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EDITORIAL

"Come December a Disaster awaits" is the alert for NIWE. Last December a watery grave swept away properties and person. This December, is a wind storming the loss of Green Cover of NIWE. Leave alone the possible impact of demonetization / cashless transactions in the Industrial Growth, wind sector is already strained with competing solar technologies which are becoming closer to becoming grid parity. We are about 1400 megawatt installed capacity in the 3rd quarter, may be the wind industry is optimistic to reach at least 4000 megawatt this financial year (FY 2016-17).

It is encouraging to have a few more new entrants in the manufacturing of wind turbine equipment in India. However, power purchase agreements, permissions, land acquisitions, low-interest rate operational cash flow, power evacuations and prompt payments from DISCOMs are still the retarding factors for the fast track growth of wind power sector in India inspite of having second largest manufacturing base for WTG equipment in the World to the tune of 8 to 10 GW per year. The under utilization of available manufacturing capacity is also due to the competition from solar counterpart, the late starter in India with the pampered fast track growth. With falling interest rates in the banking sector, if green awareness is prioritized, there is a likely spurt in wind/solar sector growth in India.

NIWE, in this quarter has made significant progress towards realization of offshore wind potential in India by way of measuring wind resource at Tamil Nadu coast and at Gujarat coast. In Tamil Nadu we have bankable measurement for over three years ensuring a potential of wind power generation with annual wind speeds at 8.65 m/s lasting for almost 10 months in a year. At Gulf of Khambhat, Gujarat within a month a LiDAR based measurement project would be commissioned. Geophysical and Geotechnical investigations for offshore project are also initiated.

WRA of NIWE has completed 21 consultancies with 10 MW wind farm verification projects, 274.4 MW energy estimation projects, 100 MW technical due diligence projects during this period. Forecasting services have been upscaled to give effective scheduling as well for the entire installed capacity of Tamil Nadu.

Two agreements for Wind Turbine Testing and an execution of another wind turbine testing at Madhya Pradesh are in progress.

The last RLMM Committee meeting was completed at NIWE on 26-10-2016 prior to RLMM function being directly handled by MNRE. Part of the tasks for the Internationally Accredited Certification projects are already executed by NIWE certification team as part of capacity building in collaboration with TUV Rheinland, Germany.

At WTRS, NIWE / Kayathar, a wind solar externally coupled hybrid project has been commissioned and second 2 MW research wind turbine with DFIG technology is under installation.

Delegates from Netherland & Ministerial delegation from Germany visited NIWE and interacted with Scientists.

During this period, ITCS / NIWE had conducted one National Training programme &. a special training course on Wind Resource Assessment and Wind Farm Planning" for Officials of Ministry of Energy and Mineral Department, Uganda. Induction training for newly recruited Scientists of MNRE was also conducted.

NIWE also participated in few exhibitions during this period by hosting stalls. Around 130 students including teachers and faculty members visited NIWE during this period. 2 students attended internship training at ITCS / NIWE. One student from Senegal joined NIWE under RTF-DCS programme.

Digital India campaign of GOI was participated by NIWE through Video Conferencing. Secretary MNRE dedicated NIWE as a National Institute to the Nation while also inaugurating the Video Conferencing facilities established at NIWE.

SRRA activities include calibration and data processing.

KSM was able to attract several youth in the academia to come and carry out Research using NIWE's facility. 6 TTT series lectures were also organized during the period apart from NIWE staff delivering several invited lectures in external forums.

While I would like to bid farewell to NIWE next month I want to thank "Team NIWE" which has made possible the upscaling of NIWE as a National Institution with 7 fold increase in annual earnings (Net revenue of US $15 million in 8 years) and 5 fold increase in corpus fund, self sustaining salary component for over a decade. 25 staff members obtained higher qualification / graduate / post graduate / Ph.D and 35 staff deputed to foreign country visits. It is immensely satisfying to hand over the baton to a "Elite Team NIWE" to proceed further to meet the targets of 175 GW of renewable energy.

Inviting constructive criticism considering the significant role of NIWE backing a vibrant Industry with 1,80,000 crores of private investment to serve you with renewed vigor and energy, wish you all a Healthy, Happy & Wealthy New Year 2017.

Dr. S. Gomathinayagam, Director General

Contents

Editorial Board

Offshore Wind & Industrial Business

I) i) Sub structure for mounting LiDAR (Monopile & Platform) at Gulf of Khambhat, Gujarat

NIWE has identified offshore wind potential sites in Gulf of Kambhat, Gujarat. In this regard, it was proposed to collect real time wind data by installing LiDAR based offshore data collection platform.

The fabrication work of Monopile & Support platform is underway at the fabrication yard located at Reti bunder, Belapur, Navi Mumbai. The monopile is 42.5m long with 1.2m diameter and is comprising of 3 sections with allied components namely Boat Landing, Fender, Ladder and hand rails etc. The support platform for mounting LiDAR is having 5m Diameter with 25mm Thickness.

The sub structure will be transported to the proposed site location (Lat :20041'30'N, Long :71032'50" E) Gulf of Khambat off Gujarat coast by using Jack Up Barge. The Hydraulic guiding and driving mechanism will be used for installation at the proposed site for which necessary arrangements will be made in the jack up barge. The substructure is likely to be installed and erected by end of January 2017.

ii) Dye penetration Test at Critical Weld Joints on offshore Substructure

The Dye Penetration test was conducted at critical weld joints along with the entire length of the monopole and flange connectors for connecting the platform to figure out surface hair cracks, Weld defects and slag weld insulations.

iii) Requisite Clearances for Substructure work for mounting LiDAR

As per the National Offshore Wind Energy Policy-2015, NIWE has obtained following In-principle clearances / No objection Certificate (NOC) from the following Central Ministries / State Governments for carrying out wind resource assessment studies & associated surveys at Gulf of Khmabhat, off Gujarat Coast for development of offshore wind power projects.

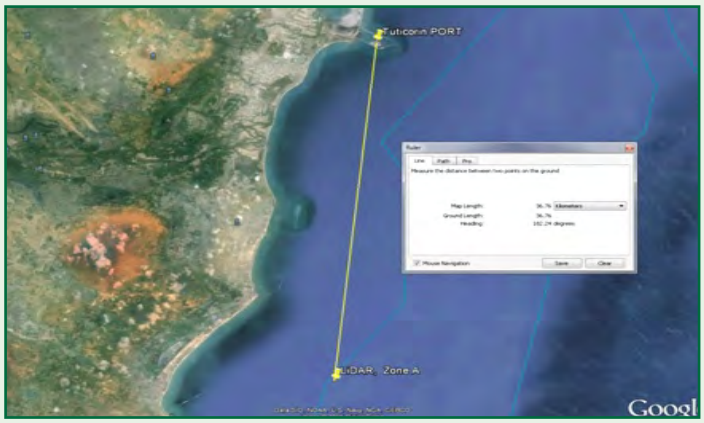
I. Central level clearances			
S. No.	Concerned Central Ministries / Departments	Status of Clearances	Remarks
1	Ministry of Defence (MoD)	Obtained	Clearance related to defence & security aspects, related to Army, Navy, Air force, DRDO and other such institutions under MoD.
2	Ministry of External Affairs (MEA)	Obtained	Clearance for development of offshore wind energy projects within maritime zones of India.
3	Ministry of Home Affairs (MHA)	Obtained	Clearance regarding deployment of foreign nationals in offshore wing energy blocks
4	Department of Space (DoS)	Obtained	Clearance from security angle with regard to DoS installations and for minimum safety distance to be maintained from DoS installations
5	Ministry of Environment & Forests and climate Change	Online Application Filed Clearance Underway	Environmental Impact Assessment & Coastal Regulation Zone Clearance
II. State level clearances			
1	Gujarat Maritime Board (GMB)	Obtained	Clearance for operating near major port to operate away from shipping lanes.
2	Gujarat State Coastal Zone Management Authority (GSCZMA)	Obtained	Environmental Impact Assessment & Coastal Regulation Zone Clearance at state level

In addition to the above, NIWE is also in process of obtaining Naval Security Inspection (NSI) at Mumbai from The Flag Officer Offshore Defence Advisory Group (FODAG) for the respective vessels, instruments and sensors to be deployed at the proposed site for carrying out studies and surveys related to wind resource, oceanographic and bathymetric assessments.

