price point. However, the execution of the auctioned projects has been challenged due to grid and land related infrastructural bottlenecks. New installations under the central auction mechanism are expected to vary between 9-13 GW in the next three years, depending on the extent to which the challenges are resolved.

Demand: Nearly half of electricity demand in India (as of March 2019) stems from 21 states which can only procure wind through central auctions. Of these, 14 states are major demand centres. The 2022 RPOs of these states vary between 6-9%, which translates to nearly 10 GW of new demand for wind procurement. Central government intermediaries aggregate this demand to conduct auctions towards fulfilment of these RPOs.

Economics: Most states without wind resource have an average power purchasing cost (APPC) 30-40% higher for wind than in central auctions. The cost feasibility of these projects is ensured by the central government through waive-off of inter-state grid transmission charges (ISTS) for a period of 25 years.

Substantial demand for wind procurement is visible towards 2022 in the mentioned states, which can be procured at pricing levels lower than APPCs. The central government has conducted nine auctions towards fulfilment of this demand. However, execution of awarded projects has been challenged due to infrastructural bottlenecks on the ground.

Grid Availability Delays

Grid is planned to support installation but is expected to be delayed in availability. Nearly 26 substations have been allocated to evacuate wind generation in India. However, the projects bid in central auctions have gravitated towards two substations – Bhuj in Gujarat and Tirunelvelli in Tamil Nadu.

For new bidding activity, short-term grid visibility is challenged. Out of 26 substations for wind evacuation, only six substations are viable for new bids as the rest are either at uncompetitive wind resource sites or are fully booked by the existing pipeline. Out of the six, three substations are yet to be budgeted due to lack of advanced stage project activity, making them very risky for bidding projects given their availability before 2022 remains uncertain.15 Bid participation is expected to be restricted unless construction of the three substations is prioritised. The mismatch in project and grid augmentation timelines is delaying projects in India and restricting the installations for 2020 and 2021. Also, limited visibility of additional substations is creating flexibility issues for developers to submit bids – as a result, central auctions in 2020 are expected to be under-subscribed, unless construction of selected substations is prioritised.

Land Policy Change

Local policies regarding land availability have changed creating delays.

Changes in local land policies in the state of Gujarat and Tamil Nadu have impacted the timelines and cost of 93% of the projects awarded under central auctions for these states. Revenue land in Gujarat is owned and allocated by the state government. The local authority changed its land allocation policy, retrospectively impacting the central auction pipeline in the state. New allocation of revenue land for projects that bid under central auctions was stopped in mid-2018 and new policy for future land allocation within designated 'wind parks' was introduced in 2019.

Following intervention by MNRE, Gujarat allocated revenue land at desired locations for projects that had bid before the state initiated its policy change; for the rest of the projects, the land was planned to be allotted strictly within the designated wind parks.

The allocation of land at state-mandated locations in Gujarat created uncertainties around resource, land development and grid costs for project developers. Nearly 3.2 GW capacity faces uncertainty on land allotment and is likely to relocate to private land in Gujarat.

On the other hand, in Tamil Nadu, the latest construction bill has increased the minimum land requirement per MW of wind plant. The change will create delays in acquiring additional land for projects in the state. Given the ambiguities at the provided wind parks in Gujarat and increased land requirement in Tamil Nadu, their project pipelines are likely to be delayed for re-planning sites and acquisition. This will have an adverse impact on the project costs and timelines.

Going forward, the execution challenges in central auction projects are expected to be resolved towards 2022; however, uncertainty of grid and land availability creates variance within 2020 and 2021 installations. In the latest tender guideline issued in March 2020, the government has removed pricing caps for all future bids, for developers to account for the impact of infrastructural bottlenecks. Installation related to central auction projects are expected to vary between 4.3 to 7.7 GW in these two years.

ii. State Market

State markets have slowed down since the introduction of central auctions

The seven states with wind resource have been traditional demand centres and are responsible for most of the installations to date in India. Over the last decade, these states have established well defined processes for infrastructure creation and allocation. However, project activity has declined in the last two years, following the introduction of central auctions. Going forward, installations are expected to remain muted, driven by continuing payment issues. Net capacity addition varies between 1 GW in the low case and 2.5 GW in the best case.

Demand: The seven states which have high wind resource contributed nearly 52% of India's electricity demand in 2019. These states have continuously had the highest RPOs in India and target 9-13% of non-solar procurement towards 2022. These aggressive targets are expected to generate demand for roughly 10 GW of wind procurement in state markets towards 2022.

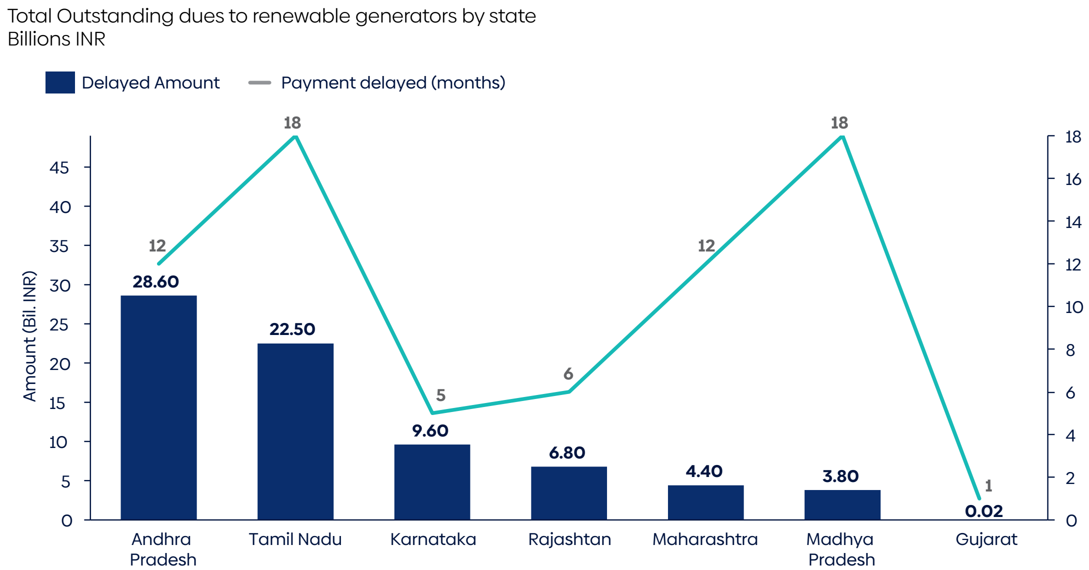
Economics: Given the presence of competitive wind resource sites in respective states, wind power procurement is most suitable for fulfilment of non-solar RPOs. The average power procurement cost is 10-40% higher than the cost of wind in all seven states, apart from Madhya Pradesh.

However, after central auctions were introduced in the last two years, activity in state markets has been muted. Three (Gujarat, Maharashtra and Tamil Nadu) out of the seven states have tried their hand at conducting their own auctions16 but apart from Gujarat, states have failed to generate developer interest. The biggest challenge for state markets is DISCOMs' inability to make timely payments to developers. As a result, developers have steered away from state auctions. The remaining four states are now in a state of flux, and have procured no new power in the last two years.

Payment Delays

Payment risks remain high and are not yet managed for state auctions

DISCOMs in India have been financially distressed for many years, with debts mounting to INR 300 billion due to cost of supply exceeding per-unit revenue. This has affected their ability to make timely payments to generators. DISCOMs of seven states with wind resource have a total of INR 75 billion outstanding payments to all renewable generators with a payment delay of



Note: All data according to Praapti as on 30-11-2019
Source: CEA; Praapti; Newspaper articles; MEC+ Analysis

Figure 3: *Re Generators face Delayed Payments from State DISCOMs*

up to 18 months. Unlike the central auctions, state markets do not have payment guarantees in place.17 PPAs that were signed before introduction of the auction mechanism did not have any guarantees. While PPAs signed through auctions require a letter of credit but are not stringently implemented.

Sanctity of PPAs

In May 2019, the newly elected Andhra Pradesh government decided to review, negotiate and bring down the tariff of all renewable projects signed by the previous government, citing that tariffs were much higher than the rest of the country. AP DISCOMs were financially unable to buy electricity at such high rates. To enforce the new rates, DISCOMs withdrew all the new PPA contracts under approval and started curtailing power from renewable energy generators. The AP High Court ruled that the state government did not have the power to renegotiate contracts and that procured wind power had to be paid at INR 2.43/kWh until the issue is resolved. As a result, MNRE intervened and a three-point resolution was set:

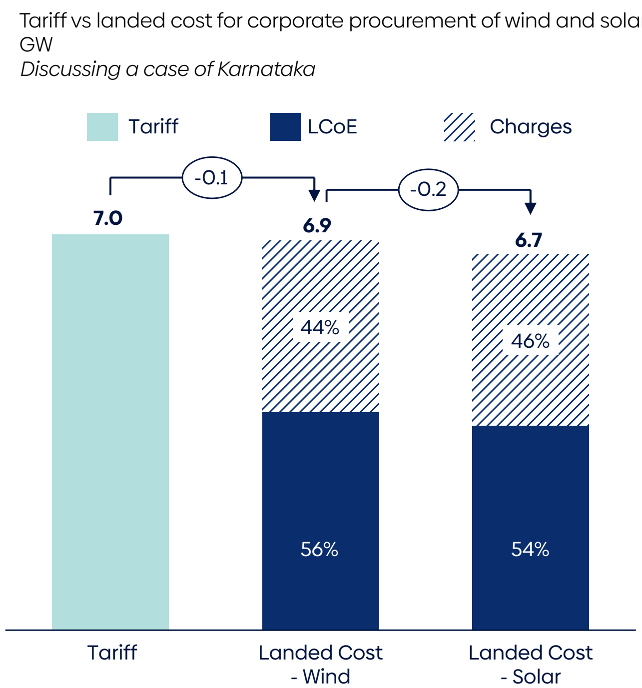
1. It was re-established that PPAs are sacrosanct and prices are non-renegotiable
2. AP DISCOMs arranged competitive loans from government institutions
3. ISTS charges were waived off for excess power generated and sold by DISCOMs or wholesale market.

However, the AP government cited a need for additional financial support from the federal government.

As of December 2019, the federal and state governments have been considering a solution that is politically and commercially viable to all stakeholders. The central government has maintained that PPAs are sacrosanct and price renegotiation is not possible. Currently, AP DISCOMs have started paying back dues at INR 2.43/kWh and the central government expects the AP government to revert to original PPA rates with due clearance.

iii. C&I Market

Small in volume, but consistent in procurement the C&I sector, including the private and public sector like Steel Authority of India (SAIL) and Oil and Natural Gas Corporation (ONGC), is the largest power consumer in India, contributing roughly 50% of overall demand. Primarily the sector is dependent on grid power, however ~35-39% of the segment's power needs are estimated to be fulfilled by self-procurement. India has installed



Source: MEC+ Analysis

Figure 4: *Regulatory Charges Impact Business Case for C&I Demand*

nearly 65 GW of captive and third-party PPA projects as of December 19, of which 12 GW is renewable-based (excluding rooftop solar). Wind contributes nearly 8GW of this capacity, most of which is derived from captive wind installations. Only 10-20% of the 65 GW comes from third-party PPAs. Going forward, C&I procurement is expected to remain a small yet consistent market, varying between 0.7-1.4 GW in the next three years.

Demand: Growing urbanisation and industrialisation continue to drive demand of electricity in India. Towards 2027, electricity demand in the C&I sector is expected to increase by 66%, according to the national electricity plan, creating a strong driver for corporate procurement. The demand for corporate procurement is facilitated by presence of an open access (OA) regulation in India which enables all entities with demand greater than 1 MW to procure power on their own. Additionally, certain C&I consumers are bound to meet RPOs.

Economics: With renewables becoming the cheapest source of grid power, C&I consumers have a strong financial incentive to switch to clean energy. C&I consumers typically pay 30-40% more per unit as compared to the other categories, and their tariff majorly ranges from INR 6-10/kWh. With the cost of wind and solar dropping significantly, a head-to-head comparison of C&I tariffs and cost of generation from renewable energy indicates a substantial cost differential between the two.

Regulatory Barriers: Despite the cost differential, the uptake of C&I procurement in renewables and specifically wind is inhibited by unwillingness of DISCOMs to allow open access, high regulatory charges on cross-subsidy surcharge, additional surcharge and banking charge which varies from state to state. However, the net impact on landed cost remains significant, varying between INR 2-5/kWh. Not only are OA charges high but they are also amended as and when the state desires. The majority of DISCOMs notify developers about OA charges on an annual basis, providing limited visibility to create a long-term business case for projects.

Competition with Solar: In all seven states with wind resource, solar resource availability is also high and no preferences are extended to wind. Therefore, wind competes head-on with solar to capture the C&I market. As a result, unless further regulatory support and long-term policy clarity is provided by the government, C&I is expected to be a small and geographically niche market dependent on the comparative business case in states.

iv. Wind Energy Market Forecast: 2020-2022

India is expected to install up to 13.1 GW of wind in the next three years, with uneven annual distribution.

The interplay of all these factors across markets leads to uneven pathways for wind installations, which are expected to vary

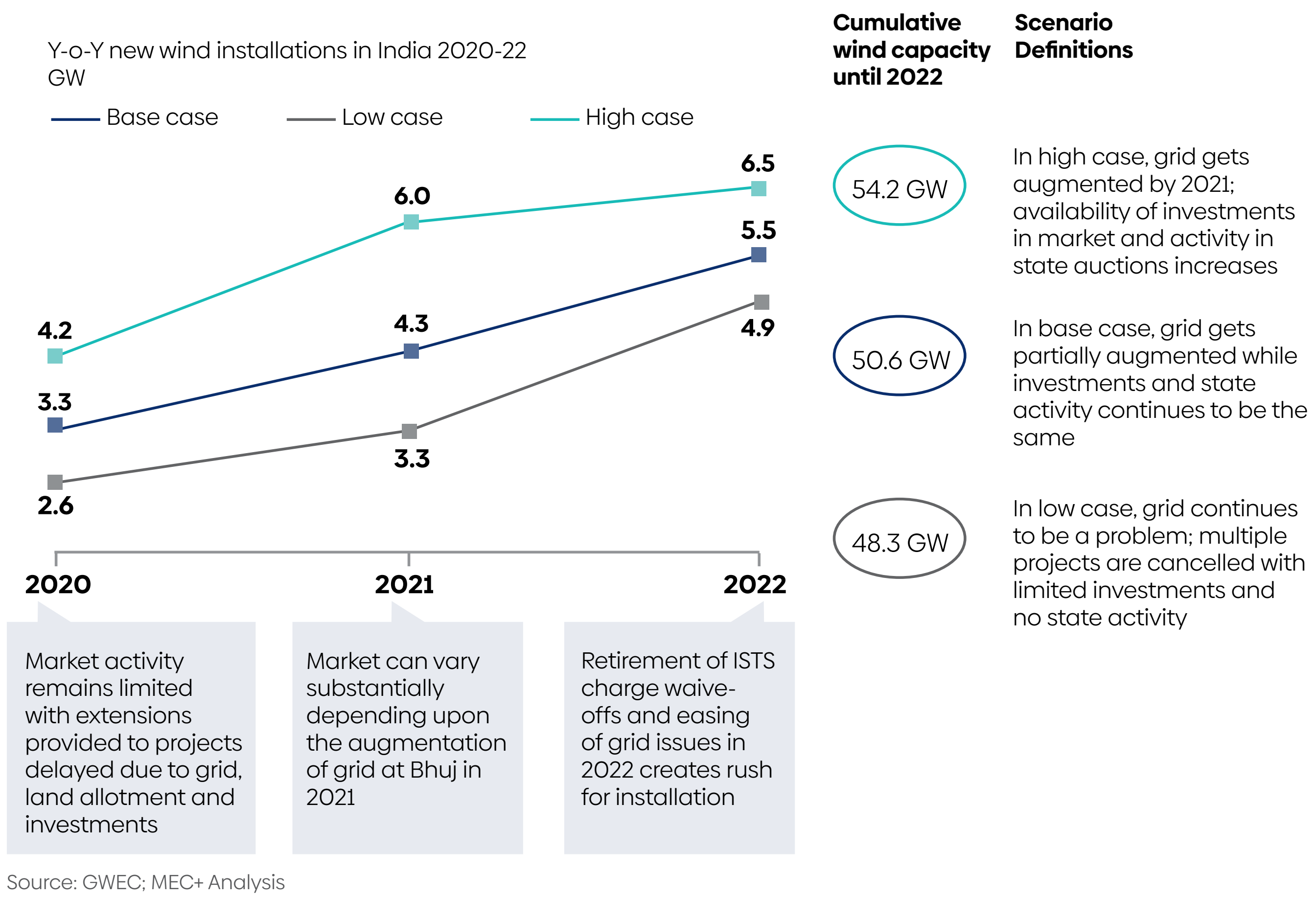


Figure 5: *Wind Installation Forecast & Scenarios*

between 11-17 GW. The base case sees a net installation of 13.1 GW between 2020 and 2022, with investments continuing at the current pace, given that federal auctions are driving the market. The high case sees an installation of 16.7 GW driven by increased investments in the market and activity in state auctions. On the other hand, in the low case, 10.8 GW of wind is expected to be installed, which may be impacted by economic slowdown in the market, leading to low activity in both central and state auctions. The low case also sees multiple projects undergoing cancellations due to financial constraints. In addition, the market has an inherent lumpiness with uneven distribution across years and geography of installations. In all scenarios, 2020 is expected to be a slow year in terms of market activity and installations are expected to be concentrated around 2022. Issues pertaining to non-availability of grid and land as well as low state auction activity impact installations in 2020. Nonetheless, the market scales up in 2021 as the issues are resolved and further volumes peak in 2022 due to retirement of incentives.

