

EDITORIAL



A welcome revival of the Wind Sector with a all time high annual installed capacity of 3.4 GW end of this financial year has shown a good sign towards reaching the targeted 60 kW by 2022.

We hope to double this

in the coming year which would be the right way forward to reach the targets. Wind Sector is also vibrant in the area of Small Wind Energy Systems (SWES) which is often combined as Wind - Solar hybrids which is finding applications on roof tops, telecom towers and several remote border areas & mountain locations. However, it requires further awareness creation and cost reduction and scaling up of market to have a big impact with small contributions in climate change mitigation efforts. The wind sector also is deprived of market for all the Wind Turbine Equipment Manufacturers over 20 as of now, facilitating a good share only to multi-megawatt players. Yet there is International enthusiasm and interest in creating state-of-the-art manufacturing facilities in India with latest features of multi-megawatt wind turbines for India specific low wind regime. This happens with higher capacity per WTG close to 2 to 3 megawatt with larger diameter rotors and taller towers of steel, concrete and hybrid lattice towers. Some of the new entrants/models are Acciona from Spain and GE Renewables who have released India specific multi-megawatt models this year.

We hope Govt. of India will certainly come out with the much awaited repowering policy wind-solar hybrid tariffs, first offshore wind farm, micro-grid policy to support sub-megawatt makers in India, inter-State transfer of power, open access sale of wind power, in addition to promoting off-grid isolated systems. The expectation of the Industry is also enhanced tariffs for wind farms integrated with energy storage systems operating like a conventional power plant. The wind industry waits to win the race from the other Renewables with the above policy initiatives.

The LiDAR structure installation order has been placed for Gujarat and several environmental clearances, other CRZ clearances are in the process. The WINDCUBE v2 equipment has been delivered at NIWE and is under calibration. The Small Wind Sector is planning for a series of promotional workshops to explain the new MNRE scheme for the stake holders for which the first has been held in Bhuvaneshwar.

Wind Power Forecasting services has been a good success in Tamil Nadu Region. The cooperation of Vortex-NIWE delivering real time forecast has been recognized by the Governing Council which recommended expansion of the service pan-India to all the windy States. The International Workshop on forecasting & scheduling and the International Workshop on NIWE's joint offer of accredited certification services along with TUV Rheinland, Germany have made a big impact among the stake holders in the Industry.

Wind Turbine Testing of 3 machines are getting ready with the instrumentation and mock tests being carried out while waiting for the windy season.

NIWE Scientists along with SLDC (TANGEDCO) and SRPC/SRLDC have been deliberating various issues of implementing LVRT requirements with greater rigor as CEA-dead lines for implementations are already passed but practical issues remain. At WTRS, Kayathar innovative micro thruster augmented wind turbine project and wind-solar hybrid projects are in progress. Two courses one international and a national and celebration of foundation day on 18-03-2016 mark this quarter. Engineering services unit was able to complete the dedication of NIWE to the Nation by President & Chairman of NIWE Mr. Upendra Tripathy I.A.S, Secretary, MNRE.

Team NIWE goes international offering services abroad, with your well wishes, and hope to improve its delivery quality, quantity in right time line with your constructive critics of Pavan.

Dr. S. Gomathinayagam, Director General

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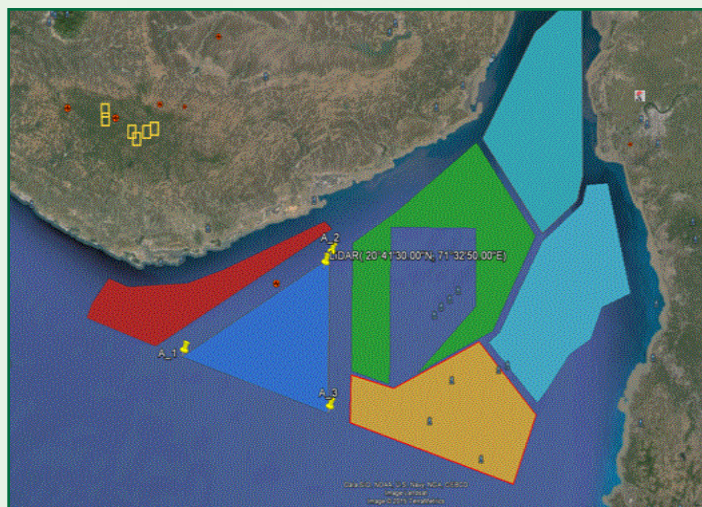
Offshore, Small Wind Hybrid System & Industrial Business

Offshore activities

(i) Environmental impact Assessment for installation of LiDAR substructure

NIWE is in the process of preparing a rapid Environmental Impact Assessment report (EIA) for installation of the LiDAR substructure near Pipavav Bandar, in Gulf of Khambhat for offshore wind resource assessment. The EIA report is to be submitted to the Gujarat State Coastal Maritime Zone / Ministry of Environment and Forest & Climate Change (MoEF&CC) for necessary environmental clearances.

Also initiated the process of obtaining clearances from the Ministry of Home Affairs, Ministry of Defence and Department of Space for requisite clearances, in this regard.



Proposed LiDAR location at LiDAR substructure near Pipavav Bandar, in Gulf of Khambhat, Gujarat

(ii) Procurement of Offshore LiDAR for offshore wind resource assessment

NIWE is in the process of establishing a platform substructure for assessing the offshore wind by LiDAR measurement at Gulf of Khambhat, off Gujarat Coast. This is an outcome of the FOWIND project of European Union (EU), aimed at developing a roadmap for offshore wind development in India.

Under the MoU between European Union (EU) and NIWE, a LiDAR has been procured. The LiDAR is Doppler Wind LiDAR system and is of WINDCUBE v2 make. Training will be imparted to NIWE staff for the LiDAR operations. The calibration of LiDAR is planned at Rameshwaram with data from a 120m offshore mast is already existing and the measurements are underway.



Doppler Wind LiDAR system – WINDCUBE v2 Offshore

Small Wind Turbine activities:

(i) Regional workshop on “MNRE Scheme for Small Wind Energy & Hybrid systems” for Stakeholders

MNRE recently has amended the policy on Small Wind Energy System (SWES) wherein Telecom Sector is also considered for Central Financial Assistance (CFA). To foster the growth rate of SWES systems in telecom sector NIWE in association with MNRE is planning to organise regional workshops / meetings for wider dissemination of the recently amended MNRE scheme on "Small wind energy and hybrid systems (SWES)". The workshop will be conducted / organised by NIWE in batches at five locations as per the details given below:

Sl.No.	Venue	Stakeholders
1.	NIWE, Chennai	Tamil Nadu and Karnataka, Andhra Pradesh and Kerala
2.	Pune	Maharashtra, Goa and Gujarat
3.	Bhopal Chattisgarh	Madhya Pradesh and Rajasthan
4.	Bhubaneshwar	Orissa, West Bengal and Jharkhand
5.	Guwahati	North Eastern States

The programme is designed and intended to make awareness for State Nodal Agencies, Financial Institutions / Bankers, Mobile tower operators and the local community users.

The first workshop has been conducted on 28th March 2016 at Bhubaneshwar covering both site selection for both WRA and SWES projects.

(ii) SWES Meeting for Empanelment

The MNRE has constituted a technical committee for review of empanelment of Small Wind Turbines. The Meeting of the Committee was conducted on 02.03.2016. The 13th List of Empanelment will be released shortly, based on the recommendations of the Committee.

Wind Resource Assessment

During the period of January to March 2016, 2 wind monitoring stations (1 in Tamil Nadu & 1 in Meghalaya) have been commissioned and 25 Wind monitoring stations have been closed down (7 in Maharashtra, 1 in Gujarat, 3 in Karnataka, 5 in Rajasthan, 2 in Andhra Pradesh, 3 in Telangana & 4 in Madhya Pradesh). Presently, 79 wind monitoring stations are operational in 14 States and 1 Union Territory under various wind monitoring projects funded by the MNRE as well as various entrepreneurs.

The following consultancy projects have been completed and reports have been submitted during this period;

- Verification of procedure of wind monitoring for 21 sites.
- Preparation of WPD map for 2 sites.
- Energy Estimation for the proposed 150 MW wind farm.
- Power Curve Energy Demonstration (PCED) test for 50 MW wind farm.
- Site validation & Generation Estimation for the proposed 50 MW wind farm.
- Repowering / inter cropping of existing wind farm.
- Wind Resource Assessment Studies for 2 sites.

Wind Power Forecasting services

- One hundred and ten ABT meters were fixed in group connect feeder of ninety substations across the State of Tamil Nadu.
- NIWE developed an in-house algorithm to fine tune the forecast results with the help of real time generation data.
- An automation system has been created to share the refined forecast results to Energy Secretary Tamil Nadu, CE-NCES, CMD – TANGEDCO, Director- Operation, CE, Operation RLDC, Chairman, IWPA & other stakeholders through e-mail.
- Second Interim report has been prepared & sent to IWPA.
- Initiated various activities to develop NIWE's own forecast model using numerical weather prediction technology.

Visitors

Prof. Purnendu K. Das, Director, ASRANet Ltd., 5, St. Vincent Place, Glasgow, G1 2DH, visited NIWE to discuss the modalities related to the INDO-UK Collaborative Industrial Research and Development Programme.

- NIWE developed a dedicated web portal for wind power forecasting.

WRA in uncovered / new areas 2015-16

One number of 50m wind monitoring station was commissioned in the State of Meghalaya.