II) LiDAR based offshore wind resource measurement at Gulf of Mannar, Tamil Nadu Coast

NIWE has also initiated the work related to LiDAR based Offshore wind resource measurements at Gulf of Mannar, near Tuticorin port off Tamil Nadu coast. The LiDAR will be installed at Zone A identified as per FOWIND report at Lat. 8° 25' 00" N,

Lan. 78° 12' 00" E. The procurement of offshore LiDAR has been initiated and the requisite clearances from MoD, MHA, MEA and DoS have been obtained for the proposed site. The applications together with Rapid Environmental Impact Assessment report has been submitted to Tamil Nadu Maritime Board (TMB) and Tamil Nadu State Coastal Zone Management Authority (TSCZMA).



Zone-A view along with the location area

III) Geophysical and Geotechnical investigations off Gujarat and Tamil Nadu Coasts.

NIWE proposes to conduct geophysical and geotechnical surveys and studies both off coasts of Gujarat and Tamil Nadu to better understand the subsea profiles. The geophysical and geotechnical studies will cover the entire Zone A as per the FOWIND report both for Gujarat and Tamil Nadu coasts. The tender bid has already been floated and the pre-bid meeting was conducted with the perspective bidders. The queries / clarifications sought by the bidders was tabled before the Standing Technical Committee (STC) comprising of team of experts and the Corrigendum has been finalized and shall be hosted in NIWE's website, shortly. The date for the study will provide useful pointers in preparing the allocation of the blocks for International Competitive Bidding (ICB) for the development of offshore wind farms in India.

Standing Technical Committee (STC) meeting for finalization of Corrigendum

Wind Resource Assessment

During the period of October to December 2016, 7 Wind monitoring stations have been closed down (2 in Gujarat, 1 in Rajasthan, 4 in Chhattisgarh). Presently, 30 wind-monitoring stations are operational in 10 states under various wind monitoring projects funded by the Ministry of New and Renewable Energy (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
- Consultancy services for 10 MW wind farm projects
- Energy Estimation for the proposed 274.4 MW wind farm projects
- Technical Due Diligence of the proposed 100 MW wind farm

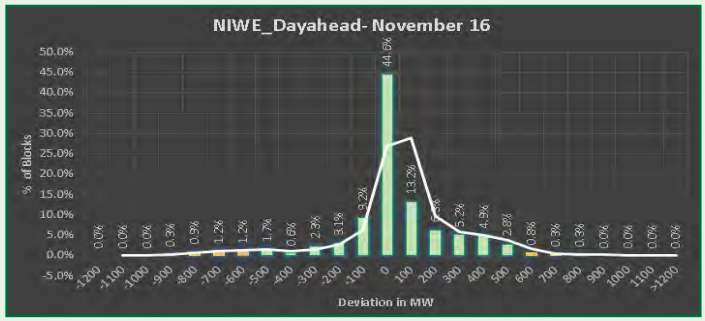
Web portal updation

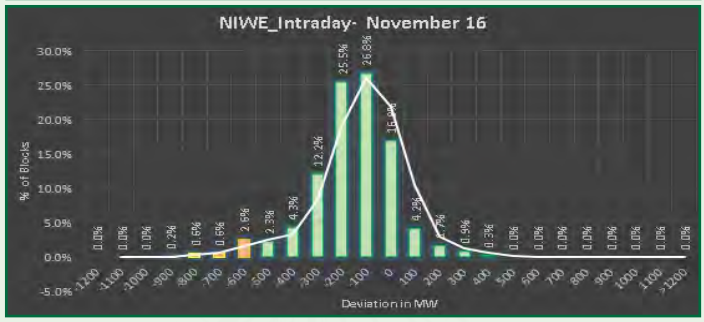
- Updation of MNRE stations data base management in the web portal has been carried out.
- Development & testing of onshore web portal for free accessing of data has been carried out.

Wind Power Forecasting services

- Implementation of NCMRWF numerical system in NIWE is completed.
- Created power curve using NCMRWF numerical system at 25 km resolution for 10m & 50m hub height for 103 sub stations.
- Creation of actual generation data monitor system is completed.
- Actual generation data report for the month of October & November 2016 has been sent to IWPA.

- Customized hub height power curve for 103 sub stations has been completed.
- Validation of created power curve model has been completed.





Forecast Graph

WRA in Uncovered / New Areas 2016-17

- Revised sanction order & 1st installment has been released to all NE region SNAs.
- Internal inspection of 250 anemometers & 50 Data loggers has been completed.
- Internal inspection of Sensors (temperature, pyranometer & pressure) has been completed.

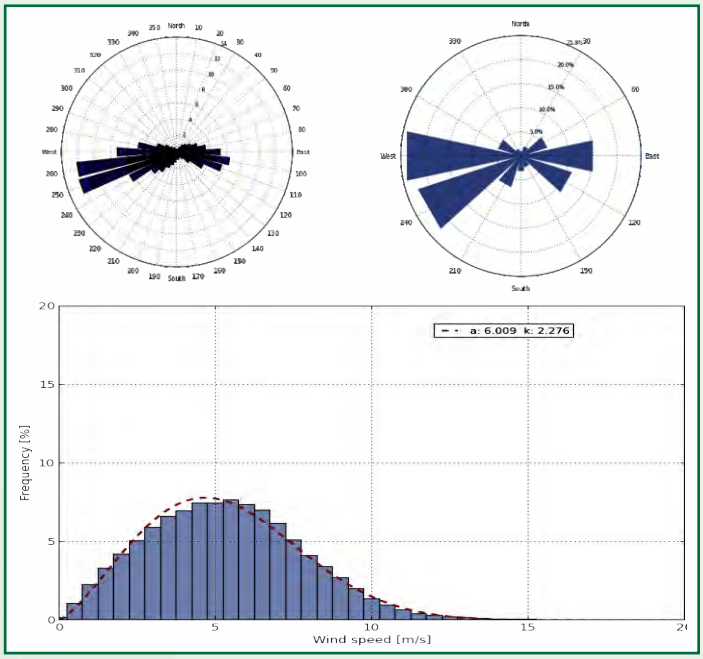
R&D Projects progress in WRA

- Routine maintenance work of SODAR has been carried out.
- Transportation & installation of WMS at Manamelkudi site has been carried out.
- Pin point marking for civil work in Thovalai site for Wind Resource Assessment research has been carried out.
- Transported Triton SODAR from Kallunirkulam site to Kayathar WTRS.

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

NIWE has established 75 (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) Wind Monitoring Stations under the project 'Estimation & Validation of Wind Power Potential at 100m level in 7 States of India' and the data acquisition has been in progress, in the last one and half years.

- Three year continuous data acquisition from 8 WMS (3 in Andhra Pradesh, 1 in Gujarat, 2 in Maharashtra & 2 in Karnataka), two year continuous data from 46 WMS (9 in Karnataka, 3 in Madhya Pradesh, 7 in Gujarat, 11 in Tamil Nadu, 2 in Maharashtra, 6 in Andhra Pradesh & 8 nos. in Rajasthan) and one year continuous data acquisition from 15 WMS (1 in Andhra Pradesh, 4 in Gujarat, 2 in Madhya Pradesh, 3 in Maharashtra, 2 in Karnataka, 2 in Rajasthan and 1 in Tamil Nadu) have been completed.
- Continuously monitoring and receiving real time wind data from 13 stations in 5 States.
- Monthly Data Analysis, Verification and preparation of Interim reports are in progress.
- Dismantling of Sensors and Mast from 62 WMS are in progress.



Monthly Data Analysis

Wind Resource Assessment Studies

- Preparation of Draft & final report for Kudgi site in Karnataka for M/s.NTPC has been carried out.
- Interim report for Doon University has been sent.

MoU

MoU for the Technical Consultancy services for the development of Wind / SOLAR energy projects has been signed between NIWE & National Hydroelectric Power Corporation (NHPC) at NIWE, Chennai on 7th October 2016.

Other Programmes

- Meeting / discussion on Wind Power Forecasting with IWPA / TANGEDCO officials has been convened at NIWE on 18th October 2016.