Given the resource availability and pipeline concentration in two states, installations are concentrated in Gujarat and Tamil Nadu. Installations outside the states are expected to be limited to 1-2 projects, possibly in Maharashtra and Karnataka.

Looking Beyond 2022

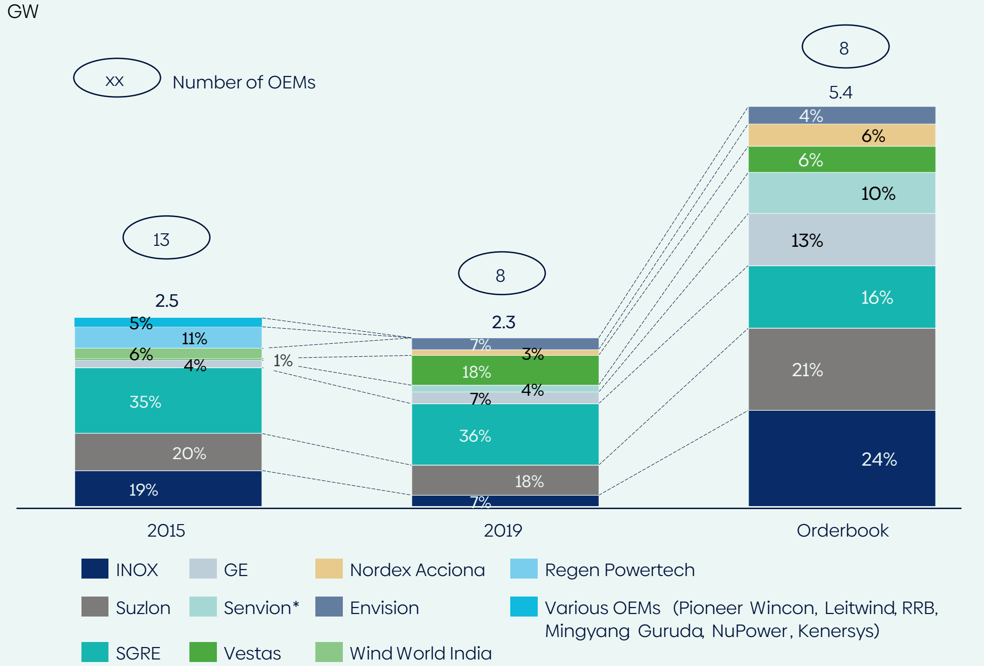
Despite the 140 GW target for 2030, the retirement of the ISTS transmission charge waiver post-2022 removes a key external stimulus, putting the market in a state of flux. As a result, annual installation volumes post-2022 is expected to shrink. However, long-term drivers are strong as the market is undergoing multiple long-term structural reforms. The major ones are: separation of wire and content business in the Electricity Act Amendment; privatisation of financially stressed DISCOMs; and migration to merit order-based dispatch in the market. These interventions favour economic power plants and wind economics fit the cut. While 2023 can be expected to be a transition year with lower activity, the market is expected to stabilise thereafter at roughly 5 GW installations annually in the long-term.

Supplier Consolidation

Five WTG OEMs dominate the market and further consolidation is expected.

Supplier Dynamics

During the FiT regime, the Indian wind sector housed 13+ active OEMs, most of which were domestic players. However, after the introduction of the auction mechanism, only 6-8 players remain active as of December 2019. This is a result of the sharp decline in wind power prices, leading to steep reductions in the profit margins of the OEMs accompanied by low volumes in the market. Volume in the market has been roughly 2 GW for the past two years, against an annual wind turbine manufacturing base of 10 GW (roughly 7 GW currently active) in the country putting excessive pressure on WTG OEMs operations. The Indian wind sector has been largely globalised with the acquisition of local players by global majors in the past two years, for instance Senvion acquiring Kenersys, Nordex acquiring Acciona and Siemens acquiring Gamesa.



Source: Calendar year data on the basis of publicly available information and approximation
Values of 1% or less are not indicated on the graph
*Senvion has agreed to sell Indian business in April, 2020; due to non-clarity of buyer, order book currently shown under Senvion
Source: GWEC Market Intelligence, April 2020; MEC+ analysis

Figure 6: *OEM's Market Share has been changing continuously and consolidating*

Future Consolidation Expectations

Smaller OEMs in India have not been able to sustain business under increasing cost pressures, visible through contraction in the number of suppliers in 2015 versus 2019. While smaller OEMs have moved out of market, larger domestic OEMs and global have struggled to keep their Indian operations profitable. The total revenue of these players (including Suzlon, Senvion, Vestas, Siemens Gamesa Renewable Energy, Nordex and others) has declined while debts have increased in last two years. A major impact is seen on Suzlon and Senvion, which are undergoing debt restructuring. Risk to their financial positions is also visible with contracts of Suzlon and Senvion being recontracted in the market. The pressure on OEMs and need for capturing volume can lead to further consolidation.

New Opportunities

New opportunities open in India where wind has a role to play.

Offshore Wind

In 2018, the Indian government announced ambitious targets for offshore wind (5 GW by 2022 and 30 GW by 2030). Offshore wind activity in India started in 2013 with the installation of the first nearshore met mast at Dhanushkodi in Tamil Nadu. However, concrete steps towards commercialisation were taken in 2018 when India announced a 1 GW Expression of Interest (EOI) for a prospective project off the Gujarat coast in the Gulf of Khambat. Forty participants responded to the EOI, including major offshore wind players. For a 1 GW offshore project in Gujarat, light detection and ranging (LiDAR) measurements and geotechnical/geophysical investigations have been completed, and preliminary permits have been secured. Moreover, PPAs have been agreed with Gujarat State Distribution Company (GUVNL) and viability gap funding is currently under review with the Ministry of Finance for one-time capital expenditure support subsidy.

However, there is no clarity on the tender issue timeline currently. Apart from this, tender for LIDAR installation and geotechnical investigation of 800 MW – 1 GW offshore wind in Tamil Nadu has been invited, while prospecting has been proposed for roughly 6 GW of projects in Gujarat and Tamil Nadu. The 'Facilitating Offshore Wind in India' (FOWIND) project led by GWEC provided a boost to the development and feasibility assessment of offshore wind in India. Other consortium partners include CSTEP, DNV GL, GPCL and WISE. The project conducted various studies for offshore wind in India, focusing on resource assessment, feasibility and supply chain.

Hybrid Plants

To increase the reliability of renewable energy, SECI started conducting solar/wind hybrid auctions in 2018. Until December 2019, around 1.6 GW of renewable energy has been awarded in the first two auctions and another 1.2 GW tender is notified. Bid prices have ranged between INR 2.67-2.7/kWh over the first two auctions. The key technical criterion in the tender is the lower cap on the capacity contribution of each technology i.e. both wind and solar need to be minimum 25% of the net project capacity.

Ultra-mega Renewable Energy Parks

Gujarat's latest land policy has marked 30 GW separate area for wind projects under central auctions. Land is to be allocated for these projects within designated wind parks in Khavada region. This area is remote with no grid accessibility and has marshy land, which means high land development and grid costs for the developers. In order to resolve this, government has taken up development activities in the region by announcing 25 GW of ultra-mega wind, solar and hybrid wind parks, where land and grid is provided by the government. Another 25 GW ultra-mega renewable energy park is being developed in Rajasthan, however, this is expected to be dominated by solar/hybrid technology since wind resource is sub-optimal here.

Round-the-clock Renewable Energy

SECI is conducting a 0.4 GW round the clock auction to solve the mismatch in load peak compared to solar or wind peak which also affects grid stability. This tender by SECI is unique in design for round-the-clock demand and could pave the way for better renewable energy integration. Under this auction, developers can choose to use standalone or combination of solar, wind and hydro projects. Bidders are expected to quote a single first-year tariff under this auction, which would increase by 4% annually, up to the end of the 15th contract year in the PPA and would subsequently be fixed thereafter for the remaining term of the PPA. Another 5 GW round-the-clock auction is planned which requires the blending of coal plants with renewable energy.

Peak Power Dispatchable Renewable Energy

To solve the peak power supply problem, SECI recently conducted a 1.2 GW peak power supply auction which was oversubscribed by 420 MW. In this auction, a project should have at least two components. One will be the energy storage system (ESS) component and the other can be either a solar photovoltaic system, a wind energy system or a hybrid system of both technologies.

Projects selected under this auction will be eligible for two-part tariffs: Peak Tariff and Off-Peak Tariff. Energy generated during the off-peak hours is to be remunerated at a fixed-tariff of INR 2.88/kWh while the tariff for energy generated during the peak hours was decided through an e-reverse auction which received a minimum bid of INR 6.12/kwh.

Attribution: India wind energy market outlook to 2022: Looking beyond headwinds. Global Wind Energy Council and MEC+ 2020.

Letters to the Editor

Dear reader,

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

Thank you,

The Editor - Indian Wind Power
Indian Wind Turbine Manufacturers Association
Email: associatedirector@indianwindpower.com
www.indianwindpower.com

Regulatory Update on Wind Power

India's Commitment to Promote Renewable Energy Proposes to Revamp the REC Mechanism

Ministry of Power has circulated a discussion paper on redesigning the Renewable Energy Certificate (REC) Mechanism for comments of stakeholders in power sector. Discussion paper on the requirement of redesigning the REC Mechanism has been prepared in order to align it with the emerging changes in power scenario and to promote new renewable technology. Salient features of changes proposed in REC mechanism are:

1. Validity period of RECs; Floor & Forbearance Price
   i. The REC validity period may be removed. Thus, the validity of REC would be perpetual i.e. till it is sold.
   ii. As RECs are perpetually valid then the floor and forbearance prices are not required to be specified as RECs holders would have the complete freedom to decide the timings to sell.
   iii. CERC will be required to have monitoring and the surveillance mechanism to ensure that there is no hording of the RECs and creation of artificial price rise in the REC market. CERC may intervene if such case of malpractices is observed in the REC trading.
2. Period for which the RECs are to be issued to RE generators:

   The RE generator who are eligible for REC, will be eligible for issuance of RECs for 15 years from the date of commissioning of the projects. The existing RE project that are eligible for REC would continue to get RECs for 25 years.
3. Promotion of new and high cost technologies in RE and the provision of multiplier for issuance of RECs.
   i. The concept of multiplier can be introduced, under which less mature RE technologies can be promoted over other matured renewable technologies.
   ii. The concept of negative list and sunset clause may also be considered for various technologies depending upon their maturity level.
   iii. Any RE technologies which need to be promoted may be identified say 2 years in advance. For such RE projects at least 15 years policy visibility would be provided to attract investments and promotion of such technologies in the renewable energy.
   iv. Multiplier:

   A technology multiplier can be introduced for promotion of new and high priced RE technologies, which can be allocated in various baskets specific to technologies depending on maturity. The multiplier would also take care of vintage depending on the date of commissioning of the project.
4. Incentivising Obligated Entities for procurement of RE Power beyond RPO.
5. No REC to be issued to the beneficiary of the concessional charges or waiver of any other charges.
6. The role of trader can be enhanced in the REC trading which will bring in two key Advantages; i.e. it will give long-term visibility to the buyers of the REC and they can fulfil the RPO. Further, the small buyers can bank on the traders for buying REC as an ease of purchase. This will ensure even the small buyers who find difficulty in trading in REC market will be able to fulfil his RPO.

Source: PIB Release ID: 1725078, 07 June 2021

Government Initiatives for Renewable Energy

Government of India has taken the following initiatives to boost India's renewable energy sector:

- In April 2021, the Central Electricity Authority (CEA) and CEEW's Centre for Energy Finance (CEEW-CEF) jointly launched the India Renewables Dashboard that provides detailed operational information on renewable energy (RE) projects in India.
- In April 2021, the Ministry of Power (MoP) released the draft National Electricity Policy (NEP) 2021 and has invited suggestions from all stakeholders such as Central Public Sector Undertakings, Solar Energy Corporation of India, power transmission companies, financial institutions like Reserve Bank of India, Indian Renewable Energy Development Agency, HDFC Bank, ICICI Bank, industrial, solar, and wind associations, and state governments.
- In March 2021, the Union Cabinet approved a Memorandum of Understanding (MoU) in the field of renewable energy cooperation between India and the French Republic.
- In March 2021, Haryana announced a scheme with a 40% subsidy for a 3 KW plant in homes, in accordance with the Ministry of New and Renewable Energy's guidelines, to encourage solar energy in the state. For solar systems of 4-10 KW, a 20% subsidy would be available for installation from specified companies.
- In March 2021, India introduced Gram Ujala, an ambitious programme to include the world's cheapest LED bulbs in rural areas for Rs. 10 (US$ 0.14), advancing its climate change policy and bolstering its self-reliance credentials.

- In the Union Budget 2021-22, Ministry for New and Renewable Energy was allocated Rs. 5,753 crore (US$ 788.45 million) and Rs. 300 crore (US$ 41.12 million) for the 'Green Energy Corridor' scheme.
- Under Union Budget 2021-22, the government has provided an additional capital infusion of Rs. 1,000 crore (US$ 137.04 million) to Solar Energy Corporation of India (SECI) and Rs. 1,500 crore (US$ 205.57 million) to Indian Renewable Energy Development Agency.
- To encourage domestic production, customs duty on solar inverters has been increased from 5% to 20%, and on solar lanterns from 5% to 15%.
- In November 2020, Ladakh got the largest solar power project set-up under the central government's 'Make In India' initiative at Leh Indian Air Force Station with a capacity of 1.5 MW.
- In November 2020, the government announced production-linked incentive (PLI) scheme worth Rs. 4,500 crore (US$ 610.23 million) for high-efficiency solar PV modules manufacturing over a five-year period.
- On November 17, Energy Efficiency Services Limited (EESL), a joint venture of PSUs under the Ministry of Power and the Department of New & Renewable Energy (DNRE), Goa, signed a memorandum of understanding to discuss roll-out of India's first Convergence Project in the state.
- In October 2020, the government announced a plan to set up an inter-ministerial committee under NITI Aayog to forefront research and study on energy modelling. This, along with a steering committee, will serve the India Energy Modelling Forum (IEMF), which was jointly launched by NITI Aayog and the United States Agency for International Development (USAID).
- India plans to add 30 GW of renewable energy capacity along a desert on its western border such as Gujarat and Rajasthan.
- Delhi Government decided to shut down thermal power plant in Rajghat and develop it into 5,000 KW solar park.
- The Government of India has announced plans to implement a US$ 238 million National Mission on advanced ultra-supercritical technologies for cleaner coal utilisation.
- Indian Railways is taking increased efforts through sustained energy efficient measures and maximum use of clean fuel to cut down emission level by 33% by 2030.