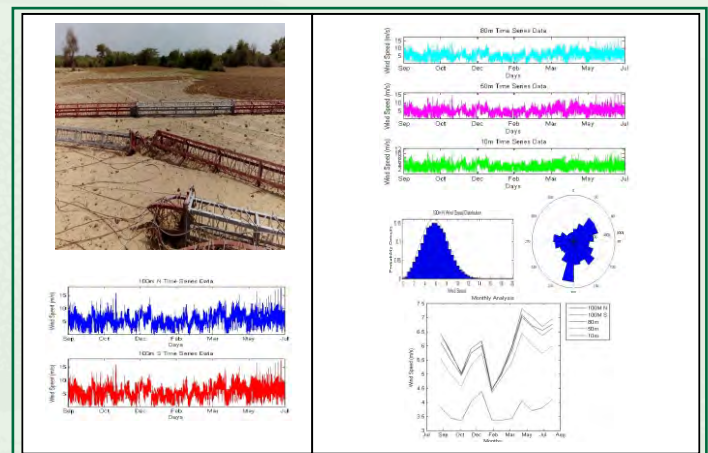
R&D Projects progress in WRA

One number of 50m wind monitoring station was commissioned at Aarupadai Veedu Institute of Technology to understand the wind flow pattern in the region.

Estimation and Validation of WPP at 100m Level in 7 States of India

Wind resource assessment unit has established 75 numbers (10 in Andhra Pradesh, 12 in Gujarat, 12 in Rajasthan, 13 in Karnataka, 8 in Maharashtra, 8 in Madhya Pradesh and 12 in Tamil Nadu) of Wind monitoring stations under the project 'Estimation & Validation of Wind Power Potential at 100m level in 7 States of India' and the data acquisition is in progress.

- One year continuous data acquisition from 69 nos. of WMS (10 in Andhra Pradesh, 12 in Gujarat, 4 in Madhya Pradesh, 8 in Maharashtra, 13 in Karnataka, 10 in Rajasthan and 12 in Tamil Nadu) and two year continuous data from 45 nos. of WMS has been completed successfully.



Monthly Data Analysis

- Continuously monitoring and receiving real time wind data from 27 stations in 7 States.
- Monthly Data Analysis, Verification and preparation of Interim reports are under progress.

The following works carried out for Wind Resource Assessment Studies

- Installation & Commissioning of 4 nos. of WMS at Assam for M/s. Oil India has been carried out.

Other Programmes

- Second Technical committee Meeting to evaluate the technical bids received and to finalize the vendor towards design, fabrication, transportation, civil work & installation of 50m mast has been convened at NIWE, Chennai on 8th January 2016.
- Advance level training on Wind Power Forecasting has been organized at NIWE, Chennai during 11th to 13th February 2016.



- First Standing Technical Committee Meeting convened to formulate technical specification for 50m / 80m lattice mast, 10m / 20m tubular mast (for urban wind monitoring) including wind sensors & data loggers and LiDAR at NIWE, Chennai on 1st March 2016.
- A.G. Rangaraj, Assistant Director (Technical) carried out verification of DBT meter fixed in selected substations in the state of Tamil Nadu in connection with wind power forecasting during 26th February to 1st March 2016.
- ESRI ArcGIS software training has been arranged for NIWE officials by M/s. ESRI at NIWE, Chennai during 29th February to 2nd March 2016.
- K. Boopathi, Unit Head & B. Krishnan, Assistant Engineer carried out site visit at Bidda, Jammu for preparation of DPR for M/s. JAKEDA, Jammu during 11th to 15th March 2016 and had discussion with Secretary, Science & Technology, Jammu.

International Workshop on Forecasting & Scheduling of Wind Power

Wind Power Forecasting service was launched on 13th May 2015 and is helping Tamil Nadu's state-owned electricity generation and distribution utility, TANGEDCO, better manage the fluctuations in wind power output in the region. Wind power forecasting plays an important role in the allocation of balancing power. As a technical focal point of the entire spectrum of Indian wind Industry, NIWE has partnered with M/s. Vortex S.L, Spain to enhance wind forecasting initially in Tamil Nadu State. Recently, Indian Wind Power Association (IWPA) had approached NIWE to carryout forecasting of Wind power for the entire State of Tamil Nadu as per CERC norms in vogue. Accordingly, NIWE has developed a new Forecasting service for the wind industry focusing on providing accurate forecast so as to allow the grid operator in the State Load Dispatch Center (SLDC) to evacuate more wind power.

Presently, Wind Resource Assessment unit organized an International Workshop on "Forecasting & Scheduling of Wind Power" jointly with Indian Wind Power Association (IWPA) during 8th to 10th February 2016 in Radisson Blu Hotel GRT, Chennai. Around 150 participants across the country, officials from M/s. Vortex, Spain, M/s. Meteoblue & stakeholders have participated in the said workshop.

Purpose of the Workshop

The wind energy in India with an installed capacity of above 25 GW can add about 4-5% of the total energy generation of India. But accommodating wind energy into the grid is a major issue, as it is an intermittent source of energy which is unable to be predicted. TANGEDCO which is in charge of the grid connection struggles to face this problem. The only way to overcome this issue is the proper forecasting and scheduling of wind energy. Now NIWE has come good in forecasting the wind energy in Tamil Nadu which consists of more than 30% of total installed capacity and the data are sent to the client for further planning. The error percentage calculated based on SERC revised formula was found to be minimum of 2 to 6%. With the forecasting technique has been proved in Tamil Nadu, now the work is to schedule the power, based on the availability and needs. In regard with this work, the workshop will pave the way for discussion between the organizations to find the ways to apply the forecasting techniques throughout the nation and also to schedule the power. Based on which the necessary actions can be taken for evacuation of the maximum wind energy.



Needs of Forecasting and Scheduling

The forerunners of wind energy like China, America, Germany, Spain, etc. has reduced the pollution created from the fossil fuels by connecting the wind energy into the grid. Provided the forecasting has to be effective in order to achieve an intermitted supply of power. To solve this problem of forecasting, NIWE has studied the forecasting techniques along with the help of M/s. Vortex Private Limited, and brought down the error percentage from 80 to 6%. Now in this workshop SLDC and other organizations can interact with the foreigners and come up with the idea of forecasting and scheduling of wind power, which can further enhance the growth of wind energy.

Mr. Sivaprakasam, Chief Guest of the function, gave an idea of how the forecasting and scheduling can help the government to achieve huge RE targets by 2022 and other Green Power projects. Integrating Grid is integrating the nation. Focus has to be shifted to build power infrastructure for reducing congestion, bringing cost effective systems and maximum green power evacuation.

It was Dr.Karl Gutbrod, who initiated the topic on forecasting in the inauguration by giving a brief introduction on "Wind Energy–An International Perspective". He insisted on some of the major reasons on why should we go for wind energy, they are going to be cheaper than the conventional energy because of zero fuel cost, maintain a sustainable growth of nation, reduce the emission from fossil fuels, the current trend of rise in energy demand can be satisfied only with the development of renewable energy, and finally the increase in confidence level on the forecasting techniques carried in wind energy has attracted the nations to explore the potential of wind energy.

Based on the global Power demand-supply chain, he classified the nations in to 3 divisions.

- I) It consists of the nations where the demand of power was remaining stable for years. The rich countries like



Switzerland comes under this category, where meeting the power demand is not at all a problem. With the availability of adequate amount of installed capacity of power, it's not necessary for them to get in to the renewable sector.

- ii) The nations which has a small rise in power demand come under this category. The developed countries like America are in this class. They can go for Renewable energy to meet their demand or they can also handle this with their availability of thermal stations to lead a luxurious life.
- iii) The Indian nation comes in this division, where the demand of power gets keep on increasing with the increase in population. India will be in energy crisis as they don't have enough thermal stations or other conventional sources of energy to meet their demand. So it becomes very much necessary for the nation to explore and utilize the renewable energy effectively to overcome the problem of energy crisis.

He also noted the point that now the global nations are looking into India to find how our nation is going to handle this problem. This can leave way even for other nations to follow.



The workshop addressed the following aspects:

S.No.	Title of the session	Name of the Speaker
1.	Wind Speed Forecasting Methodology- Introduction and Wind Speed Forecasting Methodology in detail	Dr. Karl G Gutbrod Meteoblu AG, Switzerland
2.	Wind Power Forecasting- a wind turbine manufacture perspective	Ms. Line Storelvmo Holmberg, Director Plant Siting & Forecasting, Vestas, Denmark
3.	Energy Storage	Mr. Ryan Jansen Saskatchewan Research Council, Canada
4.	Wind Energy Forecasting by NIWE- Vortex	Mr. Jordi Ferrer, Director, Vortex FDC, Spain & Dr. S. Gomathinayagam, DG, NIWE
5.	Danish experiences on Integration of Large Share of Wind Power	Mr. Peter Jorgensen, VP, Energient, Denmark
6.	Integrating and Balancing Renewable Energy in Denmark	Mr. Nevils Bisgaard Pedersen, Senior Advisor Danish Energy Agency (DEA)
7.	Scheduling Practices cum Integrating and Balancing Renewable Energy in Spain	Mr. Alejandro Lopez Couselo, Metering & Energy Trading Manager, Gas Natural Fenosa Renewables
8.	Practices followed in Spain for full absorption of Wind Energy by Ramping Up/Down of the Conventional Sources	Mr. Daniel Sanchez Luque, Renewable Dispatch Center Supervisor, Gas Natural Fenosa Renewables
9.	Green Energy Corridors	Mr. Kashish Bhambhani, CE – Smart Grid PGCIL, New Delhi
10.	Carving out Tamil Nadu Wind Power as a separate control area for common scheduling	Mr. Anil Thomas, Executive Engineer (Operations), SRPC, Bangalore
11.	Issues in integration of Wind Energy from a system operator's perspective	Mr. H K Chawla, DGM, NRLDC
12.	Market mechanism for handling surplus	Mr. Pravin Abraham, Director, Manikaran Wind Energy Power Ltd.
13.	Scheduling Wind Energy: De-pooling & DSM Charges	Mr. Vishal Pandya, Director ReConnect Energy
14.	Scheduling & Forecasting in Rajasthan	Mr. Mahesh Vipradas, Sr.GM & Head Regulatory Affairs, Suzlon
15.	Grid Stability issues in handling Wind Energy and concept of Virtual Pools	Mr. V K Agarwal, ReGen Power Tech Ltd. New Delhi
16.	CERC Regulatory norms in vogue for integrating wind energy in India	Shilpa Agarwal Deputy Chief (Engineering), CERC
17.	Managing Grid Integration of Renewable Generation	Mr. Mahesh Vipradas, Sr.GM & Head-Regulatory Affairs, Suzlon
18.	Karnataka experience in avoiding grid drop of wind energy	Mr. M R Sreenivasa Murthy, IAS. (Retd.) Former Chairman
19.	Tamil Nadu's Experience in full absorption of Wind Energy in Year 2012	Mr. P R Muralidharan, SE-REMC SLDC, TANGEDCO
20.	Global technical requirements for grid integration of wind power plants- Vestas perspective	Mr. Manoj Gupta, Specialist – Grid Integration, Vestas Wind Technology Singapore
21.	Balancing of Renewable Energy	Ms. T. Kalanithy, DGM, Southern Regional Load Despatch Centre, POSOCO, Bangalore