- WRA Scientists & Engineers imparted training on "Wind Resource Assessment and Wind Farm Planning" for the officials of Ministry of Energy and Mineral Department, Uganda at NIWE during 7th to 18th November 2016.
- WRA Scientists & Engineers imparted training on "Wind Resource Assessment" for ANERT officials at NIWE on 9th & 10th November 2016.
- A.G. Rangaraj, discussed with German delegates on Wind Power Forecasting at NIWE on 18th October 2016.
- Conducted interview for the post of Project Assistants to be posted in NE region at Guwahati, Assam on 26th November 2016 and at NIWE on 1st December 2016.

Wind Turbine Testing

- Type Testing of XYRON 1000 kW wind turbine at Richadewda Ratlam District, Madhyapradesh of M/s. Xyron Technologies Ltd. The Instrumentation work is in progress.
- An agreement was signed between NIWE and M/s. TUV INDIA PVT. LTD. for Site Calibration for Power Curve Measurements of model GE /1700/103, 1700 kW wind turbine (during Low Wind Season) at Badval, Kadapa District, Andhra Pradesh. The measurements have been completed.
- An agreement was signed between NIWE and M/s. ATRIA WIND POWER (SAVARKUNDLA) PVT. LTD. for Site Feasibility Study (SFS) for Power Curve Measurements of its model INOX DF/2000/113, 2000 kW wind turbine at Savarkundla, Amreli District, Gujarat.

Standards and Certification

- Review / Verification of documentation provided by various wind turbine manufacturers for more than 50 wind turbine models in connection with Revised List of Models and Manufacturers of wind turbines (RLMM) – Main List have been completed.
- As a part of RLMM process, Director & Head, S&C and S&C Engineer carried out the verification of the manufacturing facility for one new wind turbine manufacturer.
- Organized the RLMM Committee meeting.
- Issued RLMM Main List dated 26.10.2016 to various stakeholders including wind turbine manufacturers, State Electricity Boards, TRANSCOS and State Nodal agencies etc. The RLMM Main List dated 26.10.2016 was also hosted in NIWE website.
- Prepared consolidated list of wind turbine models and manufacturers marketed in India with Type Certificate as on October 2016 and the same was hosted in NIWE website.
- Subsequent to the issue of MNRE guidelines dated 22.10.2016, RLMM works are carried out by MNRE.
- An agreement has been signed with M/s. Southern wind farms Limited to take up the project on renewal of Certificate of "GWL 225" wind turbine model as per TAPS–2000 (amended).
- Modifications on the draft Indian Standard on "Wind turbines – Acoustic noise measurement techniques" have been communicated to Bureau of Indian Standards (BIS). Based on the modified draft document provided by BIS, an approval for the said modified draft Indian Standard has been communicated to BIS by Chairman, Wind Turbines Sectional Committee (ET 42) / DG, NIWE.
- Co-ordination works with Bureau of Indian Standards (BIS) and members of working group on standards in connection with review of draft IEC documents on wind turbines are ongoing.
- Voting recommendations for four draft IEC Standards / document have been sent to BIS for further forwarding to IEC TC 88.
- Review of request received from one Indian wind turbine manufacturer in connection with installation of prototype wind turbine model in India for the purpose of developmental works, as per MNRE guidelines, is ongoing.
- As sought by MNRE, prepared comments on "Draft Second Amendment in CEA Technical Standards for connectivity to the Grid Regulation 2007 as amended" for submission to CEA.
- Interactions with officials of TUV Rheinland (India) Private Limited & M/s. TUV Rheinland Industrie Service GmbH in connection with certification co-operation works are ongoing.
- The continual improvement and maintaining the quality management system are ongoing.

Wind Turbine Research Station

- Periodic regular Operation and Maintenance activities like preparation of 9 nos of 11 kV / 400 V transformers of 200 kW MICON Wind Electric Generators, transmission lines including transformer yards are being carried out as a part of O&M preparation of the machines for uninterrupted operation during the windy season 2017.
- Installation of Grid integration of 75 kWp Solar PV Power with Existing one of the 27 years old 200 kW MICON WEG @WTRS, Kayathar Completed, using Existing Infrastructure like Land, Transformer, Transmission lines etc. Works on smart controller for the integral portion of wind and solar power to the point of common coupling under progress.

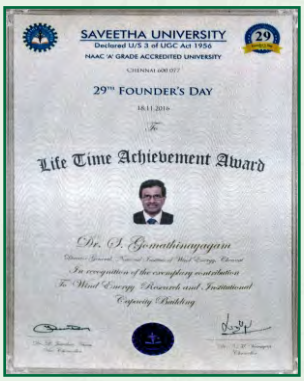
Grid Integration of 75 kWp Solar with 200 kW WEG

Smart Controller for the Integration

Visitors to NIWE

- Mr. Kees, Director, M/s. Hutselflux, Netherland visited on 18th October 2016.
- Dr. Habeck, German Minister & Mr. Fabig, Consulate General of Germany in Chennai alongwith German Delegates visited on 18th October 2016.

Awards



- Dr. S. Gomathinayagam received "Life Time Achievement Award" on Wind Energy Research and Institutional Capacity Building from Saveetha University on 18th November 2016.
- Dr. P. Kanagavel has been conferred "Indian Sustainable Leadership Award" at the India Sustainability Leadership Summit & Awards held on 23rd November 2016 organized by Sustainable Maharashtra at Mumbai.
- Dr. P. Kanagavel has been awarded "Change Agent of the Year 2016" by LIFE Academy, Sweden.

Information, Training and Customized Services

20th National Training Course

Successfully conducted the 5 days 20th National Training Course on "Wind Energy Technology" during 7th to 11th November 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 in a focussed manner. The course was attended by 38 participants from 9 States with diverse background. The course was inaugurated by Dr. Jagmohan Singh Raju, IAS, Chairman and Managing Director, Tamil Nadu Energy Development Agency (TEDA).

Chief Guest delivering Inaugural address

Prof. Sudhindra Nath Panda, Director, National Institute of Technical Teachers Training and Research (NITTTR) was the Chief Guest for the Valedictory Function and distributed the course certificates to all the participants.

Chief Guest distributing the Course certificates

Special Training Course for Officials of Uganda

The Special Training Course on "Wind Resource Assessment and Wind Farm Planning" was successfully conducted by the ITCS unit in association with WRA unit held during 7th to 18th November 2016. This is a special training course for 3 Officials of Ministry of Energy and Mineral Department (MEMD), Uganda. The course provided an invaluable platform for hands on practical training on Introduction to Wind Resource Assessment, Wind Resource Assessment techniques, Site Selection for Wind Monitoring Stations (WMS), Wind Resource Mapping, Installation, Instrumentation and Commissioning of WMS, Met Mast and Modern Measurement Techniques including measurement using remote sensing instruments (SODAR & LiDAR), Data Analytics and Processing, Software tools for Wind data Analysis, Design and Layout, Forecasting and Wind Energy Production.

Participants at Wind Resource Assessment /Mapping Lab

As part of the training study visits to Wind Turbine Test / Research Station located at Kayathar to showcase the 120m met mast and Tenkasi for SODAR instrument used for wind resource assessment were arranged.

Participants with NIWE Officials

The course structure and conduction of the training was highly appreciated by the participants. The participants were very much satisfied by the quality of lectures, practical sessions and hospitality of NIWE and India.

Induction Training for MNRE Scientists

Successfully conducted the Induction Training for 11 newly recruited MNRE scientists held on 7th & 8th October 2016.

Upcoming Trainings

NIWE has scheduled the following National and International Training Courses during the calendar year 2016-17 and the necessary preparation works are on the successful conduct of the courses.

NATIONAL TRAINING COURSE				
S.No.	Description	From	To	Duration
1.	21st National Training Course on "Wind Energy Technology"	20.03.2017	24.03.2017	5 Days
INTERNATIONAL TRAINING COURSES				
1.	19th International Training Course on "Wind Turbine Technology and Applications" for ITEC / SCAAP for Partner Countries	01.02.2017	28.02.2017	28 Days
2.	Special Training Course on "Wind Turbine Technology and Applications" for Africa Countries under AIFS-III	01.02.2017	24.02.2017	24 Days

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.

- "Switch Global Expo" – International Energy Conference at Vodadara, Gujarat during 6th to 10th October 2016.

- IGEP Fair Husum Wind India 2016 at Intersolar India at Mumbai held during 19th to 21st October 2016.

Student Visits

To create awareness and to motivate towards 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 October to December 2016, the following visits were coordinated.