Courtesy: ibef India

Power Ministry Extends Timeline for Transmission Charges Waiver for RE by 2 Years

The Ministry of Power has issued an order on 18th June 2021 for extension of the timeline by two years for waiver on inter-state transmission (ISTS) charge for electricity generated from solar and wind sources for projects to be commissioned up to 30th June 2025. Earlier, it was applicable till June 30, 2023. Besides, the waiver would now be available for Hydro Pumped Storage Plant (PSP) and Battery Energy Storage System (BESS) projects also. Further, it said that the order promotes the development of solar, wind, Hydro Pumped Storage Plant and Battery Energy Storage System, trading of RE in the power exchanges, and seamless transmission of REpower across the states.

The waiver of transmission charges has also been allowed for the trading of electricity generated/supplied from Solar, Wind, PSP, and BESS in Green Term Ahead Market (GTAM) and Green Day Ahead Market (GDAM) for two years i.e. till 30th June 2023.

This is expected to encourage the RE trade in the power exchanges. The volume of renewable energy trade in the power exchange is expected to increase further. An opportunity to minimise the curtailment of RE as the RE developers will also have the option to sell power in the power exchanges and get instantly paid on the day of delivery of power itself.

The buyers of renewable energy will also have an opportunity to sell their surplus power in the power exchanges or allow in advance the sellers to sell in the power exchange.

The order is futuristic as it also allows the waiver of transmission charges for RE trade in the Green Day Ahead Market (as part of the integrated Day-ahead market). CERC, POSOCO, and the power exchanges are working on it in mission mode to operationalise this product in the power exchanges by end of August 2021.

It has also been clarified that an intra-state transmission system which is used for the conveyance of electricity across the territory of an intervening state as well as conveyance within the state which is incidental to such inter-state transmission of electricity, shall be included for sharing of inter-state transmission charges.

Any waiver of inter-state transmission charges that applies to inter-state transmission systems shall also be applicable to such parts of the intra-state transmission.

The transmission charges of such an intra-state transmission system shall be reimbursed by the CTU as is being done for the ISTS system. Concerned Regional Power Committee may through studies identify such lines.

Thus, India paves way for an energy transition from Fossil fuel to Non-fossil fuel by giving incentives for power trade from Renewable, Hydro PSP, and Energy Storage.

This amendment Order will be a boost to renewable energy and also a step forward to achieve the targets of the Government of India in meeting the international obligations towards climate change, it added.

Source: PTI, June 22, 2021

*Contributed by: **Mr. Om Prakash Taneja,** Consultant, Renewable Energy*

SG 3.4-145, our next -generation turbine

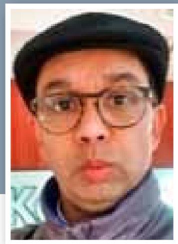
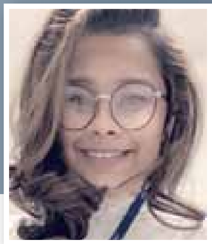
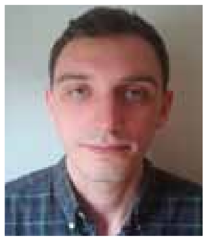
Delivering India's positive energy with SG 3.4-145, our next -generation turbine.
India's journey to become a sustainable nation is powered by a billion aspirations. We're proud to play a part in empowering India with clean and renewable energy, at affordable costs. Standing tall on a new 3MW platform, the SG 3.4-145 is a key milestone in India's clean energy story. This turbine delivers a remarkable 48% more

www.siemensgamesa.com

annual generation than its predecessor, in Indian low-wind conditions. Backed by smart monitoring system and optimized for all-weather conditions, the SG 3.4-145 is the right fit for the Indian market, delivering high profitability and reduced LCoE. The perfect turbine made for India, made in India. The SG 3.4-145 is indeed geared up to deliver India's positive energy.

SIEMENS Gamesa
RENEWABLE ENERGY

Use of 3D Printing, Variable-Ratio Gearbox and Vibration Analysis in Wind Turbine Technology in USA

Dr. Raj Shah
Director, Koehler Instrument Company
New York &
Adjunct Full Professor, Dept. of Material Science and Chemical Engineering, State University of New York, Stony Brook, New York

Mrinaleni Das
Intern

Nathan Aragon
Intern

Koehler Instrument Company

Wind energy is the leading source of renewable energy. According to the American Clean Power Association's latest report, in 2020, 7.4% of the nation's electricity came from wind energy, which is more than all other renewable sources combined.[1] The essential components of a wind plant are the turbines and tools related to them. Researchers have been trying to make this source of energy more efficient and economically viable.

3D Printing

Over the years, 3D printing has gained popularity among the STEM community. Multiple researchers have proposed the idea of using 3D printing technology in the production of horizontal and vertical axis wind turbines. These designs have been proven to be sustainable, cost-effective and energy-efficient. In a recent study, researchers used polylactic acid (PLA), a biodegradable compound, as a material for 3D printing. PLA can withstand relatively high temperature 205-225°C, and also has higher tensile strength compared to most biodegradable compounds.[2]

Turbines produced using these parameters produced the best results when the wind arrived at a 45 and 90-degree angle. This study also came to a conclusion that horizontal turbines need to be adjusted according to wind direction, whereas vertical wind turbines could yield wind in all directions. The 3D printed HAWT showed the greatest voltage output when wind indices angles were 45 and 90 degrees, but VAWT didn't show any drastic difference in output as the angle increased.[2]

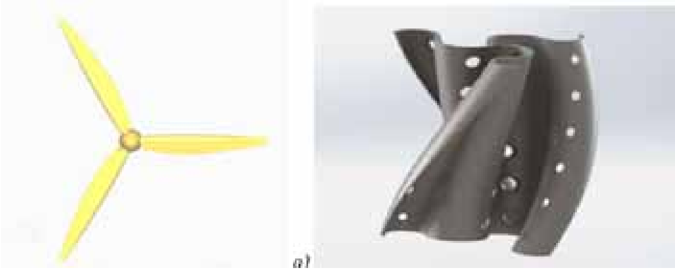


Figure 1: *3D Printed HAWT and VAWT*[2]

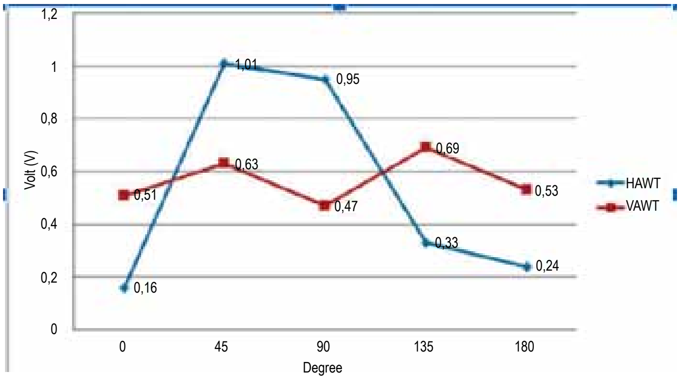


Figure 2: *Output Voltage According to Wind Angle*[2]

Recent studies have discussed the Fused Filament Fabrication (FFF) process to improve the mechanical performance of 3D printed turbines using blendings. Although the FFF process is economically viable, the FFF manufactured parts do not demonstrate high tensile strength, durability and resistance when only pure thermoplastic material is used.[3] But blending seems to be the ultimate solution. A study conducted by Corcione *et al.* suggests using NanoHydroxyApatite powder to produce b-tricalcium phosphate–based polylactic acid (PLA) composite to enhance the mechanical properties. This study suggests the use of these composites increases glass transition temperature, mechanical resistance[4], which is a very important element of wind turbines. Another study suggests using thermoplastic starches along with Acrylonitrile butadiene styrene (ABS) filaments, and it shows significant improvement in thermal resistance, heat distortion, tensile strength, and impact strength.[5] In another study, Stoof *et al.* used natural fibers blended with polypropylene as a feedstock for 3D printing and concluded that this blend increased the tensile strength by 74% and young's modulus by 214%, and reduced shrinkage by 84% to plain PP.[6] The use of these blends in 3D printed blades might solve the current problems without any major technical changes.

Table 1: *Information on SWTs*[8]

Particulars	3 blades with chord 0.08	3 blades with chord 0.106	4 blades with chord 0.08	4 blades with chord 0.106
Lifetime (years)	20	20	20	20
Energy production (20yrs, kWh)	14858.03	16125.07	15923.06	16703.44
Investment Cost ($)	2413.08	2413.08	2494.71	2494.71

In recent years, small-wind turbines (SWTs) have gained significant attention from researchers worldwide because of their small scale and efficient usages. According to, Tummala *et al.*, the installation of small wind turbines can supply the required energy for a household without having any significant negative impact on the environment.[7] A recent study suggests using 3D printed small wind turbines, which are durable, versatile, cost-effective and easy to maintain compared to the existing turbines.[8] Researchers used Acrylonitrile Butadiene Styrene (ABS), a type of thermoplastic, to 3D print the parts of wind turbines. They also re-used the wasted materials after recycling and blending them with a biodegradable material; it didn't show any significant difference in mechanical properties. ABS can withstand temperatures up to 100°C and also has good impact resistance. ABS's only shortcoming is that it soaks water in a humid environment, but it can be overcome using epoxy glue and wax. A study determines that using at least three shell layers and an infill level of more than 40% significantly increases the water resistance. This design also allows modifying each part of the turbines separately and saves maintenance costs significantly.[8]

From the table, it can be seen that 4 blades wind turbine (chord 0.106) seems to be the most profitable and efficient option among small wind turbines, and 3 blades wind turbine (chord 0.08) is the least efficient at energy production when investment cost is almost the same as other options.[8]

Dakeev *et al.* previously suggested using a cone-shaped flow directing the device to increase the air velocity and designed a blade that could utilize the downstream effect of the flow directing device. The 3D printer contained 11×11×12 dimensions in its envelope; despite the limitation, this design resulted in an increase of 60% power output when used together.[9]

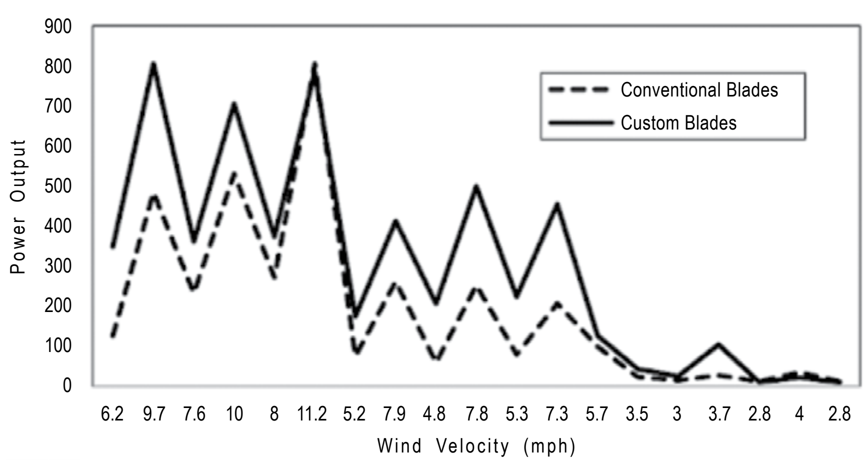


Figure 3: *Comparison between Conventional and Custom Blades*[9]

Variable-Speed Turbines/ Variable-Ratio Gearbox (VRG)

Most of the wind plants use fixed-speed turbines, but research shows that variable-speed turbines can adapt to low wind speed and result in an increase in energy efficiency. One of the major setbacks of variable speed turbines is the high maintenance cost and low reliability of electronics which enables the variation in speed.[10] Therefore, researchers are trying to find an alternative way to ensure the highest efficiency of the wind plants. A recent study proposes using Variable-Ratio Gearbox (VRG) into fixed speed gearbox to enhance wind turbines' performance. The use of VRG enables a lower gear ratio to be used in partial operation load (Region 2) and captures the wind energy that would be lost while using traditional fixed speed turbines. The main objective of using this design is to ensure the continuous selection of gear ratios while transitioning without exceeding the maximum power line.[11]

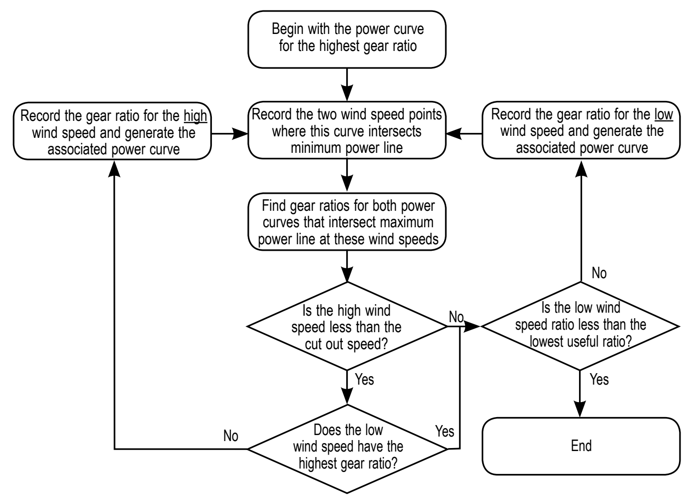


Figure 4: *Design algorithm used to develop VRG*[11]

The use of VRG along with fixed-speed turbines showcases an increase in wind capture. The gear ratio usually starts at a higher ratio to facilitate the highest torque necessary to initiate partial power load generation. When the wind speed starts increasing, the power coefficient reduces the torque so that the gear would not overheat the generators and ensure the highest efficiency of the turbines.[11]

The study suggests that in the operational mode (region 2), there is a significant increase in efficiency when gear five and six are utilized. This demonstrates that the additional gears add operational complexity and efficiency and prove the effectiveness of VRG.

Table 2: *Comparison between VRG and Single Speed Turbines*[11]

Gears			Total area (x10^4 W*m/s)			Region 2 area (x10^4 W*m/s)			Region 3 area (x10^4 W*m/s)		
No.	Low	High	Single	VRG	%inc	Single	VRG	%inc	Single	VRG	%inc
2	21.0	21.6	140.9	145.7	3.4%	75.6	77.4	2.3%	65.3	68.4	4.7%
3	20.5			147.8	4.9%		78.6	3.9%		69.3	6.1%
4	19.1			149.6	6.2%		80.4	6.3%		69.3	6.1%
5	17.1			150.8	7.0%		81.5	7.8%		69.3	6.1%
6	14.7			151.0	7.1%		81.7	8.0%		69.3	6.1%

The results prove that VRG can potentially increase the aerodynamic efficiency of wind turbines by allowing rotors to have more variations compared to single-speed turbines. Currently, variable speed turbines are the only option in areas where the wind speed is low, but VRG can emerge as a mature alternative in these areas. VRG can be developed at a very low cost by any automotive industry, and it also eliminates the use of pitch control, saving any additional costs.

Vibration Analysis

Over the years, wind turbine gearbox failures have been associated with most unplanned maintenance costs and wind-plant downtime.[12] Therefore, it is essential to immediately diagnose the faults in the gearbox and effectively avoid significant issues. Currently, vibration analysis is the most widely used fault dictation method; however, vibration signals are often mixed with different noises making it hard to extract accurate and valuable fault features from the vibration signal. Hence, it's essential to come up with a more efficient way of fault diagnosis.

A study proposes the Stacked Multilevel-Denoising Autoencoders (SMLDAE) method, which involves a multilevel denoising training scheme to teach autoencoders, which enables learning of the patterns of the fault features from complex frequency spectra of raw vibration data. Traditional denoising-autoencoders (DAEs) use a fixed noise level. Hence they cannot accurately address the non-linear noise associated with wind turbines, but when autoencoders are trained in different noise levels, they can interpret hidden complex data and help with downstream recognition tasks. SMLDAE consists of three major steps: signal acquisitions, representation learning and fault classification. The stacked network architecture captures the variation in raw data and enables viewing of the non-linear transformations. Also, the corruption of data using multiple noise levels expands the data size by utilizing artificial data, which can help to detect the smallest of the irregularities in the system.[13]

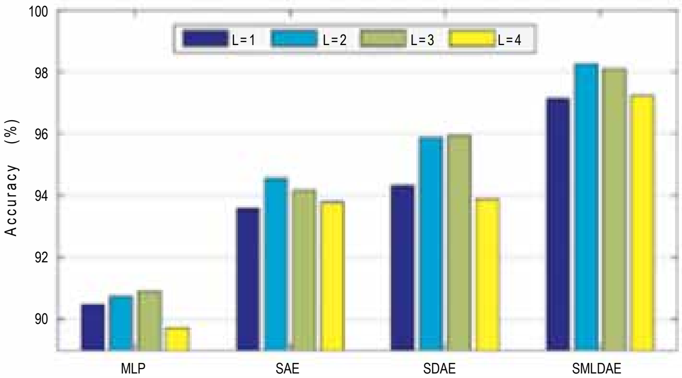


Figure 3: *Average Diagnosis Accuracies for Four Considered Methods with Different Hidden Layers*[13]

Among all the vibration analysis systems, SMLDAE has shown the most consistent and accurate results. Although, it is a relatively new approach, however, the results of the study showed the potential of this method.