Overview of the Panel Discussion

The discussion started with the moderators summarizing the issues discussed in the 3 days workshop, and then the SLDC members from each of the State introduced themselves and shared about the issues faced in the integration of wind energy into the grid from their perspectives. Finally the moderators came up with the suggestions and plans to be taken forward to solve the issues in the energy sector and also to increase the growth of Renewable Energy.

Suggestions

- The regulation will be framed in order to share the data between organizations. Hence the effective forecasting and scheduling will be carried out as a whole by the authorized organization. The balancing will also become easier to be carried out.
- Forecasting will be carried out both by the generators and the grid operators. Incentives will be provided for generators for effective forecasting.
- The regulation of REC will be maintained properly in all States of India, which can motivate the growth of renewable energy.
- The green corridors which were soon being fully in operation can help the intrastate and interstate transfer of renewable energy.
- The generators should be always recommended to operate the WPP at the standard or recommended range to maintain the grid code, which can provide the uninterrupted power supply.
- The grids will be replaced with a robust one to achieve the grid security.
- The current Indian energy market provides the permission to sell and buy energy through the market.
- As the development of storage system needs more time, the possibility of using the hydro power of neighbor States like Kerala and Karnataka have to be analyzed. Kerala and Karnataka are provided with a high potential of hydro power, where Tamil Nadu is provided with high wind potential.

Wind Turbine Testing

- Type Testing of XYRON 1000 kW wind turbine at Richadewda, Ratlam District, Madhya Pradesh of M/s. Xyron Technologies Limited. The measurements have been closed.
- Type Testing of GVSL 1700 kW wind turbine at Kampaneari Pudhukudi Village, Tenkasi Taluk, Tirunelveli District, Tamil Nadu of M/s Garuda Vaayu Shakti Limited. The measurements have been completed.
- Type Testing of INOX 2000 kW wind turbine at Kidi village, Babra Taluk, Amreli District, Gujarat of M/s. Inox Wind Limited. The measurements at the site are on-going.
- Power Curve Measurement of REGEN 1500 kW wind turbine at Vagarai Village, Dindigul District, Tamil Nadu near Dharapuram of M/s. ReGen Powertech Private Limited. The measurements are ongoing and shall be completed within the windy season of 2016.

Standards and Certification

- Review / verification of documentation provided by the various wind turbine manufacturers for more than 50 wind turbine models in connection with Revised List of Models and Manufacturers (RLMM) – Addendum-I List have been completed.
- As a part of RLMM process, the verification of the manufacturing facility of a new wind turbine manufacturer has been done.
- Organized the RLMM Committee meeting.
- Issued RLMM Addendum-I List dated 03.02.2016 to the Main List dated 28.09.2015 to various stakeholders including wind turbine manufacturers, State Electricity Boards, TRANSCOS and State Nodal agencies, etc. The RLMM Addendum-I List dated 03.02.2016 has also been hosted in NIWE website.
- Prepared consolidated list of wind turbine models and manufacturers marketed in India with Type Certificate as on February 2016 and the same has been hosted in NIWE website.
- Jointly organized workshop on “Certification of Wind

Turbines in India-Trends, Challenges and Solutions” on 16th February 2016 at NIWE, Chennai with TUV Germany & TUV India.

- NIWE along with TUV Rheinland had discussions with various Indian wind turbine manufacturers on their requirements related to type certification of wind turbines in India.

Dr. S. Gomathinayagam, Director General, NIWE and Mr. A. Senthil Kumar, Director & Head, S&C has made presentations on “Wind Turbine Certification: An Internationally Accredited Services in India now” and “Certification body for Wind Turbines: TUV Rheinland-NIWE” respectively. They also explained the various certification services offered jointly with TUV Rheinland including advantages of availing such certification services. During the workshop, Mr. Jai Prakash Narayan, Product Manager – Wind Certification Body, M/s. TUV Rheinland Industrie Service GmbH has given presentations on various topics on Certification of Wind Turbines. In addition, Mr. Eric Effern, Division Manager, Type Testing has also given a presentation on “Grid Integration – Power Quality and LVRT measurement campaigns for global and Indian wind turbine markets” through video conference from Germany.



Workshop on “Certification of Wind Turbines in India – Trends, Challenges and solutions”

- Based on the Agreement signed with M/s. Southern Wind Farms Limited, Review / Verification of documentation in connection with renewal of certificate of GWL 225 wind turbine model as per TAPS-2000 (amended) has been completed and renewed certificate has been issued to M/s. Southern Wind Farms Limited.



Issuing renewed Certificate to M/s. Southern Wind Farms Limited

- NIWE is providing technical support to CMD of Bureau of Indian Standards on IECRE activities. Communication has been sent to BIS in connection with following two IEC standards which are adopted as Indian Standards:
 - IEC 61400-21:2008, Ed.2, “Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines.
 - IEC 61400-24:2010, Ed.1, Wind turbines – Part 24: Lightning protection.
- Works are being carried out in connection with initiation of next RLMM Addendum-II List.
- Initiated renewal of Certificate of “V 39-500 kW with 47m rotor diameter” wind turbine model of M/s. RRB Energy Limited.
- Based on the request received, prototype application form has been sent for one wind turbine model in connection with installation of prototype wind turbines in India. Review / Verification of documentation received from the wind turbine manufacturer as per MNRE guidelines is ongoing.
- Co-ordination works with Bureau of Indian Standards (BIS) and members of working group on standards in connection with preparation of draft Indian standards on wind turbine related activities are ongoing.
- The continual improvement and maintaining the quality management system are ongoing.
- Mr. A. Senthil Kumar, Director & Head, S&C attended meeting in discussion with officials from UL-DEWI, Mr. Hergen Bolte, Managing Director, & Mr. Siddharth B. Naik, Business Manager-South Asia, wind services held at NIWE, Chennai on 28th January 2016.

Wind Turbine Research Station

Preventive and regular continuous Operation and Maintenance activities like replacement of Gear Oil in the Gear Box, preparation of Transformer Yard, conditioning of Control Panels, Power Panels, Functionality checks of all the sensors, conditioning of transmission lines, etc. carried out for the Wind Electric Generators at WTRS, Kayathar of capacity 4.4 MW for uninterrupted operation of the machines during the windy season 2016.

Portable Phasor Measurement (PMU) Unit (STER make) was installed by SLRDC, Bangalore at 600 kW SUZLON WEG at WTRS, Kayathar as a part of demonstration study of Transient behaviour of WEG's in the wind farm Grid. Required parameters like Voltage, Current, Frequency, Power Generated, etc. are being collected on-line for the above study by SLRDC, Bangalore.

Installation of Micro Thruster Augmented at 200 kW MICON at WTRS, Kayathar by VIT, Vellore is under progress. Erection of cylinder, compressor in the control room at site and laying of pressurised pipe inside the WEG is under progress.

Work on grid integration of 75 kW Solar PV power with one of the 200 kW MICON WEG is under progress and under ground power cable root detection for erection of mounting structure in the wind farm completed and Integration portion (PLC programming) with the WEG completed.

The following visits were coordinated and showcased the Small & Large Wind Turbine Testing, R&D and WRA facilities:

- 20 participants of 17th International Training Course on "Wind Turbine Technology and Applications" on 25th February 2016.
- 14 Faculty members of Energy Engineering from Kalasalingam University, Srivilliputtur on 29th February 2016.
- 48 Students and 2 staff of EEE Department from Tamil Nadu Agricultural University, Coimbatore on 19th March 2016.