- 17 training participants (teachers) from National Institute of Technical Teachers Training & Research (NITTTR), Taramani, Chennai on 10th November 2016.
- 25 participants (faculty) members from GKM College of Engineering, Perungalathur, Chennai on 2nd December 2016.
- 43 students & 9 staff from Akshaya Matriculation Higher Secondary School, Chennai on 5th December 2016.
- 44 students from Rajiv Gandhi College of Engineering & Research, Nagpur on 21st December 2016.

Students Internship

- Two students from PSG Institute of Technology and Applied Research, Chennai has done their internship at ITCS unit for a period of two weeks from 29th November to 9th December 2016.
- Foreign student training fellowship application has been processed under Research Training Fellowship for Developing Country Scientists (RTF-DCS) for a period of six months. - Ms. Nogoye Diaw from Senegal has joined NIWE for the research work on 15th November 2016.

MoU

MoU has been signed with Government Engineering College, Tirunelveli for academic and research purpose for a period of 3 years.on 09.11.2016.

Engineering Services Division

- The "Digital India" workshop co-ordinated by Ministry of Coal through Video Conferencing hall on 28th November 2016, is a campaign launched by Government of India to ensure that Government services are made available to citizens electronically by improving online.
- The Secretary, MNRE dedicated NIWE to the nation. In this regard, two numbers of Inscription stones have been installed in the month of 4th October 2016, one at front gate and the other one is near the reception.
- As requested by MNRE vide letter dated 06.09.2016, the Energy Audit was required to undertake to reduce energy consumption. The Energy Audit was carried out by M/s NSIC Technical Services Centre, Chennai for seven days.

Inscription in front of NIWE Campus

Zoomed Inscription

Civil Works

- The Landscaping work at front side of the NIWE campus for Gardening work has been initiated.
- The Provision of connecting bridge in between Block -II & III on roof top work has been initiated, enable to visit the Hybrid System installed on roof top.
- The Provision of turbo roof ventilator at canteen to exhaust the hot air without using electrical power has been initiated.
- Purchase indent has been raised for the Laying of Reinforced Cement Concrete (RCC) road at the main entrance of NIWE campus in between security gate to main gate.

General Maintenance Works

- Purchase indent has been raised for the land levelling and edging cement solid block at front side for VIP car parking.

Solar Radiation Resource Assessment

1. Micrositing visits carried out at :
   a. Bikaner and IIT Jodhpur new campus at Karwad for relocation of Mathania and existing IIT Jodhpur SRRA stations.
2. Quality Controlled data of 17 SRRA stations were provided to under SDSAP policy.
3. Calibration of 4 pyranometers and 2 pyrheliometers were carried out under commercial mode and calibration of 9 pyranometers were carried out under SRRA project.

SLDC Meeting -Cochin

Knowledge Sharing Management & Small Wind Hybrid Energy System

Work group facility plays a pivotal role in coordinating with all the units of NIWE for the soft skill sharing though the management of Work Group, internships and thesis project guidance as well as convenor of the Scientific and Technical research activities in NIWE it coordinates in creating a research perspective for the units works.

Technology Think Tank

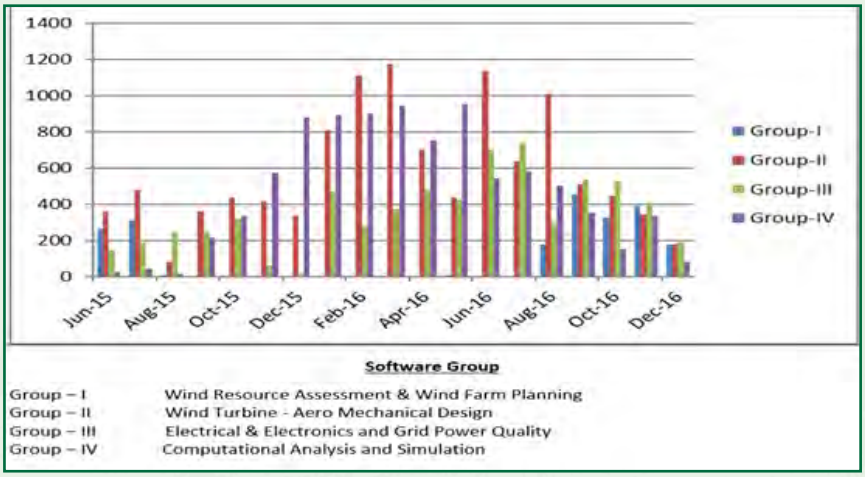
Technology Think Tank (TTT) lecture in progress

Every Thursday comes with a new topic, and expectations of a great gathering for NIWE, presented by a resource person and discoursed by the participants. More than 86 such sessions have been held of the floor at the conference room in NIWE, bringing with it a very vibrant discussion. The following technical presentations were taken up in the last quarter:

S.No.	Date	Dept.	Name	Topic of the Presentation
1	06-10-2016	WRA	Ms. D Vidya & N Sheela rani	E-Waste & Exploding Issues
2	13-10-2016	OW&IB	Ms. A. Ajitha	Facts Devices for Wind Power Plant
3	20-10-2016	WTT	Mr. V. Varadharajan	Wind Energy – Perspective of a Power System Engineer
4	27-10-2016	S&C	Mr. K. Parasaran	Economics of Wind Power Generation
5	03-11-2016	GIZ, GmbH	Mr. Aravindakshan Ramanan	Overview of Green Energy Corridors Project and Renewable Energy Management Centers
6	01-12-2016	ESD	Mr. C. Stephen Jeremias	Internet of Things – an Overview

Work Group – a Soft Skill Platform

There is a group in NIWE which has seen a steady increase in footfall and usage, patronised by all the engineers & scientific staff of NIWE. This active work group operates out of a facility provided in the NIWE premises, established to cross train the institute's personnel in multi-soft skills. This software park provides a bouquet of Industry grade software shared by various operating units of the Institute, in which aspirants sans technology creed come together to share and groom one another in various facets of its



usage for the common goal of achieving the targets set by the government. The foot fall count in the facility is any sign of its increasing contribution to NIWE's capability building and is summarised as follows:

Internship & Projects for Students

More than 60 number of students have passed through Interns and project students this year. Infusing fresh ideas and thoughts in the conventional work block can be achieved only when new bearers of ideas come in. Some of the works of interest are energy storage scenario for WTRS farm, out-of-the-box blade designs to name a few. Students from some of the major universities of Tamil Nadu work with us at NIWE. Also MNRE has approved the provision of stipend for Interns and soon full-fledged advertisements for such positions will be placed in web public domain to attract talents at NIWE.

Small Wind Energy Hybrid System

1. A Site feasibility was carried out at Karungulam location, Tamil Nadu for conducting in situ testing for a new model of grid tied Vertical Axis Wind Turbine. It will be the first of its kind by NIWE in insitu small wind measurements. The testing is proposed to be carried out during the next windy season.
2. NABL accreditation for small wind turbine testing capability is being pursued in its full vigour by the unit. Preparatory works are ongoing.
3. MNRE has sanctioned a 25 kW Research Oriented Grid tied Small Wind Solar Hybrid system to be installed in WTRS research farm at Kayathar. This facility on fully becoming operational will provide valuable insight into gird connected distributed systems of this order and will go a long way in instilling the needed confidence in operating them in the grid and allowing larger penetration of such system. This facility will be in same league as the other facilities of NIWE, like its larger wind turbine and solar hybrid plants at WTRS farm kayathar, dedicated to the nation for open research.

Research and Development Council

The twenty- fourth meeting of the R&D Council of NIWE was organized on 12.09.2016 under the august chair of Shri.S.K.Soonee, Chief Executive Officer (CEO) Power System Operation Corporation Limited. This was the first RC meeting after the reconstitution of the council and two projects were selected for funding.