Considering the future of sustainable energy sources, it can be predicted that wind energy is potentially going to be a large part of our future energy plans. One of the main hindrances of the path of sustainable energy is the production cost and efficiency. But the use of new technology and research advancements in the wind turbine industry shows that the commercialization of wind energy is not going to be as difficult as other sustainable energy sources. Studies show that 3D printers are becoming more sophisticated; hence, the possibility and future of 3D printed wind turbines look bright. Along with these, it's also time to encourage the active participation of civilians to power their homes. The US Department of Energy (DOE) predicts that by 2050, wind energy will fulfill one-third of the country's energy requirements.[14] As the consumers for renewable energy increase, we will potentially see more advanced technology in this field.

References

1. "Research Strengthens Reliability as Wind Power Shifts Into High Gear." *NREL*, 24 Feb. 2021. www.nrel.gov/news/program/2021/research-strengthens-reliability-as-wind-power-shifts-into-gear.html.
2. Turgut, Aydın & Kaya, Zekeriya & Ozsoy, Koray & Aksoy, Bekir. (2019). Design and Manufacturing of Horizontal and Vertical Wind Turbine With 3D Printing Technology.
3. Dudek, P. "FDM 3D printing technology in manufacturing composite elements." *INFONA.*
4. Esposito Corcione, C., Gervaso, F., Scalera, F., Montagna, F., Sannino, A. and Maffezzoli, A. (2016), The feasibility of printing polylactic acid–nanohydroxyapatite composites using a low-cost fused deposition modeling 3D printer.
5. Chao-Chung Kuo, Lung-Chang Liu, Wei-Feng Teng, Hsieh-Yung Chang, Fu-Ming Chien, Sheng-Ju Liao, Wen-Fa Kuo, Chien-Ming Chen. Preparation of starch/acrylonitrile-butadiene-styrene copolymers (ABS) biomass alloys and their feasible evaluation for 3D printing applications.
6. David Stoof, Kim Pickering. Sustainable composite fused deposition modeling filament using recycled pre-consumer polypropylene.
7. Abhishiktha Tummala, Ratna Kishore Velamati, Dipankur Kumar Sinha, V. Indraja, V. Hari Krishna. A review on small scale wind turbines.
8. Zawadzki, Karol, et al. "Sustainable Design of the GUST Small Wind Turbine." IOP Conference Series. Materials Science and Engineering, vol. 1002, no. 1, IOP Publishing, 2020, doi:10.1088/1757-899X/1002/1/012003.
9. Dr. Ulan Dakeev, Dr. Quamrul Mazumder, H, Design and Development of a New Small-Scale Wind Turbine Blade, American Society for Engineering Education.
10. P. Carlin, A. Laxson, E. Muljadi, The history and state of the art of variable-speed wind turbine technology, Report No. NREL/TP-28607, United States Department of Energy, 2001.
11. John F. Hall, Christine A. Mecklenborg, Dongmei Chen, Siddharth B. Pratap. Wind energy conversion with a variable-ratio gearbox: design and analysis. https://doi.org/10.1016/j.renene.2010.08.037.
12. "Zeroing In on the No. 1 Cause of Wind Turbine Gearbox Failures." *Energy Efficiency & Renewable Energy,* www.energy.gov/eere/wind/articles/zeroing-no-1-cause-wind-turbine-gearbox-failures.
13. Jiang, Guoqian, et al. "Stacked Multilevel-Denoising Autoencoders: A New Representation Learning Approach for Wind Turbine Gearbox Fault Diagnosis." *IEEE* Accessed Sept. 2017.
14. "What You Need to Know about the Future of Wind Energy: *Green Mountain Energy*." Green Mountain Energy Company, 18 Dec. 2018.

NGC

Professional in Wind Gearbox and Transmission System Solutions

NGC is a global leader in wind gearbox development and production with high performance product which provides complete main gearboxes, yaw and pitch drive product for wind turbine. NGC high reliability products are adapted to various working conditions, low/high temperature, low wind speed, high altitude, offshore and others. By far, over 80,000 NGC main gearboxes have been operating globally with excellence performance, contributing to the continuous power supply for green energy.

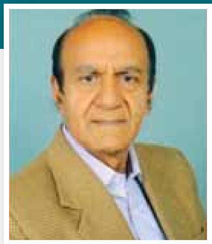
NGC TRANSMISSION ASIA PACIFIC PTE LTD
51 Changi Business Park Central 2, #06-08,
The Signature, Singapore 486066
Tel : +65 6589 8588
Fax: +65 6588 3557
E-mail: APRegion@NGCtransmission.com

NGC TRANSMISSION INDIA PVT. LTD.
DG Square, Unit 6A, 127 Pallavaram – Thoraipakkam
200 Feet Radial Road, Kilkattalai, Chennai 600117
Tel : +91 44 6612 3500
Fax: +91 44 6612 3535
E-mail: NGC.INDIA@NGCtransmission.com

www.NGCtransmission.com/en

NGC

Energy Storage for Reliable Power from Variable Renewable Energy Resources



Dr. Shambhu Ratan Awasthi
Former General Manager, BHEL

Abstract

Wind and solar resources are characterized by their variability. The identification of a viable site for installation of wind turbines is a long process. Wind turbines are sparsely installed in a wind farm to enable the wind to recoup its energy. The space between the turbines can be utilised by installing solar PV panels.

Solar energy is available during the day, whereas wind speeds are generally higher during early morning, evening and night. Thus, wind and solar resources are complementary to each other and they jointly enhance the reliability of power supply. However, the grid quality reliable power can be obtained with the provision of energy storage. Wind–solar hybrid power along with energy storage is the emerging trend as it helps the project developers to maximise the revenues.

MNRE has issued policy for large wind-solar hybrid power projects and also guidelines for tariff based competitive bidding to attract the developers and investors. The MNRE policy on wind-solar hybrid power projects gives the choice to the developer to provide energy storage.

This paper discusses the role of energy storage in providing grid quality reliable power from variable wind-solar hybrid power projects.

1. Variable Energy Resources

Wind and solar power resources are rapidly growing but both are intermittent and variable. Wind power generation is generally predominant during early morning, evening and night, whereas solar power generation depends on solar radiation available during the day. The month wise pattern of power output from a typical wind, solar and hybrid power project is shown in Figure 1.

2. Policy Initiatives for Wind-Solar Hybrid Power

The highlights of MNRE policy on wind-solar hybrid projects and guidelines for its competitive bidding are given next.

Policy for large wind–solar hybrid power projects[2]

For large (MW scale) wind-solar PV hybrid power plants, the MNRE issued 'National Wind-Solar Hybrid Policy-2018', and set a target to achieve 10,000 MW by 2022. The highlights of the policy are given below:

- Combined output of wind-solar hybrid power system will be fed to the same point of grid.
- In case of AC integration, the assessment of solar and wind power injected from the hybrid project into the grid will be worked out by apportioning the reading of main meter installed at the receiving station on the basis of readings of ABT (availability-based tariff) meters installed on LT or HT side of the wind and solar PV projects.
- The energy storage can be provided to the hybrid project to reduce the variability of output from wind–solar hybrid power plant.

MNRE Guidelines for Tariff Based Competitive Bidding[3]

MNRE issued the 'Guidelines for Tariff Based Competitive Bidding Process for procurement of power from Grid Connected Wind Solar Hybrid Projects' in October 2020. One of the objectives

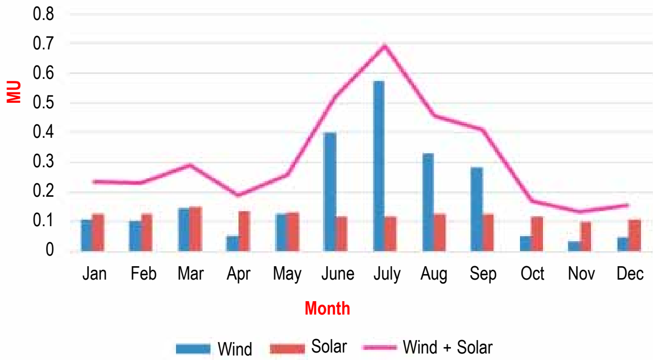


Figure 1: *Power Output from Wind, Solar and Hybrid Power Project[1]*

of guidelines is to enable Discoms (Distribution Companies) to procure electricity from wind–solar hybrid power project in a cost-effective manner. The salient features of the guidelines are as follows:

- Individual minimum capacity of the project would be 50 MW at one site and a single bidder cannot bid for less than 50 MW. Further, wind or solar power capacity shall not be less than 33% of the total contractual capacity.
- The capacity utilization factor to be declared at the time of bidding shall be minimum 30% which shall be allowed to be changed by the generator once within 3 years of COD.
- Bidders would be selected on the basis of the lowest quoted tariff for power purchase agreements (PPA) of a minimum period of 25 years. The hybrid power projects will be awarded on the basis of e-reverse auction.
- The power purchase from hybrid power projects would be mandated to provide for adequate payment security measures in order to protect the interest of the power producers. This would be done through a revolving letter of credit (LC), payment security fund and state government guarantees.
- The timeline for financial closure of wind-solar hybrid power project shall be within 12 months and commissioning shall be within 18 months from the date of signing of the PPA.

Energy storage can also contribute to meeting electricity demand during peak times when electricity becomes more expensive as power plants have to ramp-up generation.

techno-economically viable besides environmental concerns and fast depleting reserves of fossil fuels.

The energy storage addresses not only the problem of intermittency of solar and wind power but it also responds to large fluctuations in grid which makes the grid more responsive and reduces the need to build backup power plants. The performance of an energy storage system depends on time taken to discharge the energy, energy storage capacity, and time taken to recharge.

Energy storage can also contribute to meeting electricity demand during peak times when electricity becomes more expensive as power plants have to ramp-up the power generation. The distributors can buy electricity during off-peak times when energy is cheap, store it and then sell it to the grid when demand rises. The role of the energy storage in reducing the heights of peaks and depths of valleys of a load curve can be seen in Figure 2.

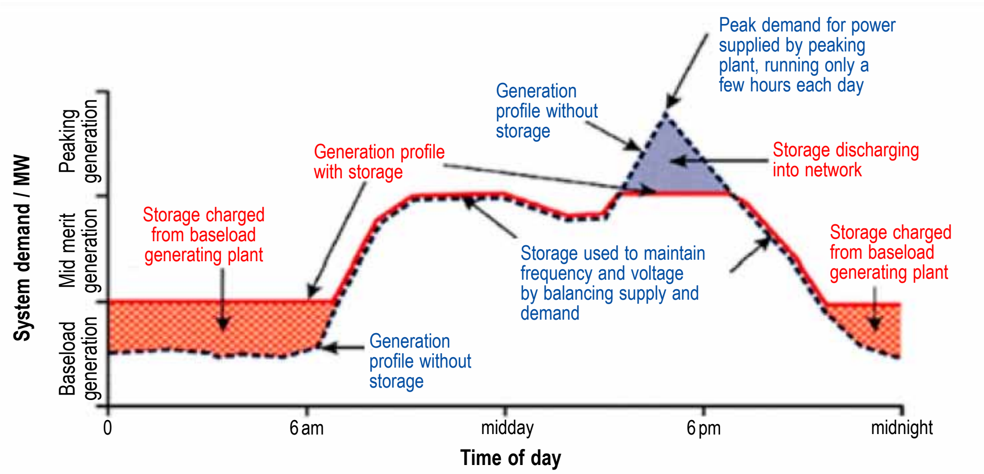


Figure 2: *Role of Energy Storage in Meeting Peak Load Demand*[4]

3. Energy Storage for Stable and Reliable Power

The energy can neither be created nor can be destroyed but it can only be converted from one form to another. It means that energy generated will either have to be consumed or stored. In case there is no provision of energy storage, the only option is to match instantaneous demand with generation. Wind and solar resources vary of their own and their output does not follow load variations. The renewable energy capacity in the country is set to exceed 100 GW this year with a share of about 80% from wind and solar resources. The present share of renewable energy in total electricity generation is about 10%.

India had an installed power capacity of 367 GW by March 2020. However, due to various technical, commercial, and regulatory constraints, a maximum output of 182.5 GW could be achieved at any point of time during 2019-20. It was mainly due to poor plant load factor of 56.4% of the coal fired power plants which constitute a major share of 62.7%. The peak demand could be met by increasing installed power capacity or by providing energy storage system. In view of the high cost of installation and O&M of power plants, adding to the generation capacity of thermal power projects would not be

The International Energy Agency (IEA) has estimated that, in order to keep global warming below 2°C, the world needs 266 GW of storage by 2030, up from 176.5 GW in 2017. In the last decade, the cost of energy storage, solar and wind energy has all dramatically decreased, making storage with renewable energy more competitive.

4. Energy Storage Systems

The energy storage systems capable of storing at least 20 MW are given in Table 1 and their performance parameters are briefly discussed. In view of this, superconducting magnetic energy storage and super-capacitors are not included.

Pumped Hydro

The pumped-storage hydro (PSH) project shown in Figure 3 offers huge energy storage in the form of potential energy of water stored in a reservoir at high elevation. In a reversible type pumped-storage system, the power is generated by the turbine-generator in a conventional manner. However, when rotated in reverse direction, same turbine-generator operates as pump-motor and pumps the water from a lower reservoir to the upper

Table 1: *Performance Parameters of Energy Storage Systems*[5]

Particulars	Max Power Rating (MW)	Discharge time	*Max cycles* or lifetime	Energy density (watt-hour per liter)	Efficiency
Pumped Hydro	3,000	4h – 16h	30 – 60 years	0.2 – 2	70 – 85%
Compressed Air	1,000	2h – 30h	20 – 40 years	2 – 6	40 – 70%
Molten Salt (Thermal)	150	Hours	30 years	70 – 210	80 – 90%
Li-ion Battery	100	1 min – 8h	1,000 – 10,000	200 – 400	85 – 95%
Lead-Acid Battery	100	1 min – 8h	6 – 40 years	50 – 80	80 – 90%
Flow Battery	100	Hours	12,000 – 14,000	20 – 70	60 – 85%
Hydrogen	100	mins –week	5 – 30 years	600 (at 200bar)	25 – 45%
Flywheel	20	secs – mins	20,000 –100,000	20 – 80	70 – 95%

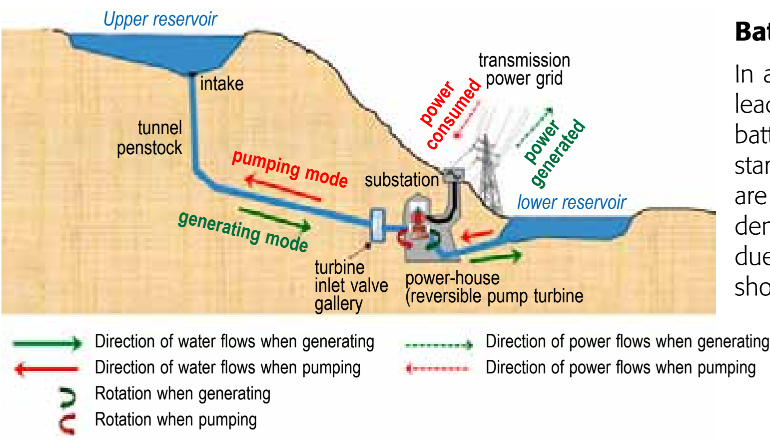


Figure 3: *Pumped Storage Project*

reservoir. This is done during off-peak hours when excess energy is available. When electricity is needed, water is discharged to the lower reservoir and the power is generated by turbine-generator.