Information, Training and Customized Services

17th International Training Course

Successfully conducted the 28 days 17th International Training Course on “Wind Turbine Technology and Applications” during 3rd February to 1st March 2016 to address all aspects of Wind Power starting from introduction to wind and its technology, wind resource assessment, installation, operation and maintenance aspects of wind farms along with financial analysis and CDM benefits. This is a special training course for ITEC / SCAAP partner countries sponsored by the Ministry of External Affairs (MEA), Government of India under ITEC / SCAAP programme. The course was attended by 23 participants from 16 countries (Azerbaijan, Cambodia, Ethiopia, Guyana, Kenya, Lesotho, Mauritius, Myanmar, Nigeria, Oman, Paraguay, Philippines, Sudan, Syria, Tunisia & Uzbekistan)



Release of Course Material

During the 28 days of training, 45 class room lectures were delivered, which was handled by NIWE scientists and external experts, Wind Turbine Manufacturers, Wind Farm and Developers, Consultants, Academicians and IPP to provide complete knowledge transfer. Also arranged practical training at NIWE Laboratories and study visit to (i) Auroville for small wind turbine manufacturing workshop cum hands on training (ii) M/s. Gamesa Wind Turbines Private Limited at Mamandur for large wind turbine manufacturing process (iii) Structural Engineering Research Centre (SERC), Taramani for Wind Tunnel facilities (iv) WTTS / WTRS, Kayathar for large and small wind turbine testing facility (v) Wind Farms in and around Kanyakumari for knowledge on various working wind turbines (vi) M/s. RS WindTech Engineers to know the

operation and maintenance process and (vii) M/s. Appollo Engineering Works to know the Controllers and Transformers.

Dr. Ashvini Kumar, Managing Director, Solar Energy Corporation of India (SECI) was the Chief Guest for the valedictory function and distributed the course certificates to all the participants.



Chief Guest distributing Course Certificates to the participants

19th National Training Course

The 19th National Training Course on “Wind Energy Technology” has been conducted successfully during 14th to 18th March 2016. The course was attended by 38 participants from 13 States with diversified background.

Dr. R. Velraj, Director, Institute of Energy Studies, Anna University was the Chief Guest for the Valedictory function and distributed the certificates to all the participants.



Chief Guest distributing Course Certificates to the participants

Student visits

To motivate research on wind energy, achieving the indigenization and also to create awareness about the activities and services of NIWE, schools and college students are encouraged to visit the campus. During the period from January to March 2016, the following visits were coordinated by the unit.

- 48 students & 5 staff from JRK Global School, Kattankulathur on 27th January 2016.
- 5 International training participants from NITTTR, Chennai on 7th March 2016.
- 53 students & 1 staff from VIT University / School of Engineering, Chennai on 10th March 2016.
- 85 students & 3 staff from Veltech Engineering College, Department of ECE, Chennai on 23rd March 2016.
- Four applications have been processed for student's internship project.
 - Mr. Tyagaraja Modelly Cunden from Mauritius for doing thesis project from 29th March 2016 to 10th April 2016.
 - Ms. Shaimaa Abd Alla Omran from Egypt for training fellowship under Research Training Fellowship for Developing Country Scientists (RTF-DCS) scheme from 14th March 2016 to 22nd August 2016 for a period of 6 months.
 - Mr. Carlos Giron from University of Oldenburg, Germany for a period of 2 months.
 - Ms. Shikha Kumari from Centre for Energy Engineering, Central University of Jharkhand.

- Mr. Sethuraman from Meenakshi Sundararajan Engineering College, Chennai.

Exhibition

NIWE had established and managed its Stall in the following exhibitions and disseminated the information about the activities and services of the Institute along with the wind energy awareness to the visitors in various capacities.

- 103rd Indian Science Congress "Pride of India - 2016" Exhibition organized by Indian Science Congress Association at University of Mysore, Mysuru held during 3rd – 7th January 2016. Hon'ble Minister of Science and Technology, Dr. Harshvardhan inaugurated the stall.



- NIWE stall in the Annual Mega Science Festival at Science City held during 26th to 29th February 2016 at Chennai.

Engineering Services Division

- **Video conferencing:** The Audio – Video conferencing setup has been inaugurated by Secretary, MNRE on 18th February 2016.
- **Solar 15 kW SPV Generation:** The Power Generation of 15kW SPV plant between January to February 2016 is 2707KWh and the Cumulative generation is 101.18MWh.
- **Solar 30 kW SPV Generation:** The Power Generation of 30 kW SPV plant between January to February 2016 is 6129.3 KWh and the Cumulative generation is 39.22 MWh.
- **LAN networking :** i) The LAN restructuring work is under progress at WTRS, Kayathar.
- **CPWD civil works:** i) The Name Board work has been

done in bronze letters on the entrance compound wall in connection with Secretary Visit. ii) The construction of ITCS cabin and new compound wall work has been approved and the CPWD work is yet to be done. iii) Construction of Security Guard room near entrance main gate and iv) The back side new compound wall work is under progress.

General Maintenance Works:

- i) Civil works for Constructing Store room and Staff room at the Utility Block is under progress.
- ii) Construction of roof top shed for 55 kVA Nacelle and near Driver Cabin work is under progress.
- Review of Networking work done at WTRS, Kayathar between 25th to 27th February 2016.

Knowledge Sharing and Management

One of the knowledge sharing initiative is sustained through the Technology Think Tank (TTT) platform. In the present quarter TTT has provided yet another set of NIWE staff an opportunity to ideate and cerebrate in open a clutch of fresh new select topics. What was broached was done, for the benefit of all at NIWE, by the speakers. The cerebration was attended enthusiastically by most of the staff at NIWE, which is now an eagerly awaited weekly gathering on Thursday afternoons at the Conference Hall of NIWE campus.



Technology Think Tank (TTT) lecture in progress

Resource personnel shared their knowledge on topics as varied from Re-cycling for sustainable future to Synchro Phasor Measurement in Electrical Grid. A session on Wave and Tidal Energy as Sustainable and Predictable source of energy elicited a lot of interest and discussion in the audience. Session on the Analytical study of solar forecasting with the help of satellite & solar radiation resource assessment data was much appreciated for the

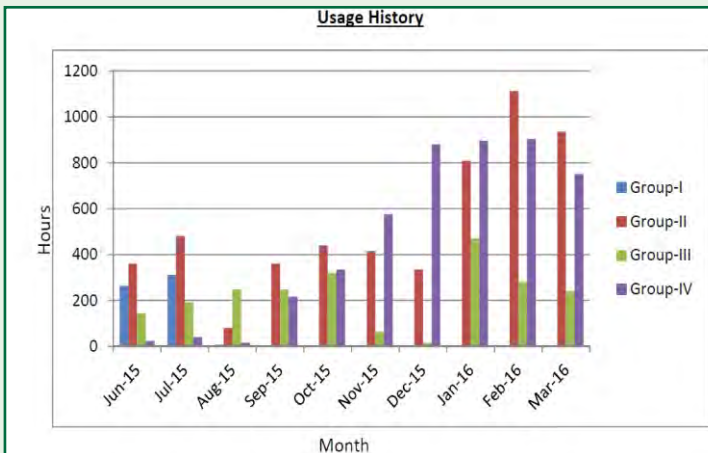
comparative analytics brought forth by the speaker. The session on Central Electricity Regulatory Commission, its functioning and the Indian Electricity Grid Code came out as an informative session for all the young engineers who have entered the portals of wind field.

The unit also conducted as a part of its skill grooming initiative a three day training programme for its engineers in a cutting edge Power System Analysis package. The programme was conducted during 27-29th January, 2016 at NIWE. The engineers trained hands on in a wide range of power system design and analysis study through top notch windows GUI with centralized database. They were able to perform steady state, transient and electro-magnetic transient analysis with utmost accuracy and tolerance during the training period.

The work group facility opened for the use of engineers has been a huge success simply due to the patronage it has received from the engineers who have stepped in to use it from the day of its inception. A meticulous record of the foot fall has been kept to map the profile of usage and the same is compiled below to show the patronage. The work-group strives to hone the skills in the various latest renewable



Training in progress



Usage History

Software Group

Group - I	Wind Resource Assessment & Wind Farm Planning
Group - II	Wind Turbine - Aero Mechanical Design
Group - III	Electrical & Electronics and Power Quality
Group - IV	Computational Analysis and Simulation

software and has rightly found its clientele in NIWE.

During the recent celebration of the open day of NIWE the facility was also showcased to the visitors and was most favoured by the Academia groups who evinced interest in the happenings at the work-group.

Solar Radiation Resource Assessment

- Quality Controlled data of 18 SRRA stations were supplied under SDSAP policy.
- Calibration readings of 14 pyranometers and 7 pyrhemometers were carried out under SRRA and 8 pyrhemometers and 1 pyranometer under commercial mode.
- Submitted draft report of 2 MEDA stations for 1 year under consultancy project to MEDA.
- SRRA carried out micro siting at IIT Bhubaneswar on 18th January 2016 for the relocation of Bhubaneswar SRRA station.
- A training program under PPP mode on "Rooftop PV systems: design and installation" organized through M/s. GSES, New Delhi at NIWE, Chennai during 15th-18th February 2016.
- Submitted Project proposal for DPR preparation at 4 locations in Maharashtra to MEDA.
- A training programme on SRRA, data analysis and Operation & Maintenance were imparted to MEDA officials at Pune on 11th & 12th February 2016 at Pune.
- Relocated PDP, Gandhi Nagar SRRA / AMS station at Gandhi Nagar.
- Price Fixing Committee (PFC) Meeting for review and fixing prices of solar data as per Solar Data sharing and Accessibility Policy (SDSAP) of the Ministry held at NIWE on 26th February 2016.
- Mr. Karthik. R along with two Project Engineers visited SRLDC, Bengaluru for discussion with the officials on solar forecasting during 2nd to 4th February 2016.
- 3 faculty members of NIT, Goa and one Scientist from GERMI, Gandhi Nagar visited NIWE to discuss on collaborative programme.
- NIWE officials, faculty members from NIT Goa and GERMI scientists visited to Smart Grid project location at Pondicherry and PITAM SRRA establishment at Thiruvallur for discussion on collaborative programme on 19th & 20th February 2016 respectively.
- Meeting with GIZ officials on Solar Forecasting held at NIWE, Chennai on 20th January 2016.