Site Feasibility carried out at "Karungulam"

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

Dr. S. Gomathinayagam, Director General

- Attended meeting held for the purpose to formulate GIS based Energy Map for India under Chairmanship of Advisor (Energy), Shri A.K.Jain, IAS., Niti Aayog at New Delhi on 4th October 2016.
- Attended Recruitment Rules Committee Meeting held at NIWE, Chennai on 5th October 2016.
- Attended RLMM Meeting at NIWE, Chennai on 14th October 2016.
- Attended Standing Parliamentary Committee meeting at Cochin on 24th October 2016.
- Attended High Level Meeting with Mr. Nagesh Iyer at Hyderabad on 26th & 27th October 2016.
- Attended 66th GC Meeting at TEDA, Chennai on 1stNovember 2016.
- Lecture given in VIT, Chennai on 8th November 2016.
- Participated as Speaker in Panel discussion under Session on Wind Retailing the Leadership position at TN Renewable Energy Conference, Chennai on 10th November 2016.
- Participated in Wind Solar Summit : Session Roadmap – to achieve wind-solar-Hybrid capacity target of 10 GW on 11th November 2016.
- Lecture delivered on Transforming India Technology and Transformation Bill Gates at 2nd IEC in the series NITI, New Delhi on 16th November 2016.
- Town Official Language Implementation Committee Meeting at NIOT on 28th November 2016.
- Participated as Speaker in the Session on "Ushering Green Energy and Renewables" at L&T Auditorium, Chennai conducted by MCCCI on 3rd December 2016.
- NABL-MRM Meeting at NIWE on 6th December 2016.
- Meeting at GIZ, New Delhi-Discussion for proposals under GIZ Line of Credit on Green Energy Corridor & LVRT on 8th December 2016.
- Meeting with Secretary, MNRE-to review the activities of NIWE & its future roadmap on 20th December 2016.

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

- Attended the meeting to obtain Coastal Regulation Zone (CRZ) clearance for Installation of LiDAR in the identified zones at Gulf of Khambhat in Gujarat and Tamil Nadu at Gujarat State Coastal Zone Management Authority (GSCZMA), Ahmedabad on 15th October 2016.
- Attended the meeting of European Union funded offshore project on "Geophysical and Geotechnical Survey and studies with FOWIND, FOWPI (COWI) and EU consultants at MNRE, New Delhi on 29th November 2016.
- Attended the meeting to present and discuss the progress of the LiDAR based offshore wind measurement campaign in Gujarat with Additional Chief Secretary, Energy and Petrochemicals departments, Govt of Gujarat at Gandhinagar, Gujarat on 1st December 2016.

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

- Solar Forecasting meeting on instruction from PSDF, POSOCO with various SLDC members at Kochi on 14th October 2016.
- A meeting of SRRA & GIZ officials and officials of Prathyusha Engineering College, Thiruvallur on calibration activities on 11th November 2016.
- SRRA officials visited Gangtok, Sikkim in connection with dedication of Gangtok SRRA station jointly with GIZ, New Delhi and SREDA, Gangtok and visited Darjeeling, West Bengal in connection with workshop on solar energy during 24th to 29th November 2016.

A. Mohamed Hussain, Deputy Director General & Head, WTRS

Lecture delivered on " Sustainable Energy Systems – Renewable Energy Sources" in National Seminar conducted by Kalasalingam University, Krishnankoil, Virudhunagar District of Tamil Nadu on 6th October 2016.

S.A. Mathew, Director & Head, WTT

Chaired R&D Meeting (Electrical & Electronics Engineering) at Veltech Dr. RR & Dr. SR Technical University, Chennai on opportunity to professors to their innovative research proposals on 16th October 2016.

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

- Participated in the meeting on "Feasibility Study on Wind Farm and ESS" with Korean Delegation team of six officials at NIWE, Chennai on 20th October 2016.
- Attended the Presentation on "Gantner Instruments & Condition monitoring" delivered by officials of M/s. Gantner Instruments GmbH & Gantner India at NIWE, Chennai on 24th November 2016.

- Participated in the review meeting of NIWE Chaired by Secretary, MNRE at MNRE, New Delhi on 21st December 2016.

M. Anvar Ali, Director & Head, ESD

- Attended the IGEP fair to establish and manage NIWE stall in the joint pavilion "Husum Wind India 2016" at Inter solar India at Mumbai on 18th to 22nd October 2016.
- Attended the meeting on "Internal Audit – NABL –ISO/IEC 17025:2005" at WTRS, Kayathar on 18th & 19th November 2016.
- Attended the meeting on "Wind Turbine Condition Monitoring System (CMS) of Gmbh" at NIWE campus, Chennai on 24th November 2016.

J.C. David Solomon, Additional Director & Head - KSM & SWES

Meeting of SNAs from North East states on Small Wind Energy Systems at Shillong on 25th November 2016.

K. Boopathi, Additional Director & Head, WRA

- Attended meeting to formulate GIS based Energy map for India at NITI, New Delhi on 4th October 2016.
- Carried out site visit for R&D study in Idukki District, Kerala on 16th & 17th October 2016.
- Attended Committee Meeting on Wind/Solar Hybrid Policy at MNRE, New Delhi on 20th October 2016.
- Delivered a lecture on Wind Power potential onshore & offshore during sixth Annual Conference on "Wind Power in India" at New Delhi on 22nd November 2016.
- Attended review meeting on the status of implementation of 50m WMS in NE region at Shillong, Meghalaya on 25th November 2016.

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

- Inaugurated and delivered a Key Note Speech in the One day National Conference on Information Literacy on "Bibliotherapy and Webotherapy for Women" on 1st October 2016 held at Soka Ikeda College of Arts and Science for Women, Madhanangkuppam, Chennai.
- Inaugurated the Science Expo "Velocity" 2016 as Chief Guest organized at Kaligi Ranganathan Montford Matriculation Higher Secondary School, Perambur, Chennai on 15th October 2016.
- Participated in the Panel Discussion on "Effectiveness of Green and Renewable Energy in solving Socio Economical Issues" on 19th October 2016 as part of STEMFest 2016 at University of Mysuru held during 17th to 20th October 2016.
- Inaugurated and delivered a lecture in the One Day Workshop for School Teachers on "Solution for Pollution" at Bentinck Girls Hr. Secondary School, Vepery, Chennai on 25th November 2016.
- Delivered a lecture on "Energy, Environment, Renewable and Wind Energy Overview" in the Faculty Development Programme at GKM College of Engg. & Tech., Perungalathur, Chennai on 28th November 2016.
- Delivered a lecture on "Wind Energy Technology: an Overview" at "The Indian Public School", Perungudi, Chennai on 30th November 2016.
- Delivered a lecture on "Wind Turbine Technology and Applications" in the two day National Workshop on "Emerging Technologies using Renewable Energy Sources" organised at Kingston Engineering College, Vellore on 16th December 2016.

A. Hari Baskaran, Deputy Director, KSM & SWES

- Inspected axis Vertical Wind Turbine manufactured by Mr. Vedmithani at Ahmedabad on 5th October 2016.
- Visited Shillong to discuss with the Director, MNREDA in connection with the workshop on Small wind hybrid system to be held at Shillong during 18th to 20th October 2016.
- Attended review meeting on the status of implementation of 50m WMS in NE region at Shillong, Meghalaya on 25th November 2016.

Deepa Kurup, Deputy Director, KSM & SWES

Meeting of SNAs from North East states on Small Wind Energy Systems at Shillong on 25th November 2016.

A.G. Rangaraj, Assistant Director (Technical), WRA

- Attended meeting on Wind Power Forecasting services with IWPA, CE/NCES & field officials on various meter related issues at Nagercoil during 10th to 12th November 2016.
- Attended closed half day round table consultation on Wind Energy sector to brainstorm on key issues to achieve 60,000 MW target for wind energy by 2022 at Hyderabad on 16th November 2016.

J. Bastin, Assistant Director (Technical), WRA

Attended 1st ESRI India Regional User Conference 2016 (RUC) and Exhibition at Hyderabad on 4th August 2016.

G.Arivukkodi, Assistant Engineer, WRA

Attended training on Modeling and Forecasting Techniques organized by NCMRWF at Noida during 3rd to 7th October 2016.

B. Krishnan, Assistant Engineer, WRA

- Carried out site visit for R&D study in Idukki District, Kerala on 16th & 17th October 2016.

Prasun Kumar Das, Assistant Director (Technical) Contract

- Lecture delivered on "Solar Radiation Resource" for NTPC officers at GERMI, Ahmedabad on 21st November 2016.

R. Karthik, Assistant Director (Technical) Contract

Presentation on SRRA activities to the students and staff members of Prathyusha Engineering College, Thiruvallur on 16th November 2016.

R. Sasikumar, Consultant

Presentation on "SRRA in the induction training for the MNRE, Scientists on 7th October 2016.