Compressed Air

In case of compressed air storage, air is pumped into an underground hole, mostly a geological cavity during off-peak hours when electricity is cheaper. When energy is needed, the air from the underground cave is released back up into the combustion chamber for its heating as shown in Figure 4.

The expanded heated air rotates generator. This heating process generally uses natural gas.

Thermal Energy Storage

Thermal energy storage systems use temperature to store energy. When energy needs to be stored, the insulated rocks, salts, water, or other materials are heated. When load demand increases, the thermal energy is released by pumping cold water onto the hot rocks, salts, or hot water in order to produce steam, which is used to rotate turbines.

Battery Storage

In a battery, electrical energy is stored as chemical energy. The lead-acid battery is based on the oldest technology. Lead-acid batteries find wide range of applications such as UPS system, starting, automobiles for ignition and lighting. However, they are not preferred for grid storage because of their low-energy density, slow charging, limited cycle life and adverse effect on life due to deep cycling. The evolution of Battery Storage Systems is shown in Figure 5.

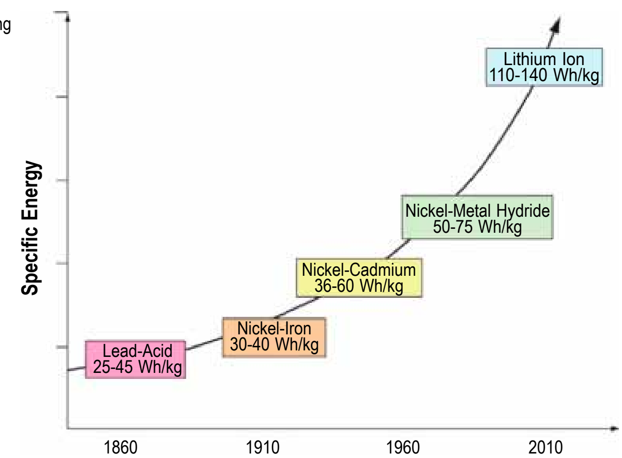


Figure 5: *Evolution of Battery Storage Systems*[7]

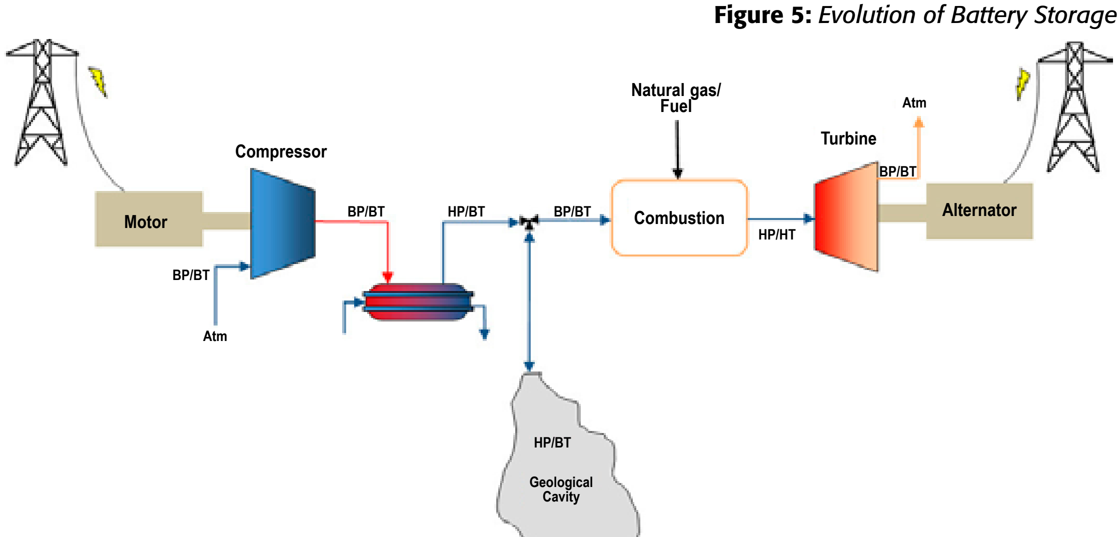


Figure 4: *Adiabatic Compressed Air Energy System*[6]

Lithium-ion Batteries

The low capacity lithium-ion batteries were initially used for consumer items. However, now they are used for larger-scale energy storage and occupy over 90% of the global market. It has low weight but high energy density as compared to other types of batteries. New innovations, such as replacing graphite with silicon to increase the battery's power capacity will make it even more competitive for energy storage. Several advantages include modular construction and fast ramping. Grid-scale energy storage facilitate reliable power to customers, power quality management, effective renewable integration and peak load management, system flexibility, frequency regulation and reliability of the network. The 100 MW battery at Hornsdale Power Reserve in Southern Australia is the world's largest lithium-ion battery. It helps to stabilize the power grid with the energy received from a wind farm. Globally, the price of grid battery storage has fallen from around 800 dollars a kWh in 2013 to a little over 100 dollars a kWh. With economies of scale, costs and prices are likely to fall further.

Figure 6: *Lithium-ion Battery Bank for Energy Storage*

Flow Batteries

The flow batteries are an alternative to lithium-ion batteries. The iron flow batteries may be a better option for utility-scale power grid storage due to longer storage duration up to 12

Figure 7: *Flow Batteries Storage System*

hours, unlimited cycle life and no degradation in capacity over a 25-years operating life (against typically 7000 cycles and a 7 to 10 years of Li-ion batteries). They are non-flammable, non-toxic, no risk of explosion and can operate safely in the temperature range of -10°C to 60°C.

A 200 MW (800 MWh) vanadium redox flow battery, the largest in the world is under manufacture at Dalian is scheduled to be installed at Rongke Power, China this year.

Solid State Batteries

Solid state batteries using solid electrolytes have advantages over lithium-ion batteries in large-scale grid storage. They have higher energy densities and are much less prone to fires than liquid electrolytes. The compact and safer solid-state batteries are well suited for large-scale power grid. However, high cost is the main constraint.

Hydrogen Fuel Cells

Hydrogen fuel cells generate electricity by combining hydrogen and oxygen. They are reliable due to the absence of any moving parts. They have high energy density and may be the cleanest source of energy with water as the byproduct. If the process is reversed, it can be used for storing the energy in the form of hydrogen. Fuel cells can produce hydrogen when electricity is in excess during off-peak hours and cheap, and use the same hydrogen to generate electricity when electricity demand increases. The hydrogen is produced by electrolysis process, stored and utilized in fuel cells for generation of electricity as shown in Figure 8.

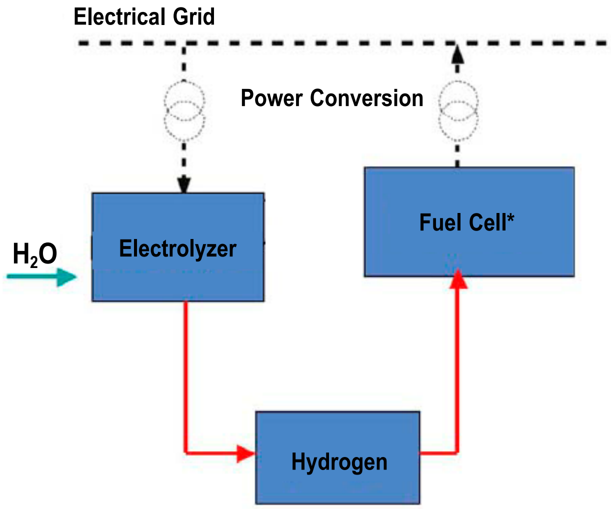


Figure 8: *Hydrogen Storage Scheme*[8]

Flywheels

The flywheels are effective for load-leveling and load-shifting applications. They have long-life cycle, high-energy density, fast response and need low maintenance. Motors store energy into flywheels by accelerating them to very high speeds of few thousand revolutions. The motor can later use that stored kinetic energy to generate electricity by moving in the reverse direction. Flywheels are generally installed in a vacuum so as to minimize the air friction loss. High energy density flywheels can be made of carbon fiber composites using magnetic bearings which enable the rotational speeds up to say, 60,000 RPM.

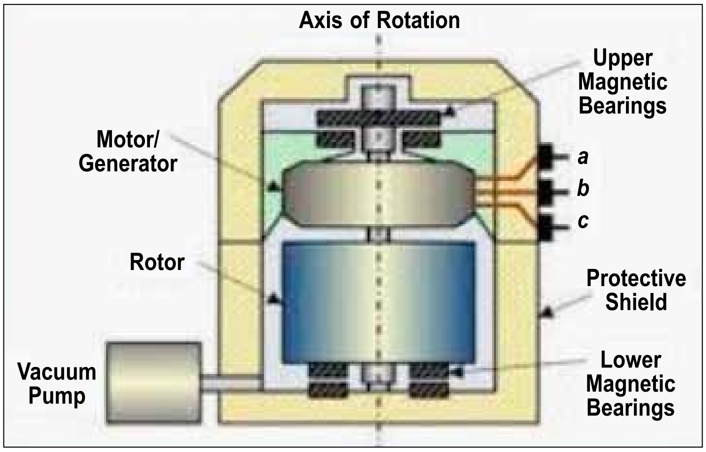


Figure 9: *Flywheel Energy Storage*

5. Global Scenario

Kennedy Energy Park is the world's first utility-scale wind-solar hybrid power project with the provision of energy storage in North Queensland, Australia. Total project owned by Windlab comprises of two phases. Kennedy Energy Park is the first phase whereas Big Kennedy is the second.

The Kennedy Energy Park consists of 43.2 MW of wind power, 15 MW of solar, and a 4 MWh lithium-ion battery storage supplied by Tesla. The wind farm consists of 12 nos. wind turbines each 3.6 MW with 67 m long blades and 132 m hub height. The energy park consists of 56,000 single-axis tracking solar PV modules. The installation of the project has been completed as shown in Figure 10.

The power from the project will be transmitted to the national grid using existing transmission system.

Figure 10: *Solar-Wind 60 MW Hybrid Power Project with Energy Storage in Australia*

Upcoming Projects

Status of some wind–solar hybrid power projects with energy storage is given below:

- USA: Western Farmers Electric Cooperative in Oklahoma is installing the Skelton Creek hybrid power project. It will integrate 250 MW wind, 250 MW solar and 200 MW battery storage. All the wind turbines have been commissioned in December 2020. The solar and battery energy systems will be operational by 2023.
- Mongolia: The Asian Development Bank is financing a 41-MW hybrid wind–solar plant with a battery storage.
- Europe: The Swedish utility Vattenfall is installing a hybrid power plant along with storage in the Netherlands. It comprises of 22 MW wind, 38 MW solar PV and 12 MWh battery storage.
- USA: In February 2019, Portland General Electric announced a hybrid power plant with 300 MW wind, 50 MW solar PV and 30 MW/120 MWh battery storage.

6. Indian Scenario

India's first grid-scale battery-based energy storage system was launched in February 2019 at a substation in Rohini, Delhi. The 10-MW system shown in Figure 11 is owned by AES Corp. and Mitsubishi Corp., and operated by Tata Power Delhi Distribution Ltd. (Tata Power-DDL). It is designed to provide grid stabilization, better peak-load management, higher flexibility & reliability, and protection of critical facilities for Tata Power-DDL.

Figure 11: *A 10 MW Battery Storage System in a Substation at Rohini, Delhi*[9]

World's Largest Wind-Solar Hybrid Project

In December 2020, the foundation of the world's largest wind-solar power park of 30 GW capacity was laid which is being developed at an investment of Rs. 1.5 lakh Crore near India Bridge, Rann of Kutch in Gujarat. In this remote desert area, the gusts of wind flow uninterrupted across the bare landscape. An area of nearly the size of Singapore, 726 square km – has been identified. It is planned to achieve 15 GW of installed power capacity by 2024. The state-run Gujarat Power Corporation Limited is developing the park.

In this mega wind-solar park, variable output form wind-solar power park would be a major issue and obviously many developers will be attracted to install energy storage systems.

7. Conclusion

Pumped storage projects offer the largest natural energy storage but they involve high cost and long gestation period. The pumped storage projects with cumulative capacity of over 5000 MW have been either commissioned in India or under different phases of construction. It is necessary to make optimum use of this resource for energy storage as all of these projects are not operated in pumping mode to store energy. Its 'ready to start' feature makes it ideal for meeting the peak demand and at the same time stabilizing the grid frequency. However, the main challenges lies in obtaining reliable and grid quality power from variable renewable energy resources, mainly wind and solar. This challenge can be partially overcome by wind-solar hybrid power projects. However, the solution lies in providing the energy storage system with wind-solar hybrid systems for grid quality reliable power. In view of advancements in battery technology, the battery-based, mainly lithium-ion energy storage has emerged as a preferred option which provides the flexibility needed for better integration with the grid.

In 2020, the bids were invited for energy storage by SECI (Solar Energy Corporation of India). The rates of renewable energy with energy storage were comparable with the rates of new coal based thermal power plants. Out of the two successful bids, one opted for pump storage whereas the other preferred battery storage.

India has taken initiative in 2021 by including the manufacture of batteries in the PLI (Production Linked Incentive) scheme. It is a major initiative towards 'Atmanirbhar-Bharat' in this field of vital importance.

References

1. Bhoopathi K., Giridhar G., Lavanya M.C., Das P.K., and Gomathinayagam S., 2016. Wind-solar hybrid energy production: Analysis Report. NIWE
2. National wind-solar hybrid policy. 2018. Ministry of New and Renewable Energy.
3. Guidelines for tariff based competitive bidding process for procurement of power from grid connected wind-solar hybrid projects, 2020, Ministry of New and Renewable Energy. https://mnre.gov.in/img/documents/uploads/file_s-1602674926052.PDF
4. SM Whittingham, 2012, History, Evolution, and Future Status of Energy Storage, Proceedings of the IEEE, Vol. 100
5. Fact sheet: Energy storage, 2019. EESI-https://www.eesi.org/papers/view/energy-storage-2019
6. Kera A., Goetz A., Py X., Olives R., Sadiki N., and Mercier E. 2013. Dynamic behavior of a sensible-heat based thermal energy storage, Energy Procedia, SolarPaces 2013. Elsevier.
7. Yekini M., Suberu M., Mustafa W., and Bashir N., 2014. Energy storage systems for renewable energy power sector integration and mitigation of intermittency. Renewable and Sustainable Energy Reviews.
8. Susan M., Schoenung, and Susan M, 2011. Economic analysis of large-scale hydrogen storage for renewable utility applications, Sandia National Laboratories, USA.
9. Proctor D. 2019. India installs its first grid-scale battery storage system. Power: https://www.powermag.com/india-installs-its-first-grid-scale-battery-storage-system/

Rajasthan Govt. Set To Retire Two Thermal Power Units in Kota

Two aging units of the Kota Thermal Power station with a generation capacity of 110 MW each will ride off into sunset if the state government approves a proposal for their closure.

Set up in 1983, the units have completed their useful life of 25 years as per the guidelines of the Central Electricity Act and need to be closed. A recent order of ministry of environment and forest (MoEF) says if they are kept operational beyond December 2022, they will be liable to a penalty of Rs 10-20 paisa per unit of the power. Mr. Dinesh Kumar, Principal Secretary, department of energy has said that there is a proposal from the Rajya Vidyut Utpadan Nigam Limited (RVUNL) and the government will take a decision at the appropriate level.

Built with old technology and design, the two units consume more coal to produce per unit of power. As per the industry parlance, the heat rate should not be more than 2,600 kilo calories of coal per unit of power. The two units are consuming 3,000 kilo calories to produce one unit of power which is environmentally not sustainable.

Source: TNN, May 29, 2021

New Vehicle-to-Grid Integration Technology Options in Europe and US

In Europe, Nuvve is partnering with the Danish charging solution provider Spirii. Under the agreement, the two companies' platforms will be integrated to provide unidirectional grid services and bidirectional customer offers for electric vehicle (EV) fleets in Denmark, the Nordics and northern Europe. In the US, Nuvve is partnering with the private equity firm Stonepeak Partners to form a joint venture, Levo Mobility, to accelerate the deployment of V2G infrastructure for electric buses and other electric fleets.