Invited lecture delivered / meeting attended by NIWE Official in external forums

Dr. S. Gomathinayagam, Director General

- Panel Member & presentation on behalf of MNRE in the 103rd Session of the Indian Science Congress at Mysuru on 4th January 2016.
- Attended Meeting of Steering Committee of 2nd Renewable Energy Global Investors Meet & Expo (RE-INVEST) at New Delhi on 13th January 2016.
- Meeting with GIZ at NIWE on 20th January 2016. Attended First Doctoral Committee Meeting for Mr. M. Natesan at VIT University, Chennai on 23rd January 2016.
- Attended Foundation Laying Ceremony of International Solar Alliance (ISA) Secretariat Building within NISE Campus at New Delhi on 25th January 2016.
- Lecture delivered in the International Workshop “Wind Engineering and Wind Energy” at BITS Pilani, Hyderabad on 28th January 2016.
- Chaired the RLMM Meeting on 1st February 2016.
- Attended Meeting on compliance of Hon’ble CERC order in respect of Petition at Central Electricity Authority, Southern Region Power Committee at Bengaluru on 5th February 2016.
- Attended the SPC on Energy meeting chaired by Hon’ble Minister for Power, Coal, New & Renewable Energy Shri Piyush Goel at Tripathi on 19th February 2016.
- Invited as Chief Guest and delivered inaugural address on “International conference in Disaster Mitigation Management for sustainable Development and Risk Reduction” at NIT, Trichy on 22nd February 2016.
- Meeting with INOX, Delhi along with TUV Rheinland on 25th February 2016.
- Chaired Twelfth Meeting of the Committee for the Empanelment of Small Wind Turbines at NIWE on 2nd March 2016.
- Attended the first meeting of the Committee to review the Recruitment Rules of NIWE, NISE & NIBE on 5th March 2016.
- Attended the Review Meeting at MNRE, New Delhi on 9th March 2016.
- 37th GC of NIWE at MNRE, New Delhi on 9th March 2016.

- Attended the Consultation meet on establishment of Centralized Monitoring System (CMS) for remote / online monitoring of Grid connected solar rooftop on 9th March 2016.
- Attended the Doctoral Committee Meeting at MIT, Chennai on 23rd March 2016.
- Signed MoU with SA Engineering College and Chief Guest for the inauguration of “Centre of Excellence in Power and Energy Systems” on 29th March 2016.
- Attended GE's Next Generation Wind Turbine & Digital Wind Farm Launch at New Delhi on 30th March 2016.

Dr. Rajesh Katyal, Deputy Director General and Head, OSWH&IB

- Attended a meeting of delegates from European Union on “Technical Assistance for setting up of first off-shore wind farm in India under Clean Energy Cooperation in India Project” held at MNRE, New Delhi on 3rd February 2016.
- Attended a meeting on “Discuss the Draft REMC DPR for the State of Karnataka and current status of Intra State GEC” held at MNRE, New Delhi on 4th February 2016.
- Attended a meeting with Assam Energy Development Agency at Guwahati to discuss about SWTs for telecom tower on 15th February 2016.

K. Boopathi, Additional Director & Head, WRA

- Delivered a lecture on “Wind Resource Assessment & techniques” at Gandhi Gram Rural Institute – Deemed University on 4th March 2016.
- Attended Governing Council meeting at MNRE, New Delhi on 9th March 2016.
- Attended pre-bid meeting at Andhra Pradesh Power Generation Corporation Limited, Hyderabad on 10th March 2016.
- Attended Development of India's Offshore wind industry workshop at MNRE, New Delhi on 22nd March 2016.
- Delivered a lecture on “Instrumentation in Power Plant” at St. Joseph College of Engineering, Chennai on 23rd March 2016.
- Delivered a lecture on “Instrumentation in Power Plant” at Anand Institute of Higher Technology, Chennai on 24th March 2016.

A.G. Rangaraj, Assistant Director (Technical)

- Attended Review Committee Meeting in connection with Grid integration in Southern region at Tamil Nadu Electricity Board on 12th January 2016.
- Attended meeting on compliance of honorable CERC order in respect of LVRT and other provisions of CEA/CERC regulations at Bangalore on 5th February 2016.
- Attended meeting/discussion with SR/REMC on Wind Power Forecasting Services at TNEB on 16th February 2016.
- Attended meeting on formation of REMC organized by Joint Secretary, MNRE and preliminary meeting with Mr. Kashish Bhambhani, Chief Manager, PGCIL at MNRE, New Delhi on 24th February 2016.

A. Senthil Kumar, Director & Head, S&C

- Attended meeting on "Bill of Material (BOM) Evaluation/ Approval Committee for issuance of Special Additional Duty (SAD) and EDEC for manufacturers of (WOEG) and its components" held at MNRE, New Delhi during 17th – 19th February 2016.

A. Senthil Kumar, Director & Head, S&C & **S. Arulselvan**, Assistant Engineer attended SRPC meeting on compliance of Hon'ble CERC order in respect of petition No.420/MP/2014 held at SRPC, Bangalore on 5th February 2016.

Dr. P. Kanagavel, Additional Director & Head, ITCS

- Delivered a lecture on "Green Library" in one day workshop on "Skills Building" on 29th January 2016 organized by PG and Research Department of Library and Information Science of Bishop Heber College, Trichy.
- Attended and delivered lecture on "Scholarly Information Access Methods and Patterns" at Arrupe Library, St. Joseph's College, Trichy in the Rev. Fr. S. Lazar Endowment Seminar on "Digital Visibility of Research Productivity" held on 30th January 2016.
- Delivered a lecture on "Renewable Energy" in Sri Sankara Vidyashramam Matriculation Higher Secondary School, Chennai on 10th February 2016.
- Delivered a lecture on "Research opportunities in the area of Wind Energy Technology" at SRM University, Kattankulathur on 25th February 2016.

- Delivered a lecture for the M.Tech. students of Renewable Energy at Gandigram Rural Institute, Dindugul on 4th & 5th March 2016.
- Delivered a lecture on "Wind Turbine Technology and Applications", covering Energy, Environment and its impact and use of Alternate Energy particularly Wind Energy" at Centre for New and Renewable Energy Studies (CNRES), Periyar University, Salem on 28th March 2016.

Joel Franklin Asaria, Additional Director, ITCS

Delivered a Lecture for the M.Tech. students of Renewable Energy at Gandigram Rural Institute, Dindugul on 4th & 5th March 2016.

M. Anvar Ali, Additional Director & Head, ESD

- Co-ordinated with 17th International training course participants for field visit at Pondicherry on 19th & 20th February 2016.
- Co-ordinated with the International participants for field visit & Ayyanaruthu SS real time monitoring & VC system Inspection at WTRS, Kayathar and Kanniyakumari between 25th to 27th February 2016.

Dr. G. Giridhar, Deputy Director & Head, SRRA

- Chief Guest for the conference organized by Agricultural College, Coimbatore on 22nd January 2016.
- Attended the foundation laying ceremony of International Solar Allianee (ISA) Secretariat Building in the NISE Campus, Guragon and held discussion with MNRE / SECI officials at New Delhi on 24th & 25th January 2016.
- Attended 3rd meeting of the Interim Administrative Cell (ICA) of ISA and meeting with Dr. Ashvini Kumar, MD, SECI on 11th March 2016.
- Delivered lecture on "Solar Radiation Resource Assessment" at NPTI, Bengaluru on 15th March 2016.

Prasun Kumar Das, Assistant Director (Technical) Contract, SRRA

- Delivered a lecture on "Solar Technology and Grid integration" at NPTI, Bengaluru on 15th March 2016.

Karthik.R, Assistant Director (Technical) Contract, SRRA

- Delivered a lecture on "Solar Radiation Technologies" and inaugurated SRRA Facility at NIE Institute of Technology, Mysuru on 20th January 2016.

103rd Indian Science Congress Exhibition

- **M. Anvar Ali, J.C. David Solomon** and **Dr. P. Kanagavel** managed NIWE Stall in the 103rd Indian Science Congress Exhibition held at Mysore University, Mysuru during 3rd to 7th January 2016.

Visits Abroad

Dr. S. Gomathinayagam, Director General, NIWE and **Mr. A. Senthil Kumar**, Director & Head, S&C participated in meetings held with Officials of M/s. Fraunhofer Institute for Wind Energy and Energy System Technology IWES at Bremerhaven, Germany, Officials of M/s. TUV Rheinland Industrie Service GmbH at Cologne, Germany and also participated in "Berlin Energy Transition Dialogue 2016" held at Berlin, Germany during 15th to 18th March 2016.

K.Boopathi, Additional Director & Head, WRA

- Attended "World Future Energy Summit – Global Atlas Workshop" organized by International Renewable Energy Agency (IRENA) on 18th January 2016 at Abu Dhabi.
- Participated and presented a paper on "Wind Power Forecasting – Pilot in Tamil Nadu" in the workshop on advancing the use of Wind & Solar Forecasting to facilitate the integration of variable Renewable Energy to the Grid organized by USEA in collaboration with USG in Bangkok during 16th to 18th February 2016.

K. Boopathi, Unit Head & **B. Krishnan**, Assistant Engineer visited Sri Lanka to carry out site visit for ground reality verification for 10 MW wind farm in Colombo during 17th to 20th March 2016.

Prasun Kumar Das attended the workshop on "Global Atlas Medium-term Strategy" at Abu Dhabi organized by IRENA during 17th to 19th January 2016.