International Energy Conference 2016

Dr. S. Gomathinayagam, J.C. David Solomon, M. Anvar Ali and A. Hari Bhaskaran have attended "International Energy Conference" (Switch Global Expo) Organized by MNRE & Government of Gujarat at Vadodara, Gujarat on 5th to 10th October 2016.

Internal Audit

M. Saravanan & S. Paramasivan attended the Internal Audit ISO/IEC 17025:2005 at WTTS, Kayathar on 18th November 2016 and at NIWE, Chennai on 21st November 2016.

Eleventh Management Review Meeting

S.A. Mathew, M.Saravanan, Bhukya Ramdas & S. Paramasivan attended the Eleventh Management Review Meeting for ISO/IEC 17025:2005 at NIWE, Chennai on 7th December 2016.

Structural Engineering Convention – 2016 (21st - 23rd December 2016)

Dr. S. Gomathinayagam, Dr. Rajesh Katyal, Dr. G. Giridhar, S.A. Mathew, A. Senthilkumar, N. Rajkumar, Mohamad Hussain & J.C. David Solomon have attended "Structural Engineering Convention – 2016" organized by CSIR – Structural Engineering Research Centre jointly with IIT Madras & Anna University, Chennai under the auspices of Indian Association for Structural Engineering (IASE) & Indian Concrete Institute (ICI) held at CSIR-SERC, Chennai. Dr. S. Gomathinayagam delivered a keynote lecture. Also chaired a technical session on "Mitigation of Structures against Natural Hazards" on 23rd December 2016.

Abroad Visit

- **K. Boopathi**, Unit Head & **B. Krishnan**, AE attended WindSim User Meet 2016 and visited Mingyang China Power Company, Beijing, China during 23rd to 28th October 2016.
- **Dr. P. Kanagavel** has participated and presented a paper "Wind Energy Growth in India - An Overview" in the "15th World Wind Energy Conference and Exhibition (WWEC 2016) held at Tokyo University, Tokyo during 31st October to 2nd November 2016.
- **Dr. G. Giridhar** attended "Renewable Energy & Efficiency Week 2016-Expert Workshop and Energy Transition day" from 31st October to 4th November 2016 at Berlin, Germany organized by GIZ, New Delhi.

Publications

Dr. S. Gomathinayagam, Interview for Renewable Watch's Anniversary Issue, November 2016.

The following NIWE staff delivered lecture(s) in the 20th National Training Course on "Wind Energy Technology" held during 7rh to 11th November 2016

S.No.	Topic	Speaker
1	Introduction and Status of Wind Energy Technology	Dr. S. Gomathinayagam
	Wind Turbine Tower concepts	
2	Certification of Wind Turbine	Shri. A. Senthilkumar
3	Wind Measurement and Instrumentation	Shri. K. Boopathi
	Wind Resources Assessment & Techniques	
	Forecasting of Wind and Energy Production	
4	Design and Layout of Wind farms	Shri. J. Bastin
5	Wind Turbine Components	Shri. J. C. David Solomon
6	Wind Turbine Gearbox	Shri. N. Raj Kumar
7	Wind Electric Generators & Types	Shri. M. Anvar Ali
8	Control and Safety System of Wind Turbine System	Shri. S. Arulselvan
9	Wind Turbine Foundation	Dr. Rajesh Katyal
	Small Wind Turbines and Hybrid Systems	
10	Indian Wind Energy Development & Role of NIWE	Dr. P. Kanagavel
11	Grid Integration of Wind Turbines	Smt. Deepa Kurup
12	Wind Turbine Testing & Measurement Techniques	Shri. S. A. Mathew
13	Offshore Wind Energy : An overview	Shri. M. Joel Franklin Asaria

The following NIWE staff delivered lecture(s) in the Special Training Course on "Wind Resource Assessment and Wind Farm Planning" held during 7th to 18th November 2016

S.No.	Topic	Speaker
1	Guidelines for WRA	Shri. K. Boopathi
	Wind Resource Assessment and Techniques	
	Wind Measurements by Remote Sensing Instruments	
2	Site Selection for Wind Monitoring Stations (WMS)	Shri. B. Krishnan
3	Introduction to Wind Technology and WRA program	Dr. S. Gomathinayagam
4	Installation of WMS	Shri Suresh & Shri. R. Vinod Kumar
5	Measurement of wind parameters	Shri. B. Krishnan
	Indian Wind Atlas An Overview	Shri. J. Bastin
6	Wind Analysis - Data collection, Validation, Processing and Reporting	Smt. G. Arivukkodi
7	Forecasting of Wind and Energy Production	Shri. K. Boopathi & Shri.A. G. Rangaraj
8	Software tools for Wind data Analysis	Shri. B. Krishnan

The following NIWE staff delivered lecture(s) in the Two days Induction Training for MNRE newly recruited Scientists "B" held on 7th & 8th October 2016

S.No.	Topic	Speaker
1	Wind Energy Growth in India & Role of NIWE	Shri. M. Joel Franklin Asaria
2	Introduction and Status of Wind Energy Technology	Dr. S. Gomathinayagam
3	Wind Resource Assessment and Techniques	Shri K. Boopathi
4	Wind Turbine Testing & Measurement Techniques	Shri S.A. Mathew
5	Wind Turbine Certification & Standards	Shri A. Senthil Kumar
6	Solar Radiation Recourse Assessment	Dr. G. Giridhar

Training / Conferences / Seminars attended by NIWE Officials

Dr. S. Gomathinayagam, Director General

- Attended National Workshop on Testing Standardisation & Certification for RE Sector at Vigyan Bhawan, New Delhi on 22nd December 2016.

K. Boopathi, Additional Director & Head, WRA

- Attended training on Modeling and Forecasting Techniques organized by NCMRWF at Noida during 3rd to 6th October 2016.
- Attended Management Development Programme on "Financing Renewable Energy Projects" organized by TERI University at New Delhi on 9th December 2016.

A.G. Rangaraj, Assistant Director (Technical), WRA

- Attended training on Modeling and Forecasting Techniques organized by NCMRWF at Noida during 3rd to 7th October 2016.

J. Bastin, Assistant Director (Technical), WRA

- Attended the Tamil Nadu Renewable Energy Integration International Conference at Chennai on 22nd & 23rd September 2016.

S.A. Mathew, Director & Head, WTT

- Attended the One Day Management Development Programme on "Financing Renewable Energy Projects" organized by Tata Energy Research Institute (TERI) at TERI University, Delhi on 9th December 2016.
- Attended the National Training Seminar on "Adaptation of Thermal Power Plants to Fluctuating Renewable Energies" by Indo-German Energy Forum at Hyatt Regency, New Delhi on 16th December 2016.

Wind Turbine Testing

- S.A. Mathew & Bhukya Ramdas attended the training on "A Guide to Wind Farm Performance" by M/s. DNVGL at Bangalore on 7th & 8th November, 2016.
- Testing Unit staff attended the training on "First Aid" both theoretical and practical provided by M/s. Safecorp Safety Services LLP at WTTS, Kayathar on 15th November 2016.
- Testing Unit staff attended the training on "Working at Heights both theoretical and practical provided by M/s. Safecorp Safety Services LLP at WTTS, Kayathar on 16th & 17th November 2016.
- S. Paramasivan attended the Windsim Software Training on "New Features of Windsim-8 Software" by Mr. Arne R. Gravdahi, Ph.D, CTO & Founder, M/s. Windsim, Norway NIWE, Chennai on 8th December 2016.

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

Participated in the two days training programme for Technical Committee Members on 15th & 16th December 2016 organized by BIS at National Institute for Training for Standardization (NITS), Noida.

N. Rajkumar, Deputy Director (Technical), S&C

- Attended the Presentation on "ABB PowerStoreTM and its capabilities" delivered by Mr. Abilash E.T. Nair, ABB India Ltd, Bangalore at NIWE, Chennai on 16th November 2016.
- Participated in WebEx on "New Features of Windsim-8 Software" delivered by Mr. Arne R.Gravdahi, Ph.D CTO & Founder, M/s. Windsim, Norway at NIWE, Chennai on 8th December 2016.

S.Arulselvan, Assistant Engineer, S&C

Attended the Presentation on "Gantner Instruments & Condition monitoring" delivered by officials of M/s. Gantner Instruments GmbH & Gantner India at NIWE, Chennai on 24th November 2016.