Source: Smart Energy International, May 31, 2021

Cerulean Winds Plans Floating Wind Turbine Project in UK North Sea

Low-carbon infrastructure developer Cerulean Winds has said that it has submitted plans to develop a floating wind turbine project in the British North Sea. An application for a lease for the 10 billion pound ($14 billion) project has been submitted to Marine Scotland, which manages Scotland's seas and freshwater fisheries. The project, made up of 200 floating wind turbines with a capacity of 3 GW, if approved would seek to sign contracts to feed power to offshore oil and gas facilities and use the excess for onshore green hydrogen plants. The British government is touting green hydrogen, whereby renewable energy powers the process to extract hydrogen from water using electrolysis, as a way to help lower emissions but costs are still expensive and it is not yet at commercial scale.

Source: Reuters, June 01, 2021

Terra.do: Would you like to work for climate?

Climate is literally everything under the sun. In case you wish to start working for climate change, where and how do you start? An edtech start-up has set for itself a very ambitious target: Getting 100 million people working by 2030 to help mitigate climate change. One of the aims is to get the learners at Terra.do inspire their contacts and others to work for mitigating climate change in various capacities—both personal and professional. Terra.do offers courses on climate change and how one can be part of the climate solution.

Source: Financial Express, May 31, 2021

Aditya Birla Group - Advanced Materials Business Plans Capacity Addition

Aditya Birla Group - Advanced Materials business, plans to invest towards increasing business capacity by ~125 KTPA through a brown field expansion at the existing location of Vilayat, Gujarat, India. It will include standard & specialty epoxy products along with curing agents. This is in addition to the existing manufacturing sites at Rayong, Thailand & Russelsheim, Germany.

APTEL Landmark Judgement on Compensation for Curtailment of Power

There are regulatory provisions for Must Run. "Must Run status have been accorded to both wind and solar power projects in the states in line with the Indian Electricity Grid Code 2010 and the Electricity Act 2003. As per IEGC renewable energy can be curtailed due to Grid Security. Ministry of New and Renewable Energy has been regularly reiterating this point to all Discoms, the latest letter is F. No. 283/20/2020-GRID SOLAR (ii) dated 4th April 2020. Ministry has added that still some of the Discoms are resorting to curtailment without any valid reason i.e. grid security and any curtailment but for grid safety would amount to deemed generation. Despite clear regulatory provisions, backing down of windmills during peak wind generation season is a major problem and a big loss to the power generators since long.

Appellate Tribunal for Electricity (APTEL), New Delhi has passed a landmark judgement dated 2nd August 2021 in the matter of appeal no. 197 of 2019 & IA No.1706 of 2019 filed by National Solar Energy Federation of India, New Delhi versus Tamil Nadu Electricity Regulatory Commission, Chennai, Tamil Nadu Generation and Distribution Corp. Ltd. (TANGEDCO), Chennai, Tamil Nadu State Load Despatch Centre ((TNSLDC), Chennai, Tamil Nadu Transmission Corp. Ltd. (TANTRANSCO), Chennai and Ministry of New and Renewable Energy (MNRE), New Delhi.

APTEL has issued the following directions:

134. (i) For the period 01.03.2017 to 30.06.2017, the Respondents shall pay compensation for 1080 blocks considered by POSOCO, during which curtailment instructions were issued for reasons other than grid security, at the rate of 75% of PPA tariff per unit within 60 days from the date of this order. The computation shall be made separately for individual members of the Appellant Association based on the curtailment period/blocks falling in 1080 blocks.

(ii) POSOCO shall carryout similar exercise for the period up to 31.10.2020 on the same lines and submit report to Respondent Commission within 3 months. Tamil Nadu SLDC and Appellant are directed to submit details to POSOCO. Based on POSOCO report, State Commission shall allow compensation for the backed down energy at the rate of 75% of the PPA tariff per unit.

(iii) Curtailment quantum shall be considered as per POSOCO report.

(iv) The Respondents shall pay compensation along with interest at 9% for the entire period.

APTEL has also directed for:

Way forward for curtailment of RE power by State Load Dispatch Centre

135. We have noticed that the analysis made by POSOCO is based on the grid parameters, margins available for backing down of conventional energy sources and the status of drawal by the State from the central grid.

These parameters are apt for deciding whether the backing down is for the purpose of grid security or on commercial reasons. We also make it clear that the replacement of solar power by purchases of cheaper power from short term power markets shall also be treated as unauthorized activity.

Accordingly, the following directions are issued to all the State Commissions, Discoms and SLDCs with regards to curtailment of power generated from Renewable Energy sources.

In the above referred case of deemed generation compensation Appellate Tribunal for Electricity (APTEL), New Delhi has directed the State Load Despatch Centre and DISCOM to pay 75% of the tariff for the curtailed units along with 9% interest. APTEL has also mentioned that in future for any such curtailments full tariff should be paid.

While the case was in the context of curtailment for 3 months, APTEL further directed POSOCO to analyse curtailment until October 2020 and the units that were not curtailed due to grid reasons will have to be compensated at 75% tariff too.

(i) For Future, any curtailment of Renewable Energy shall not be considered as meant for grid security if the backing down instruction were given under following conditions:
   a) System Frequency is in the band of 49.90Hz-50.05Hz.
   b) Voltages level is between: 380kV to 420kV for 400kV systems & 198kV to 245kV for 220kV systems.
   c) No network over loading issues or transmission constraints.
   d) Margins are available for backing down from conventional energy sources.
   e) State is overdrawing from the grid or State is drawing from grid on short-term basis from Power Exchange or other sources simultaneously backing down power from intrastate conventional or non-conventional sources.

(ii) As a deterrent, the curtailment of Renewable Energy for the reasons other than grid security shall be compensated at PPA tariff in future. The compensation shall be based on the methodology adopted in the POSOCO report. POSOCO is directed to keep the report on its website.

(iii) The State Load Dispatch Centre (SLDC) shall submit a monthly report to the State Commission with detailed reasons for any backing down instructions issued to solar power plants.

(iv) The above guiding factors stipulated by us would apply till such time the Forum of Regulators or the Central Government formulates guidelines in relation to curtailment of renewable energy.

Contributed by: ***Mr. Om Prakash Taneja***
Consultant, Renewable Energy

Boosting turbine performance and profitability

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

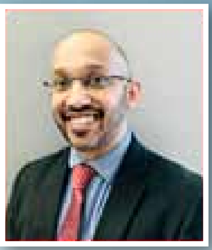
SKF's dedicated wind turbine solutions can help both turbine manufacturers and wind farm owners to:

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

For these and more solutions, visit www.skf.com/wind
or contact
Mahavir Kanwade
Manager-Application Engineering SKF India Limited
mahavir.kanwade@skf.com
020-66112684

Advances in Wind Energy Prognosis – An Indian Perspective

M. P. Ramesh
Former Executive Director
National Institute of Wind Energy, Chennai



Vitor Antao
Hendrickson Renewables India Private Limited

Abstract

Recent history of wind flow modelling as practiced in India has been explored. Various data sources and methods have been employed over a period of time. Their influences on policy making, regulatory controls and investment decisions have been examined. With the backdrop of more information, computing power, much research, validation now available, the current practices have been noted. In order to make informed decisions on project viability in terms of as accurate as is feasible energy estimates during the service life of wind farms, it has been attempted to make a case for relooking at some of the entrenched conventions that tend to discount value of the advances made in the field. Some aspects that form the basis of getting a dependable energy estimates have been put in perspective. Some suggestions have been made with respect to the way energy prognosis is carried out and a possible relook at policy environment that should be made more up to date.

1.0 Background

In order to get an idea about what to expect from a given wind farm in terms of possible generation over the service life, it is essential to use best possible input data sets; validated wind flow models and balanced application of loss factors and uncertainties. When grid connected wind turbines first appeared in the early eighties the estimations were based on very sketchy information on wind environment and other factors as well. Over last decades, considerable progress has been achieved in the field of wind energy specific measurements and modelling. However, some of the initial hesitance and its impact on regulations, policies, and investment climate continue to play a decisive role when green field projects are contemplated. There is an urgent need to look at some of the assumptions frozen in time and relook at what was the origin and what are the consequences of blindly going by those assumptions without paying much attention to the need of the hour. Often, this has an influence on the guidelines issued by regulatory bodies. In this paper we are hoping to address some of the important aspects of wind energy prognosis based on various factors and the need to revisit the assumptions made while carrying out horizontal and vertical extrapolation of wind field based on site measurements. The way the paradigms were established and used with little modifications and over a period of time, there has been no attempt to rationalise this aspect.

Until 1977-78 there was hardly any interest in wind as a source of energy. The oil shocks of 1977 made almost all countries including India to start exploring wind as a possible energy resource. Quite quickly it became apparent that the quality and quantity of data made available by India Meteorological Department (IMD) could not be used for the purpose of making reasonable estimates of wind power availability at any given location. One primary reason is that the departmental observatories were normally in cities and towns and often, placement of sensors was not very ideal. It can be seen that the anemometers and direction sensors cannot have proper exposure and the errors introduced cannot be quantified. The measurements obtained with such sensor positioning have the possibilities of misrepresenting the wind environment (figure 1).

This issue was recognised quite early in India by Dr. P.Nilakantan[1], who noted that the available meteorological data cannot be used for making reliable estimates of wind power. However, much attention was not paid to this at that point in time.

Figure 1: *Typical Wind Measurement Instrumentation Deployed at a Few Observatories*

The interest in the field picked up in late seventies and revisit to available data resulted in designing special measurement program. After the first 40 kW wind turbine was installed at Veraval in Gujarat in the premises of JK Synthetics, Gujarat also saw small turbines installed with an aggregate capacity of 1.1 MW. Government of India, in association with DANIDA, deployed four demonstration projects with installed capacity of 0.55 MW in states of Gujarat, Maharastra, Tamil Nadu and Orissa with 55 kW wind turbines during 1984-85.

2.0 Early Forays into Commercial Wind Farming

By the time wind turbine installations moved into private space around early nineties, two complementary actions initiated in early eighties helped the organic growth of the field. Government of India sponsored special wind monitoring program in known windy areas as early as 1984-85. Second was that the growth of wind farming in India virtually picked up subsequent to the three DANIDA funded 20 MW (aggregate) wind farms came into being in early nineties, followed up by a World Bank backed low cost funding and incentives extended by the central and state governments. The growth of number of installations started in this period. There was a momentary lull in the field after the debacle of over 150 turbines getting destroyed in a cyclone along coast line of Gujarat. The need to look at locating wind turbines very carefully in terms of safety and generation became more apparent.

2.1 Wind Data Availability

National Aerospace Laboratories (NAL), in association with Karnataka Power Corporation deployed first ever digital wind monitoring systems in Western Ghats in 1982-84. Since then, the measurement program was replicated under a centrally funded wind monitoring program, which was launched with a 20/25m high mast installed in carefully chosen locations. The

Figure 2: *Typical Wind Monitoring Station from 1985*

Government of India funded measurement program was not part of the meteorological observations routinely carried out by India Meteorological Department. Initially from 1985 onwards the Field Research Unit of Indian Institute of Tropical Meteorology started establishing monitoring stations[2]. The mast supported pairs of anemometers and direction vanes at 10 and 20/25 magl and had a digital data logger that processed and stored data on Electronically Programmable Read Only Memory (EPROM) chips of 4 kB capacity. Figure 2 shows a typical installation in complex terrain. The data logger used 0.5 Hz sampling frequency and had some preloaded programs that would create coarse interval wind rose information, frequency distribution based on 2 second samples, time series of hourly wind speeds and directions and store monthly summaries.

Subsequently data loggers with some flexibility in terms of setting up averaging intervals, more analog and digital channels, more versatile data storage features became available and the national wind monitoring program started employing these instruments in lieu of the restrictive models.

The data collected from these data loggers were published as wind data hand books[3] and also made available as digital files by 1990. This was the only data source available from the remote areas with all the limitations of the period. The advent of NCEP/NCAR[4] and other global data sets was still some distance away. Even post their becoming available in the early part of 2000, the synthesised data sets were available on very coarse grid intervals and monthly mean values limiting their use in energy prognosis.

2.2 Wind Flow Modelling for Wind Energy Estimation in the Nineties

During late eighties, a large number of rudimentary flow models implemented on personal computers started to be employed for wind energy prognosis. Until early nineties the wind flow modelling was not yet in the commercial space. There were no well-established methods of analysis in the country and many projects were set up based on estimated energy computed using frequency distribution and some reduction factors were applied to provide financial safety. Some of the models developed were MS Micro (Mason & Sykes), Numerical Objective Analysis of Boundary Layer (NOABL) from National Renewable Energy Laboratory, USA. MS-Micro later was released as MS3DJH for use on personal computers. It was an improvement over the original implementation capable of dealing with three dimensional model spaces. There were many more models and implementation by several groups. Although there were a few users of WAsP in India, a formal entry into India was made by Riso National Laboratory in 1996 through a workshop organised by NAL. Over a period of time, WAsP was widely used in wind power related work in India.

Just to give an impression of how the rudimentary approach to micro-siting was implemented, results from a wind farm established in 1997-98 are presented in figure 3 and 4.

The wind farm consisted of 18 numbers of E-30 turbines rated 230 kW to be installed on a low height ridge line near the Chitradurga town in Karnataka. It is part of Jogimatti hill range adjoin the town.

The map data was created by manually digitizing Survey of India contour map of 1:50000 scale. The contour interval for this scale of map is 20 meters. Wind data collected in Jogimatti in

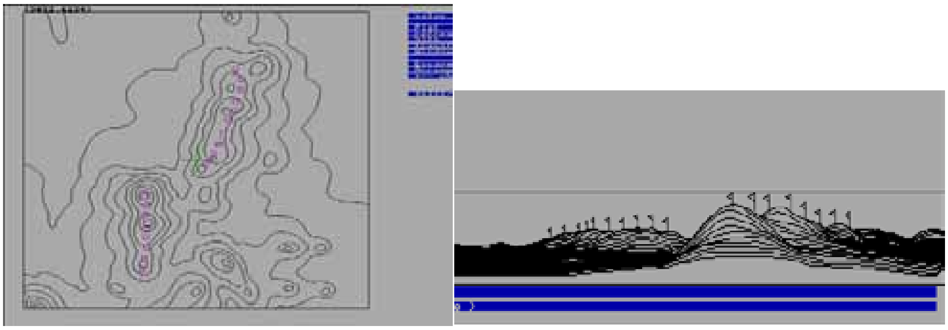


Figure 3: *Micrositing Using WASP (DOS Version) For a 18 x 230kW Wind Farm in Chitradurga, Karnataka*

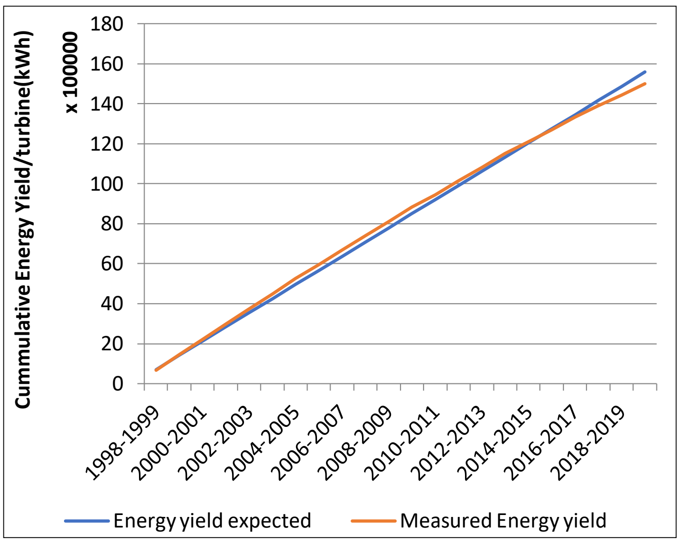


Figure 4: *Results of Predicted and Actual Generation*

Chitradurga region was employed. The then data loggers were providing joint frequency distribution with a very coarse scale and required arithmetic adjustments to create a joint frequency distribution table that was employed in the analysis.

Figure 4 provides an overview of how the wind farm has performed over two decades. The estimated generation of 12.75 million kWh based on three years of wind data from previous years at Jogimatti was exceeded in the initial years and has shown a decline in recent years. Taken on the long-term, the wind farm has delivered expected generation.