Publications

S. Gomathinayagam, K. Boopathi & A.G. Rangaraj "Scheduling & Forecasting – Experience of NIWE", INWEA Magazine, Vol.11, No.5 pp 20-21.

G. Arivukkodi, S. Gomathinayagam & S. Kanmani "Field Measurement of Wind Turbine Noise Propagation and Guidelines in India" submitted to "World Conference on Energy Sources and Environmental Technologies 2016".

Awards

Dr. S. Gomathinayagam, Director General, NIWE has received **Ariviyal Kalanzhiyam Award** from Mr. Gunaseelan, Former Hon'ble Chief Justice of India, High Court, Bharatiya Vidya Bhavan, East Mada Street, Mylapore, Chennai on 6th March 2016.

TRAINING CALENDAR FOR 2016-17

NATIONAL TRAINING COURSE

Sl.No.	Description	From	To	Duration
1.	20 th National Training Course on "Wind Energy Technology"	07.11.2016	11.11.2016	5 Days
2.	21 st National Training Course on "Wind Energy Technology"	20.03.2017	24.03.2017	5 Days

INTERNATIONAL TRAINING COURSE

Sl.No.	Description	From	To	Duration
1.	18 th International Training Course on "Wind Turbine Technology and Applications" for ITEC / SCAAP Partner Countries	17.08.2016	09.09.2016	24 Days
2.	19 th International Training Course on "Wind Turbine Technology and Applications" for ITEC / SCAAP Partner Countries	01.02.2017	28.02.2017	28 Days

**The following NIWE staff delivered lecture(s) in the 17th International Training Course on
“Wind Turbine Technology & Applications” held during 3rd February to 1st March 2016
and
19th National Training Course on “Wind Energy Technology”
held during 14th to 18th March 2016**

S.No.	Topic	Speaker
1	Introduction and Status of Wind Energy Technology	Dr. S. Gomathinayagam
	Wind Turbine Tower	
2	Wind Resource Assessment and Techniques	Mr. K. Boopathi
	Forecasting of Wind and Energy Production	
3	Guidelines for Wind Measurements	Mr. A. G. Rangaraj
	Wind Electric Generators & Types	
4	Wind Measurements by Remote Sensing Instruments	Mrs. M.C. Lavanya
5	Wind Data Measurements and Analysis	Mrs. G. Arivukkodi
6	Design and Layout of Wind Farms	Mr. J. Bastin
7	Indian Wind Energy Development and Role of NIWE	Dr. P. Kanagavel
8	Overview of Wind Turbine Components	Mr. M. Joel Franklin Asaria
	Offshore Wind Energy	
9	Wind Turbine Gear Box	Mr. N. Raj Kumar
10	Wind Turbine Generators	Mr. M. Anvar Ali
11	Control and Protection System in Wind Turbine	Mr. S. Arulselvan
	Wind Turbine Components	
12	Wind Turbine Foundation	Dr. Rajesh Katyal
	Small Wind Turbine Testing and Hybrid Systems	
13	Wind Turbine Testing & Measurement Techniques	Mr. S. A. Mathew
14	Instrumentation for Wind Turbine Testing	Mr. M. Saravanan
	Power Curve Measurements	
15	Safety and Function Testing	Mr. Bhukya Ram Das
16	Grid Integration of Wind Turbine	Mrs. Deepa Kurup
17	Type Certification of Wind Turbine and Overview of Design Requirements as per IEC 61400 - 1	Mr. A. Senthilkumar
18	Indian Government Policies and Schemes	Mr. Mohammed Hussain
19	Solar Radiation Resource Assessment	Mr. R. Karthik

Training / Conferences / Seminars attended by NIWE Officials

Dr. S. Gomathinayagam, Director General

- Attended International Workshop on Forecasting & Scheduling of Wind Power jointly organized by NIWE & IWPA at Radisson Blu Hotel GRT, Chennai during 8th to 10th February 2016.
- Attended the Workshop on "Certification of Wind Turbines in India – Trends, Challenges and Solutions" organized by NIWE-TUV Rheinland at NIWE on 12th February 2016.

K.Boopathi, Unit Head, WRA attended one day training on modified SWES focusing telecom sector and to deliver a lecture on Wind Resource Assessment & Techniques for M/s.OREDA officials at Bhubaneswar on 28th March 2016.

R. Vinodkumar, JE attended one day training on modified SWES focusing telecom sector and provided hands on training on WRA instruments for M/s.OREDA officials at Bhubaneswar on 28th March 2016.

Wind Turbine Testing

S.A. Mathew, Director & Head, WTT

- Attended the workshop on "Certification of Wind Turbines in India - Trends, Challenges and Solutions" organised by TUV Rheinland India Private Limited held at NIWE, Chennai on 16th February 2016.
- Attended International Seminar on "Planning and Management of Energy in Smart Cities" organised by M/s. Steag Energy Services (India) Pvt Ltd held at India Habitat Centre, Delhi on 28th January 2016.

S.A. Mathew & Bhukya Ramdas

- Attended the training on "Calibration Techniques for Electrical Parameters" organised by Standardisation Testing & Quality Certification (STQC), held at Centre for Electronics Test Engineering (CETE), Noida on 4th & 5th January 2016.
- Attended the training on "Evaluation of Measurement Uncertainty (Electro-Mechanical Parameters)" organised by Standardisation Testing & Quality Certification (STQC) held at Centre for Electronics Test Engineering (CETE), Noida during 20th to 22nd January 2016.

S.A. Mathew & M. Saravanan attended the training on "Wind Turbine Power Performance as per IEC 61400-12-1 ed.1 and IEC 61400-12-2 ed.1" organised by DNVGL held at Bengaluru during 14th to 17th March 2016.

S. Paramasivan and **M. Karuppuchamy** attended the Workshop on "Grounding Practices" organised by Central Power Research Institute held at Bengaluru on 28th & 29th January 2016.

S. Paramasivan attended the Training on "Laboratory Management System and Internal Auditing" based on ISO/IEC 17025:2005 for Personnel organised by M/s. Brainwave Consultants held at Chennai during 18th to 21st January 2016.

M. Karuppuchamy, **T. Sureshkumar**, **B. Krishnan**, **R. Vinodkumar** and **R. Girirajan** attended the 74th Residential Programme on "Stress & Time Management for Managerial Effectiveness" organised by Jaipur Productivity Centre (JPC) held at Goa during 15th to 19th February 2016.

S. Arulselvan, Assistant Engineer, S&C attended the training programme "Mipower Software" conducted by M/s. PRDC, Bangalore at NIWE, Chennai during 27th to 29th January 2016.

A. Senthil Kumar, Director & Head, S&C & **S. Arulselvan**, Assistant Engineer, S&C attended the one day Technology Update seminar on "ANSYS 17.0-10X-performance, Insight, Productivity" conducted by 'ANSYS India' held at Chennai on 11th March 2016.

Dr. P. Kanagavel, Additional Director & Head, ITCS & **M. Joel Franklin Asaria**, Additional Director, ITCS had coordination of one Day Regional Workshop on "MNRE Scheme for Small Wind Energy & Hybrid Systems for SNA officials for the site selection for both WRA & SWES project at Bhubaneswar, Odisha on 28th March 2016.

Prasun Kumar Das, Assistant Director (Technical) Contract, SRRA

Attended a seminar on "Opportunities and Challenges for Renewable Energy Adoption in Tamilnadu" organized by Waterfalls Institute of Technology Transfer (WITT) & The Madras Chamber of Commerce & Industry at Chennai on 16th February 2016.

MiPower Training

Deepa Kurup, **M. Saravanan**, **Bhukya Ramdas** and **A.R. Hasan Ali** attended the Training on "MiPower™ Ver.9.1 - Power System Analysis conducted by M/s. Power Research & Development Consultants Private Limited at NIWE, Chennai during 27th to 29th January 2016.

Arc GIS software training

C. Stephen Jeremias and **Naveen Muthu** have attended ESRI Arc GIS software training at NIWE, Chennai during 29th February to 2nd March 2016.

President & GC-Chairman at NIWE

The President of NIWE Mr. Upendra Tripathy, IAS, Chairman, Governing Council, NIWE and Secretary, MNRE, Government of India had visited NIWE on 18th February 2016 and inaugurated the Video conferencing facility in the campus and opened the Name Board of National Institute of Wind Energy at the Main Entrance of NIWE. He had given an inspiring address to all NIWE Staff members and interacted with the participants of 17th International Training Course. He had spent lots of time with the international participants to know their feed back and suggestions of the training.





18th Foundation Day Celebrations

"Foundation Day", 18th Birthday of NIWE was celebrated fourth consecutive year on 21st March 2016, with variety of programmes. 'Open Day' was announced for public to visit all the facilities of NIWE on 21st March 2016 between 9.30 am and

12.30 pm to create awareness about the Renewable Energy Sources and its applications.

As part of the celebrations, in association with World Wide Fund for Nature (WWF) India, various competitions were conducted for school children wherein more than 600 students from 30 schools across Tamil Nadu participated in the competitions. Dr. Praveen Saxena, Chief Executive Officer - Designate and Former Advisor, MNRE & Director General, National Institute of Solar Energy were the Chief Guest and delivered Foundation Day Lecture at the Conference Hall of NIWE among NIWE staff and winners of the competitions. As Chief Guest of the day, he distributed award to the winning students as well as the awards and souvenirs to the NIWE Staff. Dr. S. Gomathinayagam, Director General, NIWE and Mr. J. K. Jethani, Principal Scientific Officer, MNRE had also addressed the gathering.