Knowledge Sharing Mangement & Small Wind Hybrid Energy System

- **Training on MI –POWER, Power System Analysis Software :** The unit staff underwent a two- day exhaustive industrial training cum hands on at PRDC., Bangalore on 23rd & 24th November 2016.
- The unit engineers attended the conference conducted by CII and they picked up a lot of value from the discussions to why they were exposed to at the forum.

A. Hari Baskaran, Deputy Director, KSM & SWES

Attended "Global Initiative for Academic Networks (GIAN)" on Fuel Cell Technology training" at IIT Gandhinagar, Gujarat during 5th to 9th December 2016.

R. Naveen Muthu, Junior Engineer, KSM & SWES

Attended one-day conference on 'Tamil Nadu Renewable Energy" organised by TEDA and CII, Chennai on 10th November 2016.

Prasun Kumar Das, Assistant Director (Technical) Contract

Attended the meeting on "Future Strategy of Providing Forecasting to Energy Sector" organised by IITM, Pune on 24th October 2016.

Advance Excel & Power Point software training

All staff attended Advance Excel & Power Point software training conducted by Excel Prodigy Training and Consultancy Private Limited at NIWE, Chennai during 13th to 15th October 2016.

Digital Payment Workshop

All staff attended Digital Payment Workshop-Video Conferencing at NIWE on 28th November 2016.

On-line Solar Energy Training

All staff attended Launching of On-line Solar Energy Training Program under PPP mode & workshop on "Utilization of Solar-Wind Energy for Specific Institutions-by I-Acharya on 13th December 2016.

Online Training Program

All staff attended the program on launching of online training program for "Solar Photovoltaic Design and Installation" and workshop on "Utilization of Solar – Wind Energy for Specific Institutions" held at NIWE, Chennai on 13th December 2016.

POWER QUALITY CHARACTERISTICS OF WIND FARMS

Dr. P Somasundaram, Assistant Professor, Department of EEE, Power System Engineering, Anna University, mpsomasundaram@annauniv.edu

Introduction

The consumption of electricity keeps growing on a worldwide basis, while most countries have set targets to reduce the emission of carbon dioxide or other air, water or soil pollution, which are caused by conventional fossilfuel's combustion, in order to stop the Earth from warming up further. The widely accepted opinion is that these targets can only be met on one hand by energy-saving incentives and on the other hand by the large scale application of renewable energy.

The wind power generation is considered as promising alternative from the aspect of the potential economy in the area with appropriate wind speed. Whereas, because of the wind power generation has its own characteristics which are different from the existing generating unit such as the fluctuation nature of the wind and the comparatively new types of its generators, connection of wind generators to power system could lead to many disturbances, such as: voltage fluctuations, flickers, harmonics, instability, blind power regulation problems, and transients. These challenges regarding the network integration of wind power mainly consists of keeping an acceptable voltage level, and the power balance of the system. Power quality issues connected with wind generation are not only important because of technical aspects, they are also vital on the free energy market.

The currently existing power quality standard for wind turbines, issued by the International Electrotechnical Commission (IEC), IEC61400-2l, defined the parameters that are characteristic of the Wind Turbine (WT) behaviour in terms of the quality of power, and also provides recommendations to carry out measurements and assess the power quality characteristics of grid connected Wts. Although the standard mainly describes measurement methods for characterizing single wind turbines, there are methodologies and models developed that enable, for well pre-defined conditions, to extrapolate the single turbine unit parameters to the typical quality characteristics of wind farms.

Power Quality

Introduction: What do we mean by 'power quality'? A perfect power supply would be one that is always available, always within voltage and frequency tolerances, and has a pure noise-free sinusoidal wave shape. Just how much deviation from perfection can be tolerated depends on the user's application, the type of equipment installed and his view of his requirements. Table I assembles power quality defects, which are the deviations from perfection, fall into five categories and their main possible causes.

Table I - Power Quality Defects and their main possible cause

Type	Power quality defects	Main possible cause
1	Harmonic distortion	Arising within the customer's own installation and may or may not propagate onto the network
2	Blackouts	Caused by the supplier but can also by the failure of on-site equipment, conductors and connections
3	Under or over voltage	Caused by fluctuation of the supply voltage, typically due to the use of large fluctuating loads (flicker)
4	Dips (or sags)	The responsibility of the supplier and surges due to harmonic current
5	Transients	Switching or lightning strikes on the network and switching of reactive loads on the consumer's site or on the same circuit

From Table I, we can realize the real question concerned of power quality is compatibility between the equipment and the supply. Consequently, ensuring good power quality requires good initial design, effective correction equipment, co-operation with the supplier, frequent monitoring and good maintenance. In other words, it requires a holistic approach and a good understanding of the principles and practice of power quality improvement. Especially, for wind turbine generator systems, there are some international standard available that characterizing the power quality of a grid connected wind turbine. The categories and characteristics of power system electromagnetic phenomena are given in Table II.

Table II - Categories and Characteristics of Power System Electromagnetic Phenomena

Categories	Typical characteristics
Overvoltage transients:	
Impulsive	Nanosecond : 5 ns riste time for < 50 ns Microsecond: 1us riste time for 50ns-1 ms Millisecond: 0.1 ms rise time for > 1 ms
Oscillatory	Low freq.: <5kHz for 0.3-50ms at 0-4 pu Me freq.: 5-500kHz for 20μs at 0-8 pu High freq.: 0.5-5MHz for 5 μs at 0-4 pu
Short duration voltage variations:	
Interruption	Momentary: <0.1 pu for 0.5 cycles - 3 s Temporary: <0.1 pu for 3 s - 1 min
Sag	Instantaneous: 0.1-0.9 pu for 0.5-30 cycles Momentary: 0.1-0.9 pu for 30 cycles - 3 s Temporary: 0.1-0.9 pu for 3 s - 1 min
Swell	Instantaneous: 1.1-1.8 pu for 0.5-30 cycles Momentary: 1.1-1.4 pu for 30 cycles - 3 s Temporary: 1.1-1.2 pu for 3 s - 1 min
Long duration voltage variations:	
Interruption Undervoltages Overvoltages	Sustained: 0.0. pu for > 1 min 0.8 - 0.9 pu for > 1 min 1.1 - 1.2 pu for > 1 min
Voltage waveform distortions:	
DC offset Harmonics Interharmonics Notching	0-0.1% 0-100th H with 0-20% magnitude 0-6 kHz with 0-2% magnitude
Voltage fluctuations:	
Intermittent	<25 Hz with 0.1-7% magnitude

Recently, several Transmission System Operators (TSOs) have developed grid codes for wind turbines and/or wind farms. These generally resemble requirements to wind farms that are very similar to those of any other power stations. The new requirements were challenging for the wind turbine industry, but it responded as requested by the TSOs. The largest problem seems to be the fact that the grid codes were issued to respond to national and regional grid characteristics that, by their intrinsic nature, are typically non-general and local-dependent thus prevent from a normalized standard approach. Some of the existing power quality standard for wind turbines, issued by the International Electrotechnical Commission (IEC) are given in the Table III.