During 1998-99, in an effort to make the data collected useful for wind farm developers, a project was initiated at NAL to create a basis document identifying useful parcels of land in the vicinity of the already set up measurement stations. Ministry of New and Renewable Energy (MNRE) sponsored the effort and a large number of reports were prepared to identify wind farmable areas close to measurement masts. The so called 'micro survey reports' contained detailed information about specific sites, potential, some idea about the infrastructure availability in terms of logistics and grid access. Private wind farm developers and other stakeholders were able to use these reports as a starting point. Wind Flow model was set up using manually digitized Survey of India maps for an area of 20 km x 20 km with the mast in the centre. Roughness maps were again created by using the area classifications defined in the Survey of India maps and site visits.

It was considered reasonable to assume that the wind data collected at the mast can be considered as representative for a radius of 10 km in simple terrain and to some extent, undulating terrain. Some important points to note are that there were very few masts available in large tracts of land and validating the flow model was very difficult. Further, the measurements were limited to heights of 20 to 25 m agl, well within the surface layer. To extrapolate results to larger distances would be risky. The concepts of applying uncertainty were not as formal as it is today.

Notwithstanding the limitations of the model and ability of personal computers, it was possible to produce reasonable estimates of the potential from the given area. For example, based on this method, possible capacity factors were estimated at 30, 40 and 50 m agl in identified locations in the areas identified around Sankaneri in Tamil Nadu to be in the range of 21 to 28% for different hub heights[5]. Suzlon set up large wind farms in the region and they consistently produced capacity factors in the range of 22 to 28%. Subsequently, this project was extended to over 100 locations across the country and it became an accepted practice to use it like a thumb rule. It also got into the guide lines of the Ministry of New and Renewable Energy as one of the recommendations in 2008[6]. When it came to permitting developers to set up wind farms based on wind data collected by their own measurements, government, while allowing the applicable incentives for such projects, stated that the wind data collected at a mast to be applicable would normally be 10 km in all directions in flat terrain and in case of complex terrain appropriate distances could be considered. Though it was a recommendation, it became rule to be applied to be followed while permitting establishment of wind farms.

There were other possibilities of using numerical simulations that were supposed to capture non-linear nature of the flow field and some of the consultancies were offering such services. However, such results suffered from some concerns – the models assume many boundary conditions and parameterisations that could quite easily alter the results and great skill and experience is needed to use them. They also lacked the rigours of validation.

3.0 Current Practices

Current practices are evolutionary in nature. There are many changes in the way the wind farming site validation and deployment is approached. Two significant aspects in this direction are the way measurements are carried out and the other is the way modelling and analysis is carried out.

3.1 Measurements

Site specific wind measurements were guided by several factors. Apart from some guidelines provided by American Wind Energy Association[7] there were very few pointers about the measurement campaigns in early years.

Subsequently with IEC 61400-12 and its revisions, meant for power performance measurements, have dealt with the subject of wind speed and direction measurement in great detail and

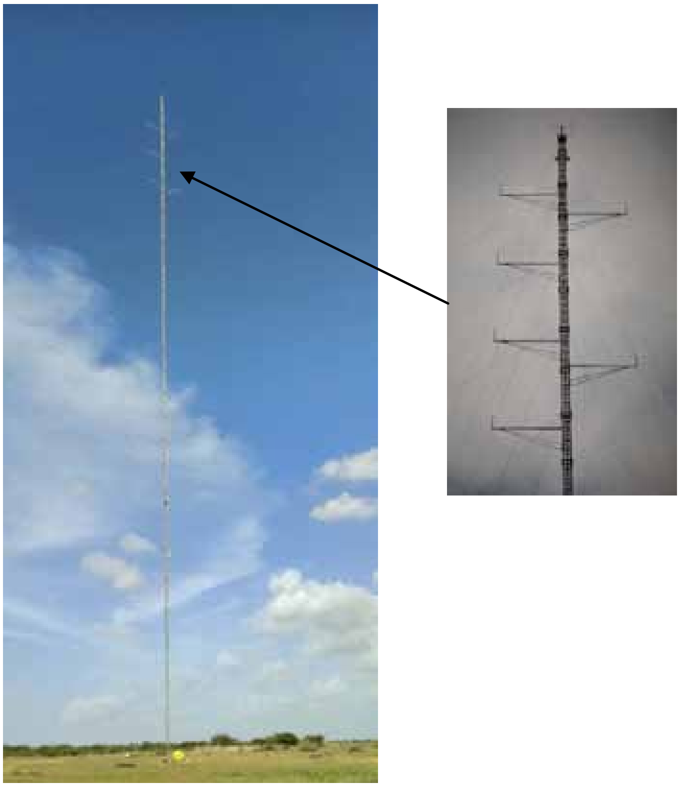


Figure 5: *Modern Wind Monitoring Station (160 M). Instrument Mounting is Inset.*

have made the process very formal. In the absence of any other well documented procedure, the principles of measurement for wind resource assessment are derived from the procedure for meteorological measurements to be used in wind turbine power performance measurements. A major change in data collection was to shift from hourly average values to ten minute averages of all measurements in line with power curve measurement standards. A lot more attention was paid towards use of IEC 61400-12 recommendations in the sensor bracket design and its orientation vis-à-vis the meteorological tower. The measurement stations used in wind resource assessment now resemble regular meteorological stations with multi-level anemometers, redundant anemometers, pressure, temperature and humidity sensors. In recent times with atmospheric stability becoming a factor in wind flow modelling, more than one temperature sensors are also deployed at various elevations in accordance with MEASNET recommendations. Keeping in view the advanced requirements the sensors and the data logging equipment are calibrated and periodically recalibrated or replaced. Masts with a top height of 160 meters are also deployed by some of the developers (figure 5).

An important point is that the tall masts are already sometimes above the surface layer or at least at the edge of surface layer[8]. The impact of local surface roughness's and other orographic influences will have lower impact on the measured wind speeds and directions. As there will be multi-level measurements, it will be feasible to analyse factors such as wind veer with measured data. Naturally the newer measurement campaigns are quite expensive and considerable prior studies and analyses precede the selection of measurement sites to ensure representativeness of the information collected from these meteorological stations. In a bid to reduce uncertainties measurement campaigns are, as a rule, undertaken at more than one location with overlapping time periods. There would be at least one or two stations with multiple years of measurements. Further, more stations in contiguous areas would be established with concurrent data period thereby helping in extending the data period by correlation. Although, much research has gone into use of SODARs and LIDARS, three dimensional ultrasonic sensors for wind speed and direction measurement, tower- based measurements are expected to be relied upon for some more time to come.

3.2 Wind Flow Modelling for Energy Prognosis

Currently, the field of wind flow modelling uses on site measurements along with global data sets that capture climate related nuances that influence long-term behaviour of winds at area of interest.

Over the years, the wind resource modelling has been evolving and presently three main wind flow modelling techniques are being used:

- Linear Flow models
- Computational Fluid Dynamics (CFD) models
- Weather Research and Forecast (WRF) models

With the improvement of computational power, which reduced cost and time Computational Fluid Dynamics (CFD) models started to become more accessible for use in commercial applications. Much research has gone into CFD modelling and quite a few service providers market both software and services. Danish Technical University has released WAsP CFD versions. The models have been operated in commercial space and considerable validation has been carried out.

Weather Research and Forecast (WRF) models were developed in the latter 90's and by the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (NOAA) (represented by the National Centre for Environmental Prediction (NCEP) and the Earth System Research Laboratory), the U.S. Air Force, the Naval Research Laboratory, the University of Oklahoma, and the Federal Aviation Administration (FAA). It had a wide range of applications in the field of weather predictions, wind resource estimation being one of them. It requires large computational power (not possible to run in personal computers). One of the key inputs is the global datasets, like MERRA, MERRA2, NCEP/NCAR, ERA-I and ERA5, etc. The global datasets have been evolving over the years, for example MERRA has been updated to MERRA2 and ERA-I have been updated to ERA-5, with improvements on the accuracy of the datasets. This has led to improvement in the results WRF modelling. The advantage of the WRF model is that it captures mesoscale effects (10km to 1000km) which are not captured by linear models or CFD.

In WAsP help page an analysis of the influence of ruggedness index (RIX), an indicator of the terrain complexity on the wind speed error is provided. RIX is defined as the percentage fraction of the terrain within a certain distance from a specific site which is steeper than some critical slope. It is mentioned that when RIX >0% it is outside the performance envelope of WAsP, however it

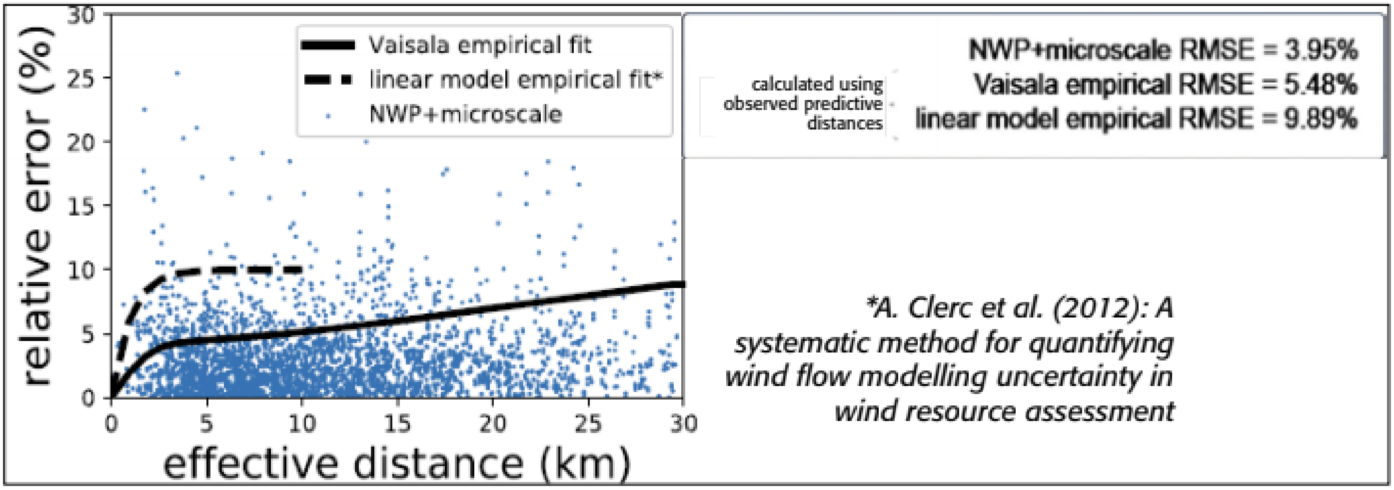


Figure 6: *Cross Prediction Errors between Met Masts as a Function of Inter Mast Distances*

is important to consider the relative RIX which is the comparison between the RIX and the measurement location and the RIX and at turbine location. When the ΔRIX is close to zero the overall prediction is valid as both errors would cancel each other. Here the concept of similarity of terrain is applied.

Not many validation studies with a large database of masts have been published on the accuracy of the wind flow models. One study done by Vaisala[9] with more than 3000 met tower pairs shows NWP coupled with microscale model have higher accuracy then linear flow models (figure 6).

The question that now arises is how far the extrapolation can go from the masts. There is no absolute and clear answer, although several recommendations have been given. Not always the ideal situation can be achieved, and the best engineering judgement together with a risk evaluation on project by project basis must be taken. The uncertainty analysis is a good indicator of the risk and must include among others, measurements quality, vertical extrapolation, long-term corrections, evaluation of the terrain, the cross prediction between different masts. The statistical analysis of each of these elements is highly dependent on the site and the final decision should be taken based on the evaluation of these elements.

Wind resource estimate is a primary step of the energy estimation and the final goal is to answer the question how accurate are the energy estimates? To answer this question, region wise validation studies must be done to understand where the wind industry should be focusing, be it wind resource, wake modelling or loss factors. Since the number of measurements and projects that have been under operation is high the creation of databases of projects will be the key element to answer the question, how accurate are the models.

Andreas *et al*[10] have explored the sensitivity of prediction errors caused by the relative distances from measurement point to the turbine location vis-à-vis the similarity. A significant outcome of this study based on a large number of measurements and wind farms, the prediction errors are under better control when the measurement site and turbine site are characterised by similar terrain features and does better than the distance weighted averaging method that is normally employed.

3.3 Global Data Sets

An important aspect of modern methods is the increased dependence on synthesised data sets obtained from MERRA and ERA resources forming basis for computing long-term time series. ERA 5 uses a ¼° x ¼° while MERRA 2 uses ½° x $^2/_3$° grid sizes. In linear distances, this roughly implies a grid size of 27 km by 27 km for ERA 5 data grid and with MERRA it is around 54 km by 72 km grid point spacing in the latitude range of 5 to 28 degrees.

It is now a standard practice to use the synthesized global data sets for making climatic adjustments to the measured data sets. One of the reasons for this is the absence of long-term measurements in the far flung areas where wind farms would come up. The underlying understanding in doing so is that these data sets are assumed to be results of fully researched continuously updated and validated weather modelling and can be employed to generate long-term corrections.

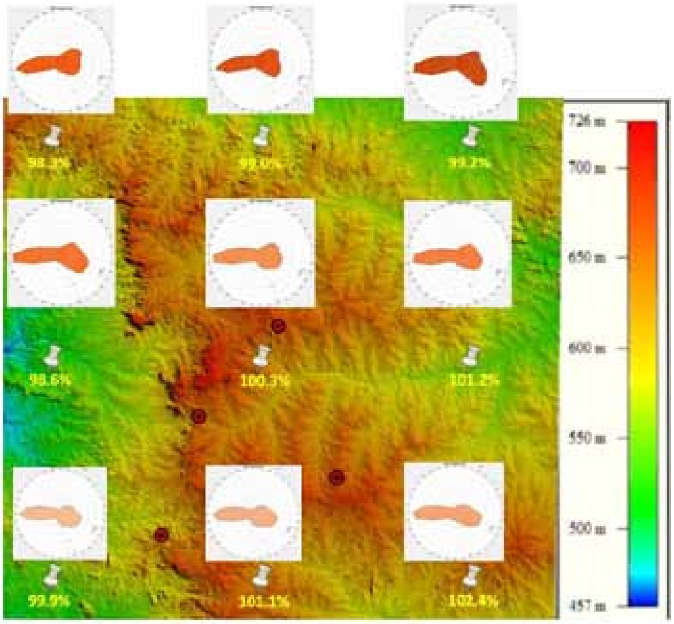


Figure 7: *Wind Speeds (% of Mean Wind Speed) and Wind Roses from ERA 5 Points at 900 hPa (≈989 masl) Over the Model Space*

In order to get an understanding of how the ERA 5 based data sets appear in a typical area in middle of southern peninsula of India (figure 7), ten year data sets were chosen from nine points (17.00-17.5 Latitude 77.75-78.25 Longitude). Data from 100 m agl and 900 hPa were looked at. With average ground elevation in the area of interest being around 510 to 670 m amsl, the mean wind speed and wind roses were plotted at respective grid points. We are looking at a fairly large area of over 8000 square kilometres.

Some observations worth noting are that the average ground elevation for the region under consideration is in the range of 590 m asl and the ERA 5 data for the area at 900 hPa (989 masl) the variation in wind speed and directions appear to be quite comparable and variations are within from -2.4 to +1.7% of the mean. Further, the wind roses from the nine ERA5 points around the area of interest, they possess very similar meteorological properties. This implies that the local upper air exhibits fairly uniform wind flow conditions both in direction and magnitudes. Closer to the ground, at 100 m agl, the variations are in the range of -3.0 to +3.5% on annual averages and seems to be logically acceptable. When such data is used to capture the climatic adjustments, there is an implied agreement that the wind flow model created for the area is operating in a region with homogeneous climate.

Figure 8 provides a measure of the relative complexity of the region. It can be seen that the RIX is around zero for a major part of the area under consideration. Therefore, measured data from the masts installed in the region is expected to provide reasonable estimates of energy for a future wind farm without distance-based limitations.