Glimpses of Public visit during Open Day of NIWE's Foundation Day



Glimpses of NIWE's Foundation Day lecture and Prize distribution

SOURCES OF WIND TURBINE BLADE NOISE

Dr. S. Gomathinayagam, Director General, NIWE, Chennai E-mail: dg.niwe@gov.in

G. Arivukkodi, Assistant Engineer, WRA, NIWE, Chennai E-mail : arivukkodi.niwe@nic.in

“Boundless and ever glorious you might carry with you, O showers of blessed gifts on humanity,
And unlimited and unbeaten force..” -Hymn on Marut, the God of Wind, from the Rig Veda.

Rig Veda itself states wind is boundless and enormous. Today without any doubt, it is recognized as the most matured renewable energy, which has been growing rapidly in the recent years. Wind farm consist of single or clusters of wind turbines, which when located near residential areas are associated with intrusive and unwanted sound called noise as shown in Fig.1. However, disturbance from wind turbines may be an obstacle for the societal health when acoustical noise would be of great concern. Regarding the source of wind turbine noise, a summary is presented:

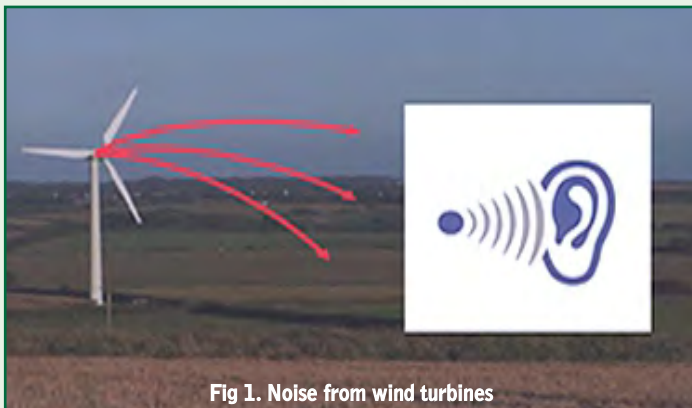


Fig 1. Noise from wind turbines

The total noise generated by a wind turbine is made up of several components, broadly grouped as mechanical and aerodynamic noise. Whenever the wind speed is below “cut-in”, the blades rotate very slowly and consequently minimal noise is generated. When the turbine is operating between the wind speeds of approximately 4m/s and 30m/s measured at hub height, the sound power level monotonically increases. The main sources of the mechanical noise are from the gearbox and generator. Other sources include yaw drivers, cooling fans, auxiliary equipment (eg. hydraulics) and application of parking brakes. The noise emitted from gearbox is structure-borne. The wind turbine mechanical noise can be reduced by some simple mitigation measures such as using acoustic enclosure protected gearbox, periodic maintenance, changing of some mechanical parts which can reduce the emitted noise. However, small wind turbines used in roof-top application will have higher mechanical noise owing to

higher RPM levels of rotor, in addition to operating in higher turbulence close to earth along with building aerodynamics.

On the other hand, the aerodynamic noise comes from the turbine blades passes through the air. Aerodynamic noise contains different frequencies and is considered to be broadband noise. This noise, propagating perpendicular to the blade rotation surface, varies with turbine size, wind speed, and the blade rotation speed. The aerodynamic phenomena that influence wind turbine noise is shown in Fig. 2. The causes of aerodynamic noise are mainly divided into three types:

- Low-frequency noise
- Turbulent inflow noise
- Airfoil self-noise

At high Reynolds number Re (based on chord length), turbulent boundary layers (TBL) develop over most of the airfoil. Noise is produced as this turbulence passes over the trailing edge (TE). At low Re , largely laminar boundary layers (LBL) develop, whose instabilities result in vortex shedding (VS) and associated noise from the TE. For nonzero angles of attack, the flow can separate near the TE on the suction side of the airfoil to produce TE noise due to the shed turbulent vorticity. At very high angles of attack, the separated flow near the TE gives way to large-scale separation (deep stall) causing the airfoil to radiate low-frequency noise similar to that of a bluff body in flow. The remaining source considered here is due to the formation of the tip vortex, containing highly turbulent flow, occurring near the tips of lifting blades or wings.

There are different prediction model stated by Lowson [1], overall sound pressure and sound power level were calculated and analysed for wind turbines of different installed capacity at varying distances. These models require simple input parameters. Lowson classified sound prediction models into three categories depending on the mechanisms causing wind turbine noise. The following Table 1 shows the semi empirical equations for different categories of overall noise prediction models.

Table 1. Overall noise prediction models

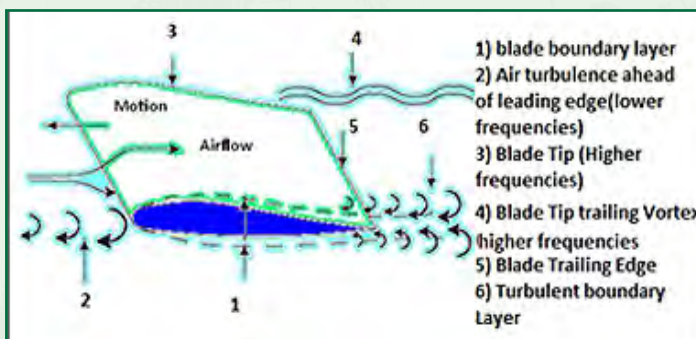
Prediction Models	Equations	
Lowson	$L_{wA} = 10\log_{10}PWT + 50$	Eq.1
Hau	$L_{wA} = 22\log_{10}D + 72$	Eq.2
Hagg	$L_{wA} = 50\log_{10}V_{Tip} + 10\log_{10}D - 4$	Eq.3
Modified Hagg	$L_{pA} = C_1\log_{10}V_{Tip} + C_2\log_{10}(nB\frac{A_b}{A_r}) + C_3\log_{10}C_T + C_4\log_{10}\frac{D}{r} - C_5\log_{10}D - C_6$	Eq.4

The above mentioned equations require inputs such as rated power of wind turbine (PWT) in Watts, rotor diameter (D) in meters, tip speed at rotor blade (V_{Tip}) in m/s, number of blades (nB), blade area (A_b), rotor area (A_r), axial force coefficient (CT), the distance between the rotor hub and the observer (r), and a few constants (C_1 - C_6) [2,3]. The constants C stated by Hagg are given in the Table 2.

Table 2. Constants of equation 4 according to Hagg

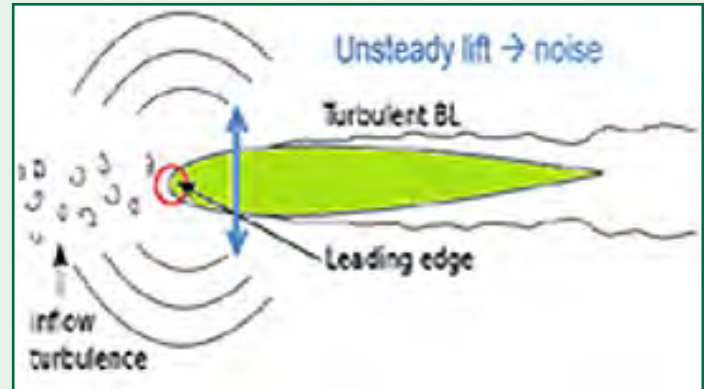
Constant	Value
C_1	63.3
C_2	11.5
C_3	2.5
C_4	20
C_5	10
C_6	27.5

Individual blade noise is found using Grosveld and Brooks, pope, morcolini (BPM) aerodynamic model[4]. In this model turbine is divided into segments, each segment has its own chord, span, angle of attack, free stream velocity, and hence each segment by virtue of varying shape, size and twist has its own contribution on the total sound level emitted.


Fig 2. Aerodynamic noise sources associated with wind turbine blade

Referring to Figure 2, the various aerodynamic sound generation mechanisms are grouped as follows:

i) Inflow turbulence noise


Fig 3. Inflow turbulence noise

As shown in Figure 3, the wind turbine blade move through the air, they encounter atmospheric turbulence that causes variations in the local angle of attack, which in turn causes fluctuations in the lift and drag forces. The semi empirical formula as shown in Equation 5 for wind turbine noise induced by inflow turbulence is based on the work presented by Grosveld [5].