Table III - IEC Standards

- IEC 61400 - 1 Design requirements
- IEC 61400 - 2 Small wind turbines
- IEC 61400 - 3 Design requirements for offshore wind turbines
- IEC 61400 - 4 Gears for wind turbines
- IEC 61400 - (5) Wind Turbine Rotor Blades
- IEC 61400 - 11, Acoustic noise measurement techniques
- IEC 61400 - 12-1 Power performance measurements
- IEC 61400 - 13 Measurement of mechanical loads
- IEC 61400 - 14 Declaration of sound power level and tonality
- IEC 61400 - 21 Measurement of power quality characteristics
- IEC 61400 - 22 Conformity Testing and Certification of wind turbines
- IEC 61400 - 23 TR Full scale structural blade testing
- IEC 61400 - 24 TR Lightning protection
- IEC 61400 - 25 - (1-6) Communication
- IEC 61400 - 26 TS Availability
- IEC 61400 - 27 Electrical simulation models for wind power generation
- IEC 60076 -16: Transformers for wind turbine applications

Critical Power Quality Issues

This section states the critical power quality issues related to integration of wind farms in weak grids. The

field study has identified the following issues to characterise the power quality:

a) Grid availability and capacity
b) Reactive power
c) Voltage unbalance
d) Voltage ranges
e) Frequency range
f) Harmonics and interharmonics
g) Voltage fluctuations
h) Injection of Fluctuating power

Of these, reactive power is at present the most important parameter for the electricity boards, while grid availability, frequency range, voltage un-balance and voltage range are the primary parameters influencing the wind turbine operation.

a. Grid availability and capacity

The wind farm development has been very intensive in the early nineties. The electricity boards were not capable to followup on that development with the required grid reinforcements. The major weakness has been the evacuation capacity. As a consequence of insufficient evacuation capacity, the wind farms have regularly been disconnected from the grid during the high wind seasons. Outages due to insufficient evacuation capacity have occurred. Also the capacity of the substations has influenced the grid availability in the wind farms. The wind farm feeders have been disconnected regularly in the high wind season due to insufficient substation transformer capacity.

b. Reactive power compensation

The majority of wind turbines are converting the mechanical power to electricity through directly connected induction generators. These induction generators require reactive power from the grid for excitation. The loads on the power systems also consume a significant reactive power, mainly due to agricultural pumps. The resulting reactive power demand causes losses in the transmission. The reactive power consumption results in so poor a power factor, that it reduces the capacity of the power stations. This is a critical issue, because the available power station capacity is insufficient to supply the peak demand. Finally, excessive reactive power consumption can be critical for the stability of the power system.

c. Voltage unbalance

Single wind turbines or smaller groups of wind turbines have been connected to existing rural load feeders in some areas. The electricity boards practice load shedding on individual phases during peak load periods. The load shedding causes significant voltage unbalance, with tripping of the wind turbines as a result.

d. Voltage ranges

According to the electricity board, the variations in the steady state voltage is in the range from + 5% to –15% at the wind turbine terminals in the wind farms. Too low voltages can cause the relay protections to trip the wind turbines. The steady state voltage also influences the losses in the induction generators. For low voltages, the no-load losses decrease slightly due to reduced iron losses, whereas the full-load losses (i.e. losses at rated power) increase due to increased currents in the generator windings.

e. Frequency range

According to electricity boards and manufacturers, the grid frequency can vary from 47 to 51.5 Hz. Most of the time, the frequency is below the rated 50 Hz. For wind turbines with induction generators directly connected to the grid, the rotor speed and thus the aerodynamic performance of the wind turbine will be modified by the frequency. The variation in frequency affects the power generation in a WEG to a large extent, by affecting the aerodynamic efficiency. Frequency variations lead to operation at non-optimal tip speed ratios and reduced aerodynamic efficiencies. These leads to reduced energy capture and power output of wind turbines. Typical aerodynamic efficiency of a 3 blade WTG is shown in the below figure.

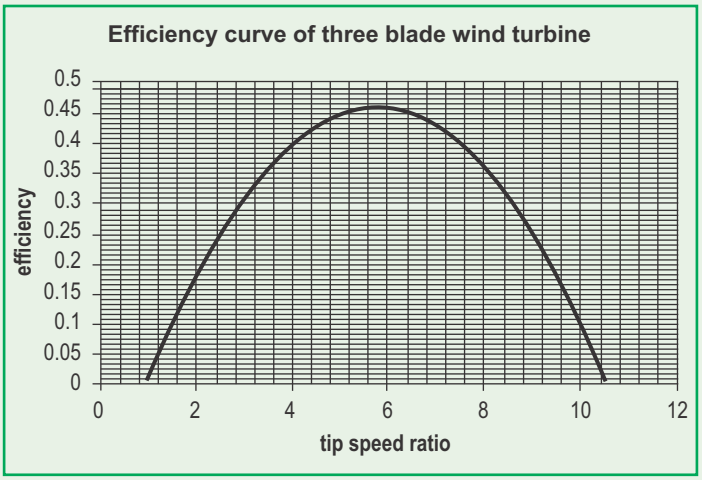
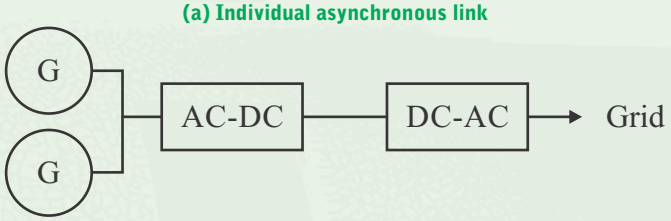


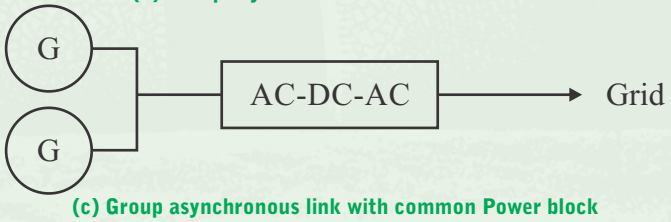
Fig. 1 TSR

Also at low frequencies the VAR output of power factor correction capacitor reduces and the flux in transformer increases thus pushing them near saturation and these results in increased VAR consumption and increased losses (and reduced generation). The above problem can be alleviated by interfacing the individual WEG to grid using an asynchronous link (AC-DC-AC link) as shown in the below figures.

(a) Individual asynchronous link



(b) Group asynchronous link with DC cable



(c) Group asynchronous link with common Power block

f. Harmonics and interharmonics

The emission of harmonic and interharmonic currents from wind turbines with directly connected induction generators has been expected to be negligible in service. Wind turbines connected to the grid through power converters however emit harmonic and / or interharmonic currents and contribute to the voltage distortion. Inverters based on new technologies have a limited emission of harmonics at lower frequencies compared to the converters used in the first generation of variable speed wind turbines. Instead they produce interharmonics at higher frequencies which are easier to filter than at lower frequencies.

g. Voltage fluctuations

Fluctuations in the voltage supplied to consumers may, depending on the frequency and the amplitude of the fluctuations, cause public annoyance due to flicker in the illumination from lamps. The power from wind turbines is fluctuating, and therefore the wind turbines contribute to the voltage fluctuations in the grid. Fluctuations in the voltage may in extreme conditions trig a voltage collapse, as a voltage drop causes increased reactive power consumption, which feeds back as an increased voltage drop.

h. Injection of Fluctuating power

Power (energy) in wind by nature is not steady and is characterized by annual, monthly, daily and hourly variations. This results in generation and injection of a power (current) that is fluctuating. Solutions for this include connection of a large number of WEG's at the point of common coupling or to configure the WEG's as an integrated energy system for operation in conjunction with other renewable energy sources, conventional energy sources and / or storage elements.

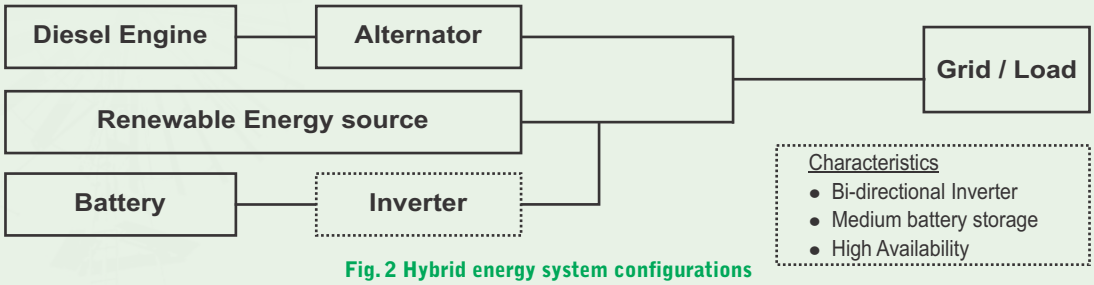


Fig. 2 Hybrid energy system configurations

Conclusions

An overview of the various aspects of Power Quality that may be of relevance for grid-connected wind turbines were analyzed. The power variability and consequently flicker emission increases with turbulence increase. While developing wind farms an integrated / holistic approach must be taken to incorporate power conditioning devices to avoid power quality issues in grid interfacing of wind electric generators. To facilitate improving power quality and operational efficiency of wind farms standards and guidelines must be framed for power quality norms for grid interfacing of wind farms. Strict compliance must be enforced from either side to ensure power quality. Tariff structures must be developed to provide incentives for improving power quality and penalize those polluting the system.

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