The concept of ruggedness index will be part of any flow model although it may not be defined in this manner. Consequently with small perturbations introduced by the terrain features will get modelled reasonably well. Therefore, it will be able to predict the generation numbers with reasonable accuracy providing that the ground-based measurements have been carried out at multiple locations.

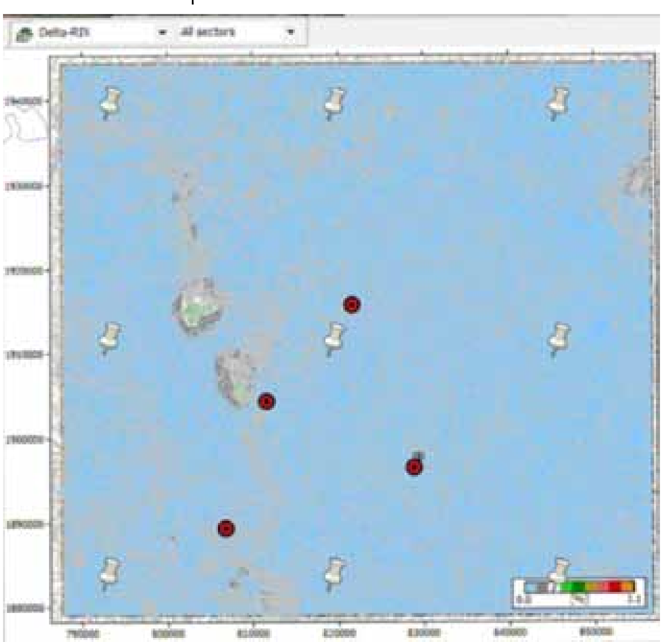


Figure 8: *ΔRIX Plot over the Area of Interest*

4.0 Impact of Measurement Height

Measured concurrent data sets from 29 meteorological masts in five contiguous wind farm areas have been studied with a view to calculate cross prediction errors. The meteorological masts used in this study have mast heights of 100 m, 153 m and had anemometers located at 57 m, 75 m, 100 m, 120 m, 130 m, 140 m and 153 m agl. Most of the measurements have been undertaken with representativeness of sites as the primary concern while keeping the ten kilometre radius as one of the guiding factors but not the only criterion. The sites are in simple terrains and a few masts are located in gently undulating terrain. In this study, we have tried to look at the cross prediction errors with respect to the distances between the masts and the height of measurement above the ground. The results are presented in figure 8 showing the cross prediction errors as a function of inter mast distances. The influence of measurement height on the cross prediction error in terms of distances has also been explored.

The sample size for this study is somewhat less than those used by the other two researchers. However, the results do show similar trends. An important observation is that the cross prediction errors are in the range of 2 to 6% and does not increase very drastically. There are some outliers which is quite natural due to the nature of diverse ground situations.

The measurement heights have grown over the years to keep up with hub heights of the wind turbines. The advantage of this is the reduced uncertainties on vertical extrapolation. However, one observation is that measurements at higher elevations above ground level appear to show lower cross prediction errors as compared to the anemometer pairs at lower elevation. With more studies the fact that measurements with taller masts do produce lower cross prediction errors and reduce uncertainty in the energy estimates would become apparent.

5.0 Analysis & Conclusions

Admittedly the wind energy prognosis has come a long way from the days of frequency distribution based calculations. At over 39 GW of wind power installed and working for over two decades in diverse environmental conditions many lessons have been learnt. There is enough information available in terms of input data, possibility of validating assumptions and it is being done on an on-going basis and used in improving the accuracies. A distinction must be drawn from the energy prognosis for small clusters of wind turbines with short height wind masts which were few and far apart and today's Giga watt size wind farms that spread over typically 50 km x 50 km and more, the very advanced and validated flow models. The sample case is typical of the kind of sites that are available today for wind farming. The terrain is far from sea coasts or mountain passes, there are no significant orographic features that will cause creation of heterogeneous wind flows. Keeping in view the project sizes of present day in the GW range and area requirements, it is always necessary to have multiple meteorological masts.

We have looked at the cross prediction results which do not show high sensitivity or divergence as the masts become more and more distant. If we take a closer look at ERA data at 100 m agl and at an equivalent height of about 400 m agl (900 hPa over a terrain of about 510-670 m above mean sea level) the wind flow pattern appears to be fairly uniform. The highest

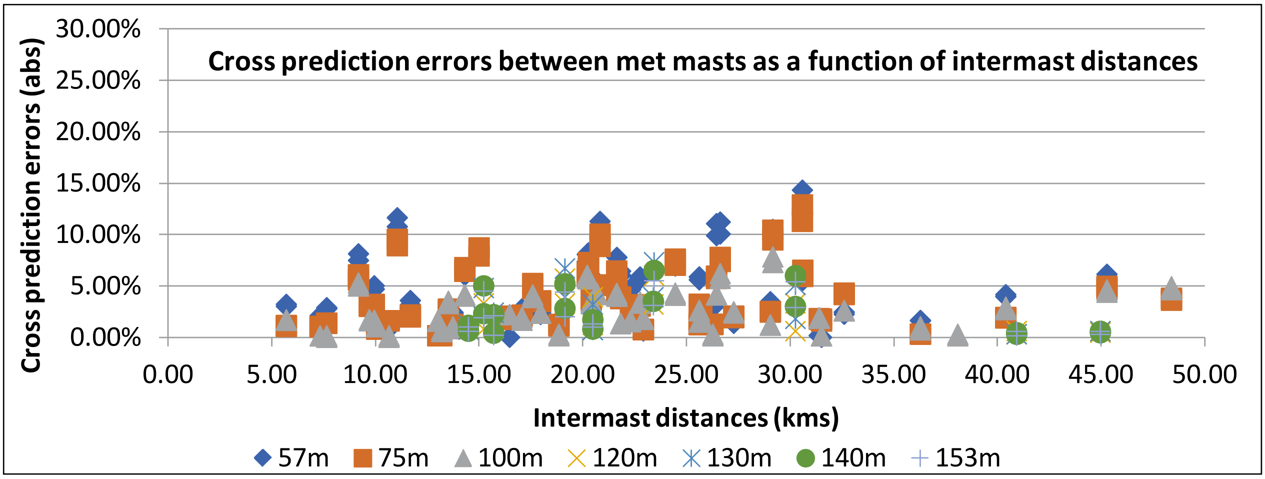


Figure 8: *Cross Prediction Errors Plotted Against the Inter Mast Distances*

to lowest elevation differences in an area of over 8000 square kilometres is in the range of 150 meters.

The ΔRIX across the area under consideration being very close to zero except for some very isolated pockets the meteorological similarity between the mast location and probable turbine location must govern the analysis and results acceptable. The advantage of advanced analytical tools and experience in wind prospecting should be available for the newer projects. Measnet in its 2016 publication has defined the maximum distance from the mast to farthest turbine is to be 10 km in level terrain and 2 km in complex terrain[11]. International standard being formulated for site suitability input conditions for wind power plants does not define any such distance. It requires the analyst to deal with associated uncertainties pragmatically. The extrapolation for larger distances would be associated with higher uncertainties. In a techno-commercial environment, if some seemingly well intentioned recommendations are made, invariably they would be used as a non-negotiable parameter to be adhered to strictly. It is obvious that in multi mast measurement campaigns lasting several years the risks of getting a divergent result are lower as compared with single mast predictions, so long as all aspects are carefully considered. That applies to even turbine locations within the ten kilometre distance from the mast. In conclusion it may be said that:

1. It is essential to recognise the fact that there is a vast difference in the way energy prognosis is carried out today as compared to what was done three decades back.
2. Advance wind flow models, like NWP or CFD should be used instead of linear models. There is an urgent need to bring in the advantages of modern methods to minimise project risks at the same time avoid over conservative approach.
3. The guidelines framed with technologies available three decades back must be looked into again and modified. For example, when multiple masts are used in large wind park areas for establishing the wind flow model, the inter-mast distances should stop being a limiting factor.
4. If there is a compulsion to put a number on the mast to turbine distance, perhaps it should be a range of 10-15 km. Although, this is not ideal, with the use of advanced models the risks associated with large horizontal extrapolations can be assessed in the uncertainty analysis on a project specific basis, which has been the common practice among independent third party consultants. Principles of similarity should be verified and used.
5. While increased number of measurement points is expected to improve the reliability of estimates, small excursions in the mast to turbine distances may be allowed based on good engineering judgement and analysis.

References

1. P. Nilakantan, Some Considerations in the choice of areas for preliminary wind power Surveys Technical note. TN – W – 9 – 62, 1962
2. M. P. Ramesh, (December 2007) Wind resource assessment in India: a program with a difference, International Journal of Environmental studies. Vol.64, No.6, 695-708
3. Anna Mani, (1990) Wind Energy Resource Survey for India – 1 ISBN 81 – 7023-297-X Allied Publishers Limited
4. E. Kalney et al, (1995) The NCEP/NCAR 40-Year Reanalysis Project, Bulletin of the American Meteorological Society
5. M. P. Ramesh & A. P. Chandran, (2000) Micro Survey Report for Sankaneri, Tamil Nadu, Report prepared at National Aeronautical Laboratory for Ministry of New and Renewable Energy, Government of India
6. Guidelines for wind measurement by private sector and subsequent development (20.062008), No.51/9/2007 WE, Ministry of New and Renewable Energy, Govt. of India
7. AWEA Standard 8.1 -1986, Standard Procedures For Meteorological Measurements at a Potential Wind Turbine Site, Siting Subcommittee Standards Program, American Wind Energy Association, 122 C Street, NW, Fourth Floor Washington, DC 20001 USA Cooperative Agreement DE-FC01-80CH10302
8. Lars Landberg, (2016) Meteorology for Wind Energy, An Introduction; John Wiley & Sons 2016; ISBN 9781118913444
9. C. Hilgenbrink, (2019) "Round-Robin Validation of Spatial Wind Modelling Using NWP at Large Number of Site in Diverse environments", tech rep., Vaisala
10. Andreas Bechmann, Juan Pablo M. Leon, Bjarke T. Olsen, and Yavor V. Hristov, (2020) "The most similar predictor – on selecting measurement locations for wind resource assessment", Wind Energ. Sci., 5, 1679–1688.
11. MEASNET Procedure: Evaluation of site-specific wind conditions, Ver 2 April 2016

Printed by R.R. Bharath and published by Dr. Rishi Muni Dwivedi on behalf of Indian Wind Turbine Manufacturers Association and printed at Ace Data Prinexcel Private Limited, 3/304 F, (SF No. 676/4B), Kulathur Road, Off NH 47 Bye Pass Road, Neelambur, Coimbatore 641062 and published at Indian Wind Turbine Manufacturers Association, Fourth Floor, Samson Towers, No. 403 L, Pantheon Road, Egmore, Chennai 600 008.
Editor: Dr. Rishi Muni Dwivedi

Snippets

NIWE Presents First Wind Turbine Type Certificate

National Institute of Wind Energy (NIWE), Chennai is an autonomous institution of Ministry of New and Renewable Energy (MNRE). NIWE provides the certification services in India based on the IS/IEC 61400-22:2010. Dr. K. Balaraman, Director General, NIWE bestowed the first wind turbine Type Certificate to Siva Wind Turbines for Siva 250/50 model in India. IWTMA congratulates NIWE in achieving this important milestone.

ReNew Power CMD Mr. Sumant Sinha Recognised as SDG Pioneers by UNGC

United Nations Global Compact has recognised Mr. Sumant Sinha, Chairman & MD of Renew Power, as one of the ten SDG Pioneers 2021, for his work to advance access to clean and affordable energy. SDG Pioneers are business leaders selected by the UN Global Compact for doing an exceptional job to advance the Sustainable Development Goals (SDGs) through the implementation of the UN Global Compact Ten Principles on human rights, environment, labor and anti-corruption. As the leader of India's leading renewable energy company, ReNew Power, Sumant has set an example by building the core business of ReNew Power around the targets of SDG 7.

Source: PTI, June 17, 2021, 15:28 IST

IWTMA Meeting with CMD, TNEB and Principal Secretary, Energy Department, Government of Tamil Nadu

IWTMA team met Mr. Rajesh Lakhoni, IAS, Chairman and Managing Director, Tamil Nadu Electricity Board and Shri Dharmendra Pratap Yadav, IAS, Principal Secretary, Energy Department, Government of Tamil Nadu on 12th July and 13th July 2021 respectively. The team discussed various matters for the development of wind power in Tamil Nadu especially Repowering of wind turbines, Wheeling and Banking and Offshore Wind Power Project on Tamil Nadu coast. It was also stressed that Tamil Nadu is endowed with one of the best wind resources in the country which can be gainfully employed for investment into the State, Creation of Rural jobs, Development and benefit to tertiary business and export of power from Tamil Nadu to other States on a trading mechanism.

Bihar CM Asks Officials to Speed up Installing Smart Meters in Every House

Reiterating his demand for 'one nation, one electricity rate' in the country, Bihar CM Mr. Nitish Kumar asked the energy department to accelerate the installation of prepaid smart meters in each household of Bihar. He assured the officials that there would be no dearth of funds for the ongoing work of installation of prepaid smart meters. Nitish said the prepaid smart meter scheme was first launched in Bihar. Later, the Centre adopted it for implementation in other states.

Source: TNN, May 23, 2021

Free Power to Farmers in Andhra Pradesh for Next 30 Years

The Andhra Pradesh government has decided to continue to provide free power for agriculture for the next 30 years. The power utilities of Andhra Pradesh are currently supplying free power to more than 18 lakh agricultural services.

The state government is developing necessary power infrastructure to continue the scheme for the next 30 years. As part of this, the government will exclusively set up a 10,000 MW solar power plant for making the free power scheme a permanent one. The subsidy given by the government to the agricultural sector in the 2018-19 financial year was Rs 6,030 crore against Rs 8,559 crore in 2020-21. Energy Secretary has said that the nearly 6,000 agricultural feeders consume around 15,700 million units of energy per annum, equivalent to the 24% of the total energy demand (66,000 MU per annum) of the state.

Source: TNN, May 31, 2021

Adani Electricity Launches Green Tariff Initiative to Switch to Renewable Energy

Adani Electricity Mumbai Limited (AEML) has decided to offer a Green Tariff Initiative for its consumers in Mumbai suburban area. As per the company's official release, all consumers right from corporates, industrial, commercial, hotels, restaurants, and residential consumers can now switch to green energy. The consumers can opt for Adani Electricity Green Tariff Initiative by paying an additional tariff of Rs. 0.66 paise per unit, AEML said. The switch can be done with immediate billing cycle and customers will receive green power certificate on a monthly basis with a separate green colour bill indicating separate line item - Green Power Tariff. The company said its consumers will have the flexibility to decide what should be the percentage of renewable energy in their total energy consumption.

Source: Livemint, 04 June 2021

SECI Invites Bid for 1,200 MW ISTS-Connected Wind Power Projects

The Solar Energy Corporation of India (SECI) has invited bids for setting up 1,200 megawatt (MW) ISTS-connected wind power projects be set-up on a build-own-operate basis in India under tariff-based competitive bidding. The last date for submission of bids is 6 July, 2021.

SECI will enter into a power purchase agreement with the successful bidders selected for a period of 25 years for discoms of Madhya Pradesh.

Source: ET Energy World, May 27, 2021

ISA, MNRE, World Bank Conduct Workshop for One Sun One World One Grid

The International Solar Alliance (ISA), the Ministry of New and Renewable Energy (MNRE) and the World Bank organised conducted a two-day strategic inception virtual workshop on 'One Sun One World One Grid (OSOWOG)' wherein all the implementation partners came together and presented their roadmap for OSOWOG. "Political leadership from other countries have also expressed faith in our vision of a solar grid interconnected with RE across countries… Some multilateral announcements are likely to be made later in the year." Mr. Indu Shekhar Chaturvedi, Secretary, MNRE said in his keynote address. Dr. Ajay Mathur, Director General - International Solar Alliance said, "The advantage of interconnecting regional grids to each other provides a huge opportunity in terms of availability of the solar electricity, especially at times in a place where solar electricity is not available from other regional grid where solar electricity is available.

Source: ET Energy World, May 26, 2021

Registered with REGISTRAR OF NEWSPAPERS for India, New Delhi
Vide No. TNENG/2015/60605

April - May 2021
Date of Publishing: 18.08.2021

ACE DATA, Coimbatore