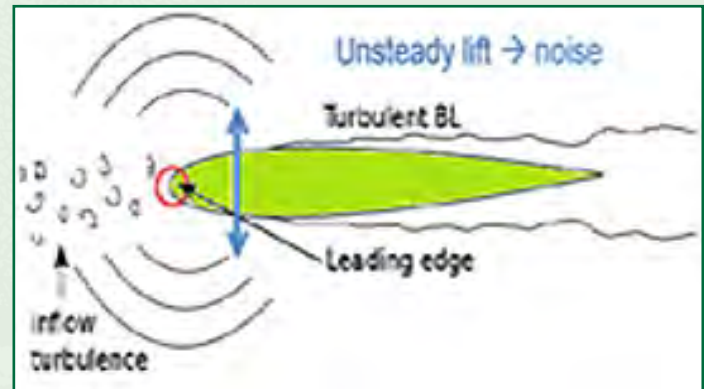
$$SPL_{1/3}(f) = 10\log_{10}[(B\sin^2\theta\rho^2c_{0.7}R\sigma^2V_{0.7}^4)/(d^2a_0^2)] + K_a \quad \text{Eq.5}$$

where,

SPL is sound pressure level at 1/3rd octave band (dB), f is the band central frequency in (Hz), θ is the angle between rotor-hub to receiver line and its vertical projection in the rotor plane(rad) ρ , the air density(kg/m³), $c_{0.7}$ is the rotor blade chord at 70% distance from rotational axis, R is the rotor radius, σ^2 is the mean square of turbulence(m²/s²), $V_{0.7}$ is the blade forward speed at 0.7 radius (0.7 R Ω) (m/s), Ω is the rotor speed (rpm), d is the observed (m), a_0 is the speed of sound (m/s), distance and K_a is the frequency dependent scaling factor (dB).

ii) Turbulent boundary layer trailing edge noise(TBL-TE)

It has a broad band frequency spectrum. As shown in Figure 4, the noise is generated by the convection of blade


Fig 4. Turbulent boundary layer trailing edge noise(TBL-TE)

attached turbulent boundary layer into wake of the airfoil. This is the major source of noise in modern wind turbines with most of the energy in the frequency range 250-1000Hz. Resulting Equation 6 for an airfoil

$$SPL_{1/3}(f) = 10 \log_{10} \left\{ V_r^5 B D \frac{\delta l}{r_0^2} \left(\frac{S}{S_{max}} \right)^4 \left[\left(\frac{S}{S_{max}} \right)^{1.5} + 0.5 \right]^{-4} \right\} + K_b \quad \text{Eq.6}$$

where,

V_r is the resultant velocity at blade element (m/s), D is the directivity factor, M is the mach number which varies with free stream velocity at each chord, M_c is the convection mach number, $0.8M$, R_n is the Reynolds number, l is the length of blade element (m), r_0 is the observed distance (m), S is the strouhal number, S_{max} is taken as 0.1, K_b is the constant scaling factor 5.5 dB.

iii) Laminar boundary layer vortex shedding (LBL-VS) noise

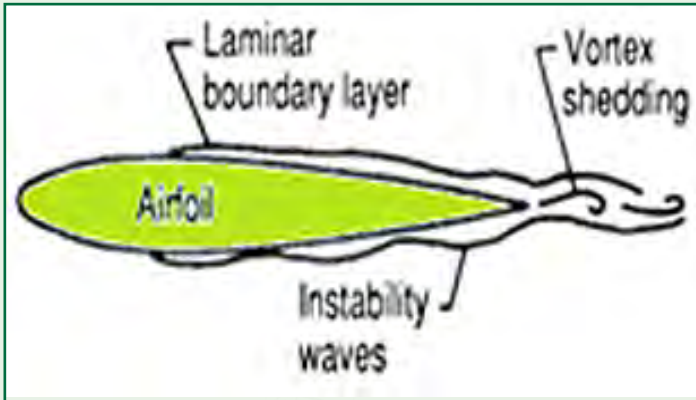


Fig 5. Laminar boundary layer vortex shedding (LBL-VS) noise

A wind turbine can be operated under a Reynolds number range from 105 to 106 because of the changes of relative wind speed and the chord length at different blade radius. As shown in Figure 5, if the laminar boundary layer exist on one or both sides of the airfoil and cover the most of the airfoil surface, a resonant interaction between the unsteady laminar to turbulent transition with the trailing-edge noise will occur. This is termed as laminar boundary layer vortex shedding noise and the empirical relation is shown in Equation 7.

$$SPL_{1/3}(f) = 10 \log_{10} \frac{BV_r^{5.3} t l \sin^2(\theta/2) \sin^2 \phi}{(1 + M \cos \theta)^0 [1 + (M - M_c) \cos \theta]^2 r_0^2} + K_c \quad \text{Eq.7}$$

Where, ϕ is angle between the source-to-receiver line and its horizontal projection in the rotor plane (rad), t is trailing edge thickness (m), K_c is the frequency dependent scaling factor (dB)

iv) Stall- Separation Noise

Separation-stall noise occurs when the angle of attack increases from moderate to high. As the angle of attack

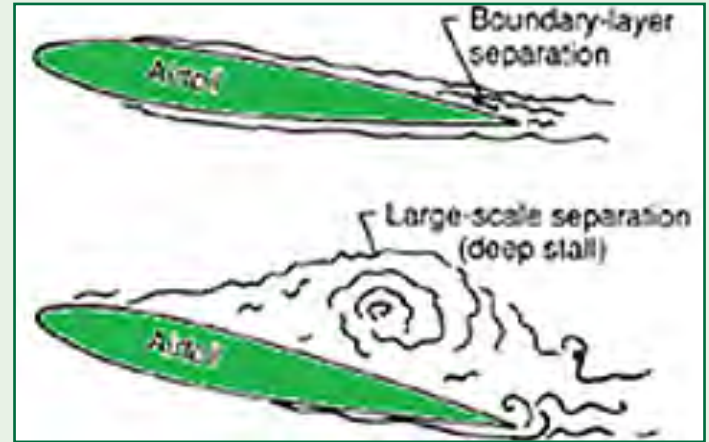


Fig 6. Stall- Separation Noise

increases, the boundary layer on the suction side increases and large-scale unsteady vortex structures begin to form, it is shown in Figure 6.

Empirical relations given by Brooks, Pope, Morcolini (BPM)[4] are shown in Equations 8-11 for separated-stall noise, they are similar to those for TBL-TE noise with different scaling factors.

$$(SPL)_{TOT} = 10 \log(10^{(L_p)_a/10} + 10^{(L_p)_s/10} + 10^{(L_p)_p/10}) \quad \text{Eq.8}$$

$$(L_p)_a = 10 \log \left(\frac{\delta_s M^5 LD_h}{R_e^2} \right) + B \left(\frac{St_s}{St_s} \right) + K_2 \quad \text{Eq.9}$$

$$(L_p)_p = 10 \log \left(\frac{\delta_p M^5 LD_h}{R_e^2} \right) + A \left(\frac{St_p}{St_1} \right) + (K_1 - 3) + K_1 \quad \text{Eq.10}$$

$$(L_p)_s = 10 \log \left(\frac{\delta_s M^5 LD_h}{R_e^2} \right) + A \left(\frac{St_s}{St_1} \right) + (K_1 - 3) \quad \text{Eq.11}$$

where, $(SPL)_{TOT}$ the total separation noise spectrum in a 1/3 –octave, δ_p δ_s are the boundary layer displacement thickness of the pressure side and suction side which is the function of Reynolds number (R_e), there is a boundary layer thickness value for every segment because of the chord and the velocity change along the span, and hence the Reynolds number varies at each segment, α is the angle of attack which is also varying from point to another along the span. D_h and D_l are the directivity functions, A , B are the frequency spectrum shape based on displacement thickness and frequency, K_1 and K_2 are the amplitude functions where K_2 is function of Mach number and K_1 .

v) Tip Vortex Formation (TIP-VF) Noise

As shown in Figure 7 noise is caused by the interaction between the tip vortex and the trailing edge. The tip noise is not significant compared to the turbulent trailing edge noise. Equation 12 only requires the parameters of the tip segment.

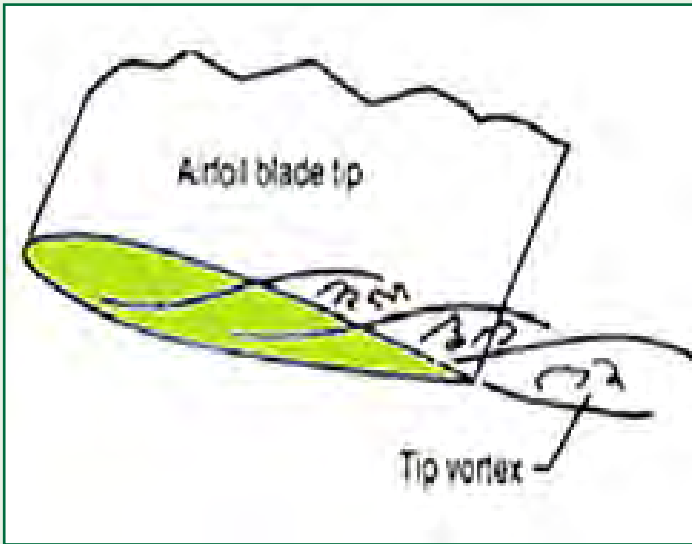


Fig 7. Tip Vortex Formation (TIP-VF) Noise

$$(L_p)_{tip} = 10 \log \left(\frac{M^2 M_{max}^5 l^2 D_h}{R_e^2} \right) - 30.5 \log(St'' + 0.3)^2 126 \quad \text{Eq.12}$$

where,

$M_{max} = M_{max}(\alpha_{tip})$ is the maximum Mach number, $l = l(\alpha_{tip})$ is the spanwise extent of the separation zone, $S'' = \left(\frac{f_h}{U_{max}} \right)$ is the strouhal number, h is the trailing edge gap, U_{max} is the maximum velocity in the vicinity of the tip vortex.

$$L_w = L_p + 10 \log r^2 + C \quad \text{Eq.13}$$

The sound power level is estimated from the overall sound pressure level using Equation 13.

Where, L_w is the overall sound power level, L_p is the overall sound pressure level in dB,

C is the summation of some correction factors depending on the medium of sources, these factors depend on directivity, source characteristics (whole, half, or quarter sphere), distance effect, air absorption, ground and meteorological effects, attenuation by surrounding areas, screening, addition by reflection, correction by the running time or other (tonality, impulsiveness). C is taken equal to 11 as stated by Hagg[3].

In summarizing the increased use of wind turbines develops the need to assess their impact on the environment where they are going to be installed since one of the most important aspect of wind turbines environmental impact on community/ habitat is its noise. In order to assess their noise impact, the sound power level and sound pressure level of the individual wind turbine needs to be estimated. With the help of the semi empirical models depending on available input parameters one can predict the individual blade region noise contribution to the equivalent noise.